CENTRE OF PLANNING AND ECONOMIC RESEARCH (KEPE)

Studies **87**

EKATERINI TSOUMA
FOTINI ECONOMOU
ALEXANDRA KONTOLAIMOU
GEORGIA SKINTZI

VALUE ADDED TAX REVENUE BUOYANCY AND ELASTICITY IN GREECE

ATHENS 2025

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Ekaterini Tsouma
Senior Research Fellow, KEPE, Coordinator

Fotini Economou
Senior Research Fellow, KEPE

Alexandra Kontolaimou
Senior Research Fellow, KEPE

Georgia Skintzi
Senior Research Fellow, KEPE

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CENTRE OF PLANNING AND ECONOMIC RESEARCH (KEPE)

The Centre was initially established as a research unit, under the title "Centre of Economic Research", in 1959. Its primary aims were the scientific study of the problems of the Greek economy, the encouragement of economic research and cooperation with other scientific institutions.

In 1964, the Centre acquired its present name and organizational structure, with the following additional objectives: first, the preparation of short, medium and long-term development plans, including plans for local and regional development as well as public investment plans, in accordance with guidelines laid down by the Government; second, the analysis of current developments in the Greek economy along with appropriate short and medium-term forecasts, the formulation of proposals for stabilization and development policies; and, third, the additional education of young economists, particularly in the fields of planning and economic development.

Today, KEPE is the largest economics research institute in Greece, focuses on applied research projects concerning the Greek economy and provides technical advice to the Greek government and the country's regional authorities on economic and social policy issues.

In the context of these activities, KEPE has issued more than 700 publications since its inception, and currently produces several series of publications, notably the Studies, *which are research monographs;* Reports *on applied economic issues concerning sectoral and regional problems;* Discussion Papers *that relate to ongoing research projects.* KEPE also publishes a tri-annual *review entitled* Greek Economic Outlook, *which focuses on issues of current economic interest for Greece.*

PREFACE

Long-persisting challenges in terms of fiscal aggregates, alongside recent developments in the public budget associated with the COVID-19 pandemic, underline the importance of investigating the response of tax revenues to prevailing economic conditions and implemented discretionary tax measures in Greece. Revenue response information of this kind is essential for effective tax revenue management, as well as for monitoring and forecasting Greek governments' public revenues, which is a prerequisite for the implementation of accurate tax measures and the conduction of sustainable fiscal policy in the country. Related knowledge should be detailed and obtained at a disaggregated level, at least, for the major tax categories, with the aim to enhance the associated benefits in terms of accuracy and adequacy.

The present Study focuses on the Value Added Tax (VAT), given the significance of the related revenues, upon which governments have come to heavily rely during times of favourable economic conditions as well as during episodes of severe crises and extraordinary disturbances. The fundamental research idea underlying the present Study is to provide an inclusive analytical framework for systematically studying the response of VAT revenues to changes in macroeconomic aggregates and implemented policy measures in Greece, i.e., for a comprehensive analysis of VAT revenue buoyancy and elasticity in the country. To this end, key conceptual and theoretical aspects are analyzed, associated institutional and legislative dimensions are explored, and sophisticated methodological and technical applications are carried out. The basic analytical framework is complemented with an extended review of the related literature and an investigation of selected specific VAT-related issues. The provision of a cohesive and wide-ranging analysis is expected to assist fiscal authorities seeking a more integrated VAT policy.

The obtained particularly rich and robust findings, which are consistent with economic rationales, strengthen the methodological choices made *and the overall analytical framework adopted for the purposes of the Study. The synthesis of all the novel and contributive elements is conducive to better interpreting the obtained results and to drawing sound conclusions with major implications. The latter justify the formulation of several recommendations for policy and associated research conduction in the future.*

PANAGIOTIS G. LIARGOVAS
Chairman of the Board
and Scientific Director

CENTRE OF PLANNING AND
ECONOMIC RESEARCH
May 2025

The aim of the present Study is to provide scholars and fiscal authorities with an inclusive framework for a thorough analysis of the response of VAT revenues to changes in macroeconomic aggregates and implemented policy measures in Greece, i.e., for a comprehensive analysis of VAT revenue buoyancy and elasticity in the country. The analysis is enriched by the investigation of selected VAT-related issues. By synthesizing a wide range of conceptual, theoretical, institutional/legislative, and methodological/technical dimensions, the Study can be considered to constitute a handbook on VAT revenue response, which could be particularly helpful in several settings and contexts for research, academic, and policy purposes. Furthermore, it can be considered to constitute a unique, comprehensive, and multifaceted study for the case of Greece.

The writing of the main body of the Study was completed in February 2024. We thank the anonymous internal referee. We are also thankful to the two anonymous external reviewers, whose useful and constructive comments and suggestions helped to improve and enrich the content of the Study. We acknowledge the assistance of the General Accounting Office of the State in providing statistical data. We appreciate the valuable work of Ms. H. Soultanakis and Ms. N. Spanoudis for editing the text and Ms. C. Loulouda who was responsible for setting up the printed form of the Study. Finally, we thank Ms. E. Toulitsi for overseeing the publication procedures of the Study.

The authors bear sole responsibility for any errors or omissions.

EKATERINI TSOUMA (Coordinator)
FOTINI ECONOMOU
ALEXANDRA KONTOLAIMOU
GEORGIA SKINTZI

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ΣΥΝΟΨΗ

Ο ρόλος των φορολογικών εσόδων στην εξασφάλιση της παροχής δημόσιων αγαθών και υπηρεσιών και, γενικότερα, στη χρηματοδότηση των κρατικών δραστηριοτήτων έχει αναγνωριστεί και τονιστεί διαχρονικά, τόσο σε θεωρητικούς όσο και πρακτικούς όρους. Είναι προφανές ότι οι εξελίξεις στα φορολογικά έσοδα, σε συνδυασμό με τις αποφάσεις πολιτικής που αφορούν τις δημόσιες δαπάνες, συνδέονται άρρηκτα με την πορεία των δημοσιονομικών ελλειμμάτων και, κατά συνέπεια, του δημόσιου χρέους. Δεδομένων των μακροχρόνιων προκλήσεων που σχετίζονται με τα δημοσιονομικά μεγέθη στην Ελλάδα, καθώς και των πρόσφατων εξελίξεων στον δημόσιο προϋπολογισμό ως απόρροια της πανδημίας COVID-19, η μελέτη της απόκρισης των φορολογικών εσόδων στις επικρατούσες οικονομικές συνθήκες και στα εφαρμοζόμενα διακριτικά φορολογικά μέτρα αποτελεί βασικό στοιχείο της φορολογικής πολιτικής και, αναμφίβολα, θέμα ύψιστης σημασίας για τη χώρα.

Οι ακαδημαϊκοί, οι ερευνητές και, ειδικά, οι υπεύθυνοι χάραξης πολιτικής έχουν παραδοσιακά ασχοληθεί με την ανάλυση των σχέσεων απόκρισης των φορολογικών εσόδων, κυρίως μέσω των εννοιών της τάσης μεταβολής (buoyancy) των φορολογικών εσόδων (*συνολική* απόκριση των εσόδων, περιλαμβανομένων των επιδράσεων των μεταβολών της διακριτικής φορολογικής πολιτικής) και της ελαστικότητας (elasticity) των φορολογικών εσόδων (*αυτόματη* ή *ενδογενής* απόκριση των εσόδων, εξαιρουμένων των διακριτικών φορολογικών μέτρων), λόγω της συσχέτισής τους με κρίσιμες πτυχές της θεωρίας, της πολιτικής και της πρακτικής εφαρμογής. Με την πάροδο του χρόνου, ενδελεχής έρευνα έχει καταλήξει στο συμπέρασμα ότι όσο μεγαλύτερη είναι η έμφαση στα επιμέρους, αντί για τα συνολικά, φορολογικά έσοδα και, ειδικότερα, στα έσοδα από τις κύριες φορολογικές κατηγορίες, τόσο μεγαλύτερο είναι το όφελος σε όρους ακρίβειας και επάρκειας. Από ένα τέτοιο συμπέρασμα συνάγεται ξεκάθαρα ότι, για βασικά εργαλεία φορολογικής πολιτικής όπως ο Φόρος Προστιθέμενης Αξίας (ΦΠΑ), στον οποίο οι κυβερνή-

σεις έχουν στηριχθεί σημαντικά τόσο σε περιόδους ευνοϊκών οικονομικών συνθηκών όσο και σε περιπτώσεις σοβαρών κρίσεων και εξαιρετικών διαταραχών, το ζήτημα της τάσης μεταβολής και της ελαστικότητας των εσόδων πρέπει να κατέχει εξέχουσα θέση στην ερευνητική ατζέντα των ακαδημαϊκών και των υπευθύνων χάραξης πολιτικής.

Βάσει των ανωτέρω θεωρήσεων, η θεμελιώδης ερευνητική ιδέα που διέπει την παρούσα Μελέτη είναι η παροχή ενός ολοκληρωμένου πλαισίου σε μελετητές και δημοσιονομικές αρχές για την ενδελεχή ανάλυση της απόκρισης των εσόδων από τον ΦΠΑ στις μεταβολές των μακροοικονομικών μεγεθών και των εφαρμοζόμενων μέτρων πολιτικής στην Ελλάδα, δηλαδή για μια ολοκληρωμένη ανάλυση της τάσης μεταβολής και της ελαστικότητας των εσόδων από τον ΦΠΑ στη χώρα. Η παρεχόμενη περιεκτική ερευνητική δομή εξελίσσεται γύρω από τη διεξαγωγή μιας σειράς οικονομετρικών εκτιμήσεων της τάσης μεταβολής και της ελαστικότητας των εσόδων από τον ΦΠΑ, οι οποίες υποστηρίζονται και ενισχύονται από την εις βάθος ανάλυση ορισμένων συνδεόμενων πτυχών, με τα επακόλουθα συμπεράσματα και τις απορρέουσες υποδείξεις να είναι παραπάνω από ουσιώδεις για τη σωστή κατανόηση και ερμηνεία των εμπειρικών ευρημάτων.

Οι αποκτηθείσες, ιδιαίτερα εκτενείς και αξιόπιστες εκτιμήσεις της τάσης μεταβολής και της ελαστικότητας των εσόδων από τον ΦΠΑ για την Ελλάδα, οι οποίες είναι συνεπείς με τις οικονομικές αρχές, υποστηρίζουν τις μεθοδολογικές επιλογές που πραγματοποιήθηκαν και το συνολικό αναλυτικό πλαίσιο που υιοθετήθηκε για τους σκοπούς της παρούσας Μελέτης και οδηγούν σε καίρια συμπεράσματα με σημαντικές συνέπειες για τη διαμόρφωση πολιτικής.

Πιο συγκεκριμένα, τα εμπειρικά αποτελέσματα των μακροχρόνιων εκτιμήσεων για το σύνολο της εξεταζόμενης περιόδου, σε συνδυασμό με τα ευρήματα από την ανάλυση σταθερότητας για όλες τις αντίστοιχες υποπεριόδους, καταδεικνύουν, πρώτον, μια λιγότερο από αναλογική συνολική και ενδογενή απόκριση των εσόδων από τον ΦΠΑ στις μεταβολές του Ακαθάριστου Εγχώριου Προϊόντος (ΑΕΠ) (μέσω τόσο της μεθόδου απευθείας εκτίμησης όσο και της μεθόδου εκτίμησης σε δύο σκέλη). Δεύτερον, παρέχουν ενδείξεις για μια αναλογική συνολική και ενδογενή σχέση απόκρισης των εσόδων από τον ΦΠΑ στις μεταβολές της φορολογικής βάσης (δηλαδή της ιδιωτικής κατανάλωσης). Τρίτον, υποδηλώνουν μια ουδέτερη επίδραση των εξεταζόμενων διακριτικών φορολογικών μέτρων στα έσοδα από τον ΦΠΑ, δηλαδή των αυξήσεων των κανονικών και μειωμένων συντελεστών κατά την υπό εξέταση περίοδο. Συνεπώς:

- Η υπόθεση της μοναδιαίας τιμής της απόκρισης (και, κατ' επέκταση, η υπόθεση της αναλογικότητας) δεν θα πρέπει σε καμία περίπτωση να θεωρείται αυτονόητα δεδομένη.
- Απαιτείται προσοχή κατά την ερμηνεία οποιουδήποτε ευρήματος αναλογικότητας ή μη αναλογικότητας (προς την ανοδική ή καθοδική κατεύθυνση) της απόκρισης των εσόδων από ΦΠΑ στις μεταβολές του ΑΕΠ, ανάλογα με το εάν η αναφορά σχετίζεται με την ανοδική ή καθοδική φάση του οικονομικού κύκλου και ανάλογα με τη διάρκεια καθεμιάς από αυτές τις φάσεις.
- Δεν θα πρέπει να θεωρείται δεδομένο ότι η ενίσχυση της ενδογενούς σχέσης μέσω της εφαρμογής μιας σειράς αυξήσεων στους κανονικούς και μειωμένους συντελεστές ΦΠΑ θα οδηγήσει αναγκαστικά, σε όρους δημοσιονομικής βιωσιμότητας, σε επιπρόσθετες επιδράσεις στο δημοσιονομικό ισοζύγιο μακροπρόθεσμα.
- Οι κυβερνήσεις θα πρέπει να δίνουν μεγαλύτερη έμφαση σε σχέσεις που θεωρούνται ότι εμπίπτουν στο πεδίο της πολιτικής και είναι περισσότερο υπό τον έλεγχό τους, όπως η σχέση μεταξύ των εσόδων από ΦΠΑ και της φορολογικής τους βάσης και, ανάλογα με τους στόχους που τίθενται και το μέγεθος του αντίστοιχου μέτρου απόκρισης, θα πρέπει να είναι έτοιμες να προσφύγουν σε πρόσθετα εργαλεία πολιτικής, σε περίπτωση που τα εφαρμοσμένα διακριτικά φορολογικά μέτρα δεν αποδειχθούν επαρκώς αποτελεσματικά.

Τα εμπειρικά αποτελέσματα των βραχυχρόνιων εκτιμήσεων, τόσο στη βάση των αναλύσεων αναφοράς όσο και των διευρυμένων αναλύσεων, σε συνδυασμό με τα ευρήματα της ανάλυσης συνέπειας, σε όλες τις περιπτώσεις για τις αντίστοιχες υπό εξέταση χρονικές περιόδους, υποδεικνύουν, πρώτον, μη αμελητέες διαφοροποιήσεις μεταξύ των μακροχρόνιων και βραχυχρόνιων σχέσεων, καθώς και ένα σημαντικό χρονικό διάστημα που απαιτείται για την προσαρμογή. Δεύτερον, δεν υποδηλώνουν επιπρόσθετες διακυμάνσεις στα έσοδα από ΦΠΑ σε βραχυχρόνιο ορίζοντα, ως αποτέλεσμα των εξεταζόμενων αυξήσεων στους κανονικούς και μειωμένους συντελεστές. Τρίτον και κυριότερο, αναδεικνύουν την ύψιστη σημασία της επίδρασης της πανδημίας COVID-19 στη φύση ορισμένων από τις υποκείμενες βραχυχρόνιες σχέσεις, υπογραμμίζοντας τον ρόλο που μπορούν να διαδραματίσουν αιφνίδιες και εξαιρετικές διαταραχές στις εξεταζόμενες σχέσεις απόκρισης. Όλες αυτές οι πτυχές υποδηλώνουν ότι:

- Είναι σαφώς ανακριβές να συγχέονται ή να θεωρούνται εκ των προτέρων ως ταυτόσημα τα αποτελέσματα οποιασδήποτε βραχυχρόνιας ανάλυσης με τα ευρήματα μιας μακροχρόνιας ανάλυσης, καθώς διαφορετικά θεμελιώδη μεγέθη διέπουν τις σχέσεις στους δύο χρονικούς ορίζοντες.
- Δεν θα πρέπει να θεωρείται δεδομένο ότι η ενίσχυση της ενδογενούς σχέσης μέσω της εφαρμογής μιας σειράς αυξήσεων στους κανονικούς και μειωμένους συντελεστές ΦΠΑ θα καταστήσει υποχρεωτικά, σε όρους σταθεροποιητικής δημοσιονομικής πολιτικής, τα έσοδα από ΦΠΑ καλύτερο ή χειρότερο αυτόματο σταθεροποιητή σε βραχυχρόνιο ορίζοντα.
- Το δυναμικό και διαρκώς μεταβαλλόμενο οικονομικό περιβάλλον, και ιδιαίτερα οι σοβαρές κρίσεις και οι απρόβλεπτες, έκτακτες διαταραχές που επηρεάζουν κρίσιμες βραχυχρόνιες σχέσεις απόκρισης, όπως η σχέση μεταξύ των διακυμάνσεων στα έσοδα από ΦΠΑ και βασικών μακροοικονομικών μεταβλητών, αλλά ακόμη και μεταξύ των διακυμάνσεων των ίδιων των βασικών μακροοικονομικών μεγεθών, θα πρέπει να τίθενται στο επίκεντρο κάθε βραχυχρόνιας ανάλυσης, ώστε να αποφεύγεται η χάραξη πολιτικής επί ενδεχομένως εσφαλμένης βάσης.

Η παροχή ενός τόσο περιεκτικού πλαισίου είναι ιδιαίτερα κρίσιμη για τη χάραξη πολιτικής για τον ΦΠΑ από τις ελληνικές κυβερνήσεις. Ωστόσο, οι δημοσιονομικές αρχές που στοχεύουν σε ένα πληρέστερο πλαίσιο πολιτικής δεν θα πρέπει να αντιμετωπίζουν τα βασικά ευρήματα που παρουσιάζονται στην παρούσα Μελέτη αποκομμένα από άλλα σημαντικά ζητήματα που σχετίζονται με τον ΦΠΑ. Άλλωστε, το σύστημα του ΦΠΑ χαρακτηρίζεται από εγγενείς διασυνδέσεις, καθώς και από αρκετές ανεπάρκειες, οι οποίες σε ορισμένες περιπτώσεις αφορούν άμεσα ή/και έμμεσα τη φορολογική βάση του ΦΠΑ ή το βασικό συνολικό δημοσιονομικό μέγεθος των εσόδων από τον ΦΠΑ. Οι υπεύθυνοι χάραξης πολιτικής θα πρέπει να συμπληρώνουν τη γνώση τους για την απόκριση των εσόδων από ΦΠΑ στην Ελλάδα με λεπτομερείς πληροφορίες σχετικά με τον βαθμό μετακύλισης των μεταβολών των συντελεστών ΦΠΑ στις τιμές των αγαθών και υπηρεσιών και, κατά συνέπεια, σχετικά με την κατανομή του φορολογικού βάρους μεταξύ καταναλωτών και παραγωγών. Τα ευρήματα που παρέχονται στην παρούσα Μελέτη καταδεικνύουν υπομετακύλιση των αυξήσεων της περιόδου 2010-2011 των μειωμένων συντελεστών ΦΠΑ για τα τρόφιμα και μη αλκοολούχα ποτά, με αποτέλεσμα οι καταναλωτές να φέρουν ένα πολύ μεγαλύτερο μερίδιο του φορολογικού βάρους σε σχέση με τους παραγωγούς. Τέτοιες πληροφορίες αποτελούν αναγκαία προϋπόθεση για την κατάρτιση πιο ενδεδειγμένων πολιτικών ΦΠΑ. Επιπλέον, δεδομένων των σοβαρών ανεπαρκειών που προκαλούν σημαντικές απώλειες εσόδων από ΦΠΑ στην Ελλάδα, όπως η εκτεταμένη μη συμμόρφωση με τη νομοθεσία ΦΠΑ και η αναποτελεσματικότητα του συστήματος ΦΠΑ που σχετίζεται με την πολιτική, οι υπεύθυνοι χάραξης πολιτικής θα πρέπει να συνδυάζουν τη γνώση για την απόκριση των εσόδων από ΦΠΑ με λεπτομερείς πληροφορίες για το κενό ΦΠΑ (VAT gap).

Το συνολικό πλαίσιο ανάλυσης της παρούσας Μελέτης επιτρέπει τη διατύπωση ορισμένων προτάσεων προς τις ελληνικές κυβερνήσεις για συγκεκριμένες κατευθύνσεις πολιτικής και για τη διεξαγωγή συναφούς έρευνας:

- Συνιστάται να βασίζονται σε αξιόπιστα και ακριβή στοιχεία σχετικά με την τάση μεταβολής και την ελαστικότητα των εσόδων από ΦΠΑ, τα οποία προκύπτουν από τη χρήση όλων των διαθέσιμων μέσων, εργαλείων και διακριτών διαστάσεων, με στόχο την αποφυγή απλοποιητικών υποθέσεων και αποφάσεων που βασίζονται σε γενικεύσεις και προσεγγιστικά αποτελέσματα. Διαφορετικά, πέραν του ότι θα είναι ανεπαρκής σε όρους μεθοδολογικής και τεχνικής προσέγγισης, η στήριξη σε οποιοδήποτε ελλιπές πλαίσιο ενέχει τον μεγάλο κίνδυνο να στρεβλώσει τη διαδικασία λήψης αποφάσεων σχετικά με οποιονδήποτε τομέα εφαρμογής που εμπεριέχει τη χρήση της τάσης μεταβολής και της ελαστικότητας των εσόδων από ΦΠΑ.

- Με δεδομένες τις συχνές εναλλαγές μεταξύ των επικρατουσών συνθηκών ως προς την πορεία της οικονομικής δραστηριότητας, τις μακροχρόνιες και σοβαρές κρίσεις, αλλά και τις έκτακτες διαταραχές, θα πρέπει να ενσωματώνουν την ανάλυση της τάσης μεταβολής και της ελαστικότητας των εσόδων σε ένα σύστημα συνεχούς αξιολόγησης και παρακολούθησης, συμπεριλαμβανομένης της θεώρησης ενδεχόμενων υποκείμενων διαρθρωτικών αλλαγών. Αυτό θα διασφαλίσει ταχύτερη και καταλληλότερη τροποποίηση και προσαρμογή σε ένα δυναμικό και συνεχώς εξελισσόμενο οικονομικό περιβάλλον.
- Θα πρέπει να διασφαλίζουν ότι παρέχονται λεπτομερή ευρήματα για την τάση μεταβολής και την ελαστικότητα των εσόδων όχι μόνο για την καίρια κατηγορία του ΦΠΑ, αλλά για όλες τις επιμέρους φορολογικές κατηγορίες, ή τουλάχιστον για τις μεγαλύτερες και πιο σημαντικές. Η απόκτηση πληρέστερων ευρημάτων δημιουργεί την αναγκαία οπτική σε όρους σχετικότητας για τις κυβερνήσεις, επιτρέποντας να αξιολογηθεί η σχετική σημασία μιας ισχυρότερης ή ασθενέστερης ενδογενούς απόκρισης των εσόδων από ΦΠΑ στις μεταβολές των κεντρικών μακροοικονομικών μεγεθών και του αντίστοιχου χώρου που υπολείπεται για περαιτέρω παρεμβάσεις και εφαρμογή μέτρων που αφορούν τον ΦΠΑ.
- Συνιστάται να δημιουργήσουν μηχανισμούς που θα ενισχύσουν τη σύνδεση μεταξύ όλων των συναφών ερευνητικών κέντρων και κέντρων λήψης αποφάσεων, προκειμένου να περιορίσουν ή ακόμη και να εξαλείψουν τον κίνδυνο της ενδεχόμενης εξουδετέρωσης ή/και αντιστάθμισης των επιδράσεων. Περιορίζοντας τα αντισταθμιστικά αποτελέσματα ως προς τους συνολικούς στόχους που αφορούν την αύξηση των εσόδων και τους φόρους, τους επιμέρους κλαδικούς και διαρθρωτικούς στόχους και τους ευρύτερους στόχους των πολιτικών ισότητας και αναδιανομής, καθώς και ως προς τις ισχύουσες εθνικές υποχρεώσεις για τα δημοσιονομικά μεγέθη, η απορρέουσα ανταλλαγή πληροφοριών θα μετριάσει την ανάγκη για επιπλέον παρεμβάσεις και ακόμη πιο επιβαρυντικά μέτρα, ενισχύοντας έτσι την αποτελεσματικότητα της πολιτικής.
- Τέλος, γίνεται η ισχυρή σύσταση να διασφαλίζουν τη βελτίωση της διαθεσιμότητας, ποιότητας και αξιοπιστίας των στατιστικών δεδομέ-

νων με άμεση συνάφεια, περιλαμβανομένης της παροχής συνεκτικών ποσοτικών δεδομένων αναφορικά με τον αντίκτυπο των εφαρμοσμένων μέτρων πολιτικής, μέσω της ενισχυμένης υποστήριξης της συνδεόμενης έρευνας τόσο σε τεχνικό όσο και σε οικονομικό επίπεδο. Προφανώς, όλες οι ως άνω διατυπωμένες συστάσεις πολιτικής συνδέονται θεμελιωδώς με τη διαθεσιμότητα των σχετικών δεδομένων, η οποία αποτελεί προϋπόθεση για οποιαδήποτε λεπτομερή και πολυσύνθετη ανάλυση της ενδογενούς και/ή της συνολικής απόκρισης των φορολογικών εσόδων στις μεταβολές βασικών μακροοικονομικών μεταβλητών.

EXECUTIVE SUMMARY

The role of tax revenues in ensuring the provision of public goods and services and, more generally, in financing government activities has long been acknowledged and emphasized in both theoretical and practical terms. Clearly, developments in tax revenues, in conjunction with policy decisions regarding public expenditure, are intrinsically linked with the course of public deficits and, thus, public debt. Given the long-persisting challenges in terms of fiscal aggregates in Greece, as well as recent developments in the public budget associated with the COVID-19 pandemic, the investigation of the response of tax revenues to prevailing economic conditions and implemented discretionary tax measures is a vital component of tax policy and, undoubtedly, a topic of utmost significance for the country.

Academics, researchers, and, not least, policymakers have traditionally engaged in the analysis of tax revenue response relations, mainly expressed through the concepts of tax revenue buoyancy (the *overall* revenue response, including the response to discretionary policy changes) and elasticity (the *automatic* or *endogenous* revenue response, excluding any discretionary tax measures), due to their association with crucial aspects in terms of theory, policy, and application. Over time, in-depth research has concluded that the higher the degree of emphasis on individual – rather than total – tax revenues and, especially, on major tax categories, the greater the benefit in terms of accuracy and adequacy. Such a conclusion clearly implies that for key tax policy instruments such as the Value Added Tax (VAT), upon which governments have come to heavily rely during times of favourable economic conditions as well as during episodes of severe crises and extraordinary disturbances, the subject of revenue buoyancy and elasticity should be placed among the top positions of the research agenda of academics and policymakers.

Based on the above considerations, the fundamental research idea underlying the present Study is to provide scholars and fiscal authorities with an inclusive framework for a thorough analysis of the response of VAT revenues to changes in macroeconomic aggregates and implemented policy measures in Greece, i.e., for a comprehensive analysis of VAT revenue buoyancy and elasticity in the country. The offered inclusive research setting evolves around the conduction of a battery of econometric estimations of VAT revenue buoyancy and elasticity, supported and reinforced by an in-depth analysis of a number of associated aspects, with the ensuing conclusions and implications drawn being essential to the correct understanding and interpretation of the empirical evidence.

The obtained particularly rich and robust estimates of VAT revenue buoyancy and elasticity for Greece, which are consistent with economic rationales, strengthen the methodological choices made and the overall analytical framework adopted for the purposes of the current Study and lead to vital conclusions with major implications for policymaking. More specifically, long-run estimation empirical results for the total period under investigation, along with the findings from the stability analysis for all the corresponding sub-periods, indicate, first, a less than proportional overall and endogenous VAT revenue response relation to changes in the Gross Domestic Product (GDP) (via both the one-step and decomposition approaches). Second, they offer evidence on a proportional overall and endogenous VAT revenue response relation to changes in the tax base (i.e., private consumption). Third, they imply a neutral effect on VAT revenues of the investigated discretionary tax measures, i.e., standard and reduced rate increases for the period under examination. As a result,

- the unity (and, hence, the proportionality) assumption should by no means be unanimously taken as a given;
- caution is needed when interpreting any proportionality or non-proportionality (in the upward or downward direction) finding of the VAT revenue response to GDP changes, depending on whether the reference is to the upward or the downward phase of the cycle and on the duration of any of these phases;
- it should not be taken for granted that complementing the endogenous relation with the implementation of a number of VAT standard and reduced rate increases will necessarily lead, in terms of fiscal sustainability, to additional fiscal balance effects in the long run;
- governments should pay more attention to relations considered to lie within the scope of policy and more under their control, such as the

relation between VAT revenues and their base, and depending on the targets set and the size of the corresponding response measure, they should be ready to resort to additional policy tools, in case the implemented discretionary tax measures have not been as effective as required.

Short-run estimation empirical results from both benchmark and extended analyses, alongside the findings from the consistency analysis, in all cases for the corresponding time periods under investigation, indicate, first, non-negligible differentiations between the long and short-run relations and a considerable time period needed for adjustment. Second, they imply no additional fluctuations in VAT revenues in the short run triggered by the investigated standard and reduced rate increases. Third and most importantly, they demonstrate the utmost significance of the impact of the COVID-19 pandemic on the nature of some of the underlying short-run relations, highlighting the role that abrupt and extraordinary disturbances can play on the response relations under examination. All these aspects imply that

- it is clearly inaccurate to confuse or *a priori* consider as identical the results from any short-run analysis to findings from a long-run analysis since different fundamentals drive relations in the two time horizons;
- it should be not considered as given that complementing the endogenous relation by the implementation of a number of VAT standard and reduced rate increases will necessarily turn, in terms of fiscal policy stabilization, VAT revenues to a better or worse automatic stabilizer in the short run;
- the dynamic and ever-changing economic environment, and especially severe crises and unexpected extraordinary disturbances, affecting important short-run response relations, such as the one between fluctuations in VAT revenues and basic macroeconomic variables and even between fluctuations in major macroeconomic aggregates themselves, should be put to the foreground in any short-term analysis to avoid conducting policy on a potentially falsely founded basis.

The provision of such an inclusive framework is absolutely crucial for VAT policy conduction by Greek governments. Nevertheless, fiscal authorities targeting a more comprehensive VAT policy framework should not view the key findings provided by the present Study in isolation from other important VAT-related issues. After all, the VAT system is characterized by intrinsic interconnections, as well as several inefficiencies, which in certain cases directly and/or indirectly involve the VAT base or the major fiscal aggregate of VAT revenues. Policymakers should complement knowledge on the VAT revenue response in Greece with detailed information on the issue of the degree of pass-through of VAT rate changes to prices of goods and services and, as a consequence, of the distribution of the tax burden between consumers and producers. The evidence provided in the present Study indicates the under-shifting of 2010–2011 increases in reduced VAT rates on food and non-alcoholic beverages prices, with consumers bearing a far larger tax burden share than producers. Such information represents a prerequisite for more suitable VAT policymaking. Moreover, given the severe inadequacies causing substantial VAT revenue losses in Greece, like the broad non-compliance with the VAT legislation and the policy-related inefficiency in the Greek VAT system, policymakers should combine knowledge on the VAT revenue response in the country with detailed information on the VAT gap.

The overall framework of the analysis of the present Study allows for the recommendation of certain directions for policy and associated research conduction for Greek governments:

- They are advised to rely on robust and accurate evidence on VAT revenue buoyancy and elasticity, resulting from the utilization of all the available tools, instruments, and distinct dimensions, with the aim to avoid simplifying assumptions and decisions based on generalizing and approximating results. Otherwise, apart from being inadequate in terms of methodological and technical involvement, reliance on any incomplete framework would entail a huge risk of distorting the decision-making process associated with any field of application involving the use of VAT revenue buoyancy and elasticity.
- Against the background of frequent shifts between prevailing regimes, long-persisting and severe crises, as well as extraordinary disturbances, they should integrate the analysis of revenue buoyancy and elasticity within a system of continuous assessment and monitoring, including the consideration of potentially underlying structural

changes. This will ensure more prompt and adequate adaptation and adjustment to a dynamic and constantly evolving economic environment.

- They should make sure that detailed evidence on revenue buoyancy and elasticity is provided not only for the key category of the VAT but for all individual tax categories, or at least for the major and most important ones. The acquisition of complete evidence creates the necessary relativity perspective for governments, allowing for an assessment of the relative importance of a stronger or weaker endogenous VAT revenue response to changes in central macroeconomic aggregates and the relative space left for further intervention and implementation of measures related to the VAT.
- They are advised to create mechanisms that strengthen the connection between all the relevant research and decision-making centers to minimize or even eliminate the risk of potentially neutralizing or even counteracting effects. By limiting offsetting outcomes in terms of any broader revenue raising, tax, sectoral and/or structural, equity, and distributional policy goals set, as well as in terms of the national obligations for fiscal aggregates in force, the ensuing information exchange will restrain the need for additional interventions and for even more burdensome measures and will, hence, enhance policy efficacy.
- Finally, they are strongly advised to guarantee the improvement of relevant statistical data availability, quality, and reliability, including the provision of consistent quantitative data on the impact of implemented policy measures, through enhanced support for relevant research in terms of both technical and economic assistance. Clearly, all the above-formulated policy recommendations are fundamentally linked to the availability of relevant data, which represents a prerequisite for any detailed and sophisticated analysis of the endogenous and/or the overall response of tax revenues to changes in major macroeconomic variables.

CHAPTER 1

INTRODUCTION

The role of tax revenues in ensuring the provision of public goods and services and, more generally, in financing government activities has long been acknowledged and emphasized in both theoretical and practical terms. Evidently, developments in tax revenues, in conjunction with policy decisions regarding public expenditure, are intrinsically linked with the course of public deficits and, thus, public debt. Such developments in tax revenues, along with fiscal policymaking, largely depend on the prevailing economic conditions not only in the short run but also in the medium to long run. In this context, the case of Greece is of particularly high interest due to the persisting fiscal imbalances as well as the observed business cycle variation, including periods of significant growth (2000–2008), severe crises (2008–2018 economic crisis and adjustment period), and extreme circumstances (COVID-19 pandemic) during the last two decades. Thus, information on the way tax revenues respond to economic activity in Greece is of fundamental importance for effective tax revenue management, along with the monitoring and forecasting of governments' public revenues, as a prerequisite for accurately implementing tax measures and conducting sustainable fiscal policy.

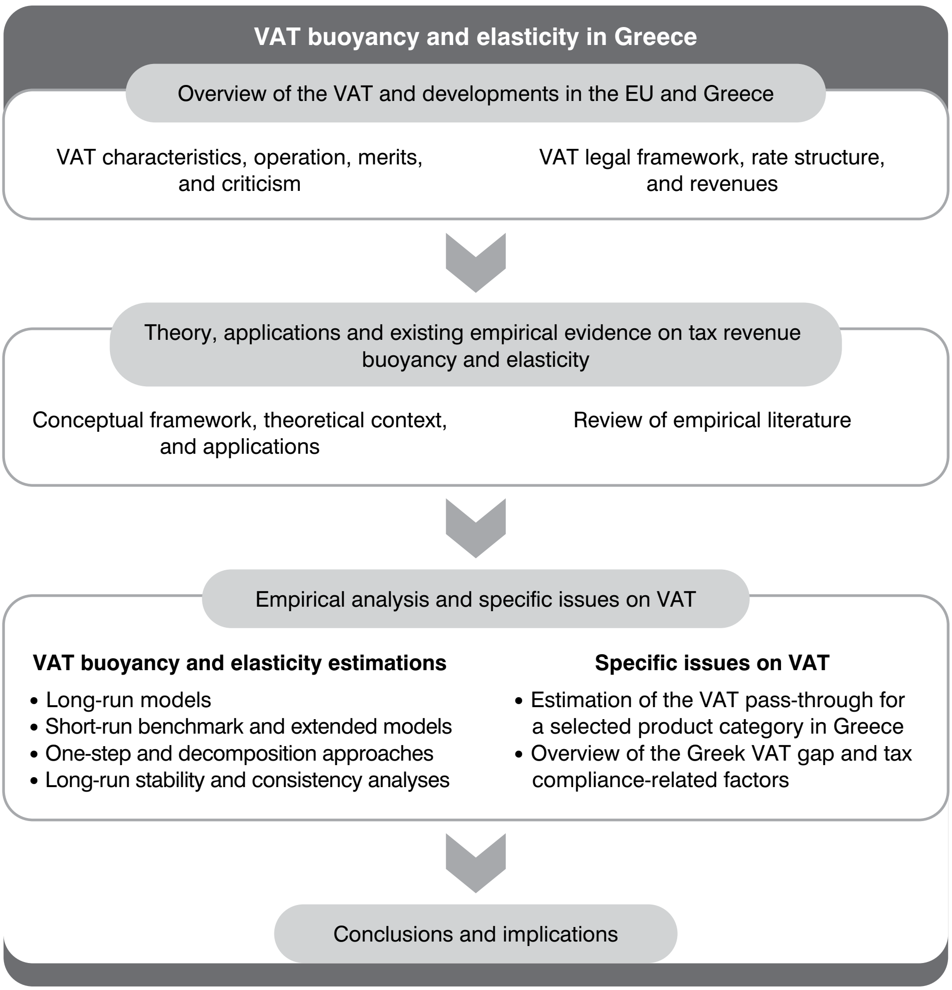
Information on tax revenue response[1] to major macroeconomic variables, actually reflecting economic activity, can be provided on an aggregate level. However, given the typically high heterogeneity of tax revenue categories, this knowledge should be detailed and obtained at a disaggregated level, taking into account potentially tax-specific reactions of reve-

[1] 'Tax revenue response' or 'revenue response' will be applied throughout the Study as an abbreviated expression of the response of tax revenues to changes in income and/or in any relevant macroeconomic variable. Related notions, such as tax revenue responsiveness and tax sensitivity are sometimes applied in the relevant branch of literature in a general context and a broad sense, mostly expressing the response of revenues to changes in income as well. However, in the present Study, any such expression will be used in a narrower sense, which will be explicitly indicated in all cases.

nues to macroeconomic developments. For instance, revenues from consumption taxes, such as the Value Added Tax (VAT), may respond differently to changes in basic macroeconomic aggregates, such as the Gross Domestic Product (GDP), and, in particular, to changes in the relevant tax base (i.e., private consumption for VAT), compared to revenues from income taxes. On the one hand, information on tax revenue response at a disaggregated level enables the categorization of tax sources according to their revenue-generating potential and the identification of the sources of fast (dynamic) or lagging revenue growth as well as the detection of weaknesses and strengths of the tax system. On the other hand, failing to distinguish among different tax categories in estimating tax revenue response may not offer clear guidance on necessary tax policy intervention, potentially limiting tax policy effectiveness. Moreover, providing related analyses, especially for major individual tax categories such as the VAT, is absolutely necessary and of utmost importance. In fact, VAT is a key tool for raising public revenues in many countries worldwide, and more specifically in Greece, where it generates billions of euros annually, amounting to a significant share of the government's total tax revenues. Indeed, Greek governments have used VAT to increase public revenues and achieve country-specific objectives, such as to support specific sectors of high significance depending on the economic conjuncture, as well as to deal with extreme circumstances due to, for example, the severe economic crisis, the refugee crisis, and the COVID-19 pandemic.

Principally motivated by the above considerations, the main objective of the current Study is to provide a comprehensive analytical framework for systematically studying the response of VAT revenues to changes in key macroeconomic variables in Greece for the 2000–2022 period. This framework unfolds around two related, yet different revenue response concepts, namely, tax revenue buoyancy and elasticity. Tax revenue buoyancy refers to the *overall* response of VAT revenues to changes in macroeconomic variables, including the response to discretionary VAT policy changes. Tax revenue elasticity captures the *automatic* or *endogenous* response of VAT revenues to such changes, excluding any discretionary tax measures (DTM). Both concepts entail essential elements from the theoretical and policymaking perspective. Thus, they should be considered complementary and must constitute parts of any inclusive tax revenue response analysis, being particularly significant in terms of public finances and fiscal policy implementation. In this context, Figure 1.1 illustrates the research design of the Study and the outline of the analytical approach adopted to thoroughly investigate this multifaceted issue. It involves several interrelated stages and tasks intended to provide an

FIGURE 1.1
Research design of the Study



inclusive analytical framework for the thorough examination of the VAT revenue response to changes in macroeconomic variables in Greece.

At the first stage, we provide an overview of the VAT, describing its main features and operation, as well as the arguments for and against its implementation according to the literature in order to explain the popularity and the rise of the VAT worldwide and, at the same time, to rationalize the focus of the Study on this tax. In addition, offering a comprehensive outline of the VAT legal framework and rate structure as well as presenting developments in VAT revenues in the EU and Greece over time are also essential tasks at this stage, intended to stress the particularities of the Greek VAT system and major legislative changes as well as to demonstrate the high importance of VAT receipts as a source of public revenue.

At the second stage, we offer a thorough analysis of the related theory, applications, and empirical evidence of tax revenue buoyancy and elasticity. This analysis builds upon detailed knowledge and deep understanding of the underlying conceptual framework and theoretical context as well as of several central fields of application of these two revenue response concepts. These are complemented with an extensive and up-to-date review of relevant empirical evidence to provide a comprehensive summary of the empirical literature findings and to uncover potential research gaps, especially for the Greek case.

At the third stage, we conduct the empirical analysis of the Study and focus on specific issues of VAT. More specifically, we perform multilevel estimations of VAT buoyancy and elasticity for Greece (on the basis of long-run models, short-run benchmark and extended models, one-step and decomposition approaches, and long-run stability and consistency analyses) to provide multifaceted, reliable, and policy-relevant empirical evidence. Moreover, for the sake of multidimensionality and the enrichment of the analysis, we examine two specific VAT-related issues, including the estimation of the VAT pass-through for a selected product category in Greece and an overview of the Greek VAT gap and tax compliance-related factors. At a final stage, we draw key conclusions and crucial implications, to provide guidance for policymaking and to enhance policy effectiveness, and suggest directions for future research.

By adopting the above-described analytical, comprehensive, and multidimensional framework, this Study makes a multifaceted contribution to the relevant literature by synthesizing conceptual, theoretical, institutional/legislative, and methodological/technical dimensions in an integrated and inclusive framework, including an explicit analysis of the related literature. Through this synthesis, the contribution of the present Study essentially unfolds on two levels. At a first level, the current work can be considered to constitute a handbook on VAT revenue response to changes in key macroeconomic aggregates, which could be particularly helpful in various settings and contexts for research, academic, and policy purposes. More specifically, it provides an analytical background of VAT implementation and integrates a plethora of conceptual and theoretical elements associated with the key notions of tax revenue buoyancy and elasticity drawing on public finance theory and fiscal policy. Given the absence of such an inclusive and coherent framing of tax revenue buoyancy and elasticity in conceptual and theoretical terms in the literature, this Study, by providing the above-described setting, constitutes a significant addition to the literature.

Moreover, at the same level, it thoroughly reviews the empirical findings on tax buoyancy and elasticity for VAT and related tax categories for various countries and time periods. This extensive and up-to-date literature review can serve as a key reference work for any subsequent study on VAT buoyancy and elasticity. It further highlights the limitations and gaps of a considerable number of empirical studies that usually focus on more general tax categories, only specific aspects of investigating revenue response to macroeconomic variables, e.g., solely VAT buoyancy or elasticity, only one-step estimations, either the long or the short run, and/or make simplifying assumptions. From a methodological perspective, the contribution of the current research primarily lies in addressing such weaknesses through a multidimensional analysis, adopting a disaggregated framework, investigating both VAT buoyancy and elasticity through one-step as well as decomposition approaches, for the long- and short-run horizon, taking into account potential asymmetric effects and business cycle variations. Importantly, the current Study contributes to the existing relevant literature by explicitly providing new evidence on the effects of the COVID-19 pandemic on the VAT revenue response, an issue which – to our knowledge – remains heretofore unexplored.

At a second level, the current work can be considered to constitute a unique, comprehensive, and multifaceted study for the case of Greece. In this respect, it is highly contributive and novel, given also that relevant analyses and evidence from Greece are scarce and fragmented. More specifically, the detailed analysis/discussion of the Greek VAT regime and the comparative analysis of the course and the importance of VAT revenues add significantly to the Greek VAT literature and offer policy-relevant information by providing a thorough overview of the main changes in the VAT structure and of the trends in VAT revenues in Greece compared to other countries, other tax categories, and specific macroeconomic variables. Most importantly, the current Study substantially contributes to the knowledge on the way VAT revenues respond to changes in basic macroeconomic variables and economic conditions in Greece by offering analytical, reliable, and up-to-date empirical evidence on VAT revenue buoyancy and elasticity, including a novel and explicit examination of the effects of the COVID-19 pandemic. In addition, our analysis is complemented by the examination of two specific VAT-related issues (the estimation of the VAT pass-through for a selected product category in Greece and an overview of the Greek VAT gap and tax compliance-related factors) linked to private consumption and VAT revenues, which appear to be of considerable policy interest in the context of the current Study, strengthening the contribution of our work for the case of Greece. The synthesis of all these novel and contributive elements is conducive to better interpreting the obtained results and to drawing sound conclusions and implications. Consequently, the present Study serves as a particularly useful guiding tool in the hands of the Greek government for the conduct of fiscal policy via VAT.

All the aforementioned elements are reinforced by the obtained particularly rich and robust estimates of VAT revenue buoyancy and elasticity for Greece. These estimates, which are consistent with economic rationales, strengthen the methodological choices made and the overall analytical framework adopted for the purposes of the current Study and lead to vital conclusions with major implications for policymaking. More specifically, long-run estimation empirical results for the total period under investigation, along with the findings from the stability analysis for all the corresponding sub-periods, indicate, first, a less than proportional overall and endogenous VAT revenue response relation to changes in GDP (via both the one-step and decomposition approaches). Second, they offer evidence on a proportional overall and endogenous VAT revenue response relation to changes in the tax base (i.e., private consumption). Third, they imply a neutral effect on VAT revenues of the investigated DTM, i.e., standard and reduced rate increases for the period under examination. At the same time, short-run estimation empirical results from both benchmark and extended analyses, alongside the findings from the consistency analysis, in all cases for the corresponding time periods under investigation, indicate, first, non-negligible differentiations between the long- and short-run relations and a considerable time period needed for adjustment. Second, they imply no additional fluctuations in VAT revenues in the short run triggered by the investigated standard and reduced rate increases. Third and most importantly, they demonstrate the utmost significance of the impact of the COVID-19 pandemic on the nature of some of the underlying short-run relations, highlighting the role that abrupt and extraordinary disturbances can play on the response relations under examination.

The remainder of the Study is structured around eight chapters. Chapter 2 provides an overview of VAT, presenting its historical development, key structural characteristics, modes of operation, and relevant design issues. It also summarizes the main arguments for and against VAT implementation, drawing on related theoretical and empirical literature.

Chapter 3 focuses on the EU and Greek VAT regimes, presenting the evolution of VAT rates over time and across EU member states. After describing the main features of the VAT legal framework in the EU and Greece, it provides an overview of the structure of VAT rates applied by the EU member states, placing particular emphasis on the main developments of the VAT rates in Greece since 2000.

Chapter 4 deals with the evolution of VAT revenues in the EU and Greece. It incorporates an extensive comparative analysis of VAT revenues, covering their relative course and performance in terms of volumes, shares, and rates of change in comparison to other EU member states and other tax categories. This is complemented by a more detailed discussion on the course of VAT revenues compared to the development of certain relevant macroeconomic variables in Greece over the 2000–2021 period.

Chapter 5 presents the conceptual framework and theoretical context surrounding the notions of tax revenue buoyancy and elasticity and describes the most important fields of their application. To this end, the two basic notions of interest are discussed in both conceptual and mathematical terms, emphasizing both disaggregated and decomposition expressions, alongside the role of the time dimension. The theoretical context of the Study is also set by associating tax revenue response with specific central notions in terms of public finance, which further involve other crucial concepts for public finance theory and policy. Finally, the practical importance of tax revenue buoyancy and/or elasticity is further highlighted by presenting their relevance for tax revenue forecasting and for distinguishing between automatic or cyclical and discretionary components.

Chapter 6 provides a thorough and an up-to-date review of the international empirical evidence on tax buoyancy and elasticity, focusing on VAT and closely related tax categories. Particular emphasis is put on presenting relevant empirical findings that are available for Greece, highlighting, at the same time, potential research gaps on the issue. The literature review is also supported by a structured table which summarizes all relevant key points drawn from the reviewed studies.

Chapter 7 comprises the main empirical analysis performed for the purposes of the current Study. It, first, presents in detail the methodological framework and clearly specifies and explains all econometric models employed in the empirical part. Then, it describes the data and the estimation procedure used in the empirical analysis. The estimation results are subsequently reported, analyzed, and interpreted, distinguishing between short- and long-run estimations, and between benchmark and extended short-run estimations. Results from long-run stability and consistency analyses are also presented and discussed.

Chapter 8 examines two specific VAT-related issues in the Greek context which deal with the VAT shifting on prices (VAT pass-through), along with the distribution of the ensuing tax burden, and the VAT gap. The first part of the chapter focuses on the VAT pass-through and the related consumer share of the tax burden, providing related empirical evidence from three Greek VAT rate increases for the category of food and non-alcoholic beverages. After discussing basic concepts, measures, and methods referring to the VAT gap, the second part of the chapter presents and analyzes the evolution of the Greek VAT gap over time, along with the relative performance of Greece in the EU27, as well as potential VAT gap determinants and compliance-related factors which are particularly relevant for the Greek case.

Finally, Chapter 9 offers key conclusions and crucial implications, also suggesting some directions for policymaking and further research.

CHAPTER 2

VALUE ADDED TAX: DEFINITION, EVOLUTION, CHARACTERISTICS, MERITS, AND CRITICISM

2.1. Introduction

The VAT is a broadly accepted indirect tax[2] that spread quickly around the world, especially during the second half of the 20th century. Limited to fewer than ten countries in the late 1960s, it has been implemented, to date, in about 170 countries worldwide (Zu, 2022). The rise of the VAT across the globe has been fast and alluring, frequently described as an unparalleled tax phenomenon and the most important development in taxation in recent decades (Tait, 1988; Ebrill et al., 2002; Keen and Lockwood, 2010; Charlet and Buydens, 2012).

Its popularity relates to a number of advantages which are widely recognized, especially in comparison to the other forms of taxation that it has replaced. The main arguments favoring VAT adoption are grounded in the VAT's neutrality properties, which imply higher revenue-raising capacity at lower economic and administrative costs than other consumption taxes (Cnossen 1998; Ebrill et al., 2001; de la Feria and Krever, 2013). However, VAT is not free of criticism, with opponents arguing mainly on the basis of equity considerations that emphasize the VAT's potentially negative distributional impact (Metcalf, 1995; Bird and Gendron, 2005).

In this context, the purpose of the present chapter is to provide an overview of the VAT, describing its development, basic characteristics, oper-

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[2] Indirect taxes are taxes which, contrary to direct ones (e.g., income taxes), are generally not levied directly on the person who is supposed to bear the burden of the tax. They are usually imposed on manufacturers or suppliers but passed on to consumers who ultimately pay the tax as a part of the market price of the good or service purchased. Since they are basically levied on the consumption of goods and services, they are frequently referred to as 'consumption taxes'. Common examples of such taxes are the VAT and the Retail Sales Tax (see also Section 2.3).

ation, and relevant design issues, and presenting the main arguments for and against its implementation. The discussion highlights the importance of VAT as an effective tool for raising the public revenues on which many national taxation systems and fiscal policies largely rely, such as the Greek one (see also Chapters 3 and 4).

In what follows, Section 2.2 briefly describes the VAT origins and the evolution of its adoption across the world. Section 2.3 defines VAT and explains its operation and main differences with a related indirect tax, i.e., the Retail Sales Tax (RST). Section 2.4 focuses on the VAT's basic structural and design features, discussing their practical implications. Section 2.5 presents the main arguments for and against VAT implementation, and finally, Section 2.6 summarizes the key points of the chapter and concludes.

2.2. VAT origins and evolution

Even though there is no consensus on the origins of the VAT, its foundational principles are attributed to the German businessman Wilhelm von Siemens and the American economist Thomas S. Adams, who worked independently, proposing such a tax type about a century ago, i.e., in the late 1910s and early 1920s (James, 2011; Narayanan, 2020). Von Siemens conceived a tax as a major improvement to the turnover tax that would enable firms' compensation for taxes charged on inputs (Sullivan, 1965). Adams considered a tax with a similar logic as a substitute for the federal income tax in the context of a radical modification of the existing federal income tax system (Adams, 1921).

However, it took more than three decades before a general turnover tax regime was established in 1954 at a national level in France, which constituted the predecessor to the VAT system (Zu, 2022).[3] The enactment of the first VAT in Denmark in 1967 marked the start of the

[3] This general turnover tax system was, in fact, an extension to a limited 'credit' mechanism for a narrow turnover tax adopted in 1948, which allowed businesses to recover some tax charged on inputs (Zu, 2022).

tax's widespread introduction in Europe, while Brazil was the first Latin American country to adopt the VAT in the same year. VAT scholars usually recognize two distinct phases in the progressive adoption of VAT worldwide (James, 2011). The first phase covers the decades of the 1960s, 1970s and the early 1980s, during which the VAT was primarily introduced in countries of Western Europe (e.g., Austria, Belgium, Denmark, Italy, Germany, the Netherlands, the United Kingdom) and Latin America (e.g., Argentina, Brazil, Chile, Uruguay). The role of the European Economic Community (EEC), i.e., the predecessor of the European Community and today's European Union, was crucial in the acceleration of VAT adoption in Europe since accession to the EEC required the adoption of a VAT in the context of harmonizing the national tax systems across all member states (James, 2011; Zu, 2022). In 1967–1977, six relevant directives were issued, with the Sixth EEC Directive[4] constituting the main document on indirect tax harmonization across EEC member states. The recast of this directive, i.e., Council Directive 2006/112/EC of 28 November 2006 on the common system of value added tax, is up to now the primary operative directive on the EU VAT (see also Chapter 3).

The introduction of VAT in industrialized countries outside the EU (e.g., Australia, Canada, Japan, Switzerland), from the late 1980s onwards, signaled the second phase of VAT adoption. During this phase, and specifically in the 1990s, the VAT rapidly spread in many transitional and developing/emerging economies in Eastern Europe (e.g., Azerbaijan, Belarus, Georgia, Moldova), Asia (e.g., Bangladesh, China, Jordan), and Africa (e.g., Algeria, Kenya, Nigeria). VAT expansion has continued in the 21st century as well, with mostly African (e.g., Angola, Egypt, Ethiopia) and Middle Eastern countries (e.g., Bahrain, the United Arab Emirates, Saudi Arabia) introducing a VAT system in latest decades. According to most recent literature, the VAT, nowadays, constitutes a major type of consumption tax in about 170 countries worldwide (Zu, 2022). A notable exception

[4] Sixth Council Directive 77/388/EEC of 17 May 1977 on the harmonization of the laws of the member states relating to turnover taxes - Common system of value added tax: uniform basis of assessment.

is the United States (US), which remains the only country in the OECD without a VAT, even though it has periodically contemplated a VAT for a variety of purposes.[5] However, it applies a similar tax on consumption, that is, the RST at a state or local government level (not the federal level), which differs from VAT in specific aspects, as discussed below.

Following its full membership in the EEC in 1981, Greece established a VAT in 1987, in compliance with the requirements of the Sixth EEC Directive. The new tax was introduced by Law 1642/1986,[6] which was later amended by Law 2859/2000 – also known as the 'Greek VAT Code' – to incorporate all available rules and regulations up to that point (Eriotis et al., 2021). As in other countries that had previously joined the EEC, the new tax replaced a number of pre-existing indirect taxes in the country, including stamp duties, the turnover tax, and special consumption taxes of less importance for revenue purposes, such as the sugar tax and the tax on entertainment services (Triantafyllou, 1987; Andrikopoulos et al., 1993).

2.3. VAT definition, operation, and comparison with the Retail Sales Tax

A VAT is an indirect tax that is based on the concept of 'value-added', that is, the economic value that a firm adds to its products or services before selling them to customers (e.g., Tait, 1988). It is typically defined as a tax on consumption levied on a product or service at every point of sale at which value has been added, along the whole chain of production/distribution, from the sale of the raw materials to its final purchase by a consumer (e.g., Ebrill et al., 2002). As such, the VAT, in principle, is collected and remitted to the government by all the traders involved in the sup-

[5] For early discussions on the scope and applicability of a VAT in the US tax system, see Aaron (1981) and Metcalf (1995).

[6] For early presentations of the Law 1642/1986 and analyses of its implications for the Greek economy, see Georgakopoulos (1978, 1986), Triantafyllou (1987), and Agapitos (1990).

ply chain of a specific product or service, but the tax is, in fact, paid by the customers or end-users who purchase the final product or service. Thus, the term 'value-added tax' refers more to the tax remittance system, rather than the intended tax base, which is the full value of the supply. For this reason, a number of countries (e.g., Canada, India, New Zealand, and Singapore) have adopted the name 'Goods and Services Tax' (GST) for their VAT regimes to reflect the tax base as opposed to the remittance method (de la Feria and Krever, 2013). Despite the difference in the name, the VAT and GST are generally considered as equivalent taxes (e.g., Narayanan, 2020).

Overall, there are four ways to compute a firm's liability for VAT: (a) the additive-direct method, (b) the subtractive-direct method, (c) the additive-indirect method, and (d) the subtractive-indirect method. First, literature usually distinguishes the direct from the indirect approach in computing VAT (e.g., Georgakopoulos, 1978; Tait, 1988). The direct approach requires the explicit computation of a firm's value added, while the indirect approach does not require the computation of the value-added itself. Second, a firm's value-added can be calculated using the additive or the subtractive method. According to the former, the value-added equals the sum of the payments made by the firm to the factors employed in producing a product or service, such as wages and salaries, interest, rents, and profits (e.g., Sullivan, 1965). The latter, i.e., the subtractive method, considers the value-added as the difference between the value of a firm's sales and the value of the purchased material inputs used in producing the firm's goods. Both methods, by definition, lead to identical results.

In the case of explicitly computing the firm's value-added, the VAT liability can be derived using either the additive-direct method or the subtractive-direct method by multiplying the firm's value-added with the relevant VAT rate. When the value-added is not directly computed, on the one hand, the additive-indirect method measures the total liability for VAT as the sum of tax amounts applied to all the components of value added (tax for wages and salaries, tax for interest payments and profits, etc.). On the other hand, the subtractive-indirect method calculates VAT liability by subtracting the VAT charged on inputs from the VAT due on a firm's taxable sales.

The four methods described above prove to be equivalent in the case of a single VAT rate applied to all production/distribution stages (e.g., Tait, 1988).[7] In practice, the subtractive-indirect method (i.e., the fourth method), also known as the 'credit-invoice', 'tax-credit', or 'invoice (-based)' method, is the most used worldwide, which the EU VAT model is based on. Japan is the only country that has adopted a variant of the second method, that is the subtractive-direct method, also referred to as the 'subtraction' or 'accounts-based' method (e.g., Tamaoka, 1994). Comparing the two, the credit-invoice method attaches the tax liability to the transaction, as demonstrated by the relevant invoice, while the VAT based on the subtraction-method is generally thought to be a tax on an entity without involving an invoice requirement.[8] Overall, the VAT form based on the credit-invoice method is considered "legally and technically far superior to other forms" (Tait, 1988).

All entities subject to VAT are obliged to register with the tax authorities.[9] A VAT regime based on the credit-invoice method requires registered firms to charge tax on their sales and enables them to reclaim tax on their inputs. The VAT, as mentioned before, applies to every transaction along the whole supply chain of a product, that is, for instance, when a raw materials producer sells a product to a factory, when the factory sells the finished product to a wholesaler, when the wholesaler sells the product to a retailer, and, ultimately, when the retailer sells it to the final consumer who, eventually, pays the VAT. The trader in each production/distribution stage charges the purchaser VAT at the rate specified for each supply, which is demonstrated by an invoice showing the amount of tax charged. The purchaser is subsequently allowed to credit that input tax against the output tax charged on its sales, remitting the difference to the tax authorities and/or receiving refunds when there are excess credits. In

[7] Methods (a), (b) and (c) cannot accommodate a multiple-rate VAT, basically, for practical reasons (see for example Tait, 1988).

[8] For a comparative analysis of the credit-invoice method and the subtraction-method in computing the VAT see, for example, Grinberg (2010).

[9] In countries where there is no registration threshold, that is, a certain volume of annual turnover above which businesses are required to register for VAT (see also Section 2.4), such as Greece, no separate registration for VAT purposes is required. The tax registration number provided to a taxpayer is used for all taxation purposes, including VAT.

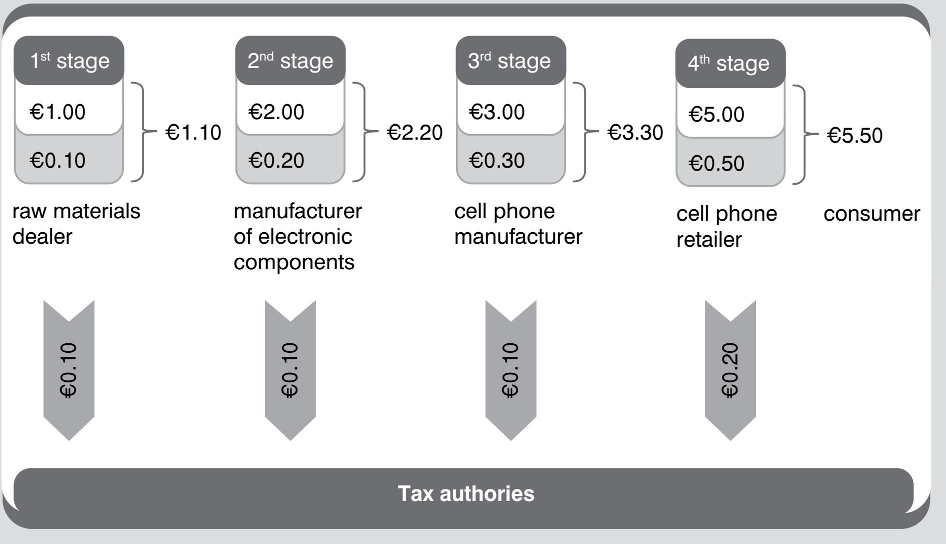
effect, this credit mechanism underlying the VAT collection process eliminates the tax on goods and services purchased by a registered firm but leaves in place the VAT on sales to final consumers (Grinberg, 2010). Box 2.1 illustrates and explains the VAT operation and payment process using a hypothetical example.

The multiple-stage collection process is the defining feature of VAT that distinguishes it from other consumption taxes, such as the RST, which is the most common consumption tax throughout the United States. The RST is collected only at the retail stage, that is, at the point of sale of the final product. An RST and a VAT of the same rate are theoretically equivalent, in the sense that they result in the same amount of tax collected by the government and identical tax burdens for the final consumer (Metcalf, 1995; Keen and Smith, 1996; Grinberg, 2010). This can be apparent from the numerical example in Box 2.1, where, unlike the VAT collection process, in case of an RST, the whole tax would be levied in the fourth stage and be ultimately borne by the final consumer, as in the case of the VAT. More specifically, across all traders involved in the supply chain of cell phones, only the cell phone retailer would remit a 50-cent RST to the tax authorities collected from the consumer, who, in fact, pays the 10% tax due on the final price of the cell phone. However, even in the case of same rates, the design and technical differences between an RST and a VAT, especially regarding the remittance method, are likely to imply considerable discrepancies in their economic effects and administrative efficiency (de la Feria and Krever, 2013).

BOX 2.1
An example of VAT

Assume that the production and distribution of cell phones involves four stages to which a VAT of 10% applies (Figure 2.1). A manufacturer of electronic components purchases raw materials made of various metals from a dealer. The manufacturer spends €1.10 (€1.00 + €1.00 × 10%) for the raw materials, and the seller of the raw materials pays the tax authorities the 10% VAT, that is €0.10 (€1.00 × 10%). At the 2nd stage of production, the manufacturer uses the raw materials to create electronic components, which are sold to a cell phone manufacturing company for €2.20 (€2.00 + €2.00 × 10%). The manufacturer of the electronic components pays the tax authorities 10 cents of the 20-cent VAT (€2.00 × 10%) it collected and keeps the other 10 cents as reimbursement for the VAT it previously paid to the raw materials dealer. The cell phone manufacturer adds value by producing mobile phones, which are sold to a cell phone retailer for €3.30 (€3.00 + €3.00 × 10%). The cell phone manufacturer pays the tax authorities 10 cents of the 30-cent VAT (€3.00 × 10%) it collected and keeps the other 20 cents as reimbursement for the VAT it previously paid to the electronic components manufacturer. Finally, the retailer sells a phone to a consumer for €5.50, that is €5.00 plus a 50-cent VAT (€5.00 × 10%), 20 cents of which is paid to the tax authorities, and the rest kept as reimbursement for the VAT the retailer previously paid to the cell phone manufacturer. The VAT paid at each sale point along the supply chain represents 10% of the value added by the seller. For example, the value added by the cell phone manufacturer is €1.00 (€3.00 – €2.00), thus the tax payable by the manufacturer is €0.10 (€1.00 × 10%). Overall, the tax authorities collect a tax of 50 cents per cell phone from all firms involved in its production and distribution, which represents 10% of the final (pre-taxed) value of the cell phone (€5.00 × 10%). Thus, the whole tax burden is eventually borne by the final customer since firms are reimbursed for the VAT paid at the previous nodes of the supply chain.

FIGURE 2.1
An example of a VAT applied to a product with four production/distribution stages



Source: Adjusted from *Investopedia* 'Value-Added Tax (VAT) Examples' (https://www.investopedia.com/ask/answers/042315/what-are-some-examples-value-added-tax.asp).

Indeed, there has been a long-lasting debate on the relative advantages and shortcomings of the two consumption tax types.[10] More specifically, the RST has been accused, in practice, of creating 'cascading', that is, a 'tax on tax' problem leading to double taxation that arises when tax is charged both on an input and the output of the same production process (e.g., Grinberg, 2010). In the case of VAT, the credit mechanism allows producers to reclaim the tax they have been charged on their inputs; thus, the VAT does not affect the prices firms ultimately pay for inputs. From

[10] For key points of the associated debate and comparative analyses of a VAT and an RST in some respects, see, for example, Zodrow (1999) and Fedeli (1998).

this perspective, it does not distort production decisions and avoids the 'cascading' problem, ensuring that the consumption of all goods and services subject to the VAT will be taxed once, at the consumer level (Ebrill et al., 2001; Ebrill et al., 2002; Grinberg, 2010).

In addition, contrary to the RST, the credit mechanism in a VAT regime largely makes the VAT self-assessed and self-enforcing since registered traders demand invoices in order to claim the input credits that reduce their own tax liability (Tait, 1988; Ebrill et al., 2001; Grinberg, 2010; Mascagni et al., 2023). Furthermore, the credit mechanism based on VAT invoices provides tax authorities with information about firms' sales, which increases businesses' compliance and, eventually, improves VAT enforcement. However, RST supporters argue that the credit mechanism allowing for refunds across the whole value chain of a commodity is likely to make the VAT more susceptible to fraud compared to an RST (e.g., de la Feria and Krever, 2013). Finally, comparative studies of VAT and RST seem to imply that, unlike a uniform VAT system, the RST may work well at relatively low rates (i.e., 5–10%), while at higher rates, it proves too vulnerable to evasion (Ebrill et al., 2001).

2.4. Structure and relevant design features

As implied by the previous sections, in practice, VAT regimes vary to a smaller or greater extent in terms of their structural and design features across countries and even within the same country over time. These features commonly refer to the adoption of a single or multiple VAT rates, the size of tax rates, the coverage of economic activities, the size of the consumption base, and potential exclusions or exemptions, including those due to registration thresholds. However, there is a consensus among VAT scholars on the general characteristics of a theoretically 'ideal' or 'good' VAT regime in the sense of imposing the least distortions and compliance costs (e.g., Giesecke and Nhi, 2010). Specifically, the 'ideal' VAT regime is widely considered the one which is characterized by a uniform, i.e., a single rate on domestic sales, a zero-rate on exports, and no or minimal exemptions[11] (Tait, 1988; Ebrill et al., 2001; James, 2011; de la Feria and Krever, 2013).

Departing from the 'ideal' VAT regime, the VAT systems applied around the world are traditionally marked by diverse and multiple rates. Indicative of the variation in VAT rates across different countries are the examples of the 5% rate in Canada and the 27% in Hungary, while the rate variation within the EU is much smaller (17%–27%).[12] In addition, many countries, mostly in Europe, apply a multi-rate structure of VAT with a standard rate for the majority of goods and services and two or three reduced rates for certain categories of commodities (for example foodstuffs, water supplies, pharmaceutical products, hotel accommodation, and restaurant and catering services) or for specific regions (see also Chapter 3). Even though the general trend outside the EU in the last decades favors the introduction of a uniform VAT rate (e.g., de la Feria and Krever, 2013), many EU and non-EU countries (e.g., Colombia, Denmark, Finland, Greece, Italy, Spain, Turkey) have introduced additional reduced VAT rates since 2020, in the context of the COVID-19 pandemic (e.g., Narayanan, 2020).

The arguments in support of multiple-rate VAT structures draw on efficiency considerations, in the sense of raising revenue without affecting aggregate real income, as well as equity considerations, in the sense of ensuring a fair distribution of aggregate income (Ebrill et al., 2001). However, given the availability of other tax instruments (i.e., excise taxes and income taxes) that could be used for distributional purposes, and taking also into account the high compliance and administration costs associated with significant rate differentiation, a rather simple tax structure with minimal rate differentiation appears to be more attractive from both an efficiency and equity point of view (Tait, 1988; Keen and Smith, 1996; Ebrill et al., 2001; Müllbacher et al., 2013).

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[11] As such, the 'ideal' VAT regime is related to the term of the *C-efficiency ratio* which is, usually, considered as an indicator of the departure of the VAT system from a perfectly enforced tax levied at a uniform rate on all final consumption (see also Chapter 8, p. 196).

[12] The figures concern standard VAT rates retrieved from the OECD Tax Database, "VAT/GST: standard and any reduced rates (2021)" <https://www.oecd.org/tax/tax-policy/tax-database/>. See also Chapter 3.

Another common practice in designing and applying a VAT scheme refers to the incorporation of exclusions or exemptions. These can take various forms referring to entities (i.e., traders), specific types of economic activities, or specific categories of commodities. Most countries specify a threshold, commonly, in terms of annual turnover, above which firms are required to register for VAT, excluding in this way businesses with annual turnover below this critical level, i.e., businesses of smaller size. Cross-country evidence reveals wide variation in the level and design of such tax thresholds (Ebrill et al., 2001; Keen and Mintz, 2004). This issue is rather contentious since raising the registration threshold involves a trade-off between the tax revenue lost and the administrative and compliance costs saved by the tax authorities and taxpayers (i.e., entities remitting the VAT), respectively, due to the lower number of (large-sized) traders subject to VAT. Further concerns about the potential distortions and implications related to the differential tax treatment of those traders above and those below the threshold make the optimal threshold setting an even more difficult and complex task (e.g., Keen and Mintz, 2004).

The standard argumentation in favor of defining rather high thresholds (thus excluding a large number of small-sized traders), is based on the empirical observation that a large proportion of VAT revenue comes from a rather small proportion of relatively large firms, while the revenue to be raised from the smaller firms maybe insufficient to cover the associated high administrative and compliance costs (e.g., Ebrill et al., 2001; de la Feria and Krever, 2013). Even though international experience shows that, indeed, low thresholds may lead a VAT system to fail (see, for instance, the case of the 1995 VAT scheme introduced in Ghana), the issue of determining appropriate thresholds along with related measures of applying these thresholds is still under debate, requiring further research and consideration (e.g., Ebrill et al., 2001; Keen and Mintz, 2004).

Apart from small traders, exporting activities are also commonly exempt from VAT or subject to a zero VAT rate.[13] Typically, this is a conse-

[13] Goods and services that are exempt from VAT are distinguished from those that are subject to 0% VAT. Contrary to the seller of goods and services which are exempt from VAT, the seller of zero-rated goods and services is entitled to reclaim input VAT on business purchases (e.g., Tait, 1988).

quence of applying the 'destination principle' in taxing international transactions, under which VAT is levied in the jurisdiction where the final consumption occurs. Effectively, exports are exempt from VAT or zero-rated and imports are taxed on the same basis and at the same rate as supplies in the domestic market, ensuring that the net tax burden on imports is equal to the net tax burden on the same domestic supplies (OECD, 2017). As opposed to the destination principle, the alternative 'origin principle' implies levying the tax in the various jurisdictions where the value was added following the production stages of the commodity. Thus, imposing VAT on an 'origin' basis means that exports would be subject to the VAT applicable in the jurisdiction of exportation and imports would be zero-rated or excluded from the tax base.

Intuitively, the origin principle implies a tax levied on production, while a destination-based tax is, in fact, a tax on consumption, being consistent with the fundamental logic of the VAT (e.g., Ebrill et al., 2001). Despite the debate on which principle is most appropriate for VAT purposes in international trade,[14] there is nowadays widespread consensus that the destination principle is preferable to the origin principle from both a theoretical and practical standpoint (Charlet and Buydens, 2012; OECD, 2017). Thus, it is widely adopted in applying VAT in international trade among OECD countries. However, in an era of rapid expansion of digital technologies and e-commerce, the application of the destination principle in taxing the cross-border trade of services and intangibles such as consultancy, accountancy, legal, advertising, and financial services is not straightforward, mainly due to the increased difficulty in identifying the place of consumption (Charlet and Buydens, 2012).[15]

Other exemptions that are rather common in traditional VAT regimes based on the European model refer to a variety of services, including postal services, health, education, sporting activities, cultural services, betting, lotteries and gambling, insurance, supply of land and buildings,

[14] For a comparative analysis and the implications on a theoretical and practical basis of applying the destination vs. the origin principle, see, for example, Ebrill et al. (2001).

[15] For a related discussion, see also Hellerstein and Gillis (2010).

and a range of financial services.[16] Beyond these standard exceptions, other consumption items that are usually exempt from VAT refer to passenger transport, waste and recyclable material, water supply, precious metals, and certain agricultural inputs. Notably, while exemptions constitute a rather typical design feature in European VAT systems, they are not frequent in jurisdictions outside the EU (de la Feria and Krever, 2013). Primarily, the rationale on incorporating exemptions in VAT systems builds on equity considerations (Ebrill et al., 2001; de la Feria and Krever, 2013; Hellerstein, 2016). Exempting essential products from VAT is considered to reduce the natural regressivity of a VAT (see Section 2.5.2) and increase consumption of the so-called 'merit goods', which is usually associated with positive externalities.

Apart from social policy reasons grounded on equity considerations, specific types of supplies such as financial services, insurance and gambling are exempt from VAT for technical reasons due to the practical difficulties of subjecting related transactions to the VAT (e.g., Hellerstein, 2016). However, despite the ongoing debate on this issue, both theoretical and empirical evidence seems to seriously question the efficacy of VAT exemptions which are driven by equity or feasibility considerations (de la Feria and Krever, 2013; Warwick et al., 2022). The relevant arguments mainly build on the considerable cost for both tax authorities and taxpayers usually implied by the application of these exemptions in terms of administration and compliance.

Based on the above, many VAT studies suggest that although most exemptions and reduced rates are adopted to improve the distributional impact of VAT, their enforcement basically runs counter to the principal logic of the VAT and undermines the core objective of raising revenue by increasing the cost of collection and often facilitating fraud (de Mooij and Swistak, 2022; Warwick et al., 2022). This conclusion has increasingly gained support among researchers and policymakers who call for a reform of many VAT systems, in both developed and developing countries, guided by a broader base, simpler structure, and simpler sets of rules (Müllbacher et al., 2013; Cnossen, 2015; Kowal and Przekota, 2021).

[16] For a detailed and up-to-date overview of the exemptions at the European level, as specified by the European VAT Directives, see Terra and Kajus (2022).

2.5. Arguments for and against the VAT

2.5.1. Arguments for the VAT

The proponents of VAT pinpoint a number of advantages and strengths of adopting a VAT regime, which basically accrue from its fundamental principles and structural characteristics. In economic terms, the neutrality properties of this tax are broadly highlighted as the principal reason for its superiority over other forms of taxation (Lindholm, 1970; Georgakopoulos, 1978; Weidenbaum et al., 1990; Cnossen, 1998; Charlet and Buydens, 2012; OECD, 2017). As described above, under a VAT regime, each business is charged with VAT when it purchases inputs from its suppliers and receives VAT from its customers on its outputs, with the business's tax liability being defined as the net amount or balance between the input VAT incurred and the output VAT received. Thus, the tax ultimately remitted to the tax authorities along a particular supply chain is proportional to the amount paid by the final consumer, whatever production method is used (capital- or labor-intensive) and independently of the allocation of resources across product markets, the nature of the supply, the structure of the distribution chain, and the number of transactions or economic operators involved (Weidenbaum and Christian, 1989; Cnossen, 1998; OECD, 2017). Contrary to other 'cumulative' indirect taxes,[17] VAT is neutral between vertically integrated firms and those active at only one stage since a smaller number of production stages does not result in a smaller tax amount remitted by involved businesses; thus, it does not incentivize firms to vertically integrate for taxation reasons (Georgakopoulos, 1978; Provopoulos, 1983). In addition, the fact that VAT is uniform across all the factors of production implies neutrality between costs and profits, which, in turn, leaves output prices unaffected (Lindholm, 1970).

[17] Cumulative taxes are multi-stage taxes which are charged at every stage of production/distribution, without allowing a credit for any tax paid in previous stages. Thus, the final tax amount applied to a product is larger as the number of stages is larger. In this way, cumulative taxes encourage the vertical integration of production, in order for firms to reduce the 'transfers' across the supply chain of a good and pay, in effect, smaller tax (e.g., Georgakopoulos, 1978).

Beyond the domestic market, the application of the destination principle in taxing cross-border transactions ensures VAT neutrality in international markets (Cnossen, 1998; Charlet and Buydens, 2012; Zu, 2022). As discussed above, in the context of a destination-based VAT regime, exports are zero-rated, while imports are taxed according to the VAT system that holds in the country of import. This ensures that imported goods are subject to the same tax regime as domestically produced goods, and that domestic and foreign businesses are treated equally in terms of taxation (Triantafyllou, 1987; Zu, 2022). In this way, business decisions about investing or undertaking activities in a specific country are driven solely by market and not by tax considerations, eliminating the risks of competitive distortion (Lindholm, 1970; Charlet and Buydens, 2012). On the contrary, the application of the origin principle in taxing commodities in an international setting would potentially distort competition between domestic and foreign firms since goods, services, and intangibles purchased from a jurisdiction without VAT or with a low VAT rate would have a significant advantage over goods, services, and intangibles purchased from jurisdictions that have higher rates. Ultimately, a VAT (under the destination principle) operates in a neutral way as far as the final consumer's choices are concerned since the latter are independent of the goods' origin, i.e., whether they are purchased in the domestic market or abroad (Triantafyllou, 1987; Tait, 1988; Cnossen, 1998).

A further typical argument in favor of VAT draws on an enhanced ability to raise revenues (Lindholm, 1970; Charlet and Buydens, 2012). Indeed, the importance of tax revenues in enabling countries to achieve sustainable tax space, address public debt imbalances, and ensure the provision of public goods has been highlighted in the economics literature (Brautigam et al., 2008). Thus, the revenue-raising capability of VAT is commonly emphasized in the relevant literature on the basis of countries' experiences and related empirical evidence (Ebrill et al., 2001; Ebrill et al., 2002; Keen and Lockwood, 2010). To assess VAT performance in terms of raising revenues, several indicators have been used, usually with respect to GDP or consumption, under the labels of 'VAT productivity', 'C-efficiency' or 'C-effectiveness'[18] (Ebrill et al., 2001; Bird and Gendron, 2006). These measures, in fact, show what percent of GDP or consumption is collected by each percentage point of the standard VAT rate (e.g., Bird and Gendron, 2006).

Comparative multi-country studies based on such indicators often report high cross-country variation, pointing to VAT systems' 'imperfections', i.e., exemptions, reduced rates, and zero-rating, as the principal factors, which, along with tax evasion, tend to erode the tax base, undermining the revenue-raising capacity of a VAT (Ebrill et al., 2001; Ebrill et al., 2002; Bird and Gendron, 2006; Hodzic and Celebi, 2017). Other studies focusing on the determinants of revenue performance of the VAT report additional or related factors that may be important, including the business cycle, the degree of openness, the regulatory and legislative framework, the effectiveness of the administrative and auditing systems, and the size of administrative costs (de Mello, 2009; Tagkalakis, 2014a; Ueda, 2017). Overall, irrespective of the factors and conditions that may be conducive to increased VAT efficiency, there is evidence which suggests that the VAT operates as a rather effective tax instrument and a substantial source of revenues in most countries worldwide (e.g., Keen and Lockwood, 2010; Cnossen, 2015).

Finally, the VAT is widely considered a particularly attractive consumption tax due to a number of basically practical advantages it exhibits; since it does not create cascading effects, it is largely self-enforcing and transparent, and discourages tax evasion (Metcalf, 1995; Ebrill er al., 2002; Grinberg, 2010). More specifically, the credit mechanism that applies to the whole supply chain of a commodity eliminates the risk of double taxation, ensuring that the business' output is taxed only once. Furthermore, it encourages voluntary compliance, reducing, in effect, the risk of tax evasion, since each firm has an incentive to receive an invoice from a seller so that it can claim the VAT credit on its input purchases (e.g., Kaplanoglou and Rapanos, 2013). A relevant argument is based on the fact that

[18] 'C-efficiency' or 'C-effectiveness' is commonly defined as the ratio of VAT revenue to consumption divided by the standard rate of the VAT. VAT productivity or efficiency is an analogous measure, but it is defined with respect to GDP rather than consumption. See also Chapter 8.

in a multi-stage payment system such as that of a VAT, each firm pays a rather small proportion of the tax, thus the incentive to evade tax is smaller relative to other taxes (e.g., Georgakopoulos, 1978).

2.5.2. Arguments against the VAT

Despite its widely recognized advantages, the VAT has also attracted much criticism. A rather traditional argument against VAT refers to the intrinsic regressivity that is generally attributed to any flat tax on consumption, frequently being compared to turnover taxes (Weidenbaum et al., 1990; Ebrill et al., 2001). The economic rationale behind this argument is based on the hypothesis that the proportion of income that is spent tends to decrease with the level of income. Thus, since the higher income households consume a lower proportion of their income, they are likely to bear a lower tax burden (as a share of their income), due to a flat broad-based VAT, in comparison to lower income households (e.g., Metcalf, 1995; Jenkins et al., 2006).[19] However, this argument is often questioned since lifetime income or lifetime consumption may be better indicators of an individual's welfare during his/her lifetime than current income; thus, the tax share should be measured with respect to the lifetime income or consumption resulting in a proportional burden of VAT (Tamaoka, 1994; Ebrill et al., 2001).[20] The issue of potential regressivity of VAT has attracted much research interest since it basically relates to equity considerations and more specifically to the distributional impact of VAT (see, for example, Leahy et al. [2011] for Ireland, Gaarder [2019] for Norway, and Missos [2021] for Greece). A general observation suggests that VAT incidence, that is, how the burden of the tax is shared between consumers and suppliers, depends on the patterns of consumer preferences, the de-

[19] In general, a regressive tax is a tax where the amount of tax paid as a proportion of income decreases with income, while the opposite holds in the case of a progressive tax, implying a higher amount of tax (as a proportion of income) paid by taxpayers with a higher income.

[20] Ebrill et al. (2001) and more recently Arsić and Altiparmakov (2013) analyzed the argument based on the lifetime perspective in more detail, while Metcalf (1995) raised doubts on the conclusion of the non-regressivity of VAT since the relevant argument does not consider nontaxed consumption, like leisure and nontaxed bequests.

sign features of the VAT, and the effectiveness of the related administration system (Ebrill et al., 2001).

The relevant empirical research does not seem to yield a definite or indisputable conclusion on the issue, exhibiting great diversity in terms of methods, time, and country coverage. Evidence from Europe (Müllbacher et al., 2013) based on VAT burden measures in terms of total expenditure, suggests that the VAT systems in all but one (Hungary) EU28 countries are non-regressive. The results on developing, transition, or emerging economies are rather mixed, with many studies emphasizing the high importance of the VAT incidence issue in these countries because of their specificities related to high income inequality, poor performance of administration systems, and large informal sectors (e.g., Bird and Gendron, 2005; Emran and Stiglitz, 2005; Keen, 2008). In general, even though early research appears to strongly support the inherent regressive nature of VAT,[21] subsequent studies seriously question this conclusion (Ebrill et al., 2001). Thus, more recent research seems to suggest that the claims on the regressivity of the VAT are largely overstated, lacking a solid foundation in theoretical and especially empirical terms, and in many cases the VAT appears to be less regressive than the other taxes (i.e., trade and excise taxes) it has replaced (Arsić and Altiparmakov, 2013).

Another point of criticism on VAT refers to its broadly proven high revenue-raising capacity, which is considered as a major reason the tax is ‘both alluring and frightening’ (Metcalf, 1995). The relevant argument builds on the ‘money-machine’ hypothesis that has been used by VAT opponents who argue against its adoption by the United States (Metcalf, 1995; McGowan and Billings, 1997; Keen and Lockwood, 2006). The basic idea underlying this hypothesis is that the VAT would extract increasing proportions of tax revenue in the form of consumption taxes from the private sector and finance the expansion of government (McGowan and Billings, 1997; Cnossen, 1998; Bird and Gendron, 2006). Lee et al. (2013) argue that the critical issue underlying the money machine argument is not whether VAT raises more revenue, but whether the expansion of the

[21] See, for example, the seminal work of Pechman (1985).

government results in a movement toward an inefficiently large level of public services. In any event, the related literature remains largely inconclusive, with available empirical evidence providing some support to the money machine hypothesis (e.g., Keen and Lockwood, 2006; Alavuotunki et al., 2019), strong support (e.g., Keen and Lockwood, 2010), or even no support (e.g., McGowan and Billings, 1997; Lee et al., 2013). After all, there is little reason to believe that a relatively efficient and fair VAT system, with increased capacity to raise revenues at the least possible welfare costs, is associated with an inefficient overexpansion of the public sector (e.g., Lee et al., 2013).

An additional argument against VAT refers to its potential inflationary effect. On the one hand, given that it is included in the price of purchases, it is expected to be reflected in all price indices and, thus, exert an inflationary force on the economy (Weidenbaum et al., 1990). On the other hand, if it replaces an existing, equal-yield tax, as in most cases in practice, there may be changes in relative prices, but no increase in the overall price index (Tait, 1991). In addition, a counterargument is frequently presented suggesting that even if prices rise, this will be a one-time effect associated with the enactment or change of the tax and would not be persistent (Weidenbaum et al., 1990; Metcalf, 1995). In any event, it seems that it is the accompanying monetary policies implemented that matter most, rather than the VAT itself in causing inflationary effects on the economy (Weidenbaum et al., 1990; Tait, 1991; Metcalf, 1995).

Focusing on technical difficulties associated with its implementation, the VAT has also been criticized for being a particularly complex tax and burdensome to both tax authorities and taxpayers (Georgakopoulos, 1978; Ebrill et al., 2001; Mascagni et al., 2023). The feature that has been considered highly responsible for creating inappropriate complexity, along with significant administration and compliance costs, is the credit mechanism which provides for refunds for businesses in case the VAT charged on their input purchases exceeds that received from their output sales. This may be particularly relevant to exporters, whose output is zero-rated under the destination principle, and to new enterprises whose investment purchases are large relative to their current sales. In any event, ineffective treatment of excess credits may result in significant and costly distortions for these groups of taxpayers.

In addition, while refunding is straightforward in principle, in practice, it may create opportunities for fraud and corruption, generating tension between tax authorities and the business sector. Also, in cases where governments face considerable cash shortages, deliberate delay or denial of refunds is often observed, while complex administrative measures may be put in force that significantly undermine the functioning of the VAT system (Harrison and Krelove, 2005). These arguments may be particularly relevant to less developed countries where administration and audit systems are likely to perform poorly and be prone to corruption (e.g., Mascagni et al., 2023). For all the above-mentioned reasons, the refund process has been frequently characterized as the VAT's 'Achilles heel' (Ebrill et al., 2002; Harrison and Krelove, 2005).

Finally, departing from its ideal model, a VAT system with multiple rates and exemptions has been linked to increased administration costs for tax authorities and compliance costs for taxpayers (Metcalf, 1995; Ebrill et al., 2001). As discussed above, the potential benefits of a complex VAT structure usually come at a significant cost, in terms of administrative complexity and collection difficulties, raising serious doubts on the appropriateness and effectiveness of such VAT schemes (Metcalf, 1995; de la Feria and Krever, 2013). This is, in fact, the main reason for which single-rate VATs with few exemptions and reliance on self-assessment appear more successful and, in many cases, prove to be less complex in their design and implementation compared to the taxes they have replaced (e.g., Ebrill et al., 2001).

2.6. Concluding remarks

VAT regimes have emerged rapidly to become one of the main revenue sources for governments worldwide. First introduced in France in 1954, followed by Denmark and Brazil in 1967, VAT is now in place in about 170 countries. The spread of the VAT, especially during the second half of the last century, has been characterized as an unparalleled tax phenomenon and the most important development in taxation.

The VAT is basically a multi-stage tax that is remitted through a credit mechanism to the tax authorities by all traders involved in the supply chain of a product or service, while ultimately the tax burden is borne by the final consumer. Although the 'ideal' VAT is widely described as a simple structured tax system with a single rate, a broad base, few exemptions, and effective self-assessment mechanisms, in practice, the VAT systems implemented in many countries deviate significantly from this scheme, being characterized by multiple tax rates, many exemptions, and complex administrative and compliance rules. The rationale for these VAT variants is usually based on equity and distributional considerations as well as feasibility reasons. However, most relevant studies appear to seriously question complex structured VAT regimes, arguing that their enforcement basically runs counter to the principal logic of the VAT and undermines the core objective of raising revenue by increasing the cost of collection and often facilitating fraud.

Regardless of the diverse design features that it may exhibit in practice, the VAT exhibits widely accepted merits related to its neutrality properties applied in both domestic and international markets, significant revenue-raising capacity, and the rather low risk of cascading effects and tax evasion, especially in comparison with other related indirect taxes, such as the RST. However, VAT has also been severely criticized for being intrinsically regressive, for operating as a 'money machine' conducive to an oversized inefficient public sector, for creating opportunities for fraud, and for being complex and bothersome for administration authorities and taxpayers. These arguments raise serious concerns about the appropriateness of the VAT in the case of developing and transition economies. Although the relevant arguments cannot be overall rejected, neither in theoretical nor in empirical terms, there is evidence suggesting that a VAT almost certainly performs better, in both theory and practice, in most countries than any feasible alternative. Probably for this reason and given its importance as a rather effective tool for raising public revenues and, generally, conducting fiscal policy, the VAT's role proves to be major in many national taxation systems, including the Greek one.

CHAPTER 3

VAT RATE REGIME: OVERVIEW OF THE LEGAL FRAMEWORK AND RATE STRUCTURE IN THE EU AND GREECE

3.1. Introduction

VAT is the main consumption tax in terms of revenue raised and the most common one in terms of geographical coverage (OECD, 2020). Although most VAT systems are based on the same principles (credit-invoice method, destination principle), there exist significant variations in rate structures, including standard rates, reduced rates, exemptions, and other special regimes among OECD countries (OECD, 2020).[22] This diversification is mainly due to different fiscal targets, equity, and social considerations, as well as practical and historical issues that governments take into account when designing the VAT rate structure.

Across OECD countries, historically, VAT rates have been trending upward. In 1975, the average standard VAT rate,[23] in the 36 OECD countries that applied VAT, was 15.6%, while it reached 18% in 2000 (Figure 3.1). From 2000 to 2008, the standard VAT rate remained relatively stable in most countries, and the OECD average ranged between 17.7% and 18%. On the contrary, during the period that followed the economic and financial crisis, 2009–2014, 23 OECD countries increased the standard VAT rate, and the OECD average reached 19.1% in 2014. In the subsequent eight years, 2015-2022, only four OECD countries increased their standard VAT rate, including Greece and Luxembourg as the only EU member states. Since January 2008, only four OECD countries (Iceland, Israel, Latvia, and Switzerland) reduced their standard VAT rate and two (Ireland and the UK) reduced it temporarily. Due to the COVID-19 pandemic,

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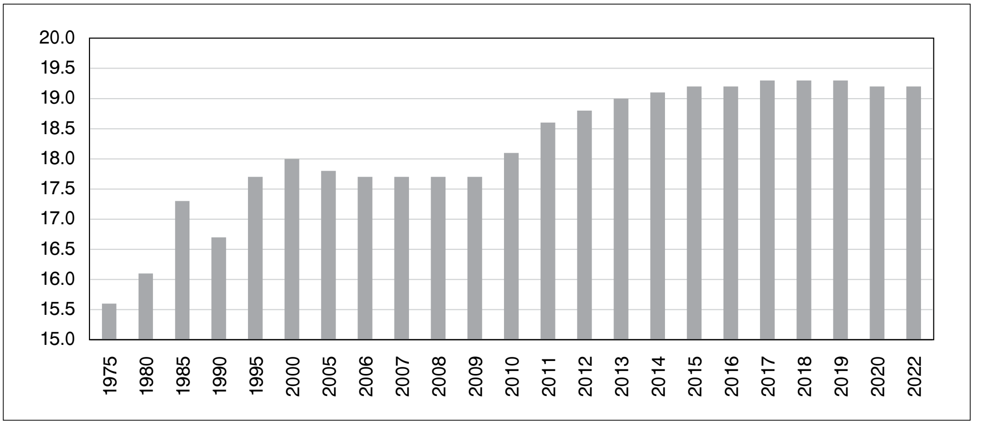
[22] See also Chapter 2.

[23] The VAT rates of each country used to calculate the average are the ones reported on the 1st of January of the respective year.

two countries (Germany and Ireland) reduced their standard VAT rate for short periods[24] (OECD, 2022a).

The standard VAT rates have traditionally exhibited great variation across OECD countries. In 2022, the rates ranged from 5% in Canada, 7.7% in Switzerland, and 10% in Australia, Japan, and Korea to 25% in Denmark, Norway, and Sweden and 27% in Hungary. Overall, 23 OECD countries applied a standard VAT rate of 20% or more and 5 countries applied a rate of 10% or less, in 2022. Moreover, most OECD countries have been implementing preferential VAT regimes, such as reduced rates and exemptions for equity reasons and other policy objectives. Usually, countries apply reduced rates or exemptions to necessity goods and services (e.g., food, water supply, health and medical supplies, education, and housing) and to 'merit goods' (e.g., cultural products). However, as discussed in Chapter 2, preferential VAT regimes tend to increase complexity and the compliance burden for companies and have a negative impact on compliance (OECD, 2022a).

FIGURE 3.1
Average standard VAT rate of OECD countries (%)



Source: OECD (2020 and 2022a).

[24] Germany reduced the standard VAT rate from June to December 2020, and Ireland from September 2020 to March 2021.

In general, VAT serves as an important fiscal instrument that generates significant revenue. Additionally, governments use VAT to achieve country-specific objectives, leading to a notable disparity in VAT rate regimes across countries. Therefore, the aim of this chapter is to offer an overview of the EU and Greek VAT rate structure. In what follows, Section 3.2 briefly describes the EU legal framework for the VAT rate regime. Section 3.3 provides an overview of the structure of VAT rates applied by EU member states. Section 3.4 focuses on the main developments of VAT rates in Greece since 2000. Finally, Section 3.5 summarizes the key points of the chapter and concludes.

3.2. European VAT legal framework

The VAT is a tax common to all EU member states. The notion of a common turnover tax was introduced by the Treaty of Rome (1957), in Article 99: "The Commission shall consider how the legislation of the various member states concerning turnover taxes, excise duties and other forms of indirect taxation, including countervailing measures applicable to trade between member states, can be harmonized in the interest of the common market." (Hellerstein and Gillis, 2010). Following this mandate, the fundamental principles of the EU VAT system were set by the First[25] and Second[26] VAT Directives, issued in 1967. According to these directives, all member states were required to replace their turnover taxes with a credit-invoice VAT by 1 January 1970. The Second and parts of the First VAT Directive were updated and/or replaced ten years later, in 1977, by the Sixth VAT Directive,[27] which set the legal framework of the VAT sys-

[25] First Council Directive of April 11, 1967, on the harmonization of legislation of member states concerning turnover taxes (67/227/EEC).

[26] Second Council Directive of April 11, 1967, on the harmonization of legislation of member states concerning turnover taxes. Structures and procedures for application of the common system of value added tax (67/228/EEC).

[27] Sixth Council Directive of May 17, 1977, on the harmonization of the laws of the member states relating to turnover taxes — Common system of value added tax: uniform basis of assessment (77/388/EEC).

tem in the EU for the next 30 years.[28] In 2006 (effective from 1/1/2007), the Sixth VAT Directive was 'recast' in order to incorporate the amendments that had been made over the years and for reasons of 'clarity and rationalization'. The Recast Sixth VAT Directive[29] (or just VAT Directive), along with several amendments adopted during the previous sixteen years, set the current EU legal framework.

According to the VAT Directive, "The principle of the common system of VAT entails the application to goods and services of a general tax on consumption exactly proportional to the price of the goods and services, however many transactions take place in the production and distribution process before the stage at which the tax is charged. On each transaction, VAT, calculated on the price of the goods or services at the rate applicable to such goods or services, shall be chargeable after deduction of the amount of VAT borne directly by the various cost components." Taxable transactions[30] include the supply of goods and services within the territory of a member state by a taxable person (in practice, i.e., a VAT-registered business, sole trader, or professionals[31]), the intra-Community acquisition of goods by a taxable person or a non-taxable legal person[32] within the territory of a member state, and the importation of goods.[33] Therefore, in the EU framework, VAT is considered a general tax since it applies to almost all goods and services consumed in the EU (this also means that imports are taxed but exports are not). Moreover, it is a con-

[28] The Third (69/463/EEC), Fourth (71/401/EEC); and Fifth (72/250/EEC) VAT Directives refer to extensions granted to Belgium and Italy in order to comply with the First and Second VAT Directives.

[29] Council Directive 2006/112/EC of November 28, 2006, on the common system of value added tax.

[30] For more details, see Articles 14-30 of the VAT Directive.

[31] For more details, see Articles 9-12 of the VAT Directive and <https://taxation-customs.ec.europa.eu/taxable-persons-under-eu-vat-rules_en>.

[32] For more details, see Article 13 of the VAT Directive and <https://taxation-customs.ec.europa.eu/taxable-persons-under-eu-vat-rules_en>.

[33] The VAT Directive does not apply to certain territories, i.e., Mount Athos, the Canary Islands, the French territories referred to in Article 349 and Article 355(1) of the Treaty on the Functioning of the European Union, the Åland Islands, the Channel Islands, the Island of Heligoland, the territory of Bósingen, Ceuta, Melilla, Livigno, Campione d'Italia, and the Italian waters of Lake Lugano.

sumption tax because it is borne by the final consumer, and it is neutral in the sense that it does not depend on the number of transactions involved (for a detailed analysis, see Chapter 2).[34]

The EU legal framework further entails the basic provisions, as far as the VAT rates are concerned, determining that the standard rate should not be less than 15% and that one or two reduced rates of not less than 5% may be applied to specific goods and services. The VAT Directive provides a list of goods and services to the supply of which reduced rates may be applied. The list includes foodstuffs, supply of water, pharmaceutical products, medical equipment, transportation of passengers, books, newspapers and periodicals, admission to cultural and sporting events, radio and television broadcasting and web casting services, services by artists, goods and services for agricultural production (excluding capital goods), accommodation, restaurant services, use of sporting facilities, provision of medical and dental care, and others.[35] In total, the list contains 29 points (groups of goods and services). Member states may apply the reduced rates to a maximum of 24 points from the list. In addition to the two reduced rates, they can apply a reduced rate lower than 5% (super-reduced rate) and the exemption with deductibility of the VAT paid at the preceding stage to no more than 7 points from the list.[36] Furthermore, certain member states (Austria, Portugal, and Greece) may apply lower rates in specific regions.

The VAT Directive includes several other provisions such as exemptions for certain activities (e.g., activities in the public interest) and special schemes (e.g., a common flat-rate scheme for farmers, and a special scheme for small enterprises). For example, as far as small enterprises are concerned, member states may apply simplified procedures, such as flat-rate schemes, for charging and collecting VAT. In addition, they can also exempt enterprises whose annual turnover is below a specified level. Moreover, extreme circumstances are taken into account. Member

[34] Also see 'What is VAT?' <https://taxation-customs.ec.europa.eu/what-vat_en>.

[35] For more details, see Council Directive 2006/112/EC, Annex III.

[36] The seven points cannot be selected from the entire list but from specific points of the list. For more details, see Article 98(2) of the VAT Directive.

states may grant exemptions to the importation of goods for the benefit of disaster victims and to the importation of products necessary to face the COVID-19 pandemic. Member states intending to apply these exemptions should inform the VAT Committee.

The VAT Directive has been amended several times since 2006. One significant change in the EU VAT system refers to the new EU VAT rules for e-commerce that came into force on 1 July 2021.[37] The scope of the new rules is to simplify cross-border e-commerce, increase transparency for EU consumers, and decrease fraud. The main changes include:

- The removal of the exemption for low-value goods (goods valued at less than €22) imported into the EU from non-EU companies, meaning that all goods imported into the EU are subject to VAT.[38]
- EU e-commerce sellers can register in one member state to declare and pay VAT on all distance sales within the EU, in case they have a turnover (from distance sales) above €10,000, a threshold common to all member states.[39] To assist e-commerce sellers and simplify procedures, an 'One Stop Shop' electronic portal has been created, where EU e-commerce sellers can handle all their VAT obligations for their sales across the entire EU.
- Similarly, an 'Import One Stop Shop' has been created for non-EU sellers, where they can register for VAT in the EU.
- Businesses facilitating supplies of goods through online marketplaces/ platforms are, in specific cases, considered to have received and supplied the goods themselves ('deemed suppliers'). In addition, new record keeping requirements are introduced for online marketplaces/ platforms.

More recently, on 8 December 2022, the European Commission proposed a series of measures that aim to improve the EU's VAT system, in-

[37] For more information, see Explanatory Notes on VAT e-commerce rules, available at <https://vat-one-stop-shop.ec.europa.eu/system/files/2021-07/vatecommerceexplanatory_notes_28102020_en.pdf>.

[38] Previously, goods valued at less than €22 imported into the EU by non-EU companies were exempted from VAT.

[39] Previously, each member state could select its own threshold.

crease its resilience to fraud, and promote digitalization, while addressing the challenges of the platform economy. The key actions proposed are

- introducing real-time digital reporting for VAT purposes based on e-invoicing for companies that operate cross-border in the EU;
- updating VAT rules for passenger transport and short-term accommodation platforms;
- introducing a single VAT registration for businesses selling to consumers across the EU.

The new rules are expected to reduce VAT fraud by up to €11 billion a year, decrease compliance costs for EU sellers by more than €4.1 billion per year over the next ten years, and further decrease registration and administrative costs for companies, especially Small and Medium-sized Enterprises (SMEs), by €8.7 billion over a ten-year period.[40]

3.3. VAT rate structure in the EU27

One of the most important features of the EU VAT system concerns the underlying rate structure, which represents a key instrument for governments to achieve fiscal and other policy goals. Although the VAT Directive sets the lower bounds for standard and reduced VAT rates, as well as other specifications, it leaves significant room for action, ensuring that member states[41] have the ability to adjust their VAT rate structure according to their distinctive characteristics and policy objectives. With regard to the standard VAT rate, from 2000 to 2008, the average standard VAT rate[42] went through a period of mild increases and drops, ranging from 19.41% to 19.73% in the EU27 and from 18.11% to 18.87% in the EA19. During the global economic and financial crisis and its aftermath, 2009–2014, the

[40] For more details, see <https://taxation-customs.ec.europa.eu/taxation-1/value-added-tax-vat/vat-digital-age_en>.

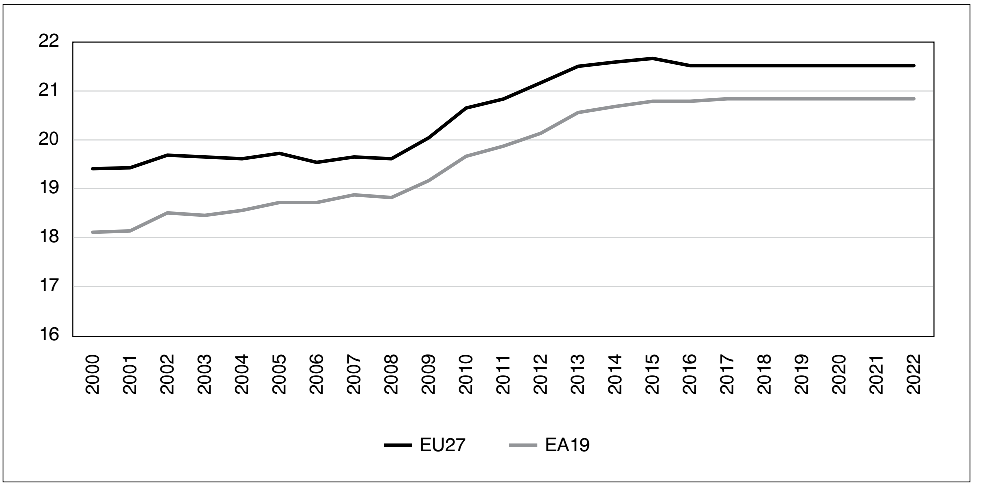
[41] In this section, when we refer to member states, we refer to EU27 member states.

[42] The VAT rates of each member state presented in this section, and used to calculate the averages, are those applicable for more than 6 months in the year considered, or on the 1st of July of that year.

average standard VAT rate increased significantly, ranging from 20.04% to 21.59% in the EU27 and from 19.16% to 20.68% in the EA19. In the following period, it remained rather stable, and since 2017, it has remained at the same level in both the EU27 and the EA19 (Figure 3.2). It is worth noting that the average standard VAT rate in the EU27 remained above the EA19 rate throughout the period under examination (2000–2022), implying that member states who do not belong to the Eurozone tend to apply higher standard VAT rates over time.

There is great differentiation among standard VAT rates applied by member states. In 2022, rates ranged from 27% in Hungary and 25% in Denmark, Croatia, and Sweden, to 18% in Malta and 17% in Luxemburg. Figure 3.3 illustrates the standard rate of the EU27 member states for three indicative years, i.e., 2000, 2008, and 2022.[43] Greece, along with Finland,

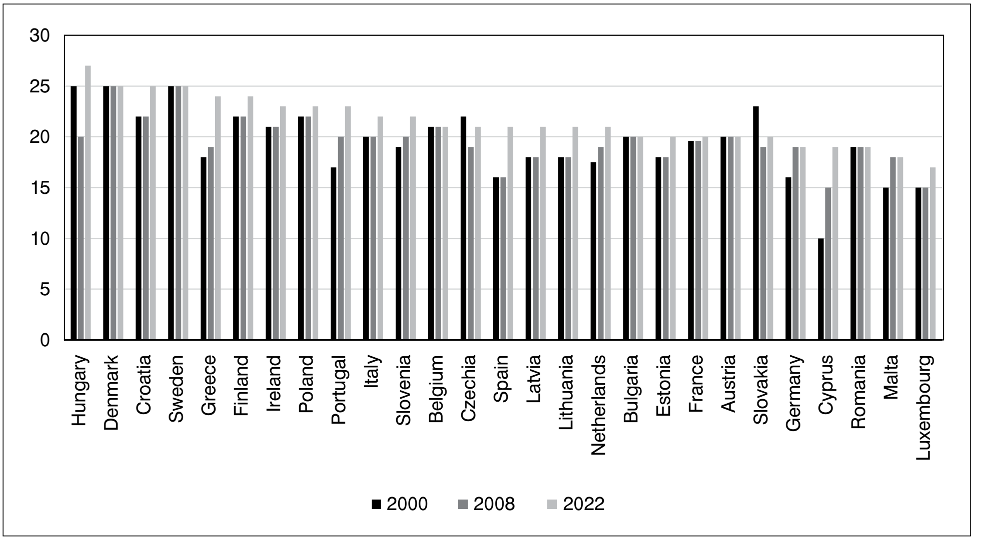
FIGURE 3.2
Average standard VAT rate of the EU27 and the EA19 (%)



Source: European Commission (2022).

[43] For more details, see Table A1 in Appendix A. Table A1 presents the standard rate of the EU27 member states from 2000 to 2022.

FIGURE 3.3
Standard VAT rate of the EU27 member states (%)



Source: European Commission (2022).

applied in 2022 the fifth highest standard VAT rate of 24%. From 2000 to 2008, seven member states (Germany, Greece, Cyprus, Malta, the Netherlands, Portugal, and Slovenia) increased their standard VAT rate and four (Czechia, Hungary, Portugal, and Slovakia) decreased it. Portugal increased the standard VAT rate in 2002 and 2005 and decreased it in 2008. Ireland decreased the standard VAT rate in 2001 and increased it back the next year. From 2009 to 2014, 19 member states increased their standard VAT rate, often as part of their fiscal consolidation efforts (OECD, 2022a), whereas two of them also decreased it during the same period,[44] and eight member states did not change it (Belgium, Bulgaria, Denmark, Germany, Luxembourg, Malta, Austria, and Sweden). During the next three years (2015–2017), only two member states (Greece and

[44] Ireland increased the standard VAT rate by 0.5 pp (percentage points) in 2009 only to decrease it back the next year and increase it again by 2 pp in 2012. Latvia increased it by 3 pp in 2009, by 1 pp in 2011, and decreased it by 1 pp in 2013.

Luxembourg) increased their standard VAT rate, and only one (Romania) reduced it. Since 2018, no member state has altered its standard VAT rate in a permanent way. Two member states (Germany and Ireland) reduced their standard VAT rate for short periods due to the COVID-19 pandemic.[45] It is worth noting, that only four member states (Belgium, Bulgaria, Austria, and Sweden) kept their standard rates unchanged throughout the entire period under consideration (2000–2022). By comparing standard rates in 2000 and 2022, it is observed that Cyprus experienced the largest increase of the standard VAT rate (from 10% in 2000 to 19% in 2022) and Greece and Portugal experienced the second largest increases (from 18% in 2000 to 24% in 2022, and from 17% in 2000 to 23% in 2022, respectively).

With reference to VAT reduced rates, almost all member states apply at least one reduced rate, with Denmark being the only exception. Moreover, five member states have not applied reduced rates for specific periods (Bulgaria, Croatia, Latvia, Romania, and Slovakia). Figure 3.4 presents the (single) reduced rate for the member states who apply only one reduced rate or the upper reduced rate[46] for the member states who apply two reduced rates, for three indicative years.[47] Figure 3.5 presents the lower reduced rate for the member states who apply two reduced rates. Similar to the standard rates, reduced rates also display significant differentiation among member states. In 2022, single or upper reduced rates ranged from 18% in Hungary and 15% in Czechia to 8% in Luxembourg and Poland and 7% in Germany and Malta. In the same year, Greece applied the fourth highest reduced rate, along with Austria, Croatia, and Portugal. Among the member states who apply two reduced rates, the most commonly applied lower reduced rate[48] was 5% (10 member states), which is also the lowest boundary for reduced

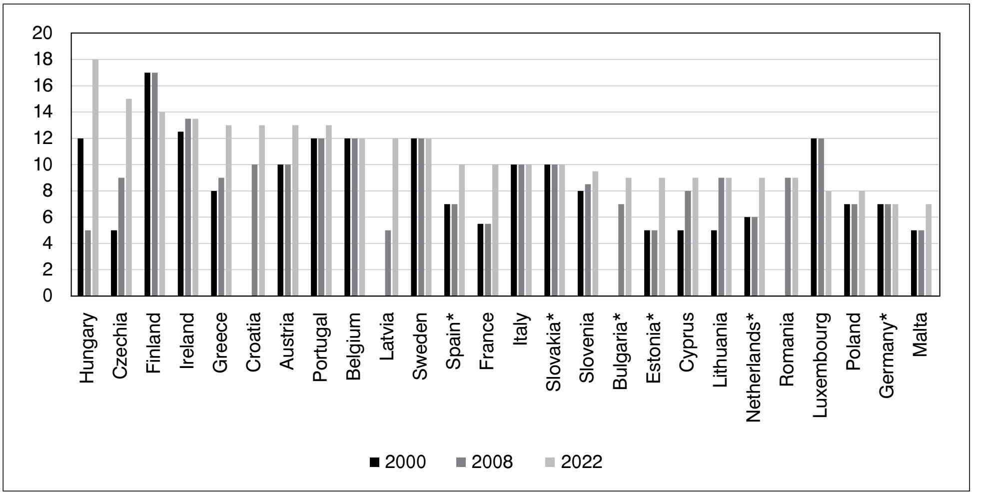
[45] Germany reduced the standard VAT rate from 19% to 16% and the reduced rate from 7% to 5% from 1 July to 31 December 2020. Ireland reduced the standard rate from 23% to 21% from 1 September 2020 to 28 February 2021.

[46] The highest of the two reduced rates applied.

[47] For more details, see Table A2 in Appendix A. Table A2 presents the reduced rates of the EU27 member states from 2000 to 2022.

[48] The lowest of the two reduced rates applied.

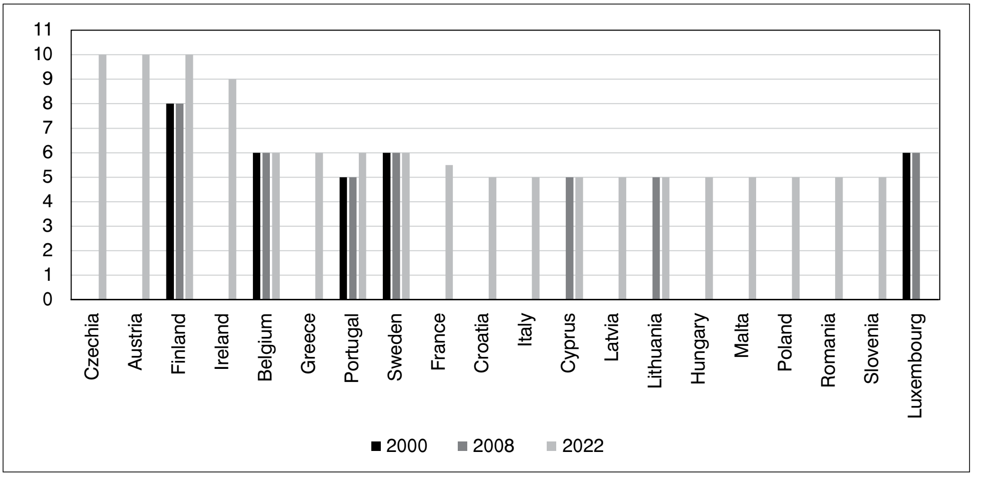
FIGURE 3.4
Single or upper reduced VAT rates of the EU27 member states (%)



Source: European Commission (2022).

Note: Member states denoted with an * had a single reduced rate throughout the period 2000–2022.

FIGURE 3.5
Lower reduced VAT rates of the EU27 member states (%)

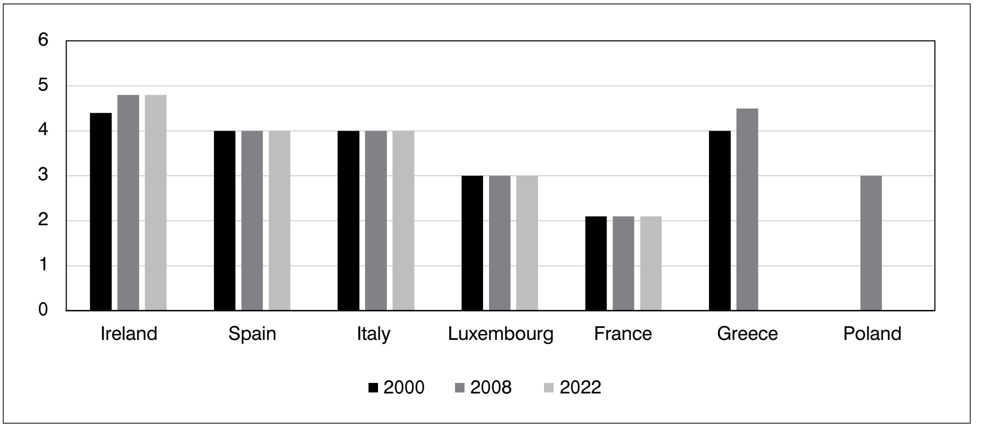


Source: European Commission (2022).

rates according to the VAT Directive. In general, the lower reduced rates ranged from 10% to 5%.

Apart from one or two reduced rates, certain member states apply super-reduced rates (i.e., reduced rates lower than 5%) to specific products or services. In 2022, only five member states applied super-reduced rates and only two more (Greece and Poland) did so during the previous years (Figure 3.6).[49] Moreover, five member states (Austria, Belgium, Ireland, Luxembourg, and Portugal) continued in 2022 to apply 'parking rates', which are 'historic rates'[50]

FIGURE 3.6
Super-reduced VAT rates of the EU27 member states (%)



Source: European Commission (2022).

[49] It should be noted that in accordance with the method of reporting used, for example, in European Commission (2022), any reduced rate below 5% is denoted as a super-reduced rate. This means that some member states may apply one reduced rate and one super-reduced rate, and some may apply two reduced rates and one super-reduced rate. For example, Spain applies a reduced rate (10%) and a super-reduced rate (4%), while Italy applies two reduced rates (10% and 5%) and a super-reduced rate (4%).

[50] Member states who, on 1 January 1991, were applying a reduced rate to goods or services other than those specified in Annex III of the VAT Directive (i.e., the Annex that lists the goods and services to the supply of which reduced rates may be applied) may continue to apply the reduced rate provided that the rate is not lower than 12%.

above 12%,[51] and six member states (Belgium, Denmark, Finland, Ireland, Lithuania, and Finland) applied zero rates.[52]

3.4. VAT rate structure in Greece

As mentioned in Chapter 2, VAT was first introduced in Greece in 1987 (Law 1642/1986 amended by Law 1676/1986 and Law 1684/1987) as part of the harmonization process of indirect taxes with the Sixth VAT Directive of the European Community (Triantafyllou, 1987). In this framework, several tax categories were abolished and replaced by VAT, such as stamp duties, turnover tax, and taxes on specific products and services (sugar, detergents, waxy substances, starch syrup, entertainment services, films, etc.).[53] According to Law 1676/1986, three different rates were initially applied: 8% (reduced rate) on food and other necessities[54] (listed in Annex II), 36% (high rate) on luxury products (listed in Annex III), and 18% (standard rate) on all other goods and services. In the Dodecanese islands, the reduced and standard rates were lower by 30% and the high rate lower by 15%, compared to the corresponding rates applied to the rest of the country.[55] Exemptions were granted for specific services such as education, health, water supply, rent, etc. (Andrikopoulos et al., 1993). In 1988, the standard rate was reduced to 16% and Annexes II and III

[51] For example, Portugal applies the ‘parking rate’ of 13% to wine, diesel for agriculture, and agricultural tools and utensils, mobile silos, tractors, pumps, and other machinery designed exclusively or mainly for the purpose of agriculture, cattle breeding, or forestry.

[52] For example, Denmark applies the zero rate to newspapers, including newspapers delivered electronically.

[53] For more details, see Triantafyllou (1987) and Andrikopoulos et al. (1993).

[54] The reduced rate applied on books, periodicals and newspapers was decreased by 50%, i.e., a 4% super-reduced rate. Note that, in accordance with the terminology used in Greek legislation and the accompanying explanatory reports, any rate below the stated reduced rate that is applied to specific goods and services is denoted as a super-reduced rate, whether or not it is below 5%. While, as explained in note 22, in the EU terminology, only reduced rates below 5% are denoted as super-reduced rates.

[55] The reduction on VAT rates applied in the specified islands did not and does not apply to tobacco products and vehicles.

were amended (effective from 1/1/1988).[56] Two years later, in 1990, the standard rate increased back to 18%, and the reduced rate increased to 8% (effective from 28/4/1990).[57] Moreover, the 30% reduction of the VAT rates was also applied to the islands of Lesvos, Chios, Samos, and Samothrace, besides the Dodecanese islands where the reduction of rates had been applied since the initiation of the VAT.[58] In 1992, the high rate was abolished and the islands of the Cyclades, North Sporades, Thasos and Skyros were added to the list of islands where the reduction of VAT rates was employed. Moreover, the list of goods and services to the supply of which the reduced rate was applied (presented in Annex III since then) was amended (effective from 8/8/1992).[59, 60]

The initial VAT law was replaced by Law 2859/2000 (VAT Code) that incorporated and codified all previous amendments (Eriotis et al., 2021). The VAT rates, standard and reduced,[61] remained the same, and the reduction applied to the specified Aegean islands as well. In 2005, the standard rate was increased to 19% and the reduced rate to 9% (effective from 1/4/2005).[62] In March 2010, the standard rate was increased to 21% and the reduced rate to 10% (effective from 15/3/2010).[63] These increases were part of the Stability and Growth Programme and were intended to reduce the general budget deficit.[64] A few months later, in June 2010, the standard rate was increased again, to 23%, and the reduced rate to 11%

[56] Ministerial Decision Π.8499/4941/ΠΟΛ 369/1988 Greek Government Gazette Β΄ 57 ratified by Law 1839/1989.

[57] Law 1884/1990.

[58] Law 1881/1990.

[59] Law 2093/1992.

[60] Apart from books, periodicals, and newspapers, the 50% decrease on the reduced rate was also applied on admission to theatres.

[61] The reduced rate applied on books, periodicals and newspapers and admission to theaters remained decreased by 50%.

[62] Law 3336/2005.

[63] Law 3833/2010 “Protection of the national economy - Urgent measures to address the fiscal crisis”.

[64] Explanatory report <https://www.hellenicparliament.gr/UserFiles/2f026f42-950c-4efc-b950-340c4fb76a24/P-EPOIKON-eis_XPress_Hamster_temp.qxp.pdf>.

(effective from 1/7/2010).[65] These increases were part of the measures for the implementation of the support mechanism for the Greek economy by the member states of the Eurozone and the International Monetary Fund and were intended to reduce the fiscal deficit. Once more, in December 2010, the reduced rate increased to 13% (effective from 1/1/2011).[66] This increase was part of the urgent measures for the implementation of the support programme for the Greek economy, and its main goal, as stated in the explanatory report, was to increase public revenue. Furthermore, in order to enhance the competitiveness of the tourism sector, a 50% reduction of the reduced rate (i.e., practically a 6.5% super-reduced rate) was applied to accommodation in hotels and similar establishments and, in order to alleviate the burden for consumers and social security funds, the same reduction was applied to pharmaceutical products and vaccines. [67]

In July 2015, Appendix III[68] was replaced by a new one that incorporated fewer goods and services.[69,70] Furthermore, the 50% decrease on the reduced rate applied to accommodation in hotels and similar establishments was abolished (effective from 1/10/2015). The super-reduced rate applied to certain pharmaceutical products and vaccines, and to books, newspapers and periodicals was reduced to 6%. In addition, the reduction of the VAT rates applied to certain islands was to be gradually abolished: to highly tourism-developed islands with high per capita income effective from 1/10/2015[71] and to less tourism-developed islands effective

[65] Law 3845/2010 "Measures for the implementation of the support mechanism for the Greek economy by the member states of the Euro Zone and the International Monetary Fund", effective from 1/7/2010.

[66] Law 3899/2010 "Urgent measures for the implementation of the support programme for the Greek economy", effective from 1/1/2011.

[67] <https://www.hellenicparliament.gr/UserFiles/2f026f42-950c-4efc-b950-340c4fb76a24/E-ELOIK-EIS.pdf>.

[68] The goods and services on the supply of which reduced rates are applied are listed in Appendix III.

[69] Law 4334/2015 "Urgent arrangements for the negotiation and agreement with the European Stability Mechanism (ESM)".

[70] Several goods and services were reclassified (removed from Appendix III and taxed with the standard rate) such as coffee, tea, flowers, and restaurants and similar services.

[71] Rhodes, Santorini, Mykonos, Naxos, Paros, Skiathos (Circular Order ΠΟΛ1224/12.10.2015 and Law 4389/2016).

from 1/6/2016.[72] The abolition was suspended for the remote islands until 31/12/2016. These measures were legislated in accordance with the Euro Summit decision of 12/7/2015,[73] in order to start negotiations on a financial assistance programme for Greece. The aim of these measures was to streamline the VAT system and broaden the tax base to increase revenues.[74]

In 2016, the standard VAT rate was once again increased to 24%, effective from 1/6/2016.[75] The aim of this change was to increase public revenues and contribute to the fiscal adjustment of Greece.[76] Moreover, as stated in the explanatory report, the 30% reduction of the VAT rates has been maintained for the island of Skopelos, due to a natural disaster that affected the island, and the islands close to the eastern borders, due to the refugee crisis. In December 2016, the 30% reduction of the VAT rates was applied to the islands of the Prefecture of Evros, Lesvos, Chios, Samos, the islands of Dodecanes with the exception of Rhodes, and to Karpathos until 31/12/2017.[77]

In 2017, Appendix III was replaced by a new one that included agricultural supplies and services for agricultural production, effective from 1/7/2017.[78] The aim of this reclassification was to strengthen the liquidity of farmers and agricultural enterprises and to support the primary production sector of the country.[79] Moreover, in December 2017, the 30% reduction in the VAT rates was maintained for the islands of Leros, Lesvos,

[72] Syros, Thasos, Andros, Tinos, Karpathos, Milos, Skyros, Alonnisos, Kea, Antiparos, Sifnos (Circular Order ΠΟΛ1061/24.5.2016 and Law 4389/2016).

[73] <https://www.consilium.europa.eu/media/20353/20150712-eurosummit-statement-greece.pdf>

[74] Explanatory report <https://www.hellenicparliament.gr/UserFiles/2f026f42-950c-4efc-b950-340c4fb76a24/e-ems-eis.pdf>.

[75] Law 4389/2016 “Urgent provisions for the implementation of the agreement on fiscal objectives and structural reforms, and other provisions”, effective from 1/6/2016.

[76] Explanatory report <https://www.hellenicparliament.gr/UserFiles/2f026f42-950c-4efc-b950-340c4fb76a24/e-epidiat-eis-sunolo-neo.pdf>.

[77] Law 4446/2016.

[78] Law 4472/2017.

[79] Explanatory report <https://www.hellenicparliament.gr/UserFiles/2f026f42-950c-4efc-b950-340c4fb76a24/S-DIMOSTRAT-EIS-ANATYP.pdf>.

Kos, Samos, and Chios until 30/6/2018.[80] The reduction applied to the five islands was prolonged until 31/12/2022 through several extensions granted.[81] In May 2019, Appendix III was once again replaced by a new one that incorporated more goods and services such as coffee, tea, cocoa, and restaurants and establishments providing similar services (effective from 20/5/2019). In addition, the super-reduced rate of 6% was applied to electricity and natural gas, and admission to music concerts (apart from the other goods and services to which it was already applied).[82]

In April 2020, due to the COVID-19 pandemic,[83] certain goods used for protection against viruses and for personal hygiene[84] were added to Appendix III and the super-reduced rate of 6% was applied to them.[85] In May, more goods and services were added to Appendix III, such as non-alcoholic beverages, transport of passengers and their accompanying luggage, and admission to cinemas (the super-reduced rate of 6% was applied to the latter), effective from 1/6/2020 until 31/10/2020.[86] In the subsequent years, the time horizon of these provisions was extended to 31/12/2022.[87] In December 2020, a zero rate of VAT was applied on vaccines and in vitro diagnostic medical devices for the prevention and diagnosis of COVID-19, effective until 31/12/2022.[88] In October 2021, sever-

[80] Law 4509/2017.

[81] The corresponding ministerial decisions were published in the Greek Government Gazette no115 issue A, 29/6/2018; no221 issue A, 31/12/2018; no2543 issue B, 26/6/2019; no4744 issue B, 23/12/2019; no2537 issue B, 24/6/2020; no5597 issue B, 21/12/2020; no2828 issue B, 30/6/2021. Moreover, Law 4811/2021 states that the reduced VAT rates can continue to apply on the five islands provided that refugee centers are operating on these islands (effective from 1/7/2021).

[82] Law 4611/2019.

[83] Explanatory report <https://www.hellenicparliament.gr/UserFiles/2f026f42-950c-4efc-b950-340c4fb76a24/k-met-koronoios-OLO.pdf>.

[84] Such goods included protective masks, gloves for medicine, soap and other preparations for personal hygiene, antiseptics, ethyl alcohol used for the production of antiseptics.

[85] Law 4683/2020. The reduction was effective until 31/12/2020 and was extended until 31/12/2022 (Law 4728/2020, Law 4753/2020, Law 4690/2021, Law 4876/2021, and Law 4949/2022).

[86] Law 4690/2020.

[87] Law 4787/2021, Law 4839/2021, Law 4876/2021, Law 4949/2022.

[88] Law 4764/2020.

al goods and services were added to Appendix III, such as residues and waste from the food industries and services provided by dance schools and gyms.[89]

Overall, the VAT law has been subject to numerous changes since 2000. More specifically, it has been amended (through legislation) 22 times during 2000–2009, 56 times during 2010–2019, and 25 times during the last three years (2020–2022).[90] The standard and the reduced

TABLE 3.1
Main changes in VAT rates and Appendix III

Law	Standard rate	Reduced rate	High rate	Super-reduced rate	Replacement of Appendix III (since 2000)	Effective from
1642/1986 & 1676/1986	18%	6%	36%	3%		1/1/1987
MD Π.8499/ 4941/ΠΟΛ369/ 1988	16%	6%	36%	3%		1/1/1988
1884/1990	18%	8%	36%	4%		28/4/1990
2093/1992	18%	8%	Abolished	4%		8/8/1992
3336/2005	19%	9%		4.5%		1/4/2005
3833/2010	21%	10%		5%		15/3/2010
3845/2010	23%	11%		5.5%		1/7/2010
3899/2010	23%	13%		6.5%		1/1/2011
4334/2015	23%	13%		6%	✓	16/7/2015 & 1/10/2015
4389/2016	24%	13%		6%		1/6/2016
4472/2017	24%	13%		6%	✓	1/7/2017
4611/2019	24%	13%		6%	✓	20/5/2019

Source: Own compilation.

[89] Law 4839/2021. The provisions regarding dance schools and gyms were effective from 1/10/2021 till 30/6/2022 and were extended till 31/12/2022 by Law 4949/2022.

[90] *Source:* European Commission Taxes in Europe Database v3.

rates have been increased four times during 2000–2022, and the super-reduced rate has been increased four times and decreased once. Moreover, Appendix III (the list of goods and services on the supply of which the reduced and the super-reduced rates were applied) has been replaced three times during the same period, but multiple other changes (adding or removing goods and services) have been made through the years. Table 3.1 above summarizes the main changes in VAT rates and Appendix III of the VAT code.

3.5. Concluding remarks

VAT is the most common consumption tax worldwide. In Europe, the notion of a common turnover tax was introduced at a very early stage by the Treaty of Rome (1957). The First and Second VAT Directives that set the fundamental principles of the EU VAT system were issued in 1967. The Recast Sixth VAT Directive, along with several amendments that have been made since, sets the current EU legal framework. The basic provisions as far as the VAT rates are concerned are that the standard rate should not be less than 15% and that one or two reduced rates of not less than 5% may be applied to specific goods and services. The VAT Directive provides a list of goods and services to the supply of which reduced rates may be applied. Historically, increasing VAT rates was a common trend for a long period of time (2000–2016), which was intensified after the economic crisis. Since 2017, the average standard VAT rate in the EU27 has remained stable at 21.52%. Nevertheless, it should be noted that there is a great diversification among VAT rates applied by member states. The standard VAT rate ranges from 27% in Hungary to 17% in Luxemburg, and the reduced VAT rate ranges from 18% in Hungary to 5% in ten member states. Greece applies the fifth highest standard VAT rate.

In Greece, VAT was introduced in 1987 as part of the harmonization process of indirect taxes with the Sixth VAT Directive of the European Community and replaced several other taxes. The standard rate was 18% but was reduced to 16% a year later, while in 1988, the reduced rate was 8%, and the super-reduced rate was 4%; there was also a high rate of 36% that was abolished in 1992. Currently, the standard rate is 24%, the reduced rate 13%, and the super-reduced rate 6%. In the period spanning from 2000 to 2009, the standard VAT rate applied in Greece was lower than the EU27 average. However, in 2010, this trend was reversed, as the Greek standard VAT rate surpassed the EU27 average and remained higher until 2022. Moreover, the Greek standard VAT rate exceeded the EA19 average during 2005–2008 and again from 2010 to 2022. These developments since 2010 can be attributed to the 5-percentage point cumulative increase in the standard VAT rate, which was part of the fiscal consolidation measures implemented between 2010 and 2016 to address the economic and fiscal crisis.

The initial VAT law has been subject to frequent and multiple amendments. In particular, since 2000, the standard and the reduced rates have been increased four times, while there has been only one reduction in the super-reduced rate, in 2015. Moreover, with regard to reclassifications, the list of goods and services on the supply of which the reduced and the super-reduced rates were applied has been amended multiple times. During the period of the fiscal consolidation programmes, most changes in VAT rates (including reclassifications) aimed at raising revenues, while the changes that have been implemented during 2020–2021 intended to address the repercussions of the COVID-19 pandemic.

Concluding, Greek governments have used VAT rate changes and reclassifications (selecting whether to apply the standard or the reduced rate on specific goods and services) to increase public revenues and to cope with extreme circumstances, such as the economic crisis, the refugee crisis, and the COVID-19 pandemic, or to support specific sectors, e.g., tourism and agriculture. Nevertheless, it should be noted that frequent changes in the legislative framework may add to an already complex tax system, such as the Greek one, increasing the compliance burden for taxpayers (Tran-Nam and Evans, 2014; Hoppe et al., 2021).

CHAPTER 4

VAT REVENUES IN THE EU AND GREECE: IMPORTANCE AND EVOLUTION DURING 2000–2021

4.1. Introduction

Taxation is the main source of government revenues, and consumption taxes are the tax category that generates the highest revenue in OECD countries, on average (OECD, 2022b). In 2020, the average OECD share of consumption taxes on total taxation including social contributions (SC) reached 32% (20% was attributed to VAT[91]), while SC amounted to 26% and personal income tax to 23%. During the last five decades, the composition of taxes on consumption has fundamentally changed. In the 1970s, the OECD average of VAT as a percentage of total taxation was 9%, while the corresponding figure for other taxes on goods and services was 24%. It was during the 1990s that the share of VAT exceeded that of other consumption taxes (on average 18% and 16%, respectively). In general, the growing significance of VAT seems to have offset the declining share of specific consumption taxes, such as excises and custom duties (OECD, 2022b).

Although most VAT systems are based on the same principles, there exist significant variations in their rate structures and specifications, leading (among other things) to significant differences in the revenues raised by each OECD country. For example, in 2021, according to the OECD Global Revenue Statistics database,[92] VAT revenues as a percentage of GDP varied from 10% in New Zealand, Hungary and Denmark to 3% in Switzerland. The corresponding figure was greater than 9% in nine OECD

[91] VAT is applied in 37 of 38 OECD countries. In the context of OECD reports, the term VAT is used to refer to any national tax that embodies the basic characteristics of a value-added tax by whatever name or acronym it is known (OECD, 2022b).

[92] Data for 2021 are provisional and data for Australia are not available.

countries and less than 6%, again, in nine countries. In the same year, VAT revenues as a percentage of total taxation including SC ranged from 43% in Chile and 31% in New Zealand to 14% in Canada and 11% in Switzerland. The corresponding figure was greater than 25% in nine countries and less than 18% in eight countries.

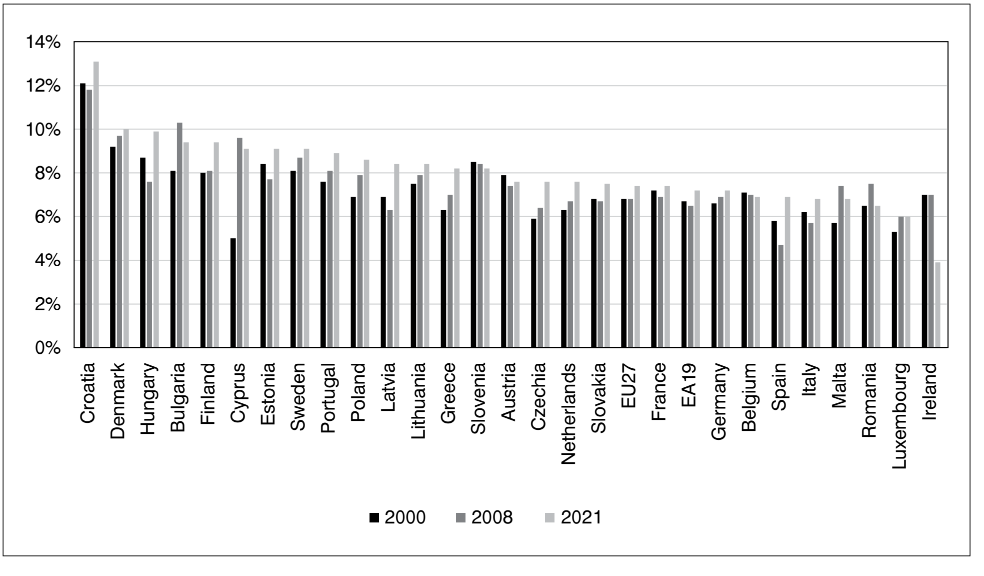
The effects of the COVID-19 pandemic on tax revenues differed among tax categories and, as far as VAT revenues are concerned, varied among OECD countries. In 2020, personal income taxes (PIT) and SC were the most resilient tax categories, increasing on average and in most OECD countries as a share of GDP, while VAT revenues remained stable, and corporate income taxes (CIT) decreased (OECD, 2022b). Although VAT revenues as a share of GDP remained stable in 2020 compared to 2019, at 6.7%, 18 OECD countries experienced a decrease, ranging from 0.9 pp to 0.1 pp. In 2021, revenues from CIT and VAT, as a share of GDP, exhibited a strong rebound, while PIT remained unchanged and SC declined (OECD, 2022b). Concerning VAT revenues as a share of GDP in 2021, an increase was observed in 30 countries, ranging from 1.5 pp to 0.1 pp, while a decrease was observed in only three countries.

Overall, VAT has gained momentum as the main consumption tax and one of the main sources of public revenue during the last decades. Moreover, VAT revenue, in the context of this Study, is the variable of interest when estimating VAT revenue response to changes in key macroeconomic variables. Therefore, the aim of this chapter is to offer an overview of the evolution of VAT revenues in the EU and Greece. In order to be able to make comparisons between EU27 member states, we have used data from Eurostat. The examination period for volumes and shares is 2000–2021 and for rates of change is 2001–2021 (data for 2022 were not available). In what follows, Section 4.2 presents VAT revenues as a share of GDP and general government (GG) total tax receipts including SC, across EU member states. Section 4.3 focuses on the main developments of VAT revenues in Greece, i.e., their evolution, from 2000 to 2021, in volumes and as a share of GG total tax receipts excluding SC and, from 2001 to 2021, their rate of change. Finally, Section 4.4 summarizes the key points of the chapter and concludes.

4.2. VAT revenues in the EU

VAT is a tax common to all EU member states, as analyzed in previous chapters (see Chapter 2 and Chapter 3). Figure 4.1 illustrates VAT revenues as a percentage of GDP across EU27 member states for three indicative years, i.e., 2000, 2008, and 2021. As it becomes evident, VAT revenues vary significantly among member states, ranging, in 2021, from 13% in Croatia and 10% in Denmark and Hungary to 6% in Luxembourg and 4% in Ireland. Notably, in 2021, VAT revenues represented more than 8% of GDP in 14 member states, including Greece where revenues accounted for 8.2% of GDP. Greece ranked 13th (along with Slovenia) among member states, well above the EU27 (7.4%) and the EA19 (7.2%). Most member states witnessed an overall increase as far as VAT revenues are concerned, over the period under examination (2001–2021). In more detail, during the sub-period 2001–2008, VAT revenues

FIGURE 4.1
VAT revenues (% of GDP) for the EU27 countries



Source: Eurostat.

as a percentage of GDP exhibited a positive average annual growth in 15 member states. During the next sub-period, 2009–2021, 19 member states witnessed an increase in VAT revenues as a percentage of GDP, on average. Over the entire period, 2001–2021, 22 member states experienced an average positive annual change of their VAT revenues as a percentage of GDP.

Furthermore, VAT is a crucial source of public revenue. The importance of VAT revenues as a share of GG total tax receipts including SC[93] in EU member states is illustrated in Figure 4.2 for three indicative years, i.e., 2000, 2008, and 2021. In this case also, the share of VAT revenues in 2021 differs significantly among member states, ranging from 37% in Croatia and 31% in Bulgaria to 15% in Belgium and Luxembourg. Notably, in 2021, the share of VAT revenues was greater than 20% in 17 member states. Greece ranked 18th, and the share of VAT revenues was 19.9%, higher than the corresponding figure for the EU27 (17.9%) and the EA19 (17.1%). Most member states witnessed an overall increase in VAT revenues as a share of GG total tax receipts including SC, over the period under consideration (2001–2021). In more detail, during the sub-period 2001–2008, 18 member states exhibited a positive average annual growth in the share of VAT revenues. During the next sub-period, 2009–2021, 14 member states witnessed an increase in the share of VAT revenues, on average. Over the entire period, 2001–2021, 22 member states experienced a positive average annual change of the respective VAT revenues share.

The importance of VAT can be further highlighted by comparing the contribution of VAT in total taxation (i.e., GG total tax receipts including SC) with that of other tax categories. It is worth noting that, in 2021,

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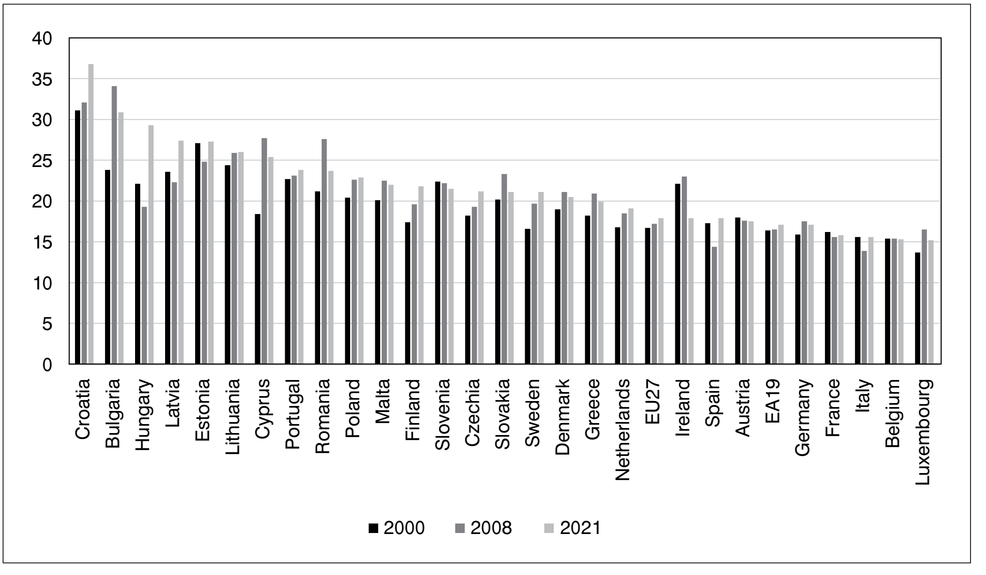
[93] According to Eurostat and ESA 2010 (European System of National and Regional Accounts) classification, total taxation including SC is defined as total receipts from taxes and SC (including imputed SC) after the deduction of amounts assessed but unlikely to be collected, i.e., the sum of taxes on production and imports, current taxes on income, wealth, etc., capital taxes, and net SC, minus capital transfers from the general government to relevant sectors representing taxes and SC assessed but unlikely to be collected. Therefore, all percentages presented in Figures 4.2, 4.3 and 4.4 are a share of this total, as provided by Eurostat. For more details on ESA 2010 classifications visit: <https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Tax_revenue>.

FIGURE 4.2
Share of VAT revenues in GG total tax receipts including SC (%)
for the EU27 countries



Source: Eurostat.

revenues from taxation were almost equally distributed among the three main tax types, i.e., indirect taxes[94] (33%), direct taxes[95] (33%), and SC[96] (34%), in the EU27. As illustrated in Figure 4.3, the main indirect tax was VAT (17.9%),[97] while the main direct taxes were PIT[98] (23.6%) and CIT[99] (7%).

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[94] Indirect taxes, i.e., taxes on production and imports (ESA 2010 code D2) including VAT (D211), taxes and duties on imports excluding VAT (D212), taxes on products, except VAT and import taxes (D214), and other taxes on production (D29).

[95] Direct taxes include current taxes on income, wealth, etc. (D5) and capital taxes (D91).

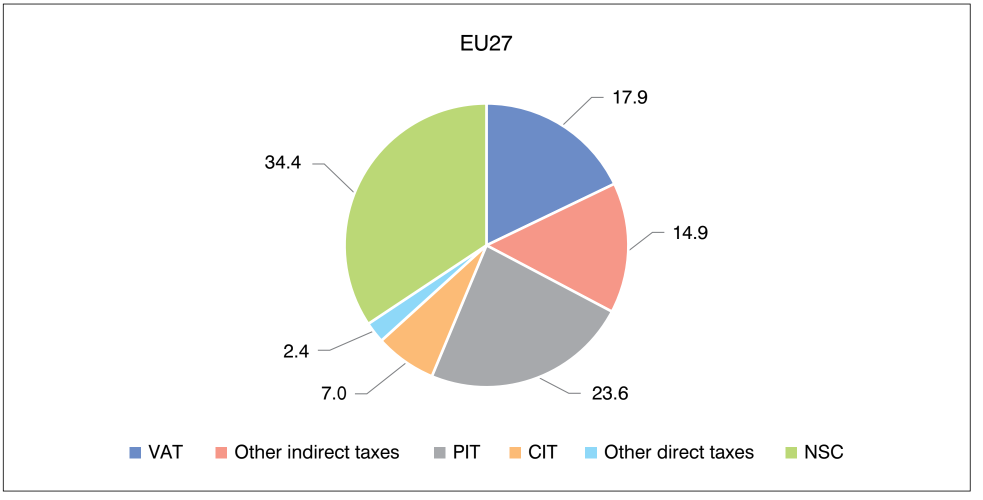
[96] SC refer to net social contributions including imputed social contributions (D61).

[97] The shares of other indirect taxes are: 0.9% taxes and duties on imports excluding VAT; 8.1% taxes on products, except VAT and import taxes; and 5.9% other taxes on production.

[98] PIT refers to taxes on individual or household income including holding gains (D51A_C1).

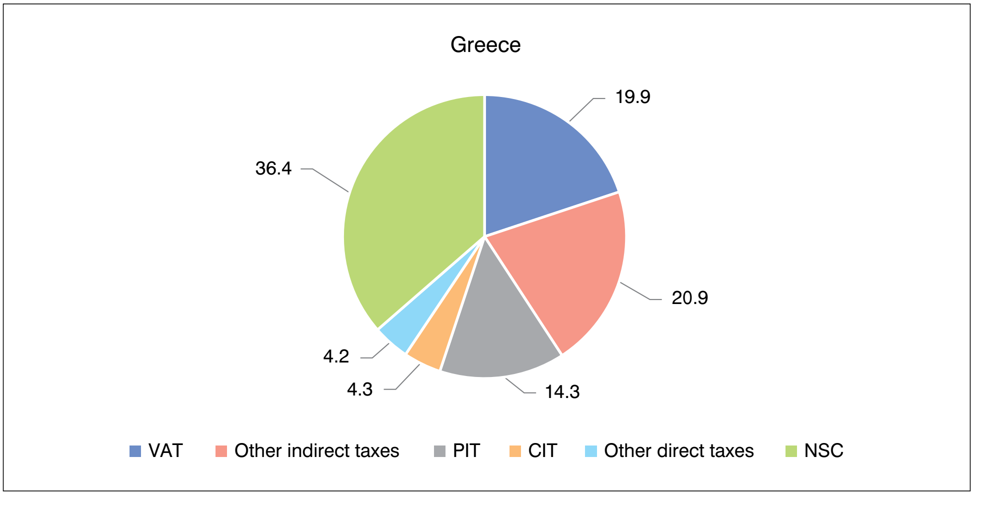
[99] CIT refers to taxes on the income or profits of corporations including holding gains (D51B_C2).

FIGURE 4.3
Structure of total taxation by tax type, 2021, EU27 countries (%)



Source: Eurostat.

FIGURE 4.4
Structure of total taxation by tax type, 2021, Greece (%)

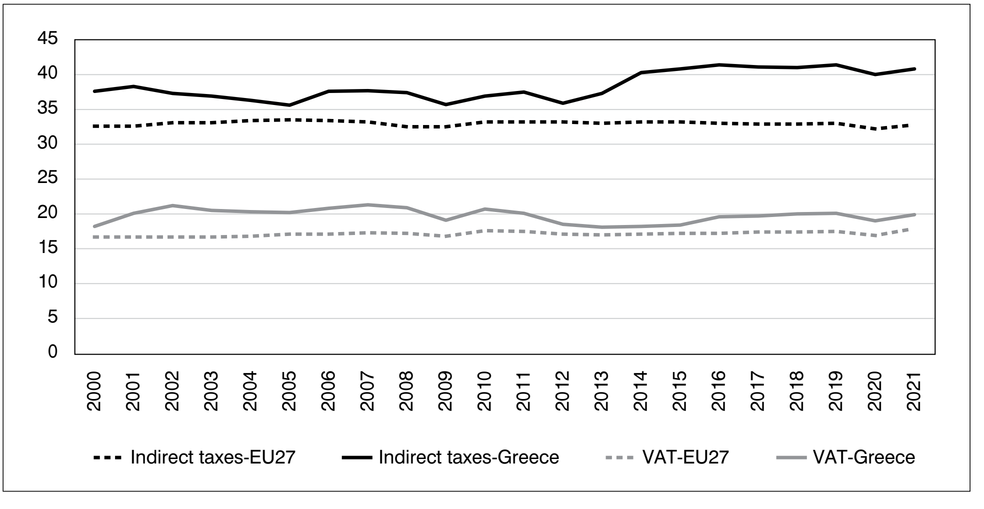


Source: Eurostat.

Greece exhibited a rather different allocation of tax revenues during the same year (Figure 4.4 above). The main source of tax revenues were indirect taxes (41%), followed by SC (36%) and direct taxes (23%). In this case also, the main indirect tax was VAT (19.9%),[100] while the main direct taxes were PIT (14.3%) and CIT (4.3%), significantly lower than the corresponding shares of the EU27.

Considering the evolution over time of the share of the different tax types for the period 2000–2021, we observe that the shares of indirect taxes and VAT remained rather stable in the EU27, ranging from 32.2% to 33.5% and from 16.7% to 17.9%, respectively (Figure 4.5). In Greece, both shares exhibited more notable fluctuations and remained above the EU27 corresponding shares throughout the examination period (2000–2021).

FIGURE 4.5
Shares of indirect taxes and VAT in total taxation including SC, for EU27 countries and Greece (%)



Source: Eurostat.

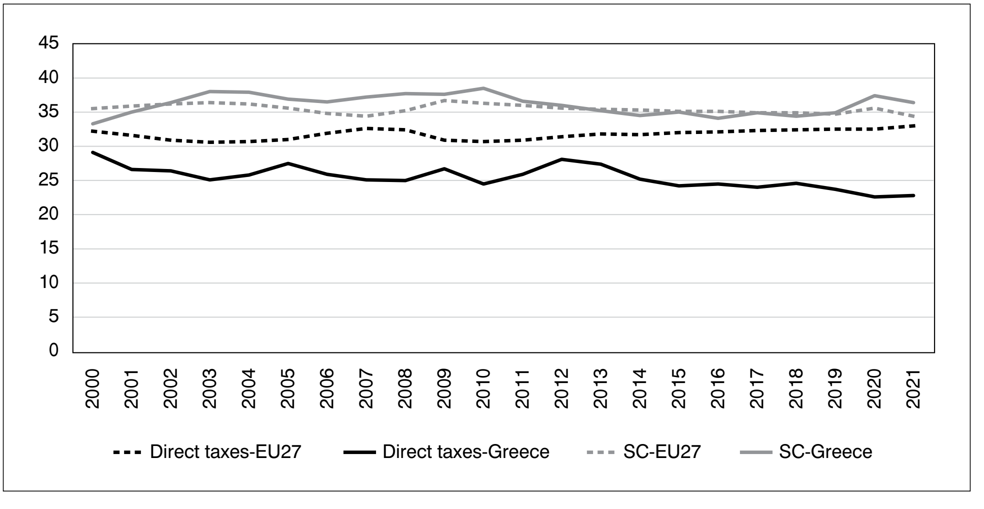
[100] The shares of other indirect taxes are: 0.6% taxes and duties on imports excluding VAT; 12% taxes on products, except VAT and import taxes; and 8.3% other taxes on production.

The share of indirect taxes ranged from 35.6% to 41.4%, while the share of VAT ranged from 18.1% to 21.3%.

Conversely, the share of direct taxes in the EU27 remained above the corresponding share in Greece throughout the period 2000–2021, with the respective shares ranging from 30.6% to 33% and from 22.6% to 29.1% (Figure 4.6). Finally, the shares of SC in the EU27 and Greece were rather close, ranging from 34.4% to 36.7% and from 33.3% to 38.5%, respectively. In conclusion, Greece seems to be, over time, more heavily reliant on revenues from indirect taxes and especially VAT, which is the main indirect tax, compared to the EU27, which is equally reliant on revenues from all three types of taxes.

Turning to the effects of the COVID-19 pandemic, most EU member states were significantly affected as far as their revenues from VAT are concerned. EU27 and EA19 VAT revenues as a share of GDP both decreased by 0.3 pp in 2020 compared to 2019, whereas 18 member states exhibited a decrease ranging from 0.9 pp to 0.1 pp (Table 4.1). In terms

FIGURE 4.6
Share of direct taxes and SC in total taxation including SC, for EU27 countries and Greece (%)



Source: Eurostat.

TABLE 4.1
Percentage change of VAT revenues and change of VAT revenues as percentage of GDP (in pp), 2019–20 and 2020–21

Member state	% change of VAT revenues		Change of VAT revenues as % of GDP, in pp	
	2019–20	2020–21	2019–20	2020–21
EU27	-7.0%	15.6%	-0.3	0.5
EA19	-8.2%	16.1%	-0.3	0.6
Belgium	-7.5%	16.9%	-0.2	0.4
Bulgaria	-0.4%	18.4%	-0.1	0.3
Czechia	-5.9%	13.2%	-0.1	0.2
Denmark	4.0%	8.2%	0.3	0.0
Germany	-9.2%	17.1%	-0.5	0.7
Estonia	-1.7%	17.9%	0.0	0.2
Ireland	-16.5%	30.2%	-0.9	0.5
Greece	-16.0%	15.6%	-0.6	0.4
Spain	-12.6%	18.2%	-0.2	0.6
France	-7.1%	14.4%	-0.1	0.4
Croatia	-14.8%	21.0%	-0.8	0.6
Italy	-10.6%	21.2%	-0.2	0.8
Cyprus	-13.5%	22.2%	-0.7	0.9
Latvia	-2.3%	9.8%	-0.1	-0.1
Lithuania	3.2%	18.3%	0.1	0.4
Luxembourg	1.5%	16.1%	-0.1	0.2
Hungary	-3.5%	13.4%	0.2	0.2
Malta	-9.1%	17.8%	-0.2	0.3
Netherlands	1.5%	10.0%	0.3	0.2
Austria	-6.6%	8.8%	-0.3	0.2
Poland	-1.2%	17.8%	0.0	0.6
Portugal	-10.6%	13.7%	-0.4	0.5

TABLE 4.1 (continued)

Member state	% change of VAT revenues		Change of VAT revenues as % of GDP, in pp	
	2019–20	2020–21	2019–20	2020–21
Romania	-3.1%	16.0%	-0.1	0.4
Slovenia	-10.3%	21.0%	-0.6	0.6
Slovakia	0.1%	9.9%	0.1	0.2
Finland	0.1%	7.0%	0.0	0.2
Sweden	1.3%	11.9%	0.1	-0.1

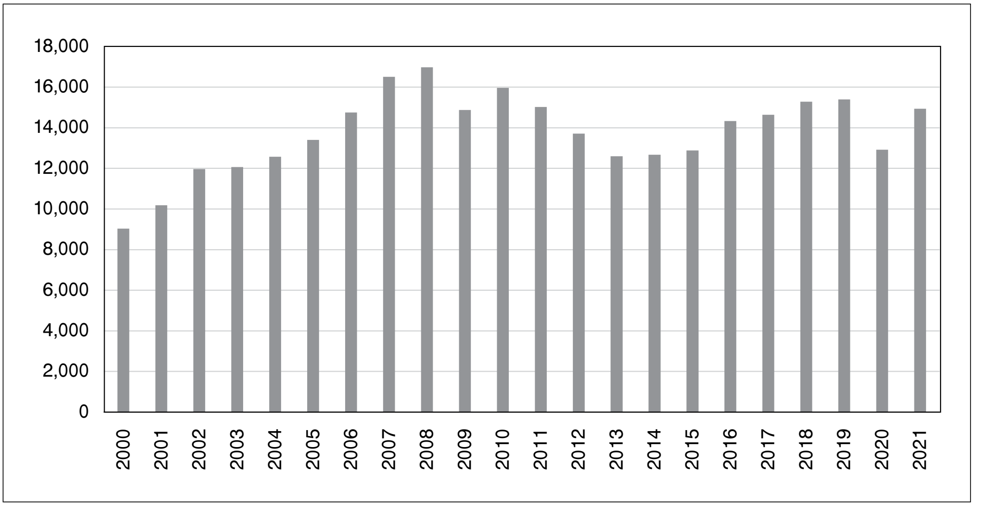
Source: Eurostat, own calculations.

of volumes, EU27 and EA19 VAT revenues decreased by 7% and 8.2%, respectively, in 2020 compared to 2019. Moreover, 21 member states exhibited a decrease of VAT revenues. The largest decreases were recorded in Ireland, by 16.5%; in Greece, by 16%; and in Croatia, by 14.8%. In 2021, VAT revenues recovered in most member states. EU27 and EA19 VAT revenues as a share of GDP increased by 0.5 pp and 0.6 pp, respectively, in 2021 compared to 2020, where as 24 member states experienced an increase ranging from 0.9 pp to 0.2 pp. EU27 and EA19 revenues increased, in 2021, by 15.6% and 16.1%, respectively. All member states exhibited an increase in their VAT revenues. The largest increases were observed in Ireland, by 30.2%; in Cyprus, by 22.2%; and in Italy, by 21.2%.

4.3. VAT revenues in Greece

Over time, VAT has been proven a crucial source of revenue for Greek governments. In 2000, VAT generated €9 billion in revenue, a figure that increased to €14.9 billion in 2021. However, its peak was in 2008, when it amounted to nearly €17 billion (Figure 4.7). In what follows, the course of VAT revenues will be presented (in terms of volumes and annual growth rate), along with the changes in VAT rates that took place

FIGURE 4.7
VAT revenues, Greece (in million €)



Source: Eurostat.

and the evolution of certain macroeconomic variables (GDP,[101] disposable income,[102] private consumption,[103] and GG total tax receipts excluding SC[104]), in order to provide a broader and more comprehensive picture of the economic conditions and the course of major macroeconomic variables involved in the estimation of VAT revenue response during the period under examination (2000–2021 for volumes and 2001–2021 for annual changes). Figure 4.8 illustrates the yearly rate of change of VAT revenues, while the years in which changes in VAT rates were implemented have been indicated in color. Figure 4.9 presents the annual growth rate of VAT revenues, GDP, disposable income, private consumption, and GG total tax receipts excluding SC.

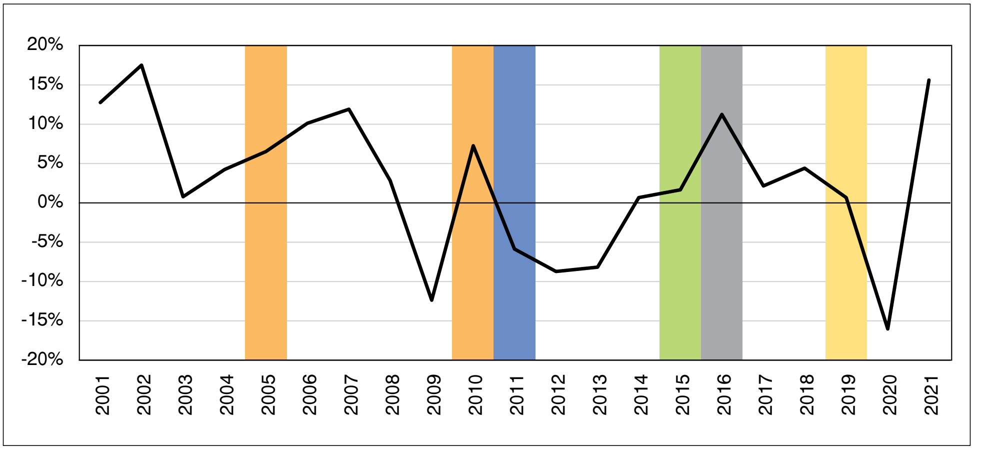
[101] We are referring to the real GDP growth rate (*Source:* Eurostat).

[102] We are referring to net adjusted disposable income in current prices (*Source:* Eurostat).

[103] We are referring to household and NPISH (Non-profit institutions serving households) final consumption expenditure, chain-linked volumes (*Source:* Eurostat).

[104] *Source:* Eurostat.

FIGURE 4.8
VAT revenues' yearly rate of change, Greece



Source: Eurostat, own calculations.

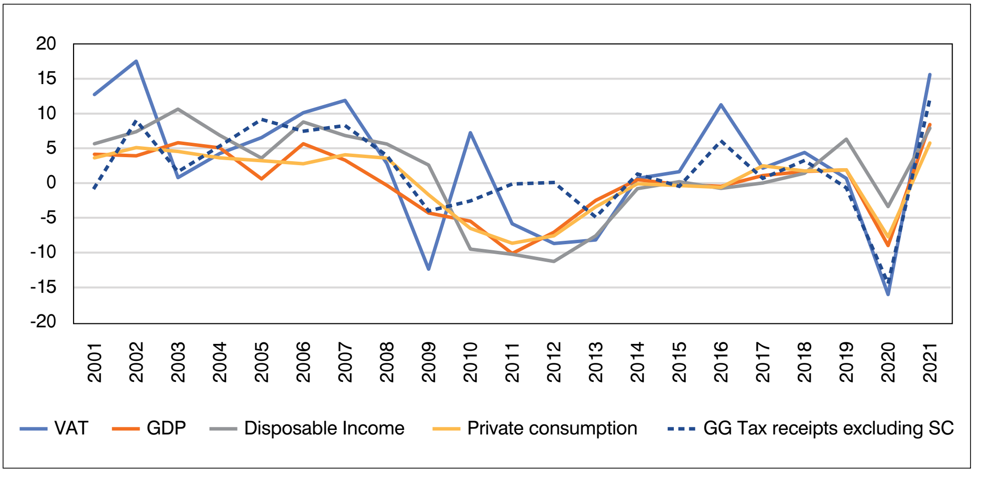
Note: Orange denotes the years when the standard, the reduced, and the super-reduced rates changed; blue denotes the year when the reduced and the super-reduced rates changed; grey denotes the year when the standard rate changed; green denotes the year when the super-reduced rate changed and Annex III was replaced; and yellow denotes the year when Annex III was replaced.

From 2001 to 2008, as demonstrated in both Figure 4.7 and Figure 4.8, VAT revenues experienced a constant increase, although the positive rate of change varied significantly, from 1% to 18%. Only one significant change in VAT rates took place during that period. After fifteen years of stability, the standard and reduced rates increased by 1 pp, in April 2005, reaching 19% and 9%, respectively, while the super-reduced rate increased by 0.5 pp. That time frame coincided with a period of economic growth (2008 was the only year that a mild contraction was recorded,[105] related to the beginning of the deep economic crisis that followed). Similarly, during the period 2001–2008, disposable income rose, and private consumption increased as well. GG total tax receipts excluding SC also increased during 2002–2008 (Figure 4.9).[106]

105 In 2008, the real GDP growth rate was -0.3%.

106 In 2001, total tax revenues experienced a mild drop by 0.7%.

FIGURE 4.9
Annual growth rates of VAT, GDP, disposable income, private consumption, and GG tax receipts excluding SC (%), Greece



Source: Eurostat, own calculations.

In 2009, VAT revenues recorded, for the first time (during the time period under investigation), a decrease of 12%, compared to 2008. This constitutes the second largest decrease of the entire period under consideration (2001–2021). At the same time, the first signs of the economic crisis that followed became apparent, where GDP and private consumption decreased, although the net disposable income continued to increase. GG total tax receipts excluding SC also decreased, by 4%, a drop significantly smaller than the reduction of VAT revenues. It should be noted that no changes in VAT rates took place that year.

In 2010, as Greece plunged further into a severe economic recession, the Greek government increased the VAT rates twice, in March and July. These increases were part of the fiscal consolidation programmes. Cumulatively, the standard VAT rate increased by 4 pp, while the reduced VAT rate increased by 2 pp, and the super-reduced by 1 pp, reaching 23%, 11%, and 5.5%, respectively. VAT revenues rose by 7%, which constituted a significant increase, but they did not return to the level observed in 2008. At the same time, the net disposable income decreased for the first time during the examined period, while private consumption continued to decline. GG total tax receipts excluding SC also fell for the second consecutive year.

The next three years, 2011–2013, are marked by a continuous decline of VAT revenues, by 6% in 2011, 9% in 2012, and 8% in 2013. At the beginning of that three-year period, another change in VAT rates came into effect. In January 2011, the reduced rate increased by 1 pp, and the super-reduced rate increased by 1 pp, reaching 13% and 6.5%, respectively. Moreover, the economic conditions in Greece worsened and GDP, private consumption, and net disposable income continued to decline. Taking into account the changes of the VAT rates that took place in 2010 and those that were implemented in 2011, it seems that they failed to prevent the drop of VAT revenues. Another interesting observation is that GG total tax receipts excluding SC remained rather stable in 2011 and 2012, while they decreased by 5% in 2013, compared with the previous year. In addition, during the period 2009–2013, the average annual rate of change of VAT revenues was -6%, while the corresponding rate for GG total tax receipts excluding SC was -2%. This might be an indication that VAT revenues are more vulnerable to adverse economic conditions than GG total tax receipts excluding SC.

The next six years (2014 to 2019) are characterized by continuous increases of VAT revenues. In more detail, in 2014, after three years of consecutive decreases, VAT revenues increased marginally, by 0.7% (GG total tax receipts excluding SC also increased by 1.3%). At the same time, VAT rates remained unchanged and the economic conditions slightly improved; that is, GDP increased by 0.5%, after six years of contraction, while private consumption and disposable income marginally decreased by less than 1%,[107] which, in fact, indicates a mild improvement compared to the dramatic fall of the previous four years.

In the summer of 2015, changes were implemented in the VAT rate structure. Although these changes did not incorporate alterations of the standard and the reduced rates – only the super-reduced rate decreased by 0.5 pp – several goods and services were reclassified (for

[107] Disposable income fell by 0.8% and private consumption by 0.1%, compared to 2013.

more details, see Chapter 3). Moreover, in October 2015, the 50% reduction of the reduced rate applied to accommodation in hotels and similar establishments was abolished, as well as the 30% reduction applied to certain islands. VAT revenues increased by 1.6% in 2015 compared to 2014. At the same time, GDP, private consumption, disposable income, and GG total tax receipts excluding SC did not record significant changes.[108]

In the next year, 2016, the standard VAT rate was increased once more, reaching 24% (which is the current VAT rate), and VAT revenues exhibited a significant increase, as they rose by 11%. GG total tax receipts excluding SC also increased (by 6%), but GDP, private consumption, and net disposable income mildly decreased by less than 1%.

Over the next three years, 2017–2019, VAT revenues continued to increase, but at a much slower pace (2.2% in 2017, 4.4% in 2018, and 0.7% in 2019, compared to the previous year). Although VAT rates remained unchanged, the amendments to the VAT law led to actual changes in the rates applied to certain parts of the country and several goods and services. On the one hand, the 30% reduction of the VAT rates applied to certain islands was abolished, meaning that VAT rates in these islands increased. On the other hand, several goods and services were added to Appendix III, meaning that the VAT rate applied to these goods and services decreased significantly, from 24% to 13% (for more details, see Chapter 3). In parallel, the economic conditions started to improve in Greece; as GDP increased, disposable income and private consumption rose as well. GG total tax receipts excluding SC also increased during 2017–2019.

The outbreak of the COVID-19 pandemic, in 2020, affected most aspects of society and the economy. GDP and private consumption decreased dramatically, and disposable income also fell. In order to address the adverse effects of the pandemic, the super-reduced rate was applied to certain goods used for protection against viruses and for personal hygiene, and more goods and services were added to Appendix III.

[108] GDP, private consumption, and GG total tax receipts excluding SC decreased by 0.2%, 0.3%, and 0.5%, respectively, and disposable income increased by 0.2%.

VAT revenues decreased by 16%, while GG total tax receipts excluding SC decreased by 14%. As the economy started to recover in 2021, GDP, disposable income, and private consumption increased significantly. In 2021, VAT revenues experienced the largest increase since 2002, for the period under consideration (2001–2021), as they rose by almost 16%. The economy rebounded as GDP disposable income and private consumption rose as well. GG total tax receipts excluding SC also increased by 12%.

Overall, VAT revenues in Greece exhibited an upward trend from 2001 to 2008, when the average annual rate of change was 8%. This tendency was reversed during 2009–2013 (the only exception was the year 2010 when VAT revenues increased), with the average annual rate of change being -6%. Finally, during the last eight years under consideration, 2014–2021, VAT revenues increased continuously (with 2020 being the only exception) and the average annual rate of change was 3%.

4.4. Concluding remarks

VAT is a key fiscal instrument that generates significant public revenue. During the last two decades, VAT revenues amounted, on average, to 20% of the total tax revenues including SC in OECD countries and 17% in the EU27. However, the importance of VAT revenues differs between member states. In 2021, VAT revenues as a share of GG total tax revenues including SC ranged from 37% in Croatia to 15% in Belgium and Luxembourg. Greece ranked 18th, and the share of VAT revenues was 19.9%, above the EU27 and the EA19 corresponding shares. Similarly, in 2021, VAT revenues as a percentage of GDP varied significantly among EU27 member states, ranging from 13% in Croatia to 4% in Ireland. Greece ranked 13th, and VAT revenues amounted to 8.2% of GDP, above the EU27 and the EA19 corresponding figures. Overall, since 2000, most member states witnessed an increasing trend as far as VAT revenues as a percentage of GDP and the share of VAT revenues on GG total tax revenues including SC are concerned.

Furthermore, the COVID-19 pandemic exerted a significant impact on VAT revenues in most EU27 member states. In 2020, 18 member states exhibited a decrease in VAT revenues as a percentage of GDP and 21 member states exhibited a decrease in VAT revenues in terms of volumes, compared to 2019. However, most member states witnessed a recovery in 2021. VAT revenues as a percentage of GDP increased in 24 member states and VAT in volumes increased in all member states.

As far as Greece is concerned, VAT is also a major source of revenue. In 2021, it generated €14.9 billion in revenue, which corresponded to 8.2% of GDP and amounted to 20% of GG total tax revenue including SC and 31.3% of GG total tax revenue excluding SC. The course of VAT revenues has been rather turbulent during the period under examination (2001–2021). From 2001 to 2008, Greece experienced a period of economic growth, during which GDP, disposable income, and private consumption were constantly rising. VAT rates increased only once, in 2005, and VAT revenues witnessed a consistent increase, although the rate of change varied significantly. The average growth rate of VAT revenues was 8%. From 2009 to 2016, Greece experienced a severe economic crisis, where GDP, disposable income, and private consumption were constantly decreasing, with very few exceptions. VAT rates changed multiple times, and the standard VAT rate was applied to several products and services that were previously taxed at the reduced rate. Cumulatively, the standard VAT rate increased by 5 pp and the reduced VAT rate by 4 pp during the period of severe economic crisis. The average rate of change of VAT revenues was -2%. During the next three-year period, 2017–2019, Greece experienced mild economic growth and GDP, disposable income, and private consumption increased. VAT rates remained unchanged, but in 2019, the reduced rate was applied to several goods and services that were previously taxed at the standard rate. The average growth rate of VAT revenues was 2%.

Similarly to the other EU27 member states, Greece was also significantly affected by the COVID-19 pandemic. In 2020, GDP and private consumption experienced a dramatic drop, and disposable income also fell. VAT revenues decreased by 16% compared to the previous year, representing the second largest decrease among EU27 member states. As the economy started to recover in 2021, GDP, disposable income and private consumption increased and VAT revenues experienced the largest increase since 2002, as they rose by almost 16%. Concluding, VAT is the main indirect tax and a major source of public revenue in Greece, whereas VAT revenues can be volatile and are shown to be strongly affected by fluctuations in economic conditions and severe unforeseen disturbances, like the COVID-19 pandemic. As a result, it is of high significance to examine the way VAT revenues respond to changes and fluctuations in major macroeconomic variables and the way they react to sudden disturbances impacting the economic environment.

CHAPTER 5

TAX REVENUE BUOYANCY AND ELASTICITY: CONCEPTUAL FRAMEWORK, THEORETICAL CONTEXT AND APPLICATIONS

5.1. Introduction

The buoyancy and elasticity of tax revenue are two significant revenue response concepts closely related to public finance theory and fiscal policy. Their importance stems basically from the role played by tax revenues at theoretical, practical, and policy levels, as they constitute a central component of the public budget. Their measurement provides key insights into the link between tax revenue development, on the one hand, and changes in macroeconomic aggregates and associated policy measures, on the other.

Given the above considerations, with the aim to provide the main rationales for the motivation and reveal key aspects of the contribution of the present Study, in the current chapter, we present the conceptual framework and theoretical context associated with the notions of tax revenue buoyancy and elasticity and describe the most important fields of their application. In Section 5.2, we provide the definitions of the two notions and present the underlying conceptual framework. In Section 5.3, we outline the theoretical context for the analysis of the more general concept of tax revenue response to changes in income. In Section 5.4, we describe several important fields of application of tax revenue buoyancy and elasticity, and in Section 5.5, we offer some concluding remarks. Where necessary and feasible, specific references to the case of VAT (or related more general tax categories, such as indirect taxes and/or consumption taxes) are included.

5.2. Definitions and conceptual framework

5.2.1. Tax revenue buoyancy

One key concept capturing tax revenue response to income changes is tax revenue buoyancy.[109] According to Dudine and Jalles (2018), a tax system's buoyancy can be generally defined as the change in tax revenues following changes in output, and more precisely as the total response of tax revenues to changes in national income as well as to discretionary tax policy changes. A significant number of related studies in the literature provide references to the concept and definition of tax buoyancy.[110] One of the most central features of tax buoyancy is the inclusion of the effects of tax policy changes on revenues. Such changes, or any discretionary tax measure (DTM) in general, is broadly defined by Princen et al. (2013) "as any legislative or administrative change in policy that has an impact on tax revenues, whether it is already finally adopted or only likely to be implemented".

In mathematical terms, buoyancy for aggregate tax revenue with respect to income, i.e., the tax-to-income buoyancy relation, is determined by the equation:

$$b_{T,Y} = \frac{\partial T^b}{\partial Y} \times \frac{Y}{T^b} \tag{5.1}$$

[109] For the sake of brevity, the term buoyancy (or tax buoyancy, or revenue buoyancy) is occasionally used instead of tax revenue buoyancy in the text.

[110] See Mansfield (1972), Khan (1973), Gillani (1986), Shome (1988), Indraratna (1991), Akbar and Ahmed (1997), McGowan and Billings (1997), Jenkins et al. (2000), Mukarram (2001), Timsina (2007), Ahmed and Mohammed (2010), Twerefou et al. (2010), Kargbo and Egwaikhide (2012), Mawia and Nzomoi (2013), Ndedzu et al. (2013), Yousuf and Huq (2013), Belinga et al. (2014), Mourre and Princen (2015), Bekoe et al. (2016), Havranek et al. (2016), Jalles (2017), Olukuru and Mandela (2017), Anderson and Shimul (2018), Birhanu (2018), Deli et al. (2018), Khadan (2019), Mourre and Princen (2019), Tanchev and Todorov (2019), IMF (2020), Jalles (2020), Lagravinese et al. (2020), Seydou (2020), Bağci (2022), Gupta et al. (2022), Hill et al. (2022), and Cornevin et al. (2023).

where T^b is total tax revenue, b stands for buoyancy, and Y is income, and it is usually understood as the percentage change in revenue associated with a one per cent change in income.

The definition of tax buoyancy underpins the importance of this concept for public finances and fiscal policy design since it helps to assess the degree to which tax mobilization follows developments in economic activity and responds to DTM undertaken as well as to evaluate whether additional effort is needed from the side of the policymakers.[111] The actual theoretical and practical – in terms of policy implementation – significance of tax buoyancy lies in its size. An overall buoyancy equal to one indicates that, taking into account all DTM, an increase in GDP[112] by one percent will lead to an increase in aggregate tax revenues by the same amount, while a buoyancy higher (lower) than one would imply a buoyant (non-buoyant) tax system, i.e., the fact that revenues rise by more (less) than GDP, thus affecting the tax-to-GDP ratio.[113]

Naturally, several important issues arise. For example, the question that emerges is whether a buoyant or non-buoyant tax system is, in fact, desirable. In addition, there are the matters of what kind of information a government may need to enhance buoyancy, if necessary, and which are the factors affecting the corresponding scope of intervention. With regard to the first issue, it may, intuitively, seem plausible to expect that, at least during economic upturns, a non-buoyant tax system is not desirable. Overall, a lower than unity or a particularly low buoyancy of a tax system may indicate issues related to the tax structure, inefficient tax administration, low tax compliance, and/or tax eva-

[111] It is interesting to note that the consideration of tax buoyancy at the country level further enables the discovery of whether tax mobilization is kept on track with economic activity by any specific government (see, for example, Dudine and Jalles, 2018; Gupta et al., 2022) and further enables the comparison across country groups to reveal the relevant position of each country (Deli et al.,2018).

[112] Income and output are basically used to define tax buoyancy in theoretical terms, while GDP is used mainly in terms of application.

[113] It is important to note that in the case of a falling GDP (or negative GDP growth), a buoyancy higher than one indicates that revenues will fall by more (or exhibit more negative growth) than GDP, which implies a deterioration of the tax-to-GDP ratio (see Deli et al., 2018).

sion (Kargbo and Egwaikhide, 2012; Mawia and Nzomoi, 2013; Birhanu, 2018; Dudine and Jalles, 2018; Jalles, 2020). In contrast, a buoyant tax system may become desirable if there is, for developing countries, increasing demand for government expenditure (Mawia and Nzomoi, 2013), and if, in general, there is increasing demand for public services (Dudine and Jalles, 2018). Still, these arguments do not imply that a buoyant tax system, i.e., a system in which tax revenues grow faster than GDP (or fall faster than GDP), is assumed to be unexceptionally desirable. Some authors, for example, claim that this would depend on policy targeting with respect to the size of the government (Olukuru and Mandela, 2017) or on the potential factors driving the tax system's buoyancy (Dudine and Jalles, 2018).

With reference to the other questions raised, in case the government wishes to enhance the tax system's aggregate buoyancy, information is definitely needed on the distinct buoyancies of the underlying individual tax categories. In addition, it is essential for the fiscal authorities to know whether high buoyancy is driven basically by DTM and/or structural components and, generally, by factors under or not necessarily under their control. Finally, the desirability of higher (or lower) buoyancy and the scope of intervention for any government is expected to be conditional upon, among other things, the time period and the time frame considered, and especially on whether it refers to the long or the short run and to different phases of the business cycle. As a consequence, emphasis should be put on disaggregating tax revenue buoyancy between individual tax categories, on decomposing the concept into separate response components, and on the issue of the time dimension of tax buoyancy.

5.2.1.1. Tax revenue buoyancy for disaggregated revenue

Apart from defining tax buoyancy on the basis of aggregate tax revenue, buoyancy can be also determined at the level of disaggregated revenue from individual tax categories (see Belinga et al., 2014; Jalles, 2017; Seydou, 2020). Tax buoyancy at the disaggregated level for individual taxes, and at least for the major tax categories (see, for example, Ahmed and Mohammed [2010] for buoyancy at the level of direct and indirect taxes), constitutes an essential tool for the categorization of tax sources according to their revenue-generating potential (see, for example, Yousuf and Huq, 2013), depending on how individual taxes respond to income increases and DTM, and for the identification of weaknesses and strengths of the tax system (see Dudine and Jalles, 2018, and Jalles, 2020). This knowledge is a prerequisite for a more precise tax policy intervention, which would be necessary in order to achieve more general targets, such as the enhancement of the overall buoyancy of the tax system (if desirable) and the improvement of the effectiveness of tax policy implementation.

In technical terms, for a given tax category generating tax revenue T_1^b, individual tax-to-income buoyancy is given by

$$b_{T_1,Y} = \frac{\partial T_1^b}{\partial Y} \times \frac{Y}{T_1^b}. \tag{5.2}$$

Using equation (5.2) to determine tax buoyancies for all[114] tax categories within a tax system enables the definition of the overall tax buoyancy as their weighted sum. Following Jenkins et al. (2000), for an indicative system of three individual taxes[115] in which total tax revenue is given by

$$T^b = T_1^b + T_2^b + T_3^b, \tag{5.3}$$

i.e., by the sum of revenue from tax categories 1 to 3, T_1^b, T_2^b, and T_3^b, and the change in total revenue is given by

$$\Delta T^b = \Delta T_1^b + \Delta T_2^b + \Delta T_3^b, \tag{5.4}$$

then, based on equation (5.1), the overall tax-to-income buoyancy can be expressed as

[114] In practice, this is done for the major taxes from the categories of direct and indirect taxes.

[115] An equivalent representation could be given for a system of n individual taxes. See Twerefou et al. (2010), Jalles (2017), and Seydou (2020).

$$b_{T,Y} = \frac{\Delta T_1^b + \Delta T_2^b + \Delta T_3^b}{\Delta Y} \times \frac{Y}{T^b} = \tag{5.5}$$

$$= \frac{\Delta T_1^b}{\Delta Y} \times \frac{Y}{T^b} + \frac{\Delta T_2^b}{\Delta Y} \times \frac{Y}{T^b} + \frac{\Delta T_3^b}{\Delta Y} \times \frac{Y}{T^b} = \tag{5.6}$$

$$= \frac{T_1^b}{T^b} \times \left[\frac{\Delta T_1^b}{\Delta Y} \times \frac{Y}{T_1^b} \right] + \frac{T_2^b}{T^b} \times \left[\frac{\Delta T_2^b}{\Delta Y} \times \frac{Y}{T_2^b} \right] + \frac{T_3^b}{T^b} \times \left[\frac{\Delta T_3^b}{\Delta Y} \times \frac{Y}{T_3^b} \right] = \tag{5.7}$$

$$= \frac{T_1^b}{T^b} \times b_{T_1,Y} + \frac{T_2^b}{T^b} \times b_{T_2,Y} + \frac{T_3^b}{T^b} \times b_{T_3,Y}, \tag{5.8}$$

which is the weighted sum of the three individual tax buoyancies with respect to income. In equation (5.8), the ratios of tax revenue by each individual tax to total revenue stand for the individual weights and $b_{T_1,Y}$, $b_{T_2,Y}$ and $b_{T_3,Y}$ stand for the individual tax revenue buoyancies of the three taxes of the indicative tax system.

5.2.1.2. Tax revenue buoyancy decomposition

Tax revenue buoyancy for individual tax categories, i.e., the response relation between revenues from a specific tax and income including the effects of DTM, is often broken down into two separate response and, hence, buoyancy components, according to the decomposition or partitioning approach (for relevant references and framework, see Shome, 1988; Akbar and Ahmed, 1997; Jenkins et al., 2000; Timsina, 2007; Twerefou et al., 2010; Mawia and Nzomoi, 2013). In this approach, the first buoyancy component is the tax-to-base buoyancy, mathematically given by

$$b_{T,B} = \frac{\Delta T^b}{\Delta B^b} \times \frac{B^b}{T^b}, \tag{5.9}$$

where B^b is the corresponding tax base. This component describes the response of revenue from a specific tax to changes in the corresponding tax base, including the effects of DTM. Any corresponding tax base is the underlying measure liable to be taxed, as is consumption in the example of consumption taxes.[116] According to Jenkins et al. (2000), this component partly reflects the legal structure and tax compliance and, thus, the effectiveness of tax policy.

The second buoyancy component is the base-to-income buoyancy, mathematically expressed by

$$b_{B,Y} = \frac{\Delta B^b}{\Delta Y} \times \frac{Y}{B^b}. \tag{5.10}$$

It represents the response of the individual tax base to changes in income. It is, hence, considered to reflect the effects of economic developments on the respective tax base, which is basically a macroeconomic measure (for example, consumption for consumption taxes), and as a result, it is regarded as a structural issue of an economy, i.e., an issue of any underlying specific economic structure (see Jenkins et al., 2000; Timsina, 2007; Twerefou et al., 2010).

The decomposition approach can be used to offer an alternative measurement approach of tax buoyancy with respect to income for individual taxes, namely as the product of the two components.[117] In other words, tax revenue buoyancy for an individual tax, i.e., the tax-to-income response relation, can also be defined as the product of the tax-to-base[118] and the base-to-income buoyancy components. In mathematical terms and in the example of revenue from a specific tax, T_1^b, the respective decomposed tax-to-income buoyancy $b_{T_1,Y}^{dec}$ can be expressed as the product of the two buoyancy components (see Jenkins et al., 2000) as

[116] Note that, in practice, it is rarely possible to obtain the ideally appropriate bases, and proxy bases are used, attempting to approximate the proper bases as closely as possible (Shome, 1988). Morris et al. (2009), for example, elaborated on the potential significance of mismatches between variables selected as tax base proxies and the 'true' (even though unobservable) bases on which taxes are actually accrued. For a further reference to the related issue, see Section 7.2.

[117] If not used to obtain revenue buoyancy as the product of the two, the components can also stand alone and be individually interpreted as meaningful separate buoyancies.

[118] Note that Haughton (1998) defined tax buoyancy as the percentage change in tax revenue to the percentage change in the base, typically taken to be GDP, but with other bases also being possible.

$$b^{dec}_{T_1,Y} = \left[\frac{\Delta T_1^b}{\Delta B_1^b} \times \frac{B_1^b}{T_1^b}\right] \times \left[\frac{\Delta B_1^b}{\Delta Y} \times \frac{Y}{B_1^b}\right]. \tag{5.11}$$

The importance of the decomposition approach lies basically in the extraction of additional information with respect to the true underlying relations and to factors that are more or less under the control of the government. In a sense, the tax-to-income buoyancy can be seen as a more indirect link (Timsina, 2007), while the partitioning approach enables a separate and more detailed identification of factors driving revenue developments. For example, there might be developments in individual tax bases (as components of GDP, hence related to its composition), explaining revenue developments, which are, however, not distinctly mirrored in the overall GDP course. As a result, the tax-to-base buoyancy might provide extra information and justification for revenue developments, related to composition effects, otherwise concealed in the tax-to-GDP buoyancy. As Lagravinese et al. (2020) pointed out, the economic recovery that took place during the 2013–2016 period in a number of EU countries was driven by net exports, which are tax-poor (since they are VAT-exempt), compared to domestic demand, which is subject to VAT. In addition, the tax-to-base component may be expected to be related to tax rates, exemptions, and improvements in tax administration, all belonging to the scope of direct intervention of any government. In contrast, influencing the base-to-income component lies practically outside the (direct) intervention scope of fiscal authorities, although it remains significant from a structural perspective. Moreover, combining and comparing tax revenue buoyancy obtained in one step through the 'traditional' (according to Timsina, 2007) approach and as the product of the two buoyancy components allows for controlling whether the distinct underlying relations are clearly reflected in the overall tax-to-income buoyancy.

Naturally, the partitioning approach can be further incorporated in a weighted sum equation to define overall tax buoyancy with respect to income. In other words, and for the same example of three distinct tax categories, equation (5.8) can be reformulated as

$$b_{T,Y} = \frac{T_1^b}{T^b} \times b^{dec}_{T_1,Y} + \frac{T_2^b}{T^b} \times b^{dec}_{T_2,Y} + \frac{T_3^b}{T^b} \times b^{dec}_{T_3,Y}, \tag{5.12}$$

and using equation (5.9) results in

$$
\begin{aligned}
b_{T,Y} = {} & \frac{T_1^b}{T^b} \times \left[\frac{\Delta T_1^b}{\Delta B_1^b} \times \frac{B_1^b}{T_1^b} \right] \times \left[\frac{\Delta B_1^b}{\Delta Y} \times \frac{Y}{B_1^b} \right] + \\
& + \frac{T_2^b}{T^b} \times \left[\frac{\Delta T_2^b}{\Delta B_2^b} \times \frac{B_2^b}{T_2^b} \right] \times \left[\frac{\Delta B_2^b}{\Delta Y} \times \frac{Y}{B_2^b} \right] + \\
& + \frac{T_3^b}{T^b} \times \left[\frac{\Delta T_3^b}{\Delta B_3^b} \times \frac{B_3^b}{T_3^b} \right] \times \left[\frac{\Delta B_3^b}{\Delta Y} \times \frac{Y}{B_3^b} \right].
\end{aligned}
\tag{5.13}
$$

In its comprehensive definition for the total tax system, the decomposition approach entails significant advantages. It is often argued that such a detailed disaggregation helps to identify the single sources of rapid, dynamic, or lagging tax revenue growth (Timsina, 2007; Twerefou et al., 2010; Mawia and Nzomoi, 2013) or, more generally, the weaknesses and strengths of the tax system (Twerefou et al., 2010). Moreover, the reliance on individual tax bases enables the analysis of the tax base composition and characteristics for separate tax categories, helping policymakers improve the design of tax systems with respect to their response to income growth (Jenkins et al., 2000).

5.2.1.3. Time dimension of tax revenue buoyancy

As Jalles (2017 and 2020) pointed out, when concerned with the notion of tax buoyancy, one crucial dimension is time. Whether defined for aggregate tax revenue or for individual tax categories, tax buoyancy may be expected to remain the same or change over time. Overall, structural developments and reforms may lead to time variations in aggregate tax revenue buoyancy, whereby structural changes in individual tax revenue categories can create a modified tax composition between more or less buoyant taxes, as Belinga et al. (2014) indicated. The authors claimed that, in the recent past, the implemented structural tax policy reforms in many OECD countries led, indeed, to changes in both the tax mix and the structure of each of the tax components. Moreover, and particularly during times of economic turbulence, the ability to assess the potential variability of tax revenue reaction to economic conditions becomes an issue of utmost importance. Lagravinese et al. (2020), for example, emphasized the significance of the analysis of tax revenue response for public finances during periods of crisis. Apart from varying tax buoyancy over time as a general notion, time differentiations may refer to the long- relative to the short-run time frame, but also to the revenue short-run reaction during distinct phases of the business cycle.

Probably the most significant distinction with respect to the time dimension of tax revenue buoyancy is the one between the long and the short run. This issue is investigated in detail by a considerable number of studies focusing on tax revenue buoyancy.[119] Long-run buoyancy can be seen to reflect revenue response to long-run growth in income, hence describing an equilibrium relation over time. Short-run buoyancy is considered to capture revenue response to short-run income fluctuations, thus picturing short-run dynamics, which may potentially lead to intermediate deviations from the underlying long-run relation. In both cases, the relations considered include the revenue response to any implemented DTM. The significance of the differentiation between the two concepts for a country's tax system lies in the inherent fiscal policy perspective associated with income growth since long-run buoyancy is related to long-term fiscal sustainability and short-run buoyancy is related to fiscal policy stabilization over the business cycle (see Belinga et al., 2014; Jalles, 2017; Olukuru and Mandela, 2017; Deli et al., 2018; Dudine and Jalles, 2018; Khadan, 2019; Tanchev and Todorov, 2019; Jalles, 2020; Lagravinese et al., 2020; Gupta et al., 2022; Hill et al., 2022).

With regard to the size, Belinga et al. (2014) claimed that the benchmark magnitude of tax buoyancy in the long run may be expected to be one or converge to one (see also Dudine and Jalles, 2018; Jalles, 2020; Lagravinese et al., 2020; Cornevin et al., 2023). According to Lagravinese et al. (2020), a long-run buoyancy higher (lower) than one would theoretically imply an indefinite increase (a continuous fall) in the revenue-to-GDP ratio (for the argument, see also Jalles, 2017; Dudine and Jalles, 2018;

[119] See Bilquees (2004), Twerefou et al. (2010), Kargbo and Egwaikhide (2012), Belinga et al. (2014), Jalles (2017), Olukuru and Mandela (2017), Deli et al. (2018), Dudine and Jalles (2018), Tanchev and Todorov (2019), Jalles (2020), Lagravinese (2020), and Gupta et al. (2022).

Jalles, 2020), where both cases would not constitute a long-run equilibrium for the sustainability of public finances (Gupta et al., 2022). Still, when a specific time interval is considered (or, according to Cornevin et al. [2023], depending on the estimation window), long-run tax buoyancy may deviate from one in an upward or downward direction, due to the combinations of automatic and discretionary changes that took place during the corresponding time period (Lagravinese et al., 2020). In terms of fiscal sustainability, long-run buoyancy greater than one would indicate that the revenue side of the budget can lead to fiscal balance improvements (Belinga et al., 2014; Jalles, 2017) and/or can support some spending expansion, while the opposite would hold for long-run buoyancy lower than one (Belinga et al., 2014), indicating problems associated with the tax structure, administration, and compliance (Dudine and Jalles, 2018). It should be stressed that differences in long-run tax buoyancy across individual categories are also possible (Belinga et al., 2014; Lagravinese et al., 2020), further strengthening the significance of an analysis by individual tax (for an analysis of long-run buoyancy for tax revenue components, see Jalles, 2017; Olukuru and Mandela, 2017; Dudine and Jalles, 2018; Tanchev and Todorov, 2019; Jalles, 2020; Lagravinese, 2020).[120] Progressive taxes,[121] for example, are generally expected to exhibit larger and regressive taxes smaller long-run buoyancy (see Gupta et al., 2022). For VAT in particular, a long-run buoyancy exceeding one could be justified by the fact that luxury goods are typically subject to the standard rate, while necessities are usually subject to reduced rates. Evidently, direct comparisons of long-run tax buoyancies across tax categories within a tax system enables tax classification with regard to their effectiveness in guaranteeing fiscal sustainability in the long run.

Short-run buoyancy may also deviate from one. In terms of fiscal policy stabilization, short-run buoyancy greater than one would indicate that the

[120] Note further, that variations across countries are also probable (Belinga et al., 2014; Lagravinese et al., 2020).

[121] Recall that the progressivity of a tax system is linked to equity considerations (see Jalles, 2017; Jalles, 2020), which is another important factor stressing the need to study tax revenue buoyancy. On the regressivity and progressivity of taxes and the related equity considerations, see Section 2.5.2.

tax system is a good automatic stabilizer[122] (Belinga et al., 2014; Jalles, 2017; Jalles, 2020). In contrast, short-run buoyancy lower than one would imply that tax revenue is more stable than GDP, hence operating to a lesser extent as an automatic stabilizer (Belinga et al., 2014). If short-run buoyancy is not different from one, then tax systems are basically neither good nor bad automatic stabilizers (Belinga et al., 2014; Jalles, 2017; Jalles, 2020). Such considerations gain even more in importance if investigated and compared across individual tax categories since considerable differences may exist[123] (for a corresponding analysis of short-run buoyancy for distinct tax revenue categories, see Jalles, 2017; Olukuru and Mandela, 2017; Dudine and Jalles, 2018; Tanchev and Todorov, 2019; Jalles, 2020; Lagravinese, 2020). In the example of a goods and sales tax, a short-run buoyancy higher than one could reflect precautionary saving during the downside phase of the cycle and the fact that aggravated credit constraints may affect tax compliance during recessions, while it may mirror buoyant spending (e.g., on luxury goods) during the upside phase of the business cycle. In contrast, a short-run buoyancy smaller than one could be justified by consumption smoothing in response to business cycle fluctuations (Belinga et al., 2014). Overall, distinct short-run tax buoyancies provide important information about potentially good or not good sources of automatic stabilization and their comparison enables the classification of individual tax components within a tax system according to their effectiveness in acting as an automatic stabilizer in the short run. In other words, and as Olukuru and Mandela (2017) pointed out, the component with the highest short-run buoyancy can be seen as the best automatic stabilizer (see also Belinga et al., 2014).

Finally, and in addition to the above analyzed considerations relating to the time perspective of tax buoyancy, there is another dimension that should not be neglected, i.e., the aspect of potential asymmetry characterizing short-run buoyancy. The stabilization (or non-stabilization) role of

[122] In addition, and to the degree that discretionary policy changes could be driven by a systematic reaction function, the interpretation of short-run buoyancy could be extended to include, in addition to the automatic stabilization component, a component related to discretionary actions (Dudine and Jalles, 2018).

[123] The same may hold for comparisons across countries.

taxation as reflected in short-run tax buoyancy is, namely, not necessarily expected to be the same over the distinct phases of the business cycle (Jalles, 2017; Jalles, 2020; Gupta et al., 2022). In other words, it may vary between the upswings and downswings (or the expansion and contraction) of the economy, and may hence exhibit asymmetry (see Belinga et al., 2014; Jalles, 2017; Dudine and Jalles, 2018). As a result, a tax system or a single tax category may not operate in the same way as an automatic stabilizer during the ups and downs of the business cycle or under normal and abnormal economic conditions. Evidently, differentiated short-run buoyancies depending on economic conditions may present better indicators and would be expected to provide more accurate signals with regard to the potential stabilization role of taxation.

5.2.2. Tax revenue elasticity

The second fundamental concept capturing the response of tax revenue to income changes is tax revenue elasticity.[124] Tax revenue elasticity is defined as the automatic or endogenous response of tax revenues to changes in income,[125] in the absence of any discretionary changes. A great number of related studies in the literature[126] provide references to the concept and definition of tax elasticity. Moreover, several studies (for ex-

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[124] For the sake of brevity, the term elasticity (or tax elasticity, or revenue elasticity) may be used instead of tax revenue elasticity throughout the text.

[125] It is important to note that in the context of the calculation of the cyclically-adjusted budget balance within the framework of the European economic governance, elasticities are defined with respect to the output gap (see Mourre et al., 2014, and Section 5.4.2 for more details).

[126] See Mansfield (1972), Khan (1973), Choudhry (1979), Gillani (1986), Shome (1988), Ehdaie (1990), Indraratna (1991), Osoro and Leuthold (1994), Akbar and Ahmed (1997), Haughton (1998), Jenkins et al. (2000), Mukarram (2001), Timsina (2007), Twerefou et al. (2010), Brückner (2012), Kargbo and Egwaikhide (2012), Koester and Priesmeier (2012), Mawia and Nzomoi (2013), Ndedzu et al. (2013), Yousuf and Huq (2013), Belinga et al. (2014), Mourre and Princen (2015), Bekoe et al. (2016), Havranek et al. (2016), Köster and Priesmeier (2017), Wawire (2017), Deli et al. (2018), Dudine and Jalles (2018), Boschi and d'Addona (2019), Mourre and Princen (2019), Conroy (2020), Jalles (2020), Lagravinese et al. (2020), Seydou (2020), and Cornevin et al., (2023). Note that Haughton (1998) describes elasticity as a 'hypothetical construct' since it attempts to reconstruct tax revenue development as if there had been no changes. The same expression was used for elasticity by Ahmed and Mohammed (2010).

ample, Legler and Shapiro, 1968; Berney and Frerichs, 1973; Friedlaender et al., 1973; Fox and Campbell, 1984; Sobel and Holcombe, 1996; Bruce et al., 2006; Anderson and Shimul, 2018) related the elasticity concept to taxes and revenues at the state level for the USA. Seyfried and Pantuosco (2003), for example, who applied the elasticity concept at the state level, defined elasticity as the change in a particular state's tax revenue relative to the state's economic growth, measured by its Gross State Product.

In technical terms, elasticity for aggregate tax revenue with respect to income, i.e., the tax-to-income elasticity relation, is determined by the equation

$$e_{T,Y} = \frac{\partial T^e}{\partial Y} \times \frac{Y}{T^e}, \tag{5.14}$$

where T^e is aggregate tax revenue free from the effects of DTM, e stands for elasticity, and Y is income. The term is interpreted as the percentage change in revenue associated with a given percentage change in income, for a constant tax structure (Creedy and Gemmell, 2006).

Several elements inherent in the definition of tax revenue elasticity underline its significance with respect to, first, the structural relation between tax revenues and economic activity and, second, fiscal policy implementation.[127] Regarding the first, tax elasticity determines whether revenue changes represent built-in effects related to the tax structure (Creedy and Gemmell, 2004). It is often argued (see, for example, Creedy and Gemmell, 2004; Lagravinese et al., 2020) that tax elasticity enables the discernment of tax revenue reaction to changes in income due to the tax system's built-in flexibility[128] in the absence of discretionary measures, from tax revenue changes arising directly from such measures.[129] In that sense, tax elasticity is sometimes referred to as a measure of the built-in

[127] Accordingly, when defined at the state level, elasticity is particularly useful for the analysis of the adequacy of a state's tax structure and for the formulation of policy recommendations (when used in conjunction with specific other variables, as Legler and Shapiro [1968] indicate). On the term 'adequacy', see Section 5.3.1.

[128] For the notion of the 'built-in flexibility', see also Section 5.3.

[129] This definitely presupposes the feasibility of the isolation of the effects on revenues arising directly and exclusively from DTM. On this point, see Sections 5.2.3 and 7.2.

response or built-in responsiveness (see Jenkins et al., 2000; Bekoe et al., 2016) of revenues to changes in income or considered as the built-in elasticity (see, for example, Mansfield, 1972; Choudhry, 1979; Gillani, 1986; Indraratna, 1991; Twerefou et al., 2010).

With regard to the second, any decision-making with regard to the potential necessity to enforce DTM to enhance revenue mobilization, in conjunction with any specific policy targeting, can be assisted by knowledge about the actual size of tax elasticity. A unitary tax revenue elasticity implies that an increase in income by one percent will be followed by an increase in aggregate tax revenues by the same amount, suggesting proportionality (or neutrality). An elastic (inelastic) tax system, i.e., elasticity above (below) unity, would indicate progressivity (regressivity) (see Poghosyan, 2011; Mourre and Princen, 2015; Mourre and Princen, 2019; Conroy, 2020). The size of tax revenue elasticity may be influenced by a number of different factors, such as progressive elements in the tax system, income distribution, and tax base composition (Choudhry, 1979; Bouthevillain et al., 2001). High elasticity of the tax system would be, for example, a necessary condition in the case of a government wishing to increase public expenditure through higher revenues, without needing to resort to discretionary changes. In that sense, it is often asserted that an elastic (or at least a neutral, see Seydou, 2020) tax system with the corresponding built-in flexibility is a generally desirable feature (see Mansfield, 1972; Indraratna, 1991; Osoro and Leuthold, 1994; Haughton, 1998; Jenkins et al., 2000; Twerefou et al., 2010; Kargbo and Egwaikhide, 2012), while an inelastic tax system would force governments to continuously implement discretionary tax measures to sustain increased public expenditures (Jenkins et al., 2000). In the case of far too low elasticity of a tax structure and existing built-in inflexibilities, even DTM may not be sufficient to generate the necessary revenue levels (Shome, 1988). Still, and as Osoro and Leuthold (1994) stressed, an elastic tax system is not free of shortcomings and any decrease in income, for example, will be accompanied by a greater decrease in tax revenues. In the framework of the performance of state (and local) tax systems, according to Anderson and Shimul (2018), an elastic tax system implies a destabilization of the state's fiscal position during the downward phase of the cycle.

Equivalently to the case of tax revenue buoyancy, there exist several more analytical dimensions which acquire a central role and require a detailed consideration when focusing on the concept of tax revenue elasticity. These refer to the revenue elasticity for individual taxes, the decomposition of elasticity, and the time dimension.

5.2.2.1. Tax revenue elasticity for disaggregated revenue

As in the case of tax buoyancy, tax elasticity can be defined at the level of disaggregated revenue from individual tax categories.[130] The disaggregation constitutes the necessary tool for the identification of more and less automatically elastic taxes and, hence, the categorization of tax sources depending on their revenue-generating potential (for the argument see Twerefou et al., 2010; Yousuf and Huq, 2013; Seydou, 2020), without taking into account the effects of DTM. In other words, disaggregated analysis enables the identification of the sources of fast (dynamic) or, in contrast, lagging endogenous revenue growth (see Mansfield, 1972; Bilquees, 2004). This kind of knowledge can be used to adjust the composition of an existing tax structure and, overall, enhance the effectiveness of tax policy implementation.

Such knowledge can be further enriched by information at an even finer level of detail if a single tax revenue category, and hence the related elasticity, can be broken down into its sub-components (Price et al., 2014), further strengthening tax policy efficiency. According to Morris et al. (2009), a more aggregate presentation has the drawback of concealing revenue changes originating from different sources. The authors focused on the importance of a more detailed breakdown, in an effort to investigate ‘unexplained’ changes in tax revenues. In their application, indirect taxes are broken down into several sub-categories, among which are the categories of VAT, excise duties, or ‘other taxes on consumption’. The rationale behind such a disaggregation can be seen to lie in the fact that

[130] Elasticities for individual tax categories may well differ among countries. In the case of VAT, for example, patterns of VAT rates and exemptions, which are expected to diverge substantially across countries (Price et al., 2015), may lead to differentiations. Elasticities may further differ across states, in the case of the US, having important implications for tax policy at the state level (Bruce et al., 2006).

VAT revenues, for example, are expected to respond differently to changes in income than revenues from excise taxes levied on tobacco products and alcoholic beverages.[131] In general, the greater the variation in individual tax sub-categories – belonging to one broad category – in terms of their structure and the inherent characteristics of the underlying products, the more essential it becomes to differentiate between their elasticities.

In technical terms, for a given tax category generating tax revenue T_1^e, individual tax-to-income elasticity is given by

$$e_{T_1,Y} = \frac{\partial T_1^e}{\partial Y} \times \frac{Y}{T_1^e}, \tag{5.15}$$

where T_1^e is tax revenue for category 1, free from the effects of DTM. Individual tax elasticities based on disaggregated revenue further serve to provide a measure of overall tax elasticity with respect to income by their combined use in a weighted sum approach (Mansfield, 1972). In the indicative example of a tax system with three taxes,[132] and following the reasoning of equations (5.3) to (5.7) as presented for tax buoyancy, overall tax-to-income elasticity is given by

$$e_{T,Y} = \frac{T_1^e}{T^e} \times e_{T_1,Y} + \frac{T_2^e}{T^e} \times e_{T_2,Y} + \frac{T_3^e}{T^e} \times e_{T_3,Y}, \tag{5.16}$$

which is the weighted sum of the three individual tax elasticities with respect to income. In equation (5.16), the ratios of tax revenue by each individual tax to total revenue stand for the individual weights, and $e_{T_1,Y}$, $e_{T_2,Y}$ and $e_{T_3,Y}$ stand for the individual tax revenue elasticities of the three taxes of the indicative tax system. A similar technical representation based on a weighted sum of individual tax sub-elasticities can be considered to

[131] See the estimation results presented in Section 7.5, in combination with the corresponding ones for tobacco products and alcoholic beverages provided by Tsouma et al. (2020).

[132] Evidently, aggregate tax elasticity for a system of *n* taxes is defined, or more 'realistically visualized' according to Mansfield (1972), as the weighted sum of all individual elasticities (see also Twerefou et al., 2010; Seydou, 2020). See Mansfield (1972) for the corresponding technical representation.

describe the aggregated tax elasticity of one single major tax category (Price et al., 2014).

5.2.2.2. Tax revenue elasticity decomposition

The elasticity concept for individual taxes, i.e., the response relation between revenues from a specific tax and income excluding the effects of DTM, is often related, similarly to the buoyancy concept, to a partitioning approach or a decomposition approach on the basis of the definition of the tax-to-base and the base-to-income elasticity components.[133] The first component gives the response of tax revenues to changes in the corresponding tax base and is determined by the structure of the tax system (Girouard and André, 2005). Since it is free of the effects of tax measures, it is used to describe the 'natural' link between tax revenues and their bases, if it is assumed that tax reforms may distort the underlying general relation (Koester and Priesmeier, 2012). The size of the tax-to-base elasticity component is closely related to the type of the underlying tax. Revenue from a progressive tax, for example, would be expected to decrease (increase) more than proportionately to its base, while tax revenue would be expected to evolve more similarly to the base for more proportional taxes, with consumption taxes, for example, being considered as more proportional (Bettendorf and van Limbergen, 2013). According to Girouard and André (2005), for proportional taxes in general, the tax-to-base elasticity is expected to be unity, but when there are several tax rates, elasticity may exceed unity (progressivity) or fall below unity (regressivity). For indirect taxes in particular, the respective elasticity may exceed the theoretical value of one due to higher tax rates being applied to certain tax categories (such as luxury and durable goods, with pro-cyclical shares) which exhibit highly cyclical demand and are, hence, subject to changes in consumer behavior over the business cycle (Bouthevillain et al., 2001). In total, two opposing effects drive the size of the tax-to-base elasticity for indirect

[133] For relevant references and framework, see Mansfield (1972), Gillani (1986), Shome (1988), Ehdaie (1990), Indraratna (1991), Akbar and Ahmed (1997), Mukarram (2001), Bilquees (2004), Timsina (2007), Twerefou et al. (2010), Poghosyan (2011), Kargbo and Egwaikhide (2012), Tagkalakis (2013a), Price et al. (2014), Isaac and Samwel (2015), Price et al. (2015), Boschi and d'Addona (2019), and Seydou (2020).

taxes: on the one hand, *ad valorem* indirect taxes like VAT may entail a progressive element, insofar as higher rates apply to more income-elastic components of the base; on the other hand, specific taxes – determined by real consumption only and not accounting for price movements – may be regressive (Girouard and André, 2005).

The second component, the base-to-income elasticity component, which can be quite complex (depending on the underlying base, see Girouard and André, 2005), associates the response of the tax base with income changes, where the growth of the respective base depends on the structural changes of the economy as it grows (see Twerefou et al., 2010; Tagkalakis, 2013a).[134]

Apart from standing alone and being interpreted separately,[135] the product of the tax-to-base and the base-to-income elasticity components can be used for an alternative determination of the tax-to-income elasticity for an individual tax. Moreover, combining and comparing tax revenue elasticity obtained in one step and as the product of the two elasticity components enables the control of whether the distinct underlying relations are clearly reflected in the overall tax-to-income elasticity.

In mathematical terms and in the example of revenue from a specific tax, T_1^e, the respective decomposed tax-to-income elasticity $e_{T_1,Y}^{dec}$ can be expressed as the product of the two elasticity components as

$$e_{T_1,Y}^{dec} = \left[\frac{\Delta T_1^e}{\Delta B_1^e} \times \frac{B_1^e}{T_1^e}\right] \times \left[\frac{\Delta B_1^e}{\Delta Y} \times \frac{Y}{B_1^e}\right], \tag{5.17}$$

[134] The author referred to the role of related composition effects. According to Boschi and d'Addona (2019), composition effects concern relative changes of tax base shares in GDP over the business cycle.

[135] Note that Koester and Priesmeier (2012) referred to the revenues-to-base and the base-to-income elasticities as separate conceptions of tax elasticities, alongside a third one, which is the revenues-to-income elasticity. The authors argued that the revenue-to-base elasticity is the most appropriate elasticity approach, as compared to the revenues-to-income elasticity, since GDP developments are expected to differ from actual developments in tax bases, and the revenues-to-income concept does not include all relevant information about tax bases that is often available. In contrast, Köster and Priesmeier (2017) differentiated between the revenue-to-base, revenue-to-output gap, and revenue-to-GDP concepts of elasticity.

where B_1^e stands for the corresponding tax base, the first term in brackets stands for the tax-to-base, and the second term for the base-to-income component.

The significant contribution of the partitioning approach is the separate identification of factors underlying the relation between the tax base and the respective revenues, and those inherent in the link between the tax base and income. The distinct and exact identification of all these factors enables policymakers, to a certain degree, to separate factors under their control from those they cannot directly affect and, hence, determine in more detail potential points of intervention (see, for example, Isaac and Samwel, 2015, and Seydou, 2020). It is argued (Mansfield, 1972; Gillani, 1986; Indraratna, 1991) that factors that affect the tax-to-base elasticity component are, to a certain degree, under the control of the authorities and this elasticity component could be raised, for example, by improvements in tax administration (in the narrow sense of more efficient procedures), prevention of evasion, and adjustment with respect to certain elements of tax policy, like exemptions and the use of *ad valorem* rates to increase revenues as the value of the base increases. The same does not hold for the base-to-income component since the growth of the tax base as a response to economic growth is related to the structure of the economy and, hence, lies outside the direct control of the government.

Evidently, the decomposition approach can be included in a weighted sum equation to define overall tax-to-income elasticity, where the weighing scheme is supposed to reflect the significance of each tax in the total tax system (Mansfield, 1972). The important contribution of such a comprehensive approach for the total tax system is the combination of the advantages of both the disaggregation in individual tax elasticities and the decomposition approach.

Technically, in the indicative case of three distinct tax categories,[136] equation (5.16) can be reformulated as

$$e_{T,Y} = \frac{T_1^e}{T^e} \times e_{T_1,Y}^{dec} + \frac{T_2^e}{T^e} \times e_{T_2,Y}^{dec} + \frac{T_3^e}{T^e} \times e_{T_3,Y}^{dec}, \qquad (5.18)$$

[136] Equivalent representations can be given for a system of n individual taxes (see, for example, Mansfield, 1972, and Indraratna, 1991).

and using equation (5.17) results in

$$\begin{aligned} e_{T,Y} = {} & \frac{T_1^e}{T^e} \times \left[\frac{\Delta T_1^e}{\Delta B_1^e} \times \frac{B_1^e}{T_1^e} \right] \times \left[\frac{\Delta B_1^e}{\Delta Y} \times \frac{Y}{B_1^e} \right] + \\ & + \frac{T_2^e}{T^e} \times \left[\frac{\Delta T_2^e}{\Delta B_2^e} \times \frac{B_2^e}{T_2^e} \right] \times \left[\frac{\Delta B_2^e}{\Delta Y} \times \frac{Y}{B_2^e} \right] + \\ & + \frac{T_3^e}{T^e} \times \left[\frac{\Delta T_3^e}{\Delta B_3^e} \times \frac{B_3^e}{T_3^e} \right] \times \left[\frac{\Delta B_3^e}{\Delta Y} \times \frac{Y}{B_3^e} \right]. \end{aligned} \tag{5.19}$$

5.2.2.3. Time dimension of tax revenue elasticity

Another important aspect for the analysis of tax revenue elasticity is the time dimension, as analytically discussed in the early work of Fox and Campbell (1984). Similarly to tax revenue buoyancy, tax revenue elasticity may be expected to remain unchanged or vary over time, whether defined for aggregate tax revenue or for individual tax categories. Osoro and Leuthold (1994) stressed the importance of potential intertemporal variation in tax elasticities, with implications for tax policy. They mentioned increased tax progressivity, the base effect (the tax base growing faster than GDP), and variations in the quality of tax administration and enforcement as some of the main reasons causing time-varying elasticities. Apart from the general notion of a time-varying elasticity, time differentiation may refer to revenue behavior in the long- compared to the short-run time frame, but also between different phases of the business cycle.

One of the most significant distinctions with respect to the time-frame aspect of tax elasticity is that between long- and short-run elasticities, whether it concerns the aggregate or disaggregated elasticities, and the overall tax-to-income or the tax-to-base and base-to-income elasticity components. A considerable number of studies refer to and analyze the respective differentiation.[137] In all cases, the concepts considered concern en-

[137] See Fox and Campbell (1984), Sobel and Holcombe (1996), Bilquees (2004), Bruce et al. (2006), Wolswijk (2009), Poghosyan (2011), Kargbo and Egwaikhide (2012), Koester and

dogenous responses and do not include the reaction to any implemented DTM. In general, long-run elasticities capture tax revenue growth (with growing income), while short-run elasticities capture tax revenue volatility or fluctuation (with fluctuating income) (see Fricke and Süssmuth, 2014; Boschi and d'Addona, 2019).[138] With reference to the tax-to-base component, Wolswijk (2009) described the long-run elasticity as the 'ultimate tax level' after a one-percent change in the tax base and the short-run elasticity as the 'immediate change' in tax revenues following a one-percent tax base change. In terms of growth and volatility, and according to Koester and Priesmeier (2012) and Köster and Priesmeier (2017), the long-run tax-to-base elasticity depicts tax revenue growth depending on the long-run growth of the base, which is the growth rate adjusted for any short-run fluctuations. The respective long-run relation may be driven by the progressivity of the tax, with respect to its base, and by several other long-run trends, such as tax evasion or tax fraud. The short-run relation, in contrast, captures tax revenue volatility, i.e., describes how tax revenues are affected by short-run fluctuations in the tax base, due, for example, to the business cycle.

Evidently, any interpretation of the size of long- and short-run elasticities is a synthetic one. It draws on both the corresponding general interpretation of the elasticity concept (and its size) and the implications of the long- versus short-run perspective. A long-run elasticity greater (smaller) than one indicates that revenue growth is faster (slower) than income growth, while a short-run elasticity greater (smaller) than one indicates that revenues fluctuate more (less) than income over the business cycle. Theoretically, 'true' long-run tax elasticities should equal unity (Jooste and Naraidoo, 2011). According to Mourre and Princen (2019), and in the example of consumption taxes, the unity assumption relies on the fact that a great number of goods and services are subject to the stand-

Priesmeier (2012), Bettendorf and van Limbergen (2013), Fricke and Süssmuth (2014), Price et al. (2014), Mourre and Princen (2015), Price et al. (2015), Havranek et al. (2016), Köster and Priesmeier (2017), Boschi and d'Addona (2019), Mourre and Princen (2019), and Conroy (2020).

[138] See Sobel and Holcombe (1996) for a similar interpretation with regard to the base-to-income relation.

ard VAT rate. Still, a certain degree of progressivity originating from lower VAT rates applied to basic necessities and higher VAT rates applied to luxury goods can justify potential deviations from the unity assumption (see, for example, Berardini and Renzi, 2022). Overall, elasticities over the medium and short term may differ from the 'true' long-run ones (Jooste and Naraidoo, 2011). Higher (lower) short-run elasticities than the corresponding long-run ones are interpreted to indicate revenue overshooting, i.e., revenues in excess of their long-run (equilibrium) level (undershooting, i.e., revenues below their long-run equilibrium level) in the short run (Köster and Priesmeier, 2017). In the specific case of VAT, short-run elasticities with respect to consumption higher than the long-run ones are interpreted by Conroy (2020) to imply significant overshooting in the VAT response to a change in consumption.

In general, deviations between long- and short-run elasticities may arise for a variety of reasons. Cyclicality may be one cause since cyclically-sensitive taxes may exhibit differences between long- and short-run elasticities (Wolswijk, 2009). In that sense, the short-run elasticity, as opposed to the long-run one, depicts temporary movements due to cyclical shocks and accounts for the actual cyclical behavior of certain taxes, such as indirect taxes (Price et al., 2014). Along the same lines of reasoning, and in the case of consumption taxes, any deviations between long- and short-run tax-to-base elasticity may be explained by the fact that cyclical (i.e., short-run) changes in consumption spending may affect differently than long-run changes the composition of spending on not uniformly-taxed categories of goods (Koester and Priesmeier, 2012; Köster and Priesmeier, 2017). Such changes in spending may be caused, for example, by short-run fluctuations in household income, having a more-than-proportional effect on the consumption of higher-taxed items and justifying the short-run elasticity being higher than the long-run one (Wolswijk, 2007).

Apart from cyclical effects, several other factors may, in general, explain the deviation of short-run elasticities from the long-run ones. Output composition (Poghosyan, 2011) and/or the composition of tax bases (Koester and Priesmeier, 2012; Price et al., 2014), lags in tax collection (Kargbo and Egwaikhide, 2012; Koester and Priesmeier, 2012; Price et al., 2014; Mourre and Princen, 2019), changes in tax compliance (Poghosyan, 2011; Mourre and Princen, 2019) and boom-and-bust cycles of assets and/or property prices (Poghosyan, 2011; Mourre and Princen, 2019) are offered as possible sources of variation. In what concerns the tax-to-base elasticity, Mourre and Princen (2019) mentioned as a possible cause, in addition to some of the above factors, the non-indexation of tax systems to inflation, which might involve a 'fiscal drag', increasing tax revenue as prices strongly rise, without having implemented any legislative change.[139] Havranek et al. (2016) further regarded, apart from lags in tax collection, discrepancies between the true tax bases and their macroeconomic proxies, the lagged reactions of agents to economic shocks, and tax optimization between successive short-run periods as further possible sources of differences between long- and short-run tax-to-base elasticities.

Whether referring to the overall tax-to-income relation or to any elasticity component and, in particular, to the tax-to-base component, it is quite crucial to distinguish between long- and short-run tax elasticities for a number of different reasons. The importance of the distinction between long- and short-run elasticities lies in the assertion that failure to account for potential differences between the two may add to the creation of 'budget surprises' and lead to incorrect assessment of the fiscal stance (Wolswijk 2007 and 2009). Along the same line of argumentation, Koester and Priesmeier (2012), Köster and Priesmeier (2017), and Havranek et al. (2016) stated that an appropriate analysis framework must consider both long- and short-run tax revenue elasticities since focusing solely on long-run elasticities would fail to account for any adjustment process to intermediate shocks (e.g. tax-base shocks), while a merely short-run analysis focusing only on contemporaneous effects of tax-base changes on revenues may turn out to be inadequate and may render misleading elasticities.

The differentiation between long- and short-run elasticities[140] gains more importance because it is further linked to the often-alleged trade-

[139] When tax systems do not include provisions for the adjustment of thresholds in response to inflation to keep pace with it, then a 'fiscal drag' occurs, i.e., tax-payers are 'dragged' into paying more taxes, and tax revenues, hence, rise due solely to inflation and not to any legislative/policy measures (see also Cornevin et al., 2023). See also Princen et al. (2013) and Kremer et al. (2006) on using the term in a broader sense, applying to all revenue items with elasticities different from unity.

[140] Here again, the reference may concern the tax-to-income or the tax-to-base elasticity.

off between revenue growth and revenue stability or variability,[141] which is quite substantial in terms of public finance. In principle, there may exist a trade-off between the growth and the stability dimension of tax revenue, if it is assumed that the faster growth of tax sources is accompanied by a stronger response to macroeconomic fluctuations, hence, implying instability. In that case, governments would need to counterbalance any revenue expansion targets with the revenue stability goal (Fricke and Süssmuth, 2014). Although this might seem to hold for an overall tax structure, differences between long- and short-run elasticities for individual tax categories may prove useful to sidestep this trade-off. If, for example, revenue stability is important, Seyfried and Pantuosco (2003) argued that it can be reinforced over the business cycle through appropriate changes in the tax structure, emphasizing taxes that are less susceptible to changes in economic conditions. Sobel and Holcombe (1996), who also explicitly referred to such an inherent trade-off between growth and stability in tax bases,[142] asserted that although it is often accepted in the literature without much question, several authors have questioned its automatic validity. They argued that differences between long- and short-run elasticities may indicate that short-run revenue variability can be reduced without sacrificing long-run growth, implying that the trade-off between growth and variability is not automatic. According to a similar argument by Wolwijk (2009), from a longer-term perspective, potential differences between the long- and short-run elasticities may allow for the overcoming of such a trade-off: high (long-run) revenue growth can be combined with short-run stability, and vice versa, whereby the suitable choice of taxes may provide “a tax portfolio closer to the tax frontiers, taking account of preferences regarding tax revenue growth and stability”. Overall and along the same line of argumentation, Fricke and Süssmuth (2014) argued in favor of detailed elasticity estimates since these can provide

[141] On revenue stability, see, for example, Fox and Campbell (1984), and the references in Section 5.3. For a reference to the importance of tax revenue stability over the business cycle at the state-level analysis, see, for example, Seyfried and Pantuosco (2003).

[142] Recall that the authors focus on a base-to-income relation. They employ state tax bases. On references to related state analysis for the US, see also Fricke and Süssmuth (2014).

some guidance on how to combine growth with stability targets with the aim to develop an adequate tax system. All the above arguments more than support the need to differentiate between individual tax categories and the long- and short-run period.

Finally, and in addition to the above presented considerations with regard to the time dimension of tax revenue elasticity, the issue of potentially asymmetric elasticities in the short run should not be neglected. Such asymmetric behavior basically refers to varying revenue response depending on different economic conditions.[143] According to Boschi and d'Addona (2019), there may be several theoretical rationales for tax elasticity varying across economic regimes, such as composition effects and behavioral aspects of taxation, which may differently impact tax compliance, shift activity between the formal and the informal sector, and, hence, affect tax collection efficiency over the business cycle. It, thus, becomes important to take into account that revenue collections might respond asymmetrically to the upward and downward phases of the business cycle, as Jooste and Naraido (2011) indicated. Such dynamics should not be ignored in order to avoid biased fiscal indicators (Wolswijk, 2009) and any kind of upward or downward revenue surprises which might endanger the achievement of policy targets and, thus, question the credibility of fiscal authorities (Jooste and Naraidoo, 2011; Tagkalakis, 2013a). Disregarding the asymmetry aspect, in particular during times of crises, could generate a downward spiral, as new measures with an adverse impact on economic activity would be required in turn, again affecting (here, lowering) tax revenues (Tagkalakis, 2013a).

5.2.3. Tax revenue buoyancy versus tax revenue elasticity

The concepts of tax revenue buoyancy and tax revenue elasticity share a number of common elements, while they differ in several other dimensions. Obviously, the essential distinction between the two lies in the theoretical importance and practical treatment of the effects of DTM, through

143 Note that according to Mourre and Princen (2015) and Mourre and Princen (2019), asymmetry in the short-run revenue response to base changes may be related to the discrepancy between long- and short-run elasticities, resulting from cyclical fluctuations. See also Princen et al. (2013).

which each one of the two revenue response concepts acquires its own distinct meaning and interpretation.[144] Tax buoyancy merges automatic revenue response with revenue changes due to discretionary actions, while tax elasticity reflects the purely endogenous revenue reaction. Still, both revenue response concepts provide important information (on this argument, see also Cornevin et al., 2023).

In attempting to directly compare the two response concepts in definitional terms, tax buoyancy may be regarded as a more comprehensive concept of the sustainability of the tax system with regard to the public spending needs and is particularly crucial in terms of policy since, in a long-run perspective, automatic and discretionary changes can be considered complementary fiscal policy tools (Lagravinese et al., 2020; Cornevin et al., 2023). Alongside the structural dimension of revenue response, it incorporates the role of DTM (IMF, 2020) in effectively enhancing tax revenues over intermediate periods of time. It becomes the relevant response concept when fiscal authorities are constrained in affecting the endogenous part of the relation between tax revenues and income (i.e., in affecting the elasticity of the tax system and/or that of individual taxes) and need to assess the effectiveness of the attempt to influence tax revenues through the implementation of discretionary changes. In other words, if the government is confronted with undesirable low elasticity (possibly due to the rigidity of the tax base, the presence of tax evasion and/or avoidance, etc.) and manages to raise additional tax revenues via DTM, then revenue enhancement is related to high buoyancy rather than high elasticity (Mansfield, 1972; Dudine and Jalles, 2018; Jalles, 2020; Lagravinese et al., 2020). More importantly, whenever in practice the exact or approximated identification and isolation of the effects of tax measures on tax revenues become problematic[145]

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[144] In using alternative labeling to differentiate between and compare the two revenue response concepts, Princen et al. (2013) referred to *gross* versus *net of DTM* elasticities. The latter should abstract from the exogenous impact of DTM and reflect only the endogenous part. Barrios and Fargnoli (2010) focused on the role of discretionary tax measures and on whether they affect tax revenues pro-cyclically, while they also refer to *gross* versus *net of DTM* elasticities. Conroy (2020) differentiated between the use of policy-adjusted and unadjusted revenue to obtain elasticities.

[145] Princen et al. (2013) offered a number of reasons in favor of the paramount importance of the availability of sound estimates of DTM.

or even unfeasible (see, for example, Sen, 2006), buoyancy remains the only accurate concept for measuring tax response to changes in income (or GDP or any appropriate macroeconomic aggregate). Dudine and Jalles (2018) argued that when information on DTM is not available, the determination of tax elasticity is rendered more complicated.[146] In this framework, Belinga et al. (2014) focused on tax buoyancy due to the absence of systematic information for all investigated countries about changes in tax policy parameters, Lagravinese et al. (2020) concentrated on buoyancy at the back of inclusiveness criteria and the questionability of isolating the effects of discretionary measures in practice, and Cornevin et al. (2023) also concentrated on buoyancy on the basis of limited availability of systematic data on changes in tax policy parameters, having identified several difficulties to be considered when estimating elasticity.

From a pure structural perspective, tax elasticity may be considered more relevant. In other words, it may be principally regarded as a better indicator than tax buoyancy for measuring tax response (Mourre and Princen, 2015; Mourre and Princen, 2019) since it captures the pure tax revenue reaction, irrespective of the implemented tax policy changes or tax law modifications. By identifying how far revenue response represents 'inbuilt' effects related to the structure of taxes (Creedy and Gemmell, 2004), it becomes more important in structural terms. Its significance is further reinforced by limitations characterizing the ability of fiscal authorities to frequently and/or repeatedly implement tax measures. More specifically, it is assumed that the implementation of DTM cannot indefinitely lead to enhanced revenues (Khan, 1973; Timsina, 2007), while tax measures – such as tax rate increases and other interventions – may be considered unpopular, politically difficult, or even non-desirable (Mansfield, 1972; Ehdaie, 1990; Haughton, 1998; Kargbo and Egwaikhide, 2012). As Jenkins et al. (2000) and Mukarram (2001) outlined, the frequent and *ad hoc* implemen-

[146] The authors even argued that in the presence of several technical issues in the estimation process (related to the panel dimension of the application), buoyancy estimates can satisfactorily approximate elasticity estimates. Köster and Priesmeier (2017) stated that they use the terms buoyancy and elasticity synonymously and analyzed elasticity relations without isolating the effects of DTM since it is impossible to construct the required policy-neutral datasets for a long time-frame and a large number of countries, due to lack of data.

tation of tax system adjustments (including tax rate changes) generates and/or aggravates uncertainties and may have adverse effects on long-term investments, due to delayed investment decisions by private agents, while it may also distort consumption decisions. For all these reasons, when a government targets higher endogenous or automatic revenue response, then elasticity becomes the appropriate concept.

In directly comparing the two revenue response concepts in terms of their relative size, and as Bilquees (2004) indicated, when revenues are increased through the effects of discretionary measures, then tax revenue buoyancy is expected to be higher than elasticity (on that point, see also Choudhry, 1979; Mukarram, 2001; Timsina, 2007; Twerefou et al., 2010; Kargbo and Egwaikhide, 2012; Ndedzu et al., 2013). Moreover, as Choudhry (1979) pointed out, the larger the effect of discretionary measures, the greater the difference between buoyancy and elasticity.[147] In reversing the argument, if elasticity exceeds buoyancy, the implemented discretionary measures are not effective in raising additional revenues or may even have an adverse effect on tax revenue growth and may dampen the overall tax system's response (Khan, 1973; Gillani, 1986; Seydou, 2020). It should be stressed that a comparison of the relative size of the two revenue response concepts, if carried out at the level of the tax system as a whole, may be misleading with regard to any potential effect of DTM. This is due to the fact that any impact at the individual-tax level may be concealed through the compensation of opposing patterns and/or counterbalancing outcomes. In such a case, significant information content may be lost, stressing the importance of differentiating between buoyancy and elasticity for individual tax categories[148] to obtain relative evidence on those taxes for which discretionary measures have been most important (Mansfield, 1972; Seydou, 2020).

It becomes evident from all the above, that both concepts of tax buoyancy and tax elasticity are particularly significant in terms of public financ-

[147] Obviously, if buoyancy and elasticity do not deviate, then discretionary tax measures have a neutral effect on tax revenues (Kargbo and Egwaikhide, 2012).

[148] On this argument, see Barrios and Fargnoli (2010) who mentioned that in many cases, in synthesis, discretionary measures offset each other.

es and fiscal policy implementation.[149] Since they both entail essential elements from the theoretical and policymaking perspective, they should be considered complementary and must constitute parts of any inclusive analysis framework.

5.3. Theoretical context

The way in which tax revenues respond to changes in income is an issue of utmost importance and has been traditionally incorporated into and/or related to certain key notions in terms of public finance. The present section aims at setting a general outline of the context which integrates tax revenue response in terms of both public finance theory and policy.[150] Several crucial concepts will be shown to be involved in this context, such as revenue stability, built-in flexibility, revenue sensitivity, stabilization through automatic versus discretionary changes, and, not least, tax revenue buoyancy and elasticity. Apart from the interconnection between certain concepts, the reference will reveal several controversies and disputes, some of which may still remain unresolved. The outline presented in this section will be unfolded on the basis of the association of tax revenue response with two major notions: the notion of the adequacy criterion of the tax yield, as analyzed in Section 5.3.1, and the notion of compensatory finance and policy, as explored in Section 5.3.2.

5.3.1. Tax revenue response and adequacy of the tax yield

The *adequacy* criterion of the revenue (or tax) yield has been one important subject of reference in the theory of public finance and, in particular, the theory of taxation. Groves and Kahn (1952) stressed the theoreti-

[149] For an interesting comparison between the two concepts for state and local taxes, see Anderson and Shimul (2018).

[150] It should be noted at this point that the present section by no means attempts to cover the particularly extensive and multidimensional literature on public finance theory and policy. Rather, it is aimed at providing the underlying theoretical background, with a historical perspective, for several notions relating to the general concept of the revenue response to income changes.

cal importance of adequacy, although it was a notion not incorporated in Adam Smith's canons of taxation. According to their definition, "By adequacy is meant not only the capacity of a particular tax to produce a given initial amount of revenue but also its capacity to sustain this level in such a manner as to permit the maintenance of a given volume and quality of governmental services". Wagner (1958) classified the adequacy of yield as one of the two financial principles, under the basic principles[151] of taxation. Musgrave and Musgrave (1989) assigned major importance to the adequacy of the revenue yield in setting out the requirements for a 'good' tax structure. Wilford (1965) also referred to the adequacy criterion in the framework of state tax stability criteria and alongside other criteria established in time as tax policy guides ("...mostly variations on the theme of Adam Smith's famous 'canons of taxation'.").

In the earlier literature, adequacy was often related to revenue stability, in contrast to revenue flexibility/instability, and was associated with elasticity in general and long-run elasticity in particular. With reference to stability, Groves and Kahn (1952) specified stability as a special case of adequacy and argued that adequacy is frequently considered a significant qualification of a good revenue system at the state and local levels. They, thereby, directly distinguished stability from flexibility by contrasting tax policy at the state and local levels with policy at the level of the federal tax system. They claimed that their work was devoted to problems arising from the desire (by state and local authorities) for revenue stability rather than flexibility, even though at the level of the federal tax system, public finance literature had paid more attention to the issue of built-in flexibility and to the income elasticity of individual taxes comprising the overall tax system. They even asserted that in contrast to the position of the federal government, who makes instability of taxes (built-in flexibility) a virtue, states and their subdivisions are primarily concerned with 'built-in stability' and, for that reason, with taxes characterized by a low sensitivity with respect to income. While classifying taxes into those with income elasticity substantially less than unity (with very stable yields), close to unity (with yields varying

[151] The second financial principle is the flexibility of taxation, while the other basic principles of taxation are categorized as economic principles, principles of justice or of the equitable distribution of taxation, and principles of tax administration.

roughly in proportion to income fluctuations), and above unity (with yields varying considerably more than in proportion to income changes), the authors clarified that the total of state and local tax revenue must have an income elasticity of less than one, if the aim is to keep always intact a certain level of government services primarily financed through taxes.[152]

Wilford (1965) described the problem of adequacy as being, in principle, two-fold: on the one hand, involving revenue structure stability during changes in economic activity levels, and, on the other hand, involving the ability of the tax structure to increase yields to meet new social needs dictated by population growth, urbanization, and technology changes. With these two goals being in conflict, since stability traditionally implied revenue insensitivity to economic fluctuations (see, for example, Davies, 1962), he clearly stated that, in order to meet raised expenditure needs, adequacy has come to require that revenues increase more rapidly than personal income. In other words, despite the theoretical emphasis given to the stability (or the inelasticity) of revenues, Wilford (1965) claimed that more recent developments in the economic theory and policy of that time required a reconsideration of adequacy criteria, away from stability in the traditional sense and towards the built-in ability of tax structures to respond to economic growth.[153] On the basis of exactly the same requirement for faster revenue growth than personal income growth, Legler and Shapiro (1968) related the adequacy of a state's tax structure with elasticity and argued that adequacy has developed to require more than the initial definition by Groves and Kahn (1952).

Williams et al. (1973) later claimed that the above stated Groves and Kahn (1952) definition turned stability into an 'antonym of growth'. They elaborated on their opinion that Groves and Kahn (1952) had actually measured long-run or secular tax/income elasticity, although they had been principally concerned with the short-run or cyclical stability of the

[152] Note that in investigating different taxes, their choice was largely based on data availability for taxes with yields remaining relatively uninfluenced by changes in law with regard to rates, tax base definition, or administration.

[153] Note that, according to the author, the determination of revenue responsiveness to statutory rate changes has been a further fiscal concern of state governments. They finally concluded that 'built-in flexibility' or 'instability' of state tax structures, instead of 'stability' or revenue insensitivity, may be a desirable objective at the level of state tax policy.

tax yield. Since the Groves and Kahn (1952) calculations led to a better measure of revenue growth, rather than of revenue stability, Willliams et al. (1973) asserted that high long-run elasticity could be considered a desirable indication of revenue growth or adequacy, instead of an undesirable manifestation of instability. Nevertheless, the authors argued that, in time, revenue instability as measured by income elasticity came to be considered a virtue, in the sense of its operation as a cyclical stabilizer in a macroeconomic framework. Instead, stability came to be considered as undesirable *per se*, despite its significance for the budget planning process, since it was viewed as “an antonym for both growth and cyclical stabilization”. Both views could be, however, circumvented since growth is a long-run matter, while stability relates to short-run behavior, and it must not be necessarily considered an alternative to the cyclical stabilization function.

Fox and Campbell (1984) focused on the differentiation between the long and the short run and directly related revenue stability to the short run. In more detail, they did not refute the validity of the often-asserted generalizations[154] with reference to relatively income elastic or inelastic taxes over the long run. Still, they questioned the extension of this logic to revenue stability, arguing that the latter is a short-run concept related to revenue fluctuation across the business cycle. In going a step further, they defined revenue stability as the situation of countercyclical (short-run nominal) income elasticity of revenues, meaning that the short-run elasticity increases in a recession and falls in an expansion. In that sense, a tax source cannot be characterized as stable simply on the basis of the income inelasticity of revenues in the long run, because its short-run pattern may be very unstable. Moreover, stability is a matter related to the timing of elasticity changes and not to the simple fact of varying elasticities.

5.3.2. Tax revenue response and compensatory finance

Compensatory finance (or compensatory budget policies) has been a central issue in exercising fiscal policy. According to Musgrave and Miller

[154] They explained that, based on conventional wisdom, state sales taxes have been considered relatively stable revenue sources because they are income inelastic, while state income taxes have been considered relatively unstable because they are income elastic.

(1948), "The essence of compensatory fiscal policy lies in adjusting the level of government receipts and expenditures so as to stabilize total income (and employment) in the economy." In other words, when disturbances occur, originating, for example, in the private sector, changes in the basic tax (and expenditure) parameters may be undertaken to compensate for these, causing compensatory budget effects (Musgrave, 1959). Apart from such undertaken adjustments, compensatory effects may also occur automatically, i.e., arise through automatic changes in tax yield (or public expenditures), while the related fiscal parameters are held constant (Musgrave and Miller, 1948; Musgrave, 1959). In that sense, adjustments undertaken through policy have been traditionally contrasted to adjustments that may occur automatically (see, for example, Musgrave and Musgrave, 1989), while potential arguments in favor of their combination have also been discussed.[155] The associated debate and controversy were often centered around certain key concepts such as tax buoyancy and/or elasticity, built-in flexibility versus tax sensitivity, and the general notion of automatic adjustment/stabilization.

Among the works including reference to most of the aforementioned crucial concepts was the one by Khan (1973). By identifying taxes as "the most important element responsive to government policy", he distinguished between two elements: on the one hand, the taxation measures (e.g., tax base expansion, tax rate increases, or the imposition of new taxes) a government can resort to with the aim to increase the flow of tax receipts to meet the ever-expanding public expenditure requirements, which may be, however, characterized by serious administrative and political limitations; on the other hand, reliance on the tax structure's built-in flexibility, whereby a given tax structure would ensure that an increasing part of income increments would be automatically channeled into the

[155] In the reference to compensatory policy and a discussion of contrasting automatic stabilizing forces with discretionary action, Walter (1951) argued that "... a mingling of automatic stabilizers and discretionary action is preferable ...". In the framework of discussing issues of compensatory finance, Musgrave (1959) argued in favor of the need for adaptability in the field of stabilization policy, at the back of ever-changing conditions. To meet the latter, automatic responses of the fiscal structure may be all to the good, but may not solve the entire problem, even if proper in scope and quality. Adjustments (monetary or fiscal) to such changing conditions would also be required, whether more or less frequent.

public funds without needing to resort to any major budgetary adjustments. He classified the response of a tax system to income increases under two broad headings: as the result of either the buoyancy or the built-in flexibility of the tax structure. He described the buoyancy of a tax system as the more comprehensive concept, given by the ratio of the percentage change in total tax revenue, due to both the automatic and the discretionary elements, to the percentage change in national income.[156] He specified built-in flexibility as "the extent to which the tax system gives an increased return with every increase in the national income without any change in either the tax base or the rates of existing taxes, or the imposition of new ones". He offered two measures of such responsiveness, the first being the average relationship between tax revenues and GDP (or between revenues from individual tax categories and the relevant GDP component). To calculate this measure, the 'flexibility co-efficient' can be mathematically obtained as the marginal rate of taxation, i.e., the ratio

$$\beta = dT/dY, \tag{5.20}$$

where T is tax revenue and Y is national income. He further identified the elasticity of the tax structure as the second and a more often used index of tax yield responsiveness to GDP, defined as the ratio of the rate of increase in tax yield to that in national income (or that of a specific component of income in the case of individual taxes),

$$E_T = [Y/T] \times [dT/dY], \tag{5.21}$$

whereby revenues are corrected for the effects of measures undertaken.

More generally, the component of automatic adjustment (stabilizers) was represented by either built-in flexibility or tax elasticity, on the basis of the underlying distinguished mathematical approaches. In addition, tax

[156] See Pechman (1956) for an early interesting attempt, based on the case of the individual income tax in the USA, to quantitatively assess the combined direct revenue effects of built-in flexibility and discretionary changes in rates and exemptions. Cohen (1959 and 1960) continued and extended the Pechman (1956) approach. Note that Edelberg (1940) had already stated that authors on taxation theory recognized and emphasized by that time the need for the measurement of the full effects on the tax yield of rate changes, variations in national income, and other factors.

elasticity was often considered equivalent to tax sensitivity. Cohen (1959) commented on the discussion about the relative merits of the two approaches and provided related literature references.

In earlier work, the built-in flexibility approach was described, in definitional terms, as the marginal method (see Cohen, 1959; Smith, 1962). According to Musgrave and Miller (1948), the related part of adjustment may happen since tax yields will fluctuate, under given statutory rates, with changing national income, as the size of the tax base typically fluctuates directly with the level of income. The magnitude of such an automatically compensatory adjustment of tax revenues, generally referred to as built-in flexibility, will depend upon the marginal tax rate (e.g., the dollar change in tax revenue as a result of a given dollar change in national income) and, the related issue may be, thus, formulated in terms of this marginal tax rate.[157] In an interesting approach, Smith (1962) even decomposed built-in flexibility into two components: the change in the tax yield associated with a change in the tax base and the change in the tax base resulting from a given change in income; he, then, defined the total built-in flexibility by the product of the two components. Cohen (1959) argued that the marginal method would be better suited for aggregative measurements, i.e., for measurements related to changes in aggregate tax yield with respect to aggregate income changes.

Apart from built-in flexibility, tax sensitivity has been analyzed and assigned great importance already in early work. Bretherton (1937) defined the sensitivity of the tax yield to trade cycle movements as the ratio of the percentage change in yield to the percentage change in National Social Income.[158] The author even claimed that the cyclical sensitivity of a tax system should be added to the list of canons or criteria of a tax system. He argued that if exercising a budgetary policy designed to control and offset the fluctuations of private business (where the old canon of stability of rates of taxation seems to have little place), there would always be an interaction with the cyclical sensitivity of the various taxes. In finding

[157] For a more detailed description of the link between the selected 'average tax rate' and the determination of the extent of 'built-in flexibility' or the marginal rate of the overall tax system, see Musgrave and Miller (1948).

[158] For the exact definition of National Social Income, see Bretherton (1937).

a satisfactory benchmark against which to measure the cycle sensitivity of taxes, he stressed the need to eliminate the effects of changes in the tax rate or basis on the tax yield to obtain a 'hypothetical yield' of the tax.

In another early work, Edelberg (1940) also elaborated on the cycle sensitivity of the tax yield. According to Walter (1951), tax sensitivity,[159] described as one aspect of the problem of compensatory finance, is nothing else but the income elasticity of the tax yield.[160] In its aggregate sense, it was described by the author to be "affected by fluctuations in the tax base, progressivity and exemptions, lags between accrual and collection, and 'built-in' rate changes".[161] Moreover, it was evaluated to be a useful measure to rank different taxes, enabling the determination of those taxes with the greatest potentialities in terms of sound fiscal policy. The author stressed that tax sensitivity is to be distinguished from built-in flexibility, which implies that elasticity is to be distinguished from built-in flexibility, as Pechman (1956) also indicated. Cohen (1959) provided a number of literature references utilizing and emphasizing the elasticity approach, but also referred to work that had been critical of the respective method.

Built-in flexibility and tax sensitivity (or income elasticity) have been further related in theoretical terms through an alternative technical definition of the first, which has been used to identify the so-called compensatory effectiveness of built-in flexibility. In recalling the discussion on compensatory finance and the fact that compensatory effects may also occur au-

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[159] The author also provided other literature references employing the definition of tax sensitivity (see, e.g., the references to Slitor [1948] and Vickrey [1945]).

[160] Davies (1962) referred to the use of the elasticity method to derive a sensitivity measure or an elasticity measure for consumption taxes with respect to income. Davies (1963) measured tax revenue sensitivity to changes in income by the macro-elasticity coefficient of taxes.

[161] For more details, see Walter (1951). Note that according to the author, 'built-in' rate changes had not yet been utilized, while he argued that there "may be some doubt as to whether 'built-in' rate changes should be classified under the heading of automatic or discretionary". Musgrave and Miller (1948) argued that the flexibility of the tax system might be increased if provision was made for automatic adjustments in tax rates with changes in income, but this could hardly be called 'built-in flexibility' in the usual sense of the term. Rather, it is a way of applying deliberate countercyclical adjustments in the rate of taxation and expenditures. Such adjustments must remain the primary reliance of fiscal policy when it appears (as it most certainly will) that the actual level of fluctuations passes tolerable limits.

tomatically, the need to measure the compensatory effectiveness of such an automatic adjustment becomes evident. To obtain such a convenient measure, Musgrave and Miller (1948) described a more analytical way to state the problem of the degree of flexibility, namely in terms of both the level of taxation (the average tax rate at the expected level of income) and the sensitivity of the tax yield (of the selected combination of tax sources) in response to changes in income. Walter (1951) also defined built-in flexibility as the product of tax sensitivity and the average tax rate, which, after cancelling out terms, is reduced to the marginal rate of taxation, as follows

$$\left(\frac{\Delta T}{\Delta Y}\times\frac{Y_1}{T_1}\right)\times\frac{T_1}{Y_1}=\frac{\Delta T}{\Delta Y}, \tag{5.22}$$

where T stands for tax revenue, Y for income, the Δ terms for the change between two periods, and Y_1 and T_1 for income and revenue in period 1, respectively. From equation (5.22) it also follows that income elasticity can be expressed as the ratio of the marginal tax rate to the average tax rate (for this elasticity specification, see Indraratna, 1991; Osoro and Leuthold, 1994; Havranek et al., 2016), such as

$$\left(\frac{\Delta T}{\Delta Y}\times\frac{Y_1}{T_1}\right)=\left[\frac{\Delta T}{\Delta Y}\right]\div\left[\frac{T_1}{Y_1}\right]. \tag{5.23}$$

In that sense, in the simplified model[162] of Musgrave and Miller (1948), with the aim to measure the compensatory effectiveness of built-in flexibility, the authors provided the expression for the change in income between periods 1 and 2 in terms of the marginal tax rate m as

$$\Delta Y=\Delta I+c\Delta Y-cm\Delta Y, \tag{5.24}$$

where I stands for investment, c for the marginal propensity to consume out of disposable income (which is assumed to remain constant), and all Δ terms stand for the change between periods 1 and 2. Solving the above

[162] For all relevant assumptions, see Musgrave and Miller (1948).

equation for ΔY, gives

$$\Delta Y = \Delta I \times \frac{1}{1-c(1-m)}, \tag{5.25}$$

or, based on equation (5.22),

$$\Delta Y = \Delta I \times \frac{1}{1-c\left(1-E\dfrac{T_1}{Y_1}\right)}, \tag{5.26}$$

where E stands for the income elasticity of the tax yield.[163]

It is interesting to note that, regardless of the earlier clear-cut mathematical distinction between built-in flexibility and tax elasticity, the two notions remain closely associated, through their feature of depicting the automatic response of the tax yield to changes in income, abstracting from discretionary measures. It is indicative that, more recently, Creedy and Gemmell (2006) described built-in flexibility, or revenue responsiveness, as the properties that generate any automatic revenue change by the tax system in the absence of discretionary changes. They argued that the tax revenue elasticity can be considered a commonly used *unit-free* measure

[163] The proposed measure for the compensatory effectiveness of built-in flexibility is then defined as $\alpha = 1-(\Delta Y/\Delta Y_\alpha)$, where ΔY stands for the change in income in the specific tax system under discussion (with the corresponding value for E), while ΔY_α stands for the change in income in a system in which the tax yield does not vary with income, i.e., where E equals zero. The ratio $\Delta Y/\Delta Y_\alpha$ represents the actual change in income to the change in income if the system had no built-in flexibility. In subtracting this ratio from 1, α measures the fraction of the change in income that is prevented due to the existence of built-in flexibility. In the case of $\alpha = 0$, there is no built-in flexibility, while in the case of $\alpha = 1$, built-in flexibility is perfect, i.e., total income remains unchanged (see, analytically, Musgrave and Miller [1948] and Musgrave [1959]). See also Lusher (1956) on the mathematical derivation of the stabilizing effectiveness of built-in flexibility, who provided an equivalent measurement to the one used by Musgrave and Miller (1948). See Vickrey (1949) for a discussion on the limitations of the effectiveness of built-in flexibility as a stabilizing device. Still, note that we do not focus on this concept here since our aim is only to provide the link between the concepts of tax elasticity and built-in flexibility in the framework of compensatory finance, to once again stress their importance.

of this responsiveness[164] and a useful *summary measure* of built-in flexibility for a number of reasons, including the fact that revenue elasticity can be compared to tax buoyancy to identify the effects of discretionary tax measures on revenues.[165]

Finally, and despite the lively discussion on notions such as built-in flexibility and tax sensitivity (or tax elasticity), the extent to which high tax sensitivity and/or built-in flexibility are desirable and sufficient properties after all remains an unresolved issue. Bretherton (1937) argued that it is not altogether obvious that it is an 'evil' to have a tax system which is highly sensitive to the trade cycle. He provided a reference to the view of the adherents of 'orthodox principles' of public finance and the view of adherents of less orthodox methods of budgeting in the trade cycle. Musgrave and Musgrave (1989) argued that built-in flexibility might be helpful or harmful to economic stability depending on the circumstances and elaborated on that on the basis of short-run and longer-run aspects. According to Musgrave et al. (1945), flexibility in tax policy is needed. Such a requirement is of two kinds: preference should be given to taxes sensitive to changes in income to ensure automatic adjustment and no need for frequent changes in tax rates, which are undesirable. However, when automatic changes in yield are not assumed to be sufficient, it should be ensured that rates can be promptly adjusted at any strategic point of the system. Similarly, the evidence provided by Musgrave and Miller (1948) did not seem to lend justification in favor of the more popular (at that time) position that built-in flexibility would be sufficient on its own and adjustment could be managed without deliberate countercyclical fiscal policy. Walter (1951) also provided a number of specific reasons suggesting that built-in flexibility might be insufficient in itself. Cohen (1959) referred to the ongoing dispute with regard to relying on automatic stabilizers versus appropriately applying discretionary tax policy measures and to the related

[164] In more detail, they argued that "revenue responsiveness is the extent to which tax revenues respond to changes in some tax base, usually income, in the absence of any discretionary action by the fiscal authority, and is typically measured by the revenue elasticity of the tax". Legler and Shapiro (1968) also related the responsiveness of tax receipts to the elasticity concept.

[165] For the remaining reasons offered, see Creedy and Gemmell (2006).

theoretical and empirical efforts to measure the magnitude of automatic stabilizers.[166]

5.4. Key applications of tax revenue buoyancy and elasticity

Having established the conceptual framework and the theoretical context integrating the notions of tax revenue buoyancy and elasticity, it remains crucial to provide an indicative reference[167] to central fields of their technical application. The study of the way in which tax revenues respond to changes in income constitutes a key ingredient of tax policy formulation not only from the general point of view of resource mobilization, tax structure reform, and/or tax revenue administration. In practice and in technical terms, tax revenue buoyancy and especially tax revenue elasticity also represent central parameters in several important applications, such as revenue forecasting, while tax revenue elasticity constitutes an essential ingredient in the distinction between discretionary and automatic components. The following sub-sections 5.4.1 and 5.4.2 aim at shedding light on the importance of revenue response concepts in the framework of these two applications.

5.4.1. Tax revenue buoyancy and elasticity and tax revenue forecasting

The importance of forecasting tax revenues for budgeting purposes, monitoring budget outturns (in particular with respect to targets set), and assessing the potential impact on revenues of tax law changes is more than self-evident (King, 1995). Jenkins et al. (2000) outlined the fact that every country undertakes revenue projections when formulat-

[166] Walter (1951) was further involved in the discussion contrasting automatic stabilizing forces with discretionary action. Elaborating on that issue lies outside the scope of the present section.

[167] The purpose of this section is not to elaborate or evaluate in-depth any of the presented subjects and the ensuing controversies, but solely to provide their close and direct connection to the two revenue response concepts, i.e., tax revenue buoyancy and elasticity, in order to demonstrate their significance.

ing its budget, while it faces the risk of ending up with deficit financing if revenues turn out to lie below budget expenditures. They elaborated on the significance and the analytical process of revenue forecasting. Based on their argumentation, tax analysis and revenue forecasting are of critical importance to governments for the purpose of ensuring stability and adequacy in tax and expenditure policies. In time, several alternative revenue forecasting techniques have been developed and applied, which may vary significantly (see, indicatively, King, 1995; Kyobe and Danninger, 2005; Chung et al., 2022). One approach for the derivation of revenue forecasts relies on the use of measures of the response of revenues to changes in GDP or other relevant macroeconomic aggregates. According to Wolswijk (2009), for example, governments use such response measures in the process of forecasting revenues during budget preparation. In that sense, revenue forecasting presents an important field of application of tax revenue response concepts (see, for example, Bilquees, 2004; Twerefou et al., 2010; Kargbo and Egwaikhide, 2012).

Even though far less frequently than tax elasticity, tax buoyancy may be employed for revenue forecasting purposes, as discussed in a number of related papers (see Timsina, 2007; Mawia and Nzomoi, 2013; Deli et al., 2018; IMF, 2020; Jalles, 2020; Seydou, 2020). More commonly, tax revenue elasticity is related to revenue forecasting, as indicated in several related studies (see Berney and Frerichs, 1973; Indraratna, 1991; Osoro and Leuthold, 1994; Timsina, 2007; Morris et al., 2009;[168] Koester and Priesmeier, 2012;[169] Bettendorf and van Limbergen, 2013; Price et al., 2014; Havranek et al., 2016; Boschi and d'Addona, 2019; Conroy, 2020; Seydou, 2020). Jenkins et al. (2000) argued that, despite the usefulness of buoyancy for policy design purposes, tax elasticity is the relevant notion

[168] Morris et al. (2009) included the assumed elasticity of revenues with respect to the base to the necessary parameters for the projection of revenues for any individual revenue item.

[169] Koester and Priesmeier (2012) directly related the tax revenue-to-base elasticity with the process of monitoring, analyzing, and forecasting public finances, where revenue forecasts rely on tax elasticities to calculate expected revenues on the basis of macroeconomic predictions.

for forecasting purposes. This is explained by the fact that revenue-forecasting models based on income or GDP rely on tax elasticity in order to estimate the collections of future tax revenues, on the basis of the current tax structure. In the same sense and according to Creedy and Gemmell (2004), tax revenue elasticities offer essential inputs into several tax forecasting models, where (in conjunction with assumptions concerning changes in the tax base) they produce revenue growth projections for given tax policies. Creedy and Gemmell (2006) argued that the revenue forecasting models used by the UK Treasury and the Institute of Fiscal Studies either estimate or impose tax revenue elasticities. More recently, Lagravinese et al. (2020) also asserted that elasticity may be inferred as the relevant concept for revenue forecasting since it excludes the effects of discretionary tax measures, and Cornevin et al. (2023) argued that elasticity is considered a better factor for forecasting purposes since it isolates revenue growth owed only to changing economic conditions (by controlling for the effects of tax policy measures).

In terms of alternative forecasting techniques as presented by King (1995), forecasting revenues using elasticities belongs to the conditional approaches among revenue-forecasting methodologies,[170] since forecasts are, in this case, conditional upon forecasts of other macroeconomic variables. Under the constant elasticity assumption, a forecast of tax revenues for a given forecast period may be derived straightforwardly from a forecast of a macroeconomic variable in the same period, in conjunction with actual figures for tax revenues and this variable in some previous period. In the case of aggregate tax revenue elasticity or individual tax revenue elasticity with respect to GDP, GDP forecasts are needed.

Clearly, central to any tax revenue forecasting framework is the accuracy of the obtained projections. Accurate forecasts contribute to avoiding budget surprises, whether revenue windfalls or shortfalls[171] and, as a result, to preventing the need for additional implementation of measures

[170] For an overview of other revenue-forecasting methodologies, see King (1995).

[171] For a detailed work on potential driving forces of revenue windfalls and shortfalls for selected EU countries, see Morris et al. (2009).

by any government. Especially for EU members, inaccurate assessments of the fiscal stance may prove to be undesirable within the surveillance framework since deviations from budgetary objectives might put in force specific correction mechanisms (Boschi and d'Addona, 2019). However, the derivation of consistent revenue projections is not an easy task. In a discussion on Asian economies, Shome (1988) indicated that even though setting revenue targets and deriving revenue projections remains essential, collected revenues more often fall short of revenues predicted. Buettner and Kauder (2010) stressed the fact that all countries make efforts to obtain reliable forecasts, but this process still remains quite challenging. This holds, in particular, during periods of abnormal economic conditions, whether in the upward or downward direction. Mourre and Princen (2019) revealed the difficulties in forecasting collected tax revenue during the Great Recession in the EU, due to the underlying complex dynamics. With respect to the extraordinary situation caused by the COVID-19 pandemic, the challenging nature of tax revenue forecasting during this crisis was stressed in IMF (2020), while Țibulcă (2022) also outlined the increased significance of accurate revenue forecasts in the EU following the related economic crisis.

It becomes evident that when tax revenue response concepts, such as buoyancy and elasticity, are used for revenue forecasting purposes, forecast accuracy will critically depend upon the accuracy of their measurement. In other words, when calculated buoyancies or elasticities are used to provide figures of revenue forecasts, the more accurate and refined these calculations are, the more precise and sound the forecasts will be. Berney and Frerichs (1973) linked revenue prediction with the accuracy of the applied elasticities. Wolswijk (2009) argued that the relevance of accurate tax elasticities came even more to the foreground during the mid-2000s, when tax revenue developments were, in many countries, more favorable than could be explained by the combination of the prevailing rates of economic growth with standard elasticities. Consequently, forecast accuracy is expected to be associated with the degree to which crucial dimensions of the concepts of buoyancy and elasticity (as analyzed in previous sections of this chapter) are taken into account, depending obviously upon the underlying objectives. This association may refer to the issue of disaggregation between individual taxes, the partitioning in components, and the time dimension, including the significance of crisis periods.

As stressed, for example, in IMF (2020) against the background of the COVID-19 pandemic, in periods of abnormal conditions it becomes very important to forecast all major taxes separately, which implies that the use of disaggregated elasticities (wherever available) acquires a key role in revenue forecasting. Moreover, according to King (1995), in the case of individual taxes (such as VAT) which are related to other macroeconomic variables (consumption in the VAT case), the availability of separate elasticities for the tax-to-base and the base-to-GDP components is useful for the forecasting process.[172] In an earlier work, Berney and Frerichs (1973) linked the elasticity concept with revenue forecasting, stressing the need to focus on the stability of elasticities over time. According to a related argument by Tagkalakis (2013a) for the case of Greece, if varying tax elasticity is not taken into account in revenue projections, revenue surprises may impair the achievement of policy targets. Then, additional measures will be needed to meet fiscal targets, with potentially negative effects on economic activity, leading to even lower tax revenues, thus generating a downward spiral in the economy. Finally, and with respect to the long- and short-term horizon, Fox and Campbell (1984) outlined the more frequent application of long-run elasticities for revenue projection purposes, compared to the infrequent use of short-run ones, as the latter have not been estimated in a useful manner. According to their argumentation, short-run elasticities chosen for the appropriate economic conditions would, however, yield better estimates of revenues. Creedy and Gemmell (2006) referred to the usefulness of tax revenue elasticities in long-run revenue forecasting. Poghosyan (2011) further stressed the importance of taking into account deviations between long- and short-term elasticities when deriving short-term projections. Mourre and Princen (2019) claimed that short-run revenue elasticities constitute the standard revenue response parameter used by professional forecasters.

[172] Under the condition, of course, that forecasts for these macroeconomic variables and/or GDP components are also available.

5.4.2. Tax revenue elasticity and discretionary versus automatic components

The tax revenue elasticity concept is deeply integrated into the important subject of the distinction between discretionary components, which are generally related to policy actions or interventions, and automatic or cyclical components, which commonly reflect any automatic response to macroeconomic changes.[173] More specifically, tax revenue elasticities with respect to a macroeconomic measure are widely employed in the process of cyclical adjustment, i.e., of the computation of the cyclical component which, then, enables the obtainment of the cyclically-adjusted component. Generally, the latter is considered structural and non-cyclical and is assumed to reflect the discretionary or policy dimension. This distinction and the associated computation become greatly important in different contexts, such as the context of assessing and/or comparing the potential stabilizing effects of automatic stabilizers and discretionary policy measures; the context of calculating fiscal (and/or tax) multipliers to assess the effects of fiscal policy on output; the context of the cyclical adjustment of the budget balance.

A separate focus and/or measurement, or comparisons of the stabilizing effects of discretionary fiscal actions and automatic stabilizers have traditionally attracted the interest of both academics and practitioners. Especially during, as well as in the aftermath of, major crises, the related discussion tends to return to the spotlight (for the argument regarding the recent global financial and economic crisis, see, for example, Follette and Lutz, 2010; in't Veld et al., 2013). The recent crisis triggered by the COVID-19 pandemic and the undertaken sizeable discretionary fiscal measures once again brought to the foreground the discussion on the relative importance and merits of such discretionary actions, as compared to the role of automatic stabilizers, in mitigating the effects of economic shocks and stabilizing the economy (Bouabdallah et al., 2020). With taxes being considered a source of automatic stabilization, the elasticity concept is an inherent part of the calculation of the size of auto-

[173] Recall that the purpose of this section is not to elaborate on any related long-standing, deeply rooted, and partly still unresolved debate, but only to provide the framework in which tax revenue elasticities are integrated.

matic stabilizers, being generally defined as the budget change ensuing from changing economic activity (in't Veld et al., 2013). More specifically, tax revenue elasticities enter the relations used to calculate such budget changes, either when employing the budgetary sensitivity or the budgetary semi-elasticity concept.[174]

The involvement of tax revenue elasticities in the distinction between discretionary and automatic (endogenous) components of revenue changes is established in the context of computing fiscal multipliers. This becomes crucial in the investigation of the size of the effects of fiscal policy and, in particular, tax policy on output (and other aggregate variables). To do that, it is necessary to obtain a measure for the changes in the relevant fiscal policy parameters, i.e., the related fiscal (revenue and expenditure) shocks. Traditionally, broad measures such as changes in total revenues and in cyclically-adjusted (corrected) revenues, which are the relevant parameters, have been used to measure changes in taxation policy (Romer and Romer, 2009 and 2010). This is related to the argument that the discretionary component of taxation should be allowed to have a different impact on output than the endogenous component, i.e., the automatic response of revenues to macroeconomic changes (Perotti, 2012[175]). In this context, tax revenue elasticities (in the disaggregated and also the decomposed form) become essential parts of the calculation of (unexpected) movements in taxes (see, for example, Blanchard and Perotti, 2002). The central role of accurate tax revenue elasticities is stressed in the strand of the relevant literature, trying to provide explanations for the observed variation and disagreement in the obtained fiscal and tax multipliers. In attempting to provide a unified framework, Caldara and Kamps (2017), for example, analytically related output elasticities of revenues with fiscal multipliers. In trying to reconcile existing evidence, Mertens and Ravn (2014) concluded on the importance of the val-

[174] For details on such calculations, see, for example, equation (B.1).

[175] The author argued that narrative "estimates of tax changes are based on 'discretionary' changes to taxation (also called changes in 'cyclically adjusted' revenues, or 'fiscal impulse'). These are meant to capture the intentional actions of policymakers, as opposed to the automatic effects of the business cycle on revenues".

ue of tax revenue elasticities (with respect to output) and of the associated assumptions and/or calculations.

Very importantly, tax revenue elasticities acquire a key role in the computation of the cyclically-adjusted budget balance (CAB). According to Masten and Grdović Gnip (2016), it is commonly accepted that the cyclical (or automatic) component of the budget balance represents the effects of automatic stabilizers. In turn, the cyclically-adjusted (structural[176]) component, i.e., the CAB, assumed to be unaffected by the cycle, underscores the implementation of discretionary fiscal policy (see also Boschi and d'Addona, 2019). The adjustment of actual government balances for cyclical developments in economic activity principally aims at contributing to obtaining a more exact picture of the underlying fiscal situation and to serving as a guide to fiscal policy analysis (Giorno et al., 1995), as changes in the CAB are considered to indicate the stance of fiscal policy (expansionary or recessionary). According to Bouthevillain et al. (2001) and Kremer et al. (2006), who focused on the methodology developed within the European System of Central Banks (ESCB), several institutions such as the EC, the IMF, and the OECD have been involved in the estimation of the CAB, to correct actual budget balances for the fluctuations of the business cycle. For EU countries in particular, following the reform of the Stability and Growth Pact (SGP), the CAB has become a central tool in the EU fiscal surveillance framework, increasing its prominence in policymaking (see Larch and Turrini, 2009). As Boschi and d'Addona (2019) pointed out, in the established surveillance framework, specific correction mechanisms are initiated in the case of a significant deviation from the medium-term budgetary objective, which is set in terms of the structural budget balance.[177] Within this framework, international organizations,

[176] The actual budget balance can be decomposed into its structural and cyclical component. CAB computation gives the structural component of the budget balance, after the deduction of one-off and temporary measures.

[177] Note that the extended use of the CAB in the inferred framework does not imply that it is unanimously accepted as the 'correct' indicator of discretionary changes in fiscal policy (see the critique in Blanchard, 1990). Furthermore, it has been shown that the EC methodology for CAB estimation often fails to identify the true fiscal policy stance and to accurately signal potential violations of the SGP limit on structural deficit (Masten and Grdović Gnip, 2016).

such as the OECD and the EE, are greatly involved with the concept and the determination or calculation of tax revenue elasticities (see Zervas, 2018). More importantly, this is done based on the approaches of both disaggregating elasticities across individual tax categories (using weighting parameters) and decomposing elasticities by the use of the two-step methodology, i.e., decomposing elasticities into the tax-to-base and the base-to-output gap components (see van den Noord, 2000).

BOX 5.1
The use of tax revenue elasticity in technical CAB computation

Tax revenue elasticities are used in the technical computation of the CAB (this fact is stressed, for example, in Blanchard, 1990; Giorno et al., 1995; Poghosyan, 2011;[178] Koester and Priesmeier, 2012; Bettendorf and van Limbergen, 2013; in't Veld et al., 2013; Havranek et al., 2016[179]). As elaborated in Mourre et al. (2014), the CAB is calculated by the subtraction[180] of the cyclical component, $[\varepsilon \times OG_t]$, from the actual balance-to-GDP ratio, $\frac{(R_t - G_t)}{Y_t}$, as follows:

$$CAB_t = \frac{(R_t - G_t)}{Y_t} - \varepsilon \times OG_t \,, \tag{B.1}$$

where R_t and G_t stand for (nominal) government revenue and expenditure, respectively, and Y_t for (nominal) GDP. The cyclical com-

[178] The author pinpoints the important fact that by considering the output gap in the process of the cyclical adjustment of fiscal balances, it is not possible to account for the output composition effects.

[179] According to the authors, both the EC method and the European System of Central Banks method use tax revenue elasticities to divide the budget balance into the cyclical and the structural part.

[180] See Mourre et al. (2014) for a reference to both the drawbacks of this subtractive approach and the merits of the exact formula.

ponent is calculated as the product of two inputs: the budgetary semi-elasticity ε,[181] as the cyclical adjustment parameter and a measure of the link between the economic cycle and the budget, and the output gap OG_t, as a measure of the cyclical position of the economy. Fiscal elasticities and, hence, tax revenue elasticity with respect to the output gap is an inherent part of the calculation of the budgetary semi-elasticity, according to the formula

$$\varepsilon = \varepsilon_R - \varepsilon_G = (\eta_R - 1)\frac{R}{Y} - (\eta_G - 1)\frac{G}{Y}, \tag{B.2}$$

where ε_R is the semi-elasticity of revenue (and ε_G the semi-elasticity of expenditure) and η_R denotes the elasticity of (total) revenue with respect to the output gap (and η_G denotes the elasticity of [total] expenditure with respect to the output gap).[182] The semi-elasticity of revenue can be further broken down into the weighted sum of disaggregated elasticities for individual revenue categories, such as

$$\varepsilon_R = \left(\sum_{i=1}^{5} \eta_{R_i} \frac{R_i}{R} - 1\right)\frac{R}{Y}, \tag{B.3}$$

in the indicative case of five individual revenue categories, which are considered cyclically sensitive. It becomes obvious that in the broken-down semi-elasticity of revenue, disaggregated elasticities become essential inputs. In addition, due to the fact that the two-step methodology is followed, originally developed in van den Noord (2000) and adopted by the OECD and the EC thereafter (see Girouard

[181] Note that, in time, the concept of the semi-elasticity of the budget balance to the output gap replaced the sensitivity of the budget balance to the cycle since it was considered as the more accurate concept for CAB computation (see Mourre et al., 2013). According to Bouabdallah et al. (2020), the concept of the semi-elasticity is also used in the ESCB method of estimating the cyclical component.

[182] For all details on the budgetary semi-elasticity and CAB computation, see Mourre et al. (2014).

and André, 2005; Mourre et al., 2014; Price et al., 2014; Price et al., 2015), the decomposed tax-to-base[183] and the base-to-output gap elasticity components are further integrated in the CAB framework. As Price et al. (2014) and Zervas (2018) indicated, the (short-run) elasticity of any cyclically-sensitive revenue (and expenditure) category with respect to the output gap is given by the product of the two elasticity sub-components.

At this point, it should be stressed that, in the case of indirect taxes and despite the corresponding systematic work done in the framework of CAB calculation, the tax-to-base and base-to-output gap components and, in some cases as a result, the tax-to-output gap elasticity are often assumed to equal unity. The unity assumption is found to be adopted in the related CAB literature for the indirect tax-to-base sub-elasticity on the basis of the proportionality assumption (Girouard and André, 2005) and due to its questionable reliability for cyclical adjustment purposes (Price et al., 2014), while it is imposed on the other indirect tax-to-base sub-elasticity due to the underlying complex tax composition (Price et al., 2015; therein, VAT revenues were distinguished from revenues from other indirect taxes, and elasticities were estimated separately). It is further adopted for the base-to-output gap sub-elasticity for indirect taxes, due to difficulties in finding consistent estimates (Girouard and André, 2005) or the lack of an observable long-run equilibrium demand structure to be imputed for all countries at potential output (Price et al., 2014; Price et al., 2015).

Still, there exist several solid arguments against the unitary elasticity assumption for indirect taxes. To these belong, according to Price et al. (2014), the facts that (i) the assumed proportionality may not hold for

[183] Koester and Priesmeier (2012) referred to the significance of the tax revenue-to-base elasticities, within the framework of the Stability and Growth Pact, for the cyclical adjustment process and the calculation of structural public balances, which acquire a central role in the assessment of fiscal policy developments. Kremer et al. (2006) underpinned the use of the individual revenue-to-base elasticities for the computation of the contribution of the fiscal drag to the change of the structural revenue ratio.

VAT, due to different VAT rates and higher rates applied to more elastic items; (ii) the asserted non-cyclicality may be contradicted by the divergent cyclical sensitivity of individual consumption components; (iii) the presumed unity assumption may not hold for specific taxes (i.e., for other major categories of indirect taxation), of which the aggregate elasticity with respect to consumption would be a function of the income elasticity of their various bases and would, presumably, not sum up to unity. It becomes evident that the validity or non-validity of the unity elasticity assumption is associated with the crucial question on whether indirect tax revenues should be subject to cyclical adjustment or not and, more generally, on whether they are cyclically sensitive or not and, hence, belong or do not belong to the principal factors driving the budget's cyclical variation (Price et al., 2014).

Moreover, in addition to the above dimensions, the time dimension with respect to the underlying elasticities seems to acquire a non-negligible role in CAB calculations, as pointed out in a number of related studies. Princen et al. (2013), for example, raised the issue about the correctness of the assumption of revenue elasticities being constant and equal to their long-run values in CAB computation. They argued that, although this assumption may appear to be suitable for the medium-term orientation of fiscal policy, the case of short-run elasticities potentially fluctuating and deviating from their long-run average deserves attention and becomes relevant when interpreting CAB variations.

Mourre and Princen (2015 and 2019) stressed the need for a more precise estimation of tax dynamics (taking into account short-run revenue volatility), despite the often-asserted reasonability of the assumption of identical long- and short-run revenue-to-base elasticities when it comes to the computation of the CAB. Indeed, the issue of possibly deviating long- and short-run revenue elasticities has been considered in Price et al. (2014), who provided the updated elasticities used by the EC as part of the EU surveillance process for the calculation of the semi-elasticity of the budget balance.[184] They described the framework applied for the calculation of the tax-to-base component, allowing for the differentiation between

[184] See also Price et al. (2015) for an equivalent application to OECD countries.

long- and short-run elasticities which may diverge, according to the authors, due to collection lags or tax-base compositional changes. For certain tax categories, a similar differentiation was also applied for the estimation of the base-to-output gap component. In making this differentiation for the case of indirect taxes (among others), the short-run tax-to-base elasticity would capture temporary movements due to cyclical shocks. However, if this (short-run) elasticity is dependent on the involved time period, problems may be posed for the process of cyclical adjustment when indirect taxes are subject to collection issues. Overall, the authors stressed that caution is needed when applying either a long- or a short-run indirect tax-to-base elasticity for cyclical adjustment purposes, in order to avoid an under- or overstated adjustment. In the same work, this time differentiation with regard to the base-to-output gap elasticity component for indirect taxes was not relevant since the unity assumption had been adopted.

With regard, finally, to the importance of potential asymmetry effects characterizing revenue elasticities, Jooste and Naraidoo (2011) stressed the important policy implications such effects may have in the use of the structural budget balance as an indicator of the overall fiscal stance. Boschi and d'Addona (2019) argued that revenue elasticities themselves change over the business cycle, posing potential complications to the CAB estimation. However, they showed that short-run elasticities that vary between boom and recession periods may be easily incorporated into the CAB computation procedure.

5.5. Concluding remarks

As a major component of the public budget, tax revenues acquire a central role at theoretical, practical, and policy levels. In that sense, the way tax revenues respond to changes in major macroeconomic aggregates and policy measures becomes an issue of utmost importance. As a result, tax revenue buoyancy and elasticity, as two key revenue response concepts, have been and still remain closely associated with public finance theory and fiscal policy. Any accurate reference and/or measurement of tax revenue buoyancy and elasticity should rely on detailed knowledge and deep understanding of the underlying conceptual and theoretical framework as well as of several central fields of application of those two revenue response concepts.

Regarding the conceptual framework, the definitions of tax revenue buoyancy and elasticity themselves provide the direct connection to tax revenue developments. Apart from that, a great part of the significance of the two concepts relates to their size. A number of additional aspects of this conceptual framework gain great importance, such as

(i) the determination of tax revenue buoyancy and elasticity not only in terms of aggregate tax revenue, but also at the level of disaggregated revenue from individual tax categories;

(ii) the breaking down of tax revenue buoyancy and elasticity for individual tax categories into separate response components, on the basis of the decomposition approach;

(iii) the time dimension of tax revenue buoyancy and elasticity, basically including variation over time, alongside the differentiation between the long- and the short-term horizon and between distinct phases of the business cycle; and

(iv) the complementarity of tax revenue buoyancy and elasticity, with both being essential elements of a comprehensive analysis, given the common elements shared by and the distinctive features characterizing the two revenue response concepts.

The related theoretical context, which integrates tax revenue response in terms of both public finance theory and policy and often includes controversies and unresolved disputes, historically involves tax revenue buoyancy and elasticity and provides their interconnection with several concepts, such as revenue stability, built-in flexibility, revenue sensitivity, and stabilization through automatic versus discretionary changes. To a certain degree, such an involvement and interconnection unfolds on the basis of the association of tax revenue response with two major notions:

(i) the notion of the adequacy criterion of the tax yield, which was, in the earlier literature, often related to revenue stability, as contrasted to revenue flexibility/instability, and was associated with elasticity in general and long-run elasticity in particular; and

(ii) the notion of compensatory finance and policy, with the associated debate and controversy being, often, centered around certain key concepts such as tax buoyancy and/or elasticity, built-in flexibility versus tax sensitivity, and the general notion of automatic adjustment/stabilization.

Given their crucial role in terms of both public finance theory and fiscal policy, tax revenue buoyancy and, especially, tax revenue elasticity represent, in practice and in technical terms, central parameters in several important applications, in which politicians, as well as the academic community, are greatly involved. Such central applications include

(i) tax revenue forecasting, the accuracy of which critically relies upon the accuracy of measuring the incorporated tax revenue buoyancy and elasticity; and

(ii) the distinction between discretionary and automatic or cyclical components, in the context of assessing and/or comparing the potential stabilizing effects of automatic stabilizers and discretionary policy measures and calculating fiscal (and/or tax) multipliers to assess the effects of fiscal policy on output, as well as in the context of the cyclical adjustment of the budget balance, in particular within the EU fiscal surveillance framework.

The total of the above-described framework and concepts provide some of the major elements of the motivation and contribution of the present Study, which is centered around the concepts of buoyancy and elasticity for VAT revenue in Greece. Furthermore, they form the basis for the inclusive and comprehensive methodological approach chosen and employed in this Study. Last but not least, they constitute the foundation for the interpretation and evaluation of the empirical results obtained in this Study.

CHAPTER 6

REVIEW OF EMPIRICAL FINDINGS ON VAT REVENUE BUOYANCY AND ELASTICITY

6.1. Introduction

Tax revenue buoyancy and elasticity have attracted research interest worldwide for several decades due to their importance for fiscal policy and public finance. Existing empirical literature concerns both total tax revenues and revenues from individual tax categories. In particular, the empirical research that examines the response of VAT revenues with respect to changes in key macroeconomic variables is rather rich, including single-country studies as well as studies for groups of countries. Empirical studies examine tax revenue response through the buoyancy and/or elasticity of tax revenues.

This chapter provides a literature review of the relevant findings, focusing on VAT, but also referring both to broader tax categories, such as indirect and consumption taxes, which include VAT, and to certain other important and similar in conception tax categories, such as sales taxes and taxes on goods and services. In what follows, the review focuses on empirical findings concerning solely tax buoyancy in Section 6.2, solely tax elasticity in Section 6.3, and both tax buoyancy and tax elasticity in Section 6.4. Relevant empirical findings for Greece are presented separately in Section 6.5, followed by some concluding remarks in Section 6.6. Finally, Table 6.1 summarizes the empirical findings of the studies presented in Chapter 6.

6.2. Empirical findings from studies examining exclusively tax buoyancy

A strand of literature examines exclusively tax revenue buoyancy. Starting with research for country groups, McGowan and Billings (1997) estimated tax buoyancy for several tax categories with respect to GDP for EU countries for the period 1970–1990. Focusing on a sample of nine EU countries, VAT buoyancy was 1.11, while the individual country results indicated that buoyancy was above unity in eight out of nine EU countries, ranging from 0.94 (France) to 1.77 (UK). Moreover, the authors provided estimations for total consumption taxes, with buoyancy being close to unity in most countries, while non-VAT consumption tax buoyancy was below unity in most countries. Belinga et al. (2014) estimated long- and short-run tax buoyancy with respect to GDP for 34 OECD countries from 1965 to 2012. The authors studied total tax revenues as well as individual tax categories. As far as taxes on goods and services are concerned, both long- and short-run buoyancies were not statistically different from one, at 0.98 and 0.92, respectively. Taking a closer look into sub-periods (1965–1988 and 1989–2012), the authors recorded an increase of short-run buoyancy with respect to GDP over time, while long-run buoyancy decreased for the same tax category. Finally, when testing for asymmetry between contraction and growth periods, the empirical results did not indicate such a finding, where in both cases buoyancy remained statistically not different from one. Khadan (2019) estimated long- and short-run tax buoyancy with respect to GDP for a group of 12 Caribbean countries and several tax categories for the period 1991–2017. As far as indirect taxes are concerned, long-run buoyancy was significantly less than one, at 0.35, while short-run buoyancy was above unity, at 1.39. With respect to taxes on goods and services, long- and short-run buoyancy were estimated at 0.712 and 1.057, respectively. Lagravinese et al. (2020) examined long- and short-run tax buoyancy with respect to GDP for total tax revenue and other tax categories for 35 OECD countries from 1995 to 2016. According to their baseline model results, the short-run buoyancy of goods and services tax was 0.56 and the long-run buoyancy was 0.79. These results did not differ qualitatively when other control variables were considered, as estimates remained well below unity and with the short-run buoyancy being consistently lower than the long-run buoyancy. Bağci (2022) estimated tax buoyancy with respect to GDP for 38 OECD countries over the period 1996–2020 for total tax revenue and other tax categories. As far as revenues from taxes on goods and services are concerned, the authors estimated a buoyancy of 0.18. The OECD (2023) also estimated short- and long-run tax buoyancy with respect to GDP for 38 OECD countries over the period 1980–2021 for total tax revenues as well as for the main tax categories. According to their results, the short-run VAT buoyancy was 1.140 and the long-run VAT buoyancy was 1.128. Testing for sub-periods (1980–1999, 2000–2010, and 2011–2021), the short-run VAT buoyancy ranged from 1.129 to 1.282, and the long-run VAT buoyancy ranged from 1.034 to 1.125. Finally, according to the results for the asymmetric short-run tax buoyancy over the business cycle, VAT buoyancy was estimated at 1.160 for the years of growth and 0.838 for the years of contraction under a moderate boom-bust scenario of above +/- 0.5% of annual real GDP. Under a strong boom-bust scenario of above +/- 1% of annual real GDP, VAT buoyancy was estimated at 1.132 for the years of growth and 0.851 for the years of contraction.

Ahmed and Mohammed (2010), testing for the determinants of tax buoyancy in 25 developing countries from 1998 to 2008, estimated and reported the buoyancy with respect to GDP, providing a wide range of results for indirect taxes, from 0.23 for Brazil to 2.9 for Ghana. Jalles (2017) estimated short- and long-run tax buoyancy with respect to GDP for total tax revenues as well as for individual tax categories for 37 Sub-Saharan African countries from 1990 to 2015. The author observed wide variations in buoyancy across the different tax categories. As far as taxes on goods and services are concerned, long-run buoyancy exceeded one, at 1.197, while short-run buoyancy was estimated at 0.938, being not statistically different from one. Controlling for developments in the corresponding tax rates did not significantly change the reported results, with the long- and short-run buoyancy being 1.052 and 0.820, respectively.[185] Moreover, buoyancy was larger during contractions and financial crisis than during economic expansions and non-crisis periods. Recently, Gupta et al. (2022) estimated both short-run and long-run tax buoyancy with respect to GDP for several tax categories for 44 Sub-Saharan African

[185] This estimation could be interpreted as a proxy for elasticity, even though the authors referred to their results only as buoyancy estimations. The inclusion of the developments in tax rates concerned 31 countries instead of 36 countries studied for the category of taxes on goods and services, due to the limited data coverage on tax rates. However, the rest of their analysis did not account for the developments of tax rates and was focused on buoyancy.

countries for the period 1980–2017. As far as taxes on goods and services are concerned, long-run buoyancy was higher than one, at 1.241 (using the preferred estimation method), and short-run buoyancy was lower, at 1.142. Focusing on two subperiods from 1980 to 1998 and from 1999 to 2017, there was an increase in the long-run buoyancy, from 1.097 during the first period to 1.211 during the second, while the opposite holds for the short-run estimates, which decreased from 0.889 in the first period to 0.791 in the second. Moreover, both long-run (1.242 during expansion and 0.611 during contraction) and short-run buoyancies (1.147 during expansion and 0.394 during contraction) were larger during economic expansions. When controlling for inflation, the long-run results remained qualitatively the same, while the short-run buoyancy was smaller and below unity.

Focusing on individual country studies, Mawia and Nzomoi (2013) investigated tax-to-base and base-to-income buoyancy in Kenya for several tax categories from 1999/2000 to 2010/2011. As far as VAT/sales taxes are concerned, the authors examined total VAT as well as local and import VAT. The estimated buoyancy with respect to the tax base was very low, at 0.21 – and statistically insignificant – for local VAT, 0.22 for import VAT, and 0.33 for total VAT. However, base-to-income estimates were higher, at 2.83 for import and local VAT and 2.50 for total VAT. Olukuru and Mandela (2017) provided a comparative analysis of tax buoyancy between Kenya (for the years 1980–2014) and South Africa (for the years 1972–2014) for different tax categories. As far as VAT is concerned, the estimated short-run buoyancy with respect to GDP for Kenya was 0.88 and the long-run buoyancy was 1.38. However, the estimated buoyancies for South Africa were not statistically significant. Birhanu (2018) estimated tax buoyancy with respect to GDP in Ethiopia for total tax revenue and its components for a 12-year period, employing data from three regional states and one city administration. The estimated VAT buoyancy was 2.1341, while turnover tax[186] buoyancy was 0.6091. Tanchev and Todorov (2019) examined long- and short-run tax buoyancies with respect to GDP

[186] In Ethiopia, turnover tax is payable on goods sold and services provided by people who are not registered for VAT.

in Bulgaria from 1999Q1 to 2017Q2 for aggregate tax revenues as well as for individual tax categories. Both long- and short-run VAT buoyancies were close to one, at 1.12 and 1.03, respectively.

Finally, Anderson and Shimul (2018) estimated tax buoyancy[187] with respect to GDP for 50 US states and the District of Columbia for the period 1972–2012. The long-run sales tax buoyancy estimates ranged from 0.896 to 0.924. The authors also provided individual state estimates, with the mean long-run estimate being 0.922. The mean short-run buoyancy was 0.184, but statistically insignificant in almost all individual states.

6.3. Empirical findings from studies examining exclusively tax elasticity

A strand of the literature focuses exclusively on tax elasticity,[188] providing empirical findings for groups of countries that offer useful insights for policymaking. To begin with, Brückner (2012) examined short-run elasticity with respect to GDP for several tax categories,[189] including VAT/sales taxes, for a group of 33 Sub-Saharan African countries from 1980 to 2000. As far as VAT/sales taxes are concerned, a 1% increase in GDP (due to the exogenous factors employed in the analysis) was found to increase VAT/sales tax revenues by up to 2%, depending on the model employed. Fricke and Süssmuth (2014) examined long- and short-run elasticity for 11 economies in Latin America from 1990Q1 to 2009Q1 based on data availability for each economy. The authors investigated different tax categories, and their results regarding the long-run VAT elasticity with respect to GDP were above unity, ranging from 1.606 to 2.550 (with the excep-

[187] Note that Anderson and Shimul (2018) explicitly state: "...we develop estimates of buoyancy in response to changes in state GDP, but for the sake of familiarity and simplicity in exposition, we refer to the elasticity of each tax and drop the distinction between elasticity and buoyancy."

[188] Note that in some cases the authors do not explicitly state whether and/or describe the way they removed the impact of tax changes and discretionary measures from tax revenues in order to estimate tax elasticity.

[189] Note that results concerning categories other than VAT and indirect taxes are not reported since they fall out of the scope of the Study.

tion of Chile, at 0.808). Moreover, the authors found that, in many cases, VAT revenues had a stronger reaction when they were above the long-run equilibrium, with the respective short-run elasticities above the long-run equilibrium ranging from 0.962 to 3.348. The short-run elasticities below the long-run equilibrium had the same range, from 0.962 to 3.348, while in several cases there was no asymmetry at all. Overall, the empirical results displayed great variability across the countries under examination.

Other studies provided elasticities used in fiscal policy and fiscal surveillance. Bouthevillain et al. (2001) estimated budget elasticities in the context of the cyclical adjustment of budget balances for all tax categories in the EU countries from 1970 or 1975 to 1998 in most cases, depending on data availability. The elasticity of indirect taxes with respect to private consumption for the EU15 was estimated at 1, with a few exceptions for specific countries (i.e., Luxembourg at 0.7, Austria and UK at 0.9, Finland and Portugal at 1.1, Sweden at 1.2). Moreover, the respective base-to-output elasticity was 1.3, ranging from 1.2 to 1.4 for the individual countries. Girouard and André (2005) estimated the elasticities underlying the OECD Economics Department's calculations of cyclically-adjusted budget balances for the period 1980 to 2003. The authors assumed indirect taxes to be proportional to their tax base, while the estimation of the indirect tax base response with respect to the output gap displayed several econometric difficulties in finding consistent estimates across countries. As a result, the authors set the elasticity of indirect taxes with respect to the output gap equal to one for all OECD economies. Price et al. (2014) estimated[190] the revenue and expenditure elasticities with respect to the output gap (as the product of the elasticities of revenue/expenditure with respect to their bases and the elasticities of the bases with respect to the output gap) for EU countries, which were used by the European Commission in the EU fiscal surveillance process. The study covered various government revenue and expenditure items, including indirect taxes, and employed data from 1990 to 2013, based on data availability for each country. The empirical results varied across countries, with an EU average indirect tax-to-consumption elasticity of 0.97. The authors

[190] This study updated the earlier study for OECD countries of Girouard and André (2005).

provided justification for using the unity assumption for indirect tax-to-output gap elasticity for cyclical adjustment purposes, due to robustness issues and difficulties in the estimation of tax-to-consumption and consumption-to-output gap elasticities. In the same spirit, Price et al. (2015) re-estimated the revenue and expenditure elasticities with respect to the output gap for OECD countries from 1990 to 2013, based on data availability for each country. The authors distinguished VAT from other indirect taxes. The average OECD indirect tax-to-output gap elasticity was 1.08 (calculated as a weighted average of VAT and other indirect tax-to-consumption elasticities), while the average OECD VAT-to-consumption elasticity was 1.16. The authors maintained the assumption of a unit consumption-to-output gap elasticity.

Moreover, Mourre and Princen (2019) examined the elasticity of several tax revenue categories with respect to their tax base for all EU countries from 2001 to 2013. Overall, both long-run and short-run consumption tax elasticities were close to or slightly above unity, using alternative model specifications. However, there was great heterogeneity in the results across countries. Furthermore, even though there was no evidence of a business cycle effect being relevant in explaining short-run elasticity, the findings suggested that it was affected by the relative cyclical position with reference to the rest of the EU. Boschi and d'Addona (2019) examined the stability of tax elasticity over the business cycle. The authors estimated tax-to-base, base-to-GDP, and tax-to-GDP elasticities for different tax categories and 15 European countries from 1980Q1 to 2013Q1 (based on data availability for each country[191]). The mean long-run indirect tax-to-base elasticity was 1.5, while the respective short-run elasticity was 0.89, with great variability across countries in both cases. The mean long-run indirect base-to-GDP elasticity was 0.71, while the respective short-run elasticity was 0.48. Overall, the mean long-run tax-to-GDP elasticity for indirect taxes, calculated as the product of tax-to-base and base-to-GDP elasticities, was 1.17, while the respective short-run elasticity was 0.51, with great variability across countries. Moreover, their results indicated that short-run elasticities tend to be larger during recessions.

[191] There were no available data for indirect tax revenues for Norway.

In addition to studies for groups of countries, individual-country studies provide in-depth analysis and valuable policy recommendations for the countries under examination. Wolswijk (2009) estimated long- and short-run tax elasticities with respect to the corresponding tax bases for different tax categories in the Netherlands. Data for VAT revenues covered the period 1980–2002. Long-run VAT elasticity with respect to private consumption was 0.90. The authors identified asymmetries in the short-run VAT elasticity: the elasticity was 0.64 when revenues were below equilibrium and 1.10 when revenues were above equilibrium, while there was no evidence of asymmetry in the error-correction terms. Bettendorf and van Limbergen (2013) also estimated long- and short-run tax elasticities for VAT (and personal income taxes) with respect to the corresponding tax base in the Netherlands from 1970 to 2011. According to their results, both long- and short-run VAT elasticities were around one. The results remained unaffected when using a broader tax base. Testing for asymmetries (1971–2008) indicated that the short-run VAT elasticity exceeded 1 in 'good times' and was smaller than one in 'bad times'. The elasticities varied depending on the definition of good/bad times, based either on the sign of the deviation from the long-run equilibrium or on the sign of the output gap.

Poghosyan (2011) highlighted the need to account for the cyclical variation of tax elasticities in order to make short-run tax revenue projections for several tax categories, providing evidence of cyclicality in VAT elasticity in Lithuania for the period 1999–2010. VAT elasticity with respect to its base ranged from 0.5 to 1.5 for Lithuania, while the authors also reported a long-run VAT elasticity with respect to its base for a panel of 10 new EU countries being close to one and a short-run VAT-to-base elasticity close to 1.2. Koester and Priesmeier (2012) examined short- and long-run elasticities for different tax categories in Germany from 1970 to 2009. The authors estimated VAT long-run elasticity with respect to its base at 0.79, while the short-run elasticity was 0.90, with almost the whole deviation from equilibrium being corrected within one period. Havranek et al. (2016) estimated short- and long-run tax revenue elasticities for different tax categories with respect to the corresponding tax base in the Czech Republic from 1995 to 2013. In the baseline estimation, the long-run tax-to-base VAT elasticity was

0.9, while the estimated short-run elasticity was not statistically significant. Berardini and Renzi (2022) examined VAT elasticity with respect to its base (private final consumption expenditure) in Italy for the period 2002Q1–2021Q1. In fact, the authors examined the determinants of VAT revenues in the context of the COVID-19 crisis. According to their results, based on alternative model specifications, short-run VAT elasticity was below or slightly below one, ranging from 0.805 to 0.999. They also documented that the inclusion of the change of the share of electronic payments had a positive and statistically significant impact on the change of VAT revenues.

Turning to developing countries, Osoro and Leuthold (1994) provided evidence of time-varying tax elasticities with respect to GDP in Tanzania for the period 1969–1990 for several tax categories. According to the authors, sales tax elasticity gradually decreased over the years from 1.127 in 1969 to 0.610 in 1990. Jooste and Naraidoo (2011) estimated elasticities with respect to the output gap for several tax categories in South Africa, employing quarterly data for the period 1994Q1–2009Q3. The authors identified an asymmetric and nonlinear response of VAT during expansions and contractions, as well as elasticities different from unity, where VAT-to-base elasticity was 2.18 during expansions and 0.81 during contractions. The respective estimations employing the output gap were not statistically significant. Isaac and Samwel (2015) provided empirical results on the decomposed elasticities in Kenya for the period 1985–2009, both in nominal and real terms. As far as sales tax/VAT is concerned, tax-to-base elasticity in nominal terms was not statistically significant and base-to-GDP elasticity was 1.121. In real terms, the tax-to-base elasticity was 0.166 and base-to-GDP elasticity was 1.188. Wawire (2017) examined the determinants of VAT revenue in Kenya for the period 1963/64 to 2008/09. The author estimated sales tax/VAT elasticity with respect to GDP well above unity, at 1.94.

US state tax elasticity also attracts research interest. Friedlaender et al. (1973) estimated the response of sales tax revenues to per capita income, population, and sales tax rate for 15 US states for the period 1953–1970. The average estimated sales tax rate elasticity was 0.93. Fox and Campbell (1984) estimated sales tax elasticity with respect to income for 10 sub-categories of sales taxes in Tennessee for the period 1975–1982. The weighted average long-run elasticity was 0.59, while the short-run estimates varied widely from 0.16 (in 1976) to 0.92 (in 1979), with elasticity falling during recessions and rising during expansions. Seyfried and Pantuosco (2003) estimated US state tax revenue elasticities with respect to Gross State Product (GSP) and wealth (captured by the S&P 500 index) for several tax categories from 1983 to 1999. Employing a sample of the 10 largest US states, the authors estimated Sales and Gross Receipts elasticity with respect to GSP from 0.44 to 1.79, while the estimated wealth effect was insignificant in most cases. Sobel and Holcombe (1996) provided estimates of long- and short-run tax base-to-GDP elasticities for all major state tax bases in the US from 1951 to 1991 (based on data availability for the specific tax categories), using alternative techniques to provide unbiased estimations. The long- and short-run elasticities for retail sales were 0.660 and 1.039, respectively, and the long- and short-run elasticities for non-food retail sales were higher, at 0.701 and 1.377, respectively (using the most advantageous estimation method). Similarly, Bruce et al. (2006) examined long- and short-run sales tax as well as income tax base elasticities with respect to personal income for each US state from 1967 to 2000. The mean long-run sales tax base elasticity was below unity at 0.811, while the mean short-run sales tax base elasticity displayed high asymmetry, being much greater when the base was above rather than below equilibrium (1.804 and 0.149, respectively), with wide variability across the individual US states.

6.4. Empirical findings from studies examining both tax buoyancy and tax elasticity

Several studies explicitly estimate both tax buoyancy and tax elasticity in order to examine the impact of the imposed discretionary policy measures on tax revenues. In this spirit, Barrios and Fargnoli (2010) examined the impact of discretionary measures on tax revenues and tax elasticity for a sample of 14 EU countries (Greece was not included) for the period 2000–2008 (based on data availability for each country). The authors simply computed the response of tax revenues (gross and net of the impact of discretionary measures, as 'gross' and 'net' elasticities, respectively)[192] with respect to GDP by dividing the annual growth of the respective tax revenues (for overall tax revenues as well as for different tax categories) with the nominal GDP annual growth rate. As far as indirect taxes are concerned, the interpretation of these simple annual calculations indicated that elasticities were quite volatile over the years, fluctuating around the OECD/European Commission benchmark of unity. In some countries, the impact of discretionary measures on tax elasticity was sometimes large, resulting in wide discrepancies between 'net' and 'gross' elasticity. Moreover, in several cases, a substantial departure from the unity assumption was observed. Dudine and Jalles (2018) investigated buoyancy with respect to GDP for 107 countries (classified as advanced, emerging, and low income) and several tax categories from 1980 to 2014. As far as taxes on goods and services are concerned, both long- and short-run buoyancies were not statistically different from 1 for emerging economies and close to 1, at 0.951 and 0.873, respectively, for advanced economies. However, long-run tax buoyancy exceeded 1 for low-income countries, while the respective short-run buoyancy was not statistically different from 1. Moreover, buoyancy was larger during contractions than during economic expansion in emerging economies. The authors also controlled for tax rates as a robustness check, practically providing estimations for elasticity. However, in the case of taxes on goods and services, the elasticity estimations refer only to advanced economies (with fewer observations based on data availability), with the long-run elasticity at 0.867 and the short-run elasticity not significantly different from 1.

Jalles (2020) also examined tax buoyancy with respect to GDP based on aggregate tax revenues and a number of tax categories for 30 Asian-Pacific countries from 1980 to 2017. As far as taxes on goods and services are concerned, both long- and short-run buoyancy were statistically not different from one. Moreover, the authors indicated that short-run tax buoyancy was generally larger during recession periods compared to periods of economic expansion. Similar to Dudine and Jalles (2018), the au-

[192] Even though the authors do not employ the term 'buoyancy', they practically estimated tax revenue buoyancy ('gross' elasticity) and elasticity ('net' elasticity) by employing tax revenues gross and net of the impact of discretionary measures, respectively.

thor also controlled for tax rates as a robustness check, practically providing estimations for elasticity. However, in the case of taxes on goods and services, the estimations were based on fewer observations due to data availability, with the long-run estimation being statistically insignificant and the short-run estimation not significantly different from 1.

Cornevin et al. (2023) provided an examination of buoyancy with respect to GDP for different groups of countries and tax categories for the period 1990–2020. The dataset included 185 countries, while the number of countries varied by year and tax category. As far as VAT is concerned, the authors employed a sample of 88 countries, including 32 advanced economies, 36 emerging market economies, and 20 low-income countries. According to the empirical results, long-run VAT buoyancy was around unity for nearly all income groups and across alternative panel data estimators. Short-run VAT elasticity estimates were rather mixed, depending on the panel data estimation method and the income group under examination. Short-run buoyancy for advanced economies and low-income economies was either below one or statistically not different from one, depending on the employed estimator, while short-run buoyancy for emerging market economies was not statistically different from one across nearly all estimators. The authors also employed several control variables to account for the impact of discretionary measures, i.e., in order to estimate elasticity. However, controlling for discretionary changes in tax rates and tax base reforms did not significantly change the respective VAT buoyancy. Finally, controlling for inflation indicated that "tax buoyancy was neutral with respect to inflation" across country income groups.

Focusing on individual country analysis, Khan (1973) examined the responsiveness of different tax categories to GDP in Pakistan from 1960 to 1972. The estimated elasticity of indirect taxes was 1.57, while the respective buoyancy estimate stood at 1.36. Gillani (1986) estimated both long- and short-run tax buoyancy and elasticity with respect to GDP for several tax categories in Pakistan from 1971/72 to 1982/83. The long-run buoyancy of sales taxes was 1.18, while the respective long-run elasticity was also above unity, at 1.24 and 1.36, employing two alternative methods to account for the impact of the discretionary tax measures on revenues. The estimated short-run buoyancy was 1.24, while the respective short-run elasticity was 1.31 and 0.91. In addition, the long-run buoyancy of indirect taxes was 1.16, while the respective long-run elasticity was also above unity, at 1.24 and 1.33, employing two alternative methods to account for the impact of the discretionary tax measures on revenues. The estimated short-run buoyancy was 1.32, while the respective short-run elasticity was 1.41 and 0.91. Akbar and Ahmed (1997) examined the buoyancy and elasticity of several tax categories and expenditure of the federal government in Pakistan for the period 1973–1990. The estimated sales tax buoyancy and elasticity with respect to GDP were 1.26 and 1.01, respectively. However, the results differed for the two reported sub-periods, i.e., 1973–1981 and 1982–1990. Buoyancy and elasticity were 1.26 and 1.08, respectively, for the first sub-period and increased to 1.71 and 1.45 for the second sub-period. The authors also estimated sales tax-to-base buoyancy and elasticity for the period 1973–1990, at 1.20 and 0.96, respectively. Looking into the two sub-periods, buoyancy and elasticity for the first sub-period were 1.12 and 1.02, respectively, and increased to 1.56 and 1.32 for the second sub-period. Finally, the authors provided the tax-to-base and base-to-GDP buoyancies, indicating that tax-to-base buoyancy increased from 1.19 in the first period to 1.56 in the second period, while base-to-GDP buoyancy was 1.06 in the first period and 1.10 in the second period. Mukarram (2001) also examined buoyancy and elasticity with respect to GDP for major tax categories in Pakistan for the period 1981–2001. Sales taxes had an elasticity close to one (0.99), while the corresponding buoyancy was 1.51. The decomposition of elasticity and buoyancy indicated that tax-to-base elasticity and buoyancy were 1.01 and 1.55, respectively, while base-to-GDP elasticity was 0.98. Bilquees (2004) estimated buoyancy and elasticity for different tax categories with respect to GDP and their corresponding tax base in Pakistan for the period 1974–2003. According to the empirical results, the long-run elasticity of sales taxes with respect to GDP slightly exceeded buoyancy (1.50 and 1.41, respectively), while short-run buoyancy slightly exceeded elasticity (0.42 and 0.38, respectively). The decomposition of sales tax elasticity indicated a tax-to-base elasticity of 1.808 and a base-to-GDP elasticity of 1.017.

Twerefou et al. (2010) examined tax buoyancy and elasticity with respect to GDP for different tax categories in Ghana from 1970 to 2007.

Long-run VAT/sales tax buoyancy was estimated at 1.20, while VAT/sales tax elasticity was 1.11, indicating that discretionary tax measures improved the responsiveness of the respective tax revenues to GDP. Short-run VAT/ sales tax buoyancy was estimated at 0.90. Moreover, the authors provided supporting evidence that buoyancy, as well as decomposed buoyancies and elasticities (tax-to-base and base-to-GDP), increased during the reform period (1985–2007) from below unity to above unity. Short-run tax-to-base elasticity was estimated at 0.70 and long-run at 1.09. Finally, the authors reported that both short-run and long-run base-to-GDP elasticities were below unity. Bekoe et al. (2016) examined buoyancy and elasticity for several tax categories with respect to GDP in Ghana for the period 1970–2013. The authors separately examined the pre-tax reform period of 1970–1981 and the post-tax reform period of 1982–2013. According to their results for sales tax, both buoyancy and elasticity were below unity for the first period, at 0.70 and 0.69, respectively, while both sales tax/ VAT buoyancy and elasticity were above unity for the second period, at 2.55 and 2.83, respectively.

Ehdaie (1990) estimated tax buoyancy and elasticity with respect to GDP for several tax categories in two Sub-Saharan African countries, namely Malawi and Mauritius, for the period 1965–1985. Consumption tax buoyancy was 1.72 for Malawi and 1.05 for Mauritius, while consumption tax elasticity was 0.92 for Malawi and 0.76 for Mauritius. Indraratna (1991) estimated long- and short-run tax elasticities, as well as buoyancies, for several tax categories in Sri Lanka for the period 1960–1994, as well as for pre- and post-reform sub-periods, i.e., 1960–1977 and 1978–1994. The overall elasticity of individual tax categories was the product of tax-to-base and base-to-GDP elasticities, and the same procedure was used for buoyancies. As far as turnover tax[193] is concerned, tax-to-base elasticity was 0.71 for the whole period, 0.55 for the period 1960–1977 and 0.84 for the period 1978–1994. The authors reported that base-to-GDP elasticities were equal to unity and the estimated short-run elasticities were equal to the tax-to-base elasticities presented above. The respective long-run tax elasticities were 0.80 for the whole period, 0.63 for

[193] Referring to taxes borne by consumers. See Indraratna (1991).

the period 1960–1977, and 0.84 for the period 1978–1994. The provided buoyancy estimations were higher compared to elasticities that were 1.35 for the whole period, 1.62 for the period 1960–1977, and 1.18 for the period 1978–1994. Timsina (2007) provided tax buoyancy and elasticity estimations for several tax categories in Nepal for the period 1975–2005. The author presented tax buoyancy and elasticity with respect to GDP as well as decomposed tax-to-base and base-to-GDP buoyancy and elasticity. As far as VAT is concerned, elasticity and buoyancy with respect to GDP were 0.55 and 1.15, respectively. The corresponding tax-to-base buoyancy and elasticity was 1.16 and 0.58, respectively, while base-to-GDP estimates were 0.99 in both cases.

Along the same line, Kargbo and Egwaikhide (2012) provided estimations of tax buoyancy and tax elasticity with respect to GDP in Sierra Leone from 1977 to 2009. The authors examined total taxes and individual tax categories. According to their results for domestic transaction taxes, buoyancy was estimated at 1.092 in the short run, and 1.291 in the long run. Elasticity was lower than buoyancy, estimated at 0.663 in the short run, and 0.799 in the long run. Ndedzu et al. (2013) estimated buoyancy and elasticity for several tax categories with respect to GDP in Zimbabwe for the period 1975–2008. Note that the authors also included a one-year lag of GDP to account for the time needed for new policy guidelines to apply, as well as administrative lags or delayed remittances. As far as sales tax/VAT is concerned, both buoyancy and elasticity were below unity, at 0.815 and 0.735, respectively, while the coefficient of the lagged GDP was statistically insignificant in both cases. Yousuf and Huq (2013) estimated tax-to-base buoyancy and elasticity for several tax categories in Bangladesh for the period 1980–2011. Sales tax & VAT-to-base elasticity was estimated at 1.18, while sales tax & VAT-to-base buoyancy was estimated at 1.28. Seydou (2020) estimated both buoyancy and elasticity with respect to GDP for total tax revenues as well as for individual tax categories in the Ivory Coast from 1984 to 2016. The results reported for indirect taxes and VAT were below unity. More specifically, buoyancy for indirect taxes was 0.76 and elasticity was 0.77, while buoyancy for VAT was 0.73 and elasticity was 0.74. The decomposition of the tax elasticity to the tax-to-base and base-to-GDP elasticities indicated a tax-to-base elasticity below unity in both cases, at 0.76 for indirect taxes and 0.73 for VAT. Base-to-GDP elasticity was close to one in both cases, at 0.99 for indirect taxes and 0.96 for VAT.

Turning to developed economies, Choudhry (1979) estimated tax buoyancy and elasticity for several tax categories in the US (for the period 1955–1975) and the UK (for the period 1955–1974). As far as consumption taxes are concerned, the author reported buoyancy estimations with respect to GDP at 0.53 for the US and 1.11 for the UK, as well as base-to-GDP elasticities of 0.99 for the US and 0.95 for the UK. Creedy and Gemmell (2004) estimated income and consumption tax (VAT and main excises) elasticities[194] with respect to GDP in the UK for the period 1989–2000. Consumption tax elasticity fell during the period under examination, from around 0.9 in the early 1990s to around 0.7 by 2000. The authors also provided buoyancy estimations based on simple calculations for sub-periods, indicating increased consumption tax buoyancy for the period 1989–1999, at 1.410. The respective results for the periods 1979–1984 and 1984–1989 were 1.323 and 0.535, respectively. Finally, Conroy (2020) examined tax revenue response employing policy-adjusted and policy-unadjusted tax revenues[195] for individual tax categories for Ireland from 1987 to 2017. As far as VAT is concerned, the author employed personal consumption and investment in the building and construction sector as macroeconomic determinants of both policy-adjusted and policy-unadjusted tax revenues. Using alternative estimation methods, the sum of the two long-run elasticities (with respect to personal consumption and investment in the building and construction sector) were not significantly different from one in all cases. When the author estimated tax elasticity only with respect to personal consumption, the long-run estimates were just above one. Moreover, the short-run estimates exceeded the long-run estimates when using the extended macroeconomic driver, while when employing only personal consumption as a tax revenue driver, the respective short-run tax elasticity was always above one, between 1.27 and 1.82 depending on the estimation method. The findings were qualitatively the same when employing policy-unadjusted tax revenues for the analysis.

194 The elasticity results were also reported by Creedy and Gemmell (2003).

195 This approach is considered equivalent to the examination of elasticity and buoyancy, respectively.

6.5. Empirical findings from studies examining tax buoyancy and/or tax elasticity for Greece

The literature on tax buoyancy and tax elasticity for Greece is rather sparse. Some studies include Greece in their analysis of large country groups. Even though these studies mostly focus on the empirical findings derived for groups as a whole, as already presented in this chapter, they often provide additional single-country results to highlight their variability for the individual countries. Even though these studies do not focus on Greece, they offer some empirical evidence related to our Study.

Starting with findings for buoyancy, recently, Lagravinese et al. (2020) estimated long- and short-run tax buoyancy with respect to GDP for total tax revenue and other tax categories for 35 OECD countries from 1995 to 2016. The reported long-run buoyancy of taxes on goods and services with respect to GDP for Greece was 0.80, while the short-run buoyancy was insignificant. The OECD (2023) also estimated short- and long-run tax buoyancy with respect to GDP for 38 OECD countries over the period 1980–2021. The reported short-run VAT buoyancy for Greece was 1.026 and the long-run VAT buoyancy was 1.030, employing nominal data, while the reported short-run VAT buoyancy for Greece was 1.074 and the long-run VAT buoyancy was 1.361, employing real data.

Concerning elasticity, Bouthevillain et al. (2001) estimated the elasticity of indirect taxes with respect to private consumption for Greece at 1, while the respective base-to-output elasticity was 1.2. Girouard and André (2005) set the elasticity of indirect taxes with respect to the output gap equal to one for all OECD economies, including Greece. Price et al. (2014) estimated the indirect tax-to-consumption elasticity for Greece at 0.81 using data for the period 1990 to 2013. However, the authors justified using the unity assumption for indirect tax/output gap elasticity for cyclical adjustment purposes. Price et al. (2015) re-estimated the revenue and expenditure elasticities with respect to the output gap from 1990 to 2013. The estimated elasticities for Greece were 1.04 and 1.06 for indirect tax-to-output gap and VAT-to-consumption elasticities, respectively. Mourre and Princen (2019) examined the elasticity for several tax revenue categories with respect to their tax base from 2001 to 2013. The empirical results indicated great heterogeneity in the results across countries, and the consumption tax elasticities for Greece were 5.62 in the short run and 2.63 in the long run. Boschi and d'Addona (2019) estimated tax-to-base, base-to-GDP, and tax-to-GDP elasticities for different tax categories from 1980Q1 to 2013Q1. According to their results for Greece (for the period 2000Q1 to 2013Q1), the long-run tax-to-base elasticity for indirect taxes was 0.97, while the short-run tax-to-base elasticity was not statistically significant. Moreover, the long-run base-to-GDP elasticity for indirect taxes was 0.83, while the short-run base-to-GDP elasticity was also not statistically significant. Finally, the resulting long-run tax-to-GDP elasticity for indirect taxes, calculated as the product of tax-to-base and base-to-GDP long-run elasticities, was 0.80.

Only a few studies focus on tax elasticity in Greece and even fewer studies focus on VAT elasticity. Tagkalakis (2013a, 2014b)[196] presented extensive empirical findings regarding indirect tax, VAT, and other indirect tax (other than VAT) elasticity, focusing on Greece, based on quarterly data for the period 2000Q1 to 2012Q3. The author provided recursive estimates of indirect tax elasticity with respect to GDP derived as the product of tax-to-base and base-to-GDP elasticities (either of the aggregate indirect taxes or VAT and other than VAT indirect taxes) and identified increased variability since 2010 in Greece. Overall, indirect tax elasticity with respect to GDP was from 25% to 80% higher than one. Focusing on the whole period under examination (2000Q1–2012Q3), VAT elasticity with respect to private consumption was estimated at 2.629, while the respective indirect tax elasticity was estimated at 1.410 and other indirect tax elasticity was statistically insignificant. The elasticity of other indirect taxes with respect to GDP was also statistically insignificant, while the elasticity of private consumption with respect to GDP was estimated at 0.957.

Hondroyiannis and Papaoikonomou (2017) examined the impact of card payments on VAT revenue in Greece for the period 2003Q4 to

[196] In another application for Greece, Tagkalakis (2014c) focused on the alternative notion of VAT C-efficiency in order to analyze VAT tax buoyancy effects (compared to the purposes of the present Study and, thus, to studies reviewed in this chapter employing VAT revenues) using various economic activity indicators and taking into consideration several control variables. He, thereby, obtained rich empirical findings. Overall, the author anticipated that VAT C-efficiency will increase with the improvement of economic conditions and lead to higher VAT revenues.

2016Q2. To this end, the authors provided time-varying coefficient estimations also presenting tax-to-base elasticities, which declined during the crisis (from above 2 in 2008 to close to zero during 2012–2014) and recovered close to unity in 2016. The authors associated this increase with the increased use of card payments.

Zervas (2018) estimated tax elasticity for individual tax categories for Greece, employing quarterly data from 1999 to 2015. As far as indirect taxes are concerned, the estimated tax elasticity with respect to GDP was 0.49, while VAT elasticity was 0.86. Based on these results as well as on other indirect tax elasticities, the author suggested that even though a unitary elasticity assumption could be "a good baseline assumption" for VAT, overall, this assumption could not be justified for indirect taxes.

Finally, Danchev et al. (2020) examined the penetration of electronic payments and its impact on VAT revenues in Greece, employing monthly data for the period 2014–2017. The authors included the tax base (i.e., private consumption and public intermediate consumption) as an explanatory variable of VAT revenues; however, the resulting elasticity was not statistically significant.

6.6. Concluding remarks

This chapter provides an extensive and thorough review of international empirical evidence on tax buoyancy and elasticity for several tax categories, groups, and individual countries, with a focus on any available related evidence for Greece (see also Table 6.1). The reported studies are mostly involved in estimating tax buoyancy and/or elasticity in order to examine the response of VAT and other relevant tax categories' revenues to changes in macroeconomic variables, i.e., GDP, the output gap, and the respective tax base. Overall, it can be observed that the estimated tax buoyancies and elasticities greatly vary across countries and time periods, rendering any direct derivation of conclusions very difficult, if not impossible. In addition, the provided evidence for Greece remains insufficient and leaves great scope for further analysis.

Still, making an effort to extract some basic trends, we observe that developing economies usually display elasticities and/or buoyancies above unity, while the unity assumption (VAT and indirect tax elasticity with respect to output gap) is often adopted for OECD or EU countries. In many cases, short-run elasticities are larger than their long-run counterparts, while there is often an asymmetric response of VAT revenues, being mostly higher during expansions than during contractions. However, short-run buoyancies are in many cases smaller than long-run ones, and buoyancy seems to be usually larger during contractions than during economic expansion. Moreover, the studies that estimated decomposed buoyancies/elasticities provide useful insights for policymakers into the responses of tax revenues, which vary for the individual countries under examination. Finally, the reported results for Greece are rather limited and inconclusive, while existing studies have not yet incorporated the impact of the recent economic and/or pandemic crises.

It follows from all the above that, even though empirical findings based on groups of countries provide useful evidence for fiscal authorities, the heterogeneity among results for the individual countries stresses the need to conduct the analysis on an individual country level as well as on a recurring basis over the years. In fact, extreme conditions such as an economic crisis or the unprecedented health crisis caused by the outbreak of the COVID-19 pandemic in 2020 make accurate estimation of tax revenue responsiveness even more important and challenging at the same time. According to the IMF (2020), traditional forecasting based on buoyancy and elasticity may result in an underestimation of tax revenue decline. Given that the effect of the pandemic is quite asymmetric, sector-specific estimations as well as individual estimations for different tax categories that are continuously updated could be more useful and precise (IMF, 2020).

In this context, the present Study extends the respective scarce literature on VAT revenue sensitivity in Greece and provides detailed empirical estimations. These can shed light onto the crucial issue of the response of VAT revenues to changes in macroeconomic variables, the potential impact of discretionary tax measures, and the possible role of asymmetries under extreme conditions. The issue is rather under-investigated for Greece, and the unprecedented conditions that accompanied the previous severe economic turmoil and the more recent pandemic crisis necessitate a thorough investigation of tax buoyancy and elasticity, alongside their further analytical dimensions, in Greece.

TABLE 6.1

Main empirical findings on VAT (and related taxes) buoyancy and/or elasticity (in chronological order)

Study	Data	Main findings
A.1. Findings on tax buoyancy - Groups of countries		
McGowan and Billings (1997)	9 EU countries (1970–1990)	• VAT buoyancy with respect to GDP was 1.11. • The individual country results indicated that buoyancy was above unity in eight out of nine EU countries, ranging from 0.94 (France) to 1.77 (UK). • Total consumption tax buoyancy was close to unity in most countries, while non-VAT consumption tax buoyancy was below unity in most countries.
Ahmed and Mohammed (2010)	25 developing countries (1998–2008)	• Buoyancy with respect to GDP varied widely for indirect taxes, from 0.23 for Brazil to 2.9 for Ghana.
Belinga et al. (2014)	34 OECD countries (1965–2012)	• Both long- and short-run buoyancies of taxes on goods and services with respect to GDP were not statistically different from one, at 0.98 and 0.92, respectively, with no asymmetries during growth or contraction periods. • Short-run buoyancy increased and long-run buoyancy decreased over time.
Jalles (2017)	37 Sub-Saharan African countries (1990–2015)	• Long-run buoyancy for taxes on goods and services with respect to GDP exceeded, one, at 1.197, while short-run buoyancy was 0.938 (not statistically different from one). • Buoyancy was larger during contractions and financial crisis than during economic expansions and non-crisis periods.
Khadan (2019)	12 Caribbean countries (1991–2017)	• Long-run tax buoyancy with respect to GDP for indirect taxes was significantly less than one, at 0.35, while short-run buoyancy was above unity, at 1.39. • With respect to taxes on goods and services, long- and short-run buoyancy were estimated at 0.712 and 1.057, respectively.
Lagravinese et al. (2020)	35 OECD countries (1995–2016)	• Baseline model results: short-run buoyancy of goods and services tax with respect to GDP was 0.56 and long-run buoyancy was 0.79.

TABLE 6.1 (continued)

Study	Data	Main findings
A.1. Findings on tax buoyancy - Groups of countries (continued)		
Gupta et al. (2022)	44 Sub-Saharan African countries (1980–2017)	• For taxes on goods and services, long-run buoyancy with respect to GDP was higher than one, at 1.241 (using the preferred estimation method) and short-run buoyancy was lower, at 1.142. • Long-run buoyancy increased from 1.097 during the first period (1980 to 1998) to 1.211 during the second period (1999 to 2017). • Short-run buoyancy estimates decreased from 0.889 in the first period to 0.791 in the second. • Both long-run and short-run buoyancies were larger during economic expansions.
Bağci (2022)	38 OECD countries (1996–2020)	• Taxes on goods and services buoyancy with respect to GDP was 0.18.
OECD (2023)	38 OECD countries (1980–2021)	• Short-run VAT buoyancy with respect to GDP was 1.140 and long-run VAT buoyancy with respect to GDP was 1.128. • Testing for sub-periods 1980–1999, 2000–2010, and 2011–2021, the short-run VAT buoyancy ranged from 1.129 to 1.282 and the long-run VAT buoyancy ranged from 1.034 to 1.125. • VAT buoyancy was estimated at 1.160 (1.132) for the years of growth and 0.838 (0.851) for the years of contraction under a moderate (strong) boom-bust scenario of above +/- 0.5% (1%) of annual real GDP.
A.2. Findings on tax buoyancy - Individual countries		
Mawia and Nzomoi (2013)	Kenya (1999/2000 to 2010/2011)	• Buoyancy with respect to the tax base was 0.21 and statistically insignificant for local VAT, 0.22 for import VAT, and 0.33 for total VAT. • Base-to-income buoyancy estimates were 2.83 for import and local VAT and 2.50 for total VAT.
Olukuru and Mandela (2017)	Kenya (1980–2014) and South Africa (1972–2014)	• Kenya: short-run VAT buoyancy (with respect to GDP) was 0.88 and long-run buoyancy was 1.38. • South Africa: not statistically significant results for VAT.

Birhanu (2018)	Ethiopia (3 regional states and 1 city administration) 12-year period	• VAT buoyancy with respect to GDP was 2.1341. • Turnover tax buoyancy was 0.6091.
Anderson and Shimul (2018)	50 US states and the District of Columbia (1972–2012)	• Long-run sales tax buoyancy with respect to GDP ranged from 0.896 to 0.924. • Individual state estimates: mean long-run buoyancy was 0.922, and mean short-run buoyancy was 0.184, but statistically insignificant in almost all individual states.
Tanchev and Todorov (2019)	Bulgaria (1999Q1–2017Q2)	• Both long- and short-run VAT buoyancies with respect to GDP were above one, at 1.12 and 1.03, respectively.
B.1. Findings on tax elasticity - Groups of countries		
Bouthevillain et al. (2001)	EU15 countries (1970 or 1975–1998, based on data availability)	• Elasticity of indirect taxes with respect to private consumption was 1, with a few exceptions for specific countries (Luxembourg 0.7, Austria and the UK 0.9, Finland and Portugal 1.1, Sweden 1.2). • The respective base-to-output elasticity was 1.3, ranging from 1.2 to 1.4 for the individual countries.
Girouard and André (2005)	OECD countries (1980–2003)	• Elasticity of indirect taxes with respect to output gap was set equal to one for all OECD economies.
Brückner (2012)	33 Sub-Saharan African countries (1980–2000)	• A 1% increase in GDP (due to exogenous factors) increased VAT and sales tax revenues by up to 2%.
Fricke and Süssmuth (2014)	11 economies in Latin America (1990Q1–2009Q1, based on data availability)	• Long-run VAT elasticity with respect to GDP was above unity, from 1.606 to 2.550 (with the exception of Chile, at 0.808). • VAT revenues above the long-run equilibrium had a stronger reaction to the business cycle, with great variability across countries (short-run elasticities from 0.962 to 3.348).
Price et al. (2014)	EU countries (1990–2013, based on data availability)	• The empirical results varied across countries, with an EU average indirect tax-to-consumption elasticity of 0.97. • The authors provided justification on the use of the unity assumption for indirect tax-to-output gap elasticity for cyclical adjustment purposes.
Price et al. (2015)	OECD countries (1990–2013, based on data availability)	• Average OECD indirect tax-to-output gap elasticity was 1.08. • Average OECD VAT tax-to-consumption elasticity was 1.16. • The authors maintained the assumption of a unit consumption-to-output gap elasticity.

TABLE 6.1 (continued)

Study	Data	Main findings
B.1. Findings on tax elasticity - Groups of countries (continued)		
Mourre and Princen (2019)	EU countries (2001–2013)	• Long-run and short-run consumption tax elasticities (with respect to the tax base) were close to or slightly above unity. • No evidence of a business cycle relevance in explaining short-run elasticity.
Boschi and d'Addona (2019)	15 European countries (1980Q1–2013Q1, based on data availability)	• Mean long-run indirect tax-to-base elasticity was 1.5 and short-run elasticity was 0.89, with great variability across countries in both cases. • Mean long-run indirect base-to-GDP elasticity was 0.71, and short-run elasticity was 0.48. • Mean long-run tax-to-GDP elasticity for indirect taxes, calculated as the product of tax-to-base and base-to-GDP, was 1.17 and short-run elasticity was 0.51, with great variability across countries. • Short-run elasticities tended to be larger during recessions.
B.2. Findings on tax elasticity - Individual countries		
Friedlaender et al. (1973)	15 US states (1953–1970)	• Average estimated sales tax rate elasticity was 0.93.
Osoro and Leuthold (1994)	Tanzania (1969–1990)	• Sales tax elasticity with respect to GDP gradually decreased over the years from 1.127 in 1969 to 0.610 in 1990.
Fox and Campbell (1984)	Tennessee (USA) (1975–1982)	• Weighted average long-run elasticity with respect to income was 0.59. • Short-run estimates varied widely from 0.16 (in 1976) to 0.92 (in 1979), with elasticity falling during recessions and rising during expansions.
Sobel and Holcombe (1996)	US (1951–1991, based on availability for specific tax categories)	• Long- and short-run tax base-to-GDP elasticities for retail sales were 0.660 and 1.039, respectively. • Long- and short-run elasticities for non-food retail sales were higher, at 0.701 and 1.377, respectively.
Seyfried and Pantuosco (2003)	10 largest US states (1983–1999)	• Sales and Gross Receipts elasticity with respect to GSP ranged from 0.44 to 1.79.

Bruce et al. (2006)	US states (1967–2000)	• Mean long-run sales tax base elasticity was below unity (0.811). • Mean short-run sales tax base elasticity displayed high asymmetry, being much greater when the base was above rather than below equilibrium (1.804 and 0.149, respectively), with wide variability across the individual US states.
Wolswijk (2009)	the Netherlands (1980–2002)	• Long-run VAT elasticity with respect to private consumption was 0.90. • Asymmetries in the short-run elasticity: elasticity was 0.64 when revenues were below equilibrium, and 1.10 when revenues were above equilibrium. No evidence of asymmetry in the error-correction terms.
Jooste and Naraidoo (2011)	South Africa (1994Q1–2009Q3)	• VAT-to-base elasticity was 2.18 during expansions and 0.81 during contractions. • The respective estimations employing the output gap were not statistically significant.
Poghosyan (2011)	Lithuania (1999–2010) & panel data for 10 new EU countries	• Evidence of cyclicality in VAT elasticity in Lithuania. • VAT elasticity with respect to its base ranged from 0.5 to 1.5 for Lithuania. • Long-run VAT elasticity with respect to its base was close to one and short-run elasticity was close to 1.2 for the 10 new EU countries.
Koester and Priesmeier (2012)	Germany (1970–2009)	• VAT long-run elasticity with respect to its base was 0.79, while short-run elasticity was 0.90, with almost the whole deviation from equilibrium being corrected within one period.
Bettendorf and van Limbergen (2013)	the Netherlands (1970–2011)	• Both long-run and short-run VAT elasticities with respect to their tax bases were around one. • The results remained unaffected when using a broader tax base. • Short-run elasticity exceeded 1 in 'good times' and was smaller than one in 'bad times'.
Isaac and Samwel (2015)	Kenya (1985–2009)	• Sales tax/VAT tax-to-base elasticity in nominal terms was not statistically significant and base-to-GDP elasticity was 1.121. • In real terms, tax-to-base elasticity was 0.166 and base-to-GDP elasticity was 1.188.
Havranek et al. (2016)	Czech Republic (1995–2013)	• Long-run VAT elasticity with respect to the corresponding tax base was 0.9, while short-run elasticity was not statistically significant.
Wawire (2017)	Kenya (1963/64–2008/09)	• Sales tax/VAT elasticity with respect to GDP was well above unity, at 1.94.

TABLE 6.1 (continued)

Study	Data	Main findings
B.2. Findings on tax elasticity - Individual countries (continued)		
Berardini and Renzi (2022)	Italy (2002Q1–2021Q1)	• Short-run VAT elasticity with respect to its base was below or slightly below one, ranging from 0.805 to 0.999. • Changes in electronic payments had a positive and statistically significant impact on the change of VAT revenues.
C.1. Findings on tax buoyancy and tax elasticity - Groups of countries		
Barrios and Fargnoli (2010)	14 EU countries (2000–2008)	• Simple calculation of 'gross' and 'net' elasticities by dividing the annual growth of the tax revenues (gross and net of the impact of discretionary measures) with the nominal GDP annual growth rate. • Volatile elasticities of indirect taxes, large discrepancies between net and gross elasticity in some cases.
Dudine and Jalles (2018)	107 countries (classified as advanced, emerging, and low income) (1980–2014)	• For taxes on goods and services, both long- and short-run buoyancies with respect to GDP were not statistically different from 1 for emerging economies and close to 1, at 0.951 and 0.873, respectively, for advanced economies. • Long-run tax buoyancy exceeded 1 for low-income countries, while the respective short-run buoyancy was not statistically different from 1. • Buoyancy was larger during contractions than during economic expansion in emerging economies. • The authors also controlled for tax rates as a robustness check, practically providing estimations for elasticity, with long-run elasticity at 0.867 and short-run elasticity not significantly different from 1.
Jalles (2020)	30 Asian-Pacific countries (1980–2017)	• For taxes on goods and services, both long- and short-run buoyancy with respect to GDP were statistically not different from one. • Short-run tax buoyancy was generally larger during recession periods compared to periods of economic expansion. • The authors also controlled for tax rates as a robustness check, practically providing estimations for elasticity, with the long-run estimation being statistically insignificant and the short-run one not significantly different from 1.

Cornevin et al. (2023)	88 countries for VAT (32 advanced economies, 36 emerging market economies, and 20 low-income countries) (1990–2020)	• Long-run VAT buoyancy with respect to GDP was around unity for nearly all income groups and across alternative panel data estimators. • Short-run VAT elasticity estimates were rather mixed, depending on the panel data estimation method and the income group under examination. • Short-run buoyancy for advanced economies and low-income economies was either below one or statistically not different from one, depending on the employed estimator. • Short-run buoyancy for emerging market economies was not statistically different from one across nearly all estimators. • Controlling for discretionary changes in tax rates and tax base reforms did not significantly change the respective VAT buoyancy.
C.2. Findings on tax buoyancy and tax elasticity - Individual countries		
Khan (1973)	Pakistan (1960–1972)	• Elasticity of indirect taxes with respect to GDP was 1.57, while the respective buoyancy estimate was 1.36.
Choudhry (1979)	US (1955–1975) UK (1955–1974)	• For consumption taxes, buoyancy estimations with respect to GDP were 0.53 for the US and 1.11 for the UK. • Base-to-GDP elasticities were 0.99 for the US and 0.95 for the UK.
Gillani (1986)	Pakistan (1971/72–1982/83)	• Long-run buoyancy of sales taxes with respect to GDP was 1.18, while the respective long-run elasticity was above unity, at 1.24 and 1.36, employing two alternative methods to account for the impact of the discretionary tax measures on revenues. Short-run buoyancy was 1.24, while the respective short-run elasticity was 1.31 and 0.91. • Long-run buoyancy of indirect taxes was 1.16, while the respective long-run elasticity was also above unity, at 1.24 and 1.33, employing two alternative methods to account for the impact of the discretionary tax measures on revenues. Short-run buoyancy was 1.32, while the respective short-run elasticity was 1.41 and 0.91.
Ehdaie (1990)	2 Sub-Saharan African countries, Malawi and Mauritius (1965–1985)	• Consumption tax buoyancy with respect to GDP was 1.72 for Malawi and 1.05 for Mauritius. • Consumption tax elasticity was 0.92 for Malawi and 0.76 for Mauritius.

TABLE 6.1 (continued)

Study	Data	Main findings
C.2. Findings on tax buoyancy and tax elasticity - Individual countries (continued)		
Indraratna (1991)	Sri Lanka (1960–1994, and pre- and post-reform sub-periods, i.e., 1960–1977 and 1978–1994)	• Overall elasticity of individual tax categories was the product of tax-to-base and base-to-GDP elasticities, and the same procedure was used for buoyancies. • Turnover tax-to-base elasticity was 0.71 for the whole period, 0.55 for the period 1960–1977, and 0.84 for the period 1978–1994. • Base-to-GDP elasticities were equal to unity and short-run elasticities were equal to the tax-to-base elasticities. • Long-run tax elasticities were 0.80 for the whole period, 0.63 for the period 1960–1977, and 0.84 for the period 1978–1994. • Buoyancy estimations were higher compared to elasticities that were 1.35 for the whole period, 1.62 for the period 1960–1977, and 1.18 for the period 1978–1994.
Akbar and Ahmed (1997)	Pakistan (1973–1990)	• Sales tax buoyancy and elasticity with respect to GDP were 1.26 and 1.01, respectively. • The results differed for the two reported sub-periods, i.e., 1973–1981 and 1982–1990. Buoyancy and elasticity were 1.26 and 1.08, respectively, for the first sub-period and increased to 1.71 and 1.45 for the second sub-period. • Sales tax-to-base buoyancy and elasticity were at 1.20 and 0.96, respectively. Buoyancy and elasticity for the first sub-period were 1.12 and 1.02, respectively, and increased to 1.56 and 1.32 for the second sub-period. • Tax-to-base buoyancy increased from 1.19 in the first period to 1.56 in the second period, while base-to-GDP buoyancy was 1.06 in the first period and 1.10 in the second period.
Mukarram (2001)	Pakistan (1981–2001)	• Sales taxes had an elasticity with respect to GDP close to one, at 0.99, while the corresponding buoyancy was 1.51. • Tax-to-base elasticity and buoyancy were 1.01 and 1.55, respectively. • Base-to-GDP elasticity was 0.98.
Bilquees (2004)	Pakistan (1974–2003)	• Short-run sales tax buoyancy with respect to GDP was 0.42 and the long-run was 1.41. • Short-run sales tax elasticity was 0.38 and the long-run was 1.50. • Tax-to-base elasticity was 1.808, and base-to-GDP elasticity was 1.017.

Creedy and Gemmell (2004)	UK (1989–2000)	• Consumption tax elasticity with respect to GDP fell during the period under examination, from around 0.9 in the early 1990s to around 0.7 by 2000. • Buoyancy based on simple calculations for sub-periods indicated increased consumption tax buoyancy for the period 1989–1999, at 1.410. The respective results for the periods 1979–1984 and 1984–1989 were 1.323 and 0.535, respectively.
Timsina (2007)	Nepal (1975–2005)	• For VAT, elasticity and buoyancy with respect to GDP were 0.55 and 1.15, respectively. • The corresponding tax-to-base buoyancy and elasticity was 1.16 and 0.58, respectively, while base-to-GDP estimates were 0.99 in both cases.
Twerefou et al. (2010)	Ghana (1970–2007)	• VAT/sales tax buoyancy with respect to GDP was 1.20, while VAT/sales tax elasticity was 1.11. • Short-run VAT/sales tax buoyancy was 0.90. • Buoyancy, as well as decomposed buoyancy, i.e., tax-to-base and base-to-GDP buoyancies, increased during the reform period (1985–2007) from below unity to above unity. • Short-run tax-to-base elasticity was 0.70 and long-run was 1.09. • Both short-run and long-run base-to-GDP elasticities were below unity.
Kargbo and Egwaikhide (2012)	Sierra Leone (1977–2009)	• Domestic transaction tax buoyancy with respect to GDP was 1.092 in the short run and 1.291 in the long run. • Elasticity was 0.663 in the short run and 0.799 in the long run.
Ndedzu et al. (2013)	Zimbabwe (1975–2008)	• For sales tax/VAT, both buoyancy and elasticity with respect to GDP were below unity, at 0.815 and 0.735, respectively.
Yousuf and Huq (2013)	Bangladesh (1980–2011)	• Sales tax & VAT-to-base elasticity was 1.18, while sales tax & VAT-to-base buoyancy was 1.28.
Bekoe et al. (2016)	Ghana (pre-tax reform period of 1970–1981 and post-tax reform period of 1982–2013)	• Sales tax buoyancy and elasticity were below unity for the first period, at 0.70 and 0.69, respectively. • Both sales tax/VAT buoyancy and elasticity were above unity for the second period, at 2.55 and 2.83, respectively.
Seydou (2020)	Cote d'Ivoire (1984–2016)	• Buoyancy with respect to GDP for indirect taxes was 0.76 and elasticity was 0.77, while buoyancy for value added taxes was 0.73 and elasticity was 0.74. • Tax-to-base elasticity was below unity in both cases, while base-to-GDP elasticity was close to one.

TABLE 6.1 (continued)

Study	Data	Main findings
C.2. Findings on tax buoyancy and tax elasticity - Individual countries (continued)		
Conroy (2020)	Ireland (1987–2017)	• Personal consumption and investment in the building and construction sector were used as macroeconomic determinants: the sum of the two long-run VAT elasticities were not significantly different from one. • Long-run estimations of VAT elasticity with respect to personal consumption were just above one, and short-run results were above one (1.27–1.82 depending on the estimation method). • Qualitatively, the same results when employing policy-unadjusted tax revenues.
D. Findings on tax buoyancy and/or tax elasticity - Greece		
Bouthevillain et al. (2001)	EU-15 countries (1970 or 1975–1998, based on data availability)	• Elasticity of indirect taxes with respect to private consumption for Greece was 1, while the respective base-to-output elasticity was 1.2.
Girouard and André (2005)	OECD countries (1980–2003)	• Elasticity of indirect tax with respect to the output gap was set equal to one for all OECD economies, including Greece.
Tagkalakis (2013a, 2014b)	Greece (2000Q1–2012Q3)	• Indirect tax elasticity with respect to GDP was from 25% to 80% higher than one. • VAT elasticity with respect to private consumption was 2.629, while the respective indirect tax elasticity was 1.410 and other indirect taxes elasticity was statistically insignificant. • Elasticity of other indirect taxes with respect to GDP was also statistically insignificant, while elasticity of private consumption with respect to GDP was 0.957.
Price et al. (2014)	EU countries (1990–2013, based on data availability)	• Indirect tax-to-consumption elasticity for Greece was 0.81. • The authors justified the use of the unity assumption for indirect tax/output gap elasticity for cyclical adjustment purposes.
Price et al. (2015)	OECD countries (1990–2013, based on data availability)	• Indirect tax-to-output gap and VAT-to-consumption elasticities for Greece were 1.04 and 1.06, respectively.

Hondroyiannis and Papaoikonomou (2017)	Greece (2003Q4–2016Q2)	• VAT-to-base elasticities declined during the crisis, from above 2 in 2008 to close to zero during 2012–2014, and recovered close to unity in 2016.
Zervas (2018)	Greece (1999–2015)	• Indirect tax elasticity with respect to GDP was 0.49, while VAT elasticity was 0.86.
Mourre and Princen (2019)	EU countries (2001–2013)	• Consumption tax elasticity with respect to the tax base for Greece was 5.62 in the short run and 2.63 in the long run.
Boschi and d'Addona (2019)	15 European countries (1980Q1–2013Q1, 2000Q1–2013Q1 for Greece)	• Long-run tax-to-base and base-to-GDP elasticities for indirect taxes for Greece were 0.97 and 0.83, respectively. • Short-run elasticities for Greece were not statistically significant. • Long-run tax-to-GDP elasticity for indirect taxes, calculated as the product of tax-to-base and base-to-GDP long-run elasticities was 0.80 for Greece.
Lagravinese et al. (2020)	35 OECD countries (1995–2016)	• Long-run buoyancy of taxes on goods and services with respect to GDP for Greece was 0.80, while short-run buoyancy was insignificant.
Danchev et al. (2020)	Greece (2014–2017)	• VAT elasticity with respect to its base was not statistically significant.
OECD (2023)	38 OECD countries (1980–2021)	• Nominal data: short-run VAT buoyancy with respect to GDP for Greece was 1.026 and long-run VAT buoyancy was 1.030. • Real data: short-run VAT buoyancy with respect to GDP for Greece was 1.074 and long-run VAT buoyancy was 1.361.

Source: Authors' compilation.

CHAPTER 7

ESTIMATING VAT REVENUE BUOYANCY AND ELASTICITY IN GREECE: EMPIRICAL METHODOLOGY, ESTIMATION, DATA, AND RESULTS

7.1. Introduction

The thorough analyses provided in the preceding chapters of this Study have well established the importance of investigating the response of VAT revenues to changes in income in Greece, whereby a number of significant dimensions have been discerned and emphasized. Moreover, it has been shown that the empirical literature on revenue buoyancy and elasticity for the individual category of VAT remains rather limited and the related evidence scarce for the case of Greece.

Motivated by the above considerations and with the aim to contribute to the relevant empirical literature by filling this gap, the present chapter provides multi-dimensional and comprehensive econometric estimates of VAT revenue buoyancy and elasticity for Greece. To this end, we use widely employed econometric techniques and quarterly data for the time period from the first quarter of 2000 to the last quarter of 2022. It is important to stress that the investigated period includes the two major economic and social episodes: first, the severe economic crisis that started in 2008 and led to a prolonged adjustment period in the country; second, the unprecedented shock caused by the outbreak of the COVID-19 pandemic in early 2020, which had extraordinary economic and social repercussions, such as the ensuing health crisis and the periods of lockdown, on economic and social activities in Greece. Along these lines, Section 7.2 presents in detail the implemented econometric modeling framework to estimate VAT revenue buoyancy and elasticity in Greece, while Section 7.3 describes the data underlying the empirical analysis. Section 7.4 outlines the estimation procedure, and Section 7.5 reports and analyzes the empirical findings. Finally, Section 7.6 discusses and interprets the empirical results.

7.2. Empirical methodology

In the present section, we present in detail the methodological approach followed for the estimation of VAT revenue buoyancy and elasticity in Greece. The basic concept behind the selected approach is to comprehensively and accurately cover the major dimensions that characterize the analysis of the response of VAT revenues to changes in income. Central to our empirical analysis is the application of a disaggregated framework, focusing on the individual tax category of VAT, having provided the rationale (see Chapter 5) in favor of a more detailed tax breakdown to more accurately investigate the way revenues from one single tax category, that of VAT, respond to changes in income and DTM. The accuracy of such an empirical investigation and, as a result, the usefulness of the ensuing implications are inextricably linked to the precision of the provided evidence, which crucially depends upon the disaggregation degree. Apart from disaggregating, the employed econometric modeling framework unfolds on the basis of three central points: the distinction between VAT revenue buoyancy and elasticity, the distinction between the one-step and the decomposition approach, and the methodological emphasis put on time dimension issues. Individually and collectively, these cornerstones of the empirical application are expected to provide crucial evidence to enhance policy effectiveness and to enable more targeted interventions.

Distinction between VAT revenue buoyancy and elasticity

The empirical framework includes the estimation of both VAT revenue buoyancy and elasticity as complementary revenue response concepts. This is done in order to distinguish between the endogenous (excluding the effects of policy measures) and the overall (including the effects of policy measures) VAT revenue response to changes in income and to be able to draw conclusions about the potential effectiveness of policy measures under consideration.

Central to the estimation of VAT revenue elasticities and, hence, to the differentiation between buoyancy and elasticity estimates for VAT is the adjustment of tax revenues for the effects of DTM. Ideally, detailed and readily available quantitative data (in the required time frequency) measuring the impact of the implemented policy measures on VAT revenues should be provided by tax authorities. In that case, adjusted revenue series would be obtained by the use of adequate technical procedures to eliminate the effects of DTM, and they would be applied for the purpose of estimating elasticities. Unfortunately, this is not the case in Greece, nor in a significant number of countries, for which research on VAT revenue response concepts is carried out. An alternative (approximative) approach for taking into account the effects of DTM and estimating the income elasticities of tax revenue is the method originally proposed by Singer (1968),[197] which is based on the introduction of dummy variables for each of the exogenous changes. Following similar practice in the corresponding empirical literature,[198] we rely on the respective methodology in this Study to take into account the impact of DTM. In more detail and on the basis of the analysis provided in Chapter 3 (see Table 3.1), we focus on the most significant among the implemented changes in the standard and reduced VAT rates in Greece during the time period under investigation: the April 2005 increase in both the standard and reduced rates, the March 2010 increase in both the standard and reduced rates, the July 2010 increase in both the standard and reduced rates, the January 2011 increase in the reduced rate, and the June 2016 increase in the standard rate.

Distinction between the one-step and the decomposition approach

The methodological framework incorporates the estimation of the tax-to-income revenue response concepts in one step, alongside the derivation of decomposed tax-to-base and base-to-income VAT revenue buoy-

[197] The author referred to Goldberger (1964) for a description of dummy variable methods. In his reference to step functions, Goldberger (1964) claimed that, supposing that the relationship between one variable and its explanatory one is known to be a step function with known breakpoints, a more natural approach (than its approximation by a higher-order polynomial) is to represent the explanatory variable by a set of ‘dummy variable’ regressors.

[198] For related references and/or applications, see Khan, 1973; Twerefou et al., 2010; Poghosyan, 2011; Kargbo and Egwaikhide, 2012; Fricke and Süssmuth, 2014; Dudine and Jalles, 2018; Boschi and d’Addona, 2019; Lagravinese et al., 2020; Seydou, 2020.

ancies and elasticities, as well as the calculation of their product wherever possible,[199] in order to obtain an alternative, implied, measure of tax-to-income revenue response. This is done with the aim to extract additional information about the more intrinsic relations driving VAT revenue response to income. The latter may help the government discern between interactions more or less under its control (see Sections 5.2.1.2 and 5.2.2.2).

We use GDP as the income measure, following a great number of related studies, for estimating the relations between revenues and income as well as the relations between income and the tax base. The main alternative application refers to the use of the output gap, which is basically adopted by international organizations in the framework of calculating the CAB and the process of fiscal surveillance (see, for example, van den Noord, 2000; Girouard and André, 2005; Mourre et al., 2013; Princen et al., 2013; Mourre et al., 2014; Price et al., 2014; Price et al., 2015).[200] Since we extend the analysis to the estimation of the decomposed tax-to-base and base-to-income VAT revenue buoyancies and elasticities, we need to employ an adequate measure for the VAT-associated tax base. In practice, data for the true tax bases, as defined by law, are not timely accessible, if available at all (Koester and Priesmeier, 2012; Havranek et al., 2016). Timely observable macroeconomic variables are used, instead, as proxies for the true tax bases (see Havranek et al., 2016; Mourre and Princen, 2019). In the present Study, we rely on Bettendorf and van Limbergen (2013), who argued that most studies use private consumption in order to approximate the VAT base, and on Berardini and Renzi (2022), who claimed that the VAT macroeconomic base is typically approximated by private consumption expenditure. Overall, the approach of employing private consumption expenditure as a proxy measure for the VAT-associated tax base is followed by a significant number of relevant empirical applications for VAT (see Timsina, 2007; Wolswijk, 2009; Twerefou et

[199] The feasibility of such calculations depends on the statistical significance of the involved coefficients.

[200] It should be noted that the use of the output gap necessitates its measurement (see Price et al. 2014), which presupposes potential output estimation. The latter is often not free of measurement errors (Girouard and André, 2005). In addition, there may be non-negligible deviations between output gap ex-post and real-time values (Princen et al., 2013).

al., 2010; Poghosyan, 2011; Bettendorf and van Limbergen, 2013; Mawia and Nzomoi, 2013; Tagkalakis, 2013a; Yousuf and Huq, 2013, for sales tax and VAT; Price et al., 2015).[201]

Time dimension issues

The empirical framework emphasizes specific time dimension issues. This is done, first, through the estimation of both long-run and benchmark[202] short-run VAT revenue buoyancies and elasticities, alongside the investigation of adjustment between the two; and second, by the conduction of a battery of extended short-run VAT revenue buoyancy and elasticity estimations controlling for Error Correction Term (ECT) asymmetry, COVID-19,[203] lockdown,[204] business cycle, and growth effects; and third, via the investigation of the stability of long-run VAT revenue buoyancy estimates[205] and

[201] It is important to stress that private consumption has also been considered as the relevant tax base proxy in a number of studies focusing on wider or more general tax categories, mainly that of indirect taxes (for example, van den Noord, 2000; Bouthevillain et al., 2001; Girouard and André, 2005; Mourre et al., 2014; Price et al., 2014; Boschi and d'Addona, 2019; Seydou, 2020), consumption taxes (for example, Choudhry, 1979; Mourre and Princen, 2015 and 2019), and other relevant categories, e.g., tax on domestic consumption (Ehdaie, 1990) and turnover tax (Indraratna, 1991).

[202] By 'benchmark' we define the standard short-run models which are also compared with the extended short-run models.

[203] To control for COVID-19 effects, we determine the COVID-19 period as being the total of the period characterized by the implementation of any kind of measures affecting and restricting economic and social activity in the country due to the pandemic. The respective period is set to start in the first quarter of 2020 and end in the second quarter of 2022 since no extraordinary measures were implemented thereafter, apart from the mandatory use of protection masks in certain cases. For robustness reasons, alternative durations/end-periods are also considered.

[204] To control for lockdown effects, we determine the lockdown periods as being the specific quarters characterized by measures directly restricting or interrupting economic and social activity in the country due to the pandemic. The question on whether the first quarter of 2020 should be categorized as a lockdown quarter or not is accounted for via robustness analysis.

[205] Note that the corresponding stability investigation for VAT long-run elasticity is not carried out since it would not be possible to repeat the exact exercise and compare the corresponding evidence. This is due to the way DTM dummies are defined, which would not allow for the inclusion of them all in each and every one of the repetitive estimations in the same way and, in certain cases, even not at all.

of the consistency of benchmark short-run buoyancy and elasticity estimates in connection with the extraordinary crisis triggered by the COVID-19 pandemic.

In the first case, such an analysis is important to differentiate between the revenue response to long-run income growth and to short-run income fluctuations, and to investigate the potential convergence process from the short to the long run, with reference to the time period under investigation. In the second case, such an analysis is necessary in order to investigate the potential role of residual-based asymmetry, of the effects of the COVID-19 pandemic period as a whole and the lockdown period due to the pandemic, as well as of the business cycle and growth, on VAT revenue response. Finally, in the third case, this is done in order to test for the stability of the provided evidence depending on the underlying sample period and the number of included observations. At the same time, great emphasis is placed on the unprecedented crisis triggered by the outbreak of the COVID-19 pandemic and its potential effect on short-run VAT revenue buoyancy and elasticity estimates for Greece.

Following a substantial branch of the relevant empirical literature, in this Study, VAT revenue long- and short-run buoyancies and elasticities are estimated using the cointegrating and Error Correction Model (ECM) framework (for similar applications, see Sobel and Holcombe, 1996; Bruce et al., 2006; Wolswijk, 2009; Twerefou et al., 2010; Kargbo and Egwaikhide, 2012; Koester and Priesmeier, 2012; Bettendorf and van Limbergen, 2013; Belinga et al., 2014; Fricke and Süssmuth, 2014; Mourre and Princen, 2015; Havranek et al., 2016; Köster and Priesmeier, 2017; Deli et al., 2018; Boschi and d’Addona, 2019; Mourre and Princen, 2019; Conroy, 2020; Cornevin et al., 2023). We rely on the cointegrating approach to estimate all long-run relations, which are expected to be stable. We further employ the ECMs to capture short-run effects at any time period, potentially capturing transitory short-run deviations expected to be corrected within a certain time interval. According to the ECM empirical approach, the dependent variables can respond to short-run changes in the independent ones (here, in the corresponding macroeconomic driver) as well as to any short-run disequilibrium from the long-run relation that might exist at the beginning of the period. In other words, two different short-run effects are captured and measured by separate regressors.[206] This approach enables the derivation of the speed of error correction or adjustment of any short-run, i.e., temporary, deviation from the long-run equilibrium relation. Evidently, the higher the speed of the adjustment, the faster the disequilibrium gap will close.

To control for potential ECT asymmetry, COVID-19, lockdown, business cycle, and growth effects, the benchmark short-run ECMs are extended in several ways. To examine for potential residual-based asymmetry, independent variables and lagged residual series are broken down into positive and negative sub-series (for related and similar applications see, for example, Bruce et al., 2006; Wolswijk, 2009; Bettendorf and van Limbergen, 2013; Fricke and Süssmuth, 2014; Conroy, 2020), in both cases on the basis of the sign of the residual series arising from the corresponding long-run relation. In that way, any potential residual-based buoyancy and elasticity asymmetries and any potential speed of adjustment asymmetry that may arise due to a varying sign (i.e., positive or negative) of the deviation from the long-run equilibrium relation are captured. Furthermore, to investigate the effects of the total period of the COVID-19 pandemic, the distinguished effect of the lockdown periods, and the potential effects of different business cycle phases and of positive versus negative growth periods, dummy variables and their corresponding dummy complements are included multiplicatively in the relevant equations, interacting with the relevant independent variables (for related and similar applications, see Belinga et al., 2014; Deli et al., 2018; Mourre and Princen, 2019; Lagravinese et al., 2020; Gupta et al., 2022). Dummies are constructed to reflect the periods including the actual emergence of the investigated crisis (i.e., the COVID-19 or the lockdown periods) or the periods referring to one direction of economic developments (i.e., expansionary or growth periods). Correspondingly, their complements reflect the periods excluding the investigated crisis (i.e., the non-COVID-19 or non-lockdown periods) or the

[206] For more detailed descriptions of the ECM, see Sobel and Holcombe (1996), Bruce et al. (2006), Wolswijk (2009), Koester and Priesmeier (2012), Köster and Priesmeier (2017) and Boschi and d'Addona (2019). In this framework, short-run changes in the dependent variable are sometimes interpreted to arise through two different channels, a direct one (through changes in the independent variable) and an indirect one (through a disequilibrium from the long run) (see Wolswijk, 2009 and Koester and Priesmeier, 2012).

periods referring to the opposite direction of economic developments (i.e., recessionary periods or non-growth periods).

The sufficient length of the underlying sample period (92 observations before adjustments) further allows us to control for the stability and consistency of our estimations. Rolling and recursive regressions are carried out in order to investigate the stability of long-run VAT revenue buoyancy estimates.[207] In both cases, we estimate sequences of moving data sub-windows. In the first case, we keep the sample size (of 52 observations) fixed and repeat the estimations by shifting the data window ahead in each successive step by one observation, i.e., dropping the first and adding one at the end of the sample, until we reach the end of the sample. In this way, we control for the stability of VAT revenue long-run buoyancy estimates over different periods of time. In the second case, we start with a sub-sample (of 52 observations) and each time expand the data window by one observation at the end, keeping the first one fixed, until we reach the full sample period. By doing this, we control for the stability of VAT revenue long-run buoyancy estimates for growing sample periods, including longer time periods. Finally, benchmark short-run buoyancy and elasticity estimations are repeated in a consistency exercise for the time period ending before the outbreak of COVID-19, i.e., up until the fourth quarter of 2019, evidently excluding the period accounting for the COVID-19 and lockdown effects. In this way, we investigate the relevancy of the benchmark short-run buoyancy and elasticity estimates in connection with the extraordinary crisis triggered by the COVID-19 pandemic. As a result, we remove any possible COVID-19 effect from the short-run estimations and derive conclusions that are not affected by the extreme and unprecedented conditions of the COVID-19 pandemic.

Model specifications

Taking into account all the above dimensions and considerations, in what follows, we formulate the long-run models, alongside the benchmark short-run and the extended short-run models to be implemented for the

[207] For related applications, see, for example, Jooste and Naraidoo (2011), Poghosyan (2011), Bettendorf and van Limbergen (2013), and Tagkalakis (2013a).

estimation of VAT revenue buoyancy and elasticity in Greece. Variables are expressed in logarithmic form[208] and differences of the logarithms of variables are used in the short-run equations. In the elasticity equations, DTM dummy variables take the value of one in the quarter of the implemented change and in the following quarter, and the value of zero otherwise (for related and similar applications, see Twerefou et al., 2010; Ndedzu et al., 2013; Boschi and d'Addona, 2019; Seydou, 2020). By choosing the most important out of the total of the implemented tax rate changes, we avoid an excessive reduction in the degrees of freedom and the efficiency of the estimators. Moreover, through the way we define the included dummy variables, first, we capture any potential delayed intervention effect, in particular when DTM are implemented in the last month of the referred quarter, and second, we ensure that any serious multicolinearity issue is eliminated. For robustness, we estimate two additional sets of long-run equations with dummy variables defined in two alternative ways. In the first case, they take the value of one in the quarter of the implemented change and in the following two quarters, and the value of zero otherwise. In the second case, they take the value of one in the quarter of the implemented change and in the following three quarters, and the value of zero otherwise. It should be noted that buoyancy and elasticity equations are identical for all base-to-GDP relations.[209]

Long-run models comprise the tax-to-GDP, tax-to-base, and base-to-GDP buoyancy and elasticity relations, as follows:

Long-run tax-to-GDP buoyancy and elasticity relations

$$lnRev_t = a_0^b + a_1^b lnGDP_t + \varepsilon_t^b, \tag{7.1}$$

[208] For presentations of the general exponential forms of equations, the log linearizing of which gives the regressions to be estimated and leads directly to buoyancy and elasticity coefficients, see, for example, Mansfield (1972), Khan (1973), Indraratna (1991), Kargbo and Egwaikhide (2012), Mawia and Nzomoi (2013), Ndedzu et al. (2013), Isaac and Samwel (2015), Price et al. (2015), Bekoe et al. (2016), Wawire (2017), Dudine and Jalles (2018), Jalles (2020), Tsouma et al. (2020).

[209] They do not include the DTM dummies since the relation between private consumption and GDP is not expected to be affected by VAT rate changes.

$$lnRev_t = a_0^e + a_1^e lnGDP_t + a_2 2005\_MD_t + a_3 2010a\_MD_t + \\ + a_4 2010b\_MD_t + a_5 2011\_MD_t + a_6 2016\_MD_t + \varepsilon_t^e, \tag{7.2}$$

Long-run tax-to-base buoyancy and elasticity relations

$$lnRev_t = b_0^b + b_1^b lnCons_t + w_t^b, \tag{7.3}$$

$$lnRev_t = b_0^e + b_1^e lnCons_t + b_2 2005\_MD_t + b_3 2010a\_MD_t + \\ + b_4 2010b\_MD_t + b_5 2011\_MD_t + b_6 2016\_MD_t + w_t^e, \tag{7.4}$$

Long-run base-to-GDP buoyancy/elasticity relation

$$lnCons_t = c_0 + c_1 lnGDP_t + u_t, \tag{7.5}$$

where $lnRev_t$, $lnGDP_t$, and $lnCons_t$ express the logarithms of VAT revenues, GDP, and private consumption, respectively, in time t; 2005_MD_t, $2010a\_MD_t$, $2010b\_MD_t$, 2011_MD_t, and 2016_MD_t stand for the selected VAT rate changes[210] describing the related implemented discretionary measures in time t; ε_t^b, ε_t^e, w_t^b, w_t^e, and u_t represent the error terms in time t; a_0, b_0, and c_0 denote the constant terms; a_1^b and a_1^e stand for the long-run buoyancy and elasticity, respectively, of VAT revenues, with respect to GDP; b_1^b and b_1^e stand for the long-run buoyancy and elasticity, respectively, of VAT revenues with respect to their base, i.e., private consumption; c_1 stands for the long-run buoyancy and elasticity of the VAT revenue base, i.e., private consumption, with respect to GDP; the simple mathematical multiplications of b_1^b with c_1, and b_1^e with c_1, give the implied, by the decomposition approach, long-run buoyancy and elasticity, respectively, of VAT revenues with respect to GDP; a_2 to a_6 represent the coefficients of the respective DTM in the long-run tax-to-GDP elasticity relation; b_2 to b_6 represent the coefficients of the respective DTM in the long-run tax-to-base elasticity relation. It should be noted that relations (7.1), (7.3), and (7.5) are also repetitively estimated in the stability exercise of the rolling and recursive regression approaches, in each case for 40 sub-samples.

[210] For more details, see the respective reference in Section 7.2 above and also Table 3.1 in Chapter 3.

In correspondence with the long-run models, benchmark short-run models comprise the tax-to-GDP, tax-to-base, and base-to-GDP buoyancy and elasticity relations, as follows:

Benchmark short-run tax-to-GDP buoyancy and elasticity relations

$$\begin{gathered}\Delta lnRev_t = d_0^b + d_1^b \Delta lnGDP_t + d_2^b \Delta lnRev_{t-1} + d_3^b \Delta lnGDP_{t-1} + \\ + h^b ECT_{t-1}^b + v_t^b,\end{gathered} \tag{7.6}$$

$$\begin{gathered}\Delta lnRev_t = d_0^e + d_1^e \Delta lnGDP_t + d_2^e \Delta lnRev_{t-1} + d_3^e \Delta lnGDP_{t-1} + \\ + h^e ECT_{t-1}^e + d_4 2005\_MD_t + d_5 2010a\_MD_t + d_6 2010b\_MD_t + \\ + d_7 2011\_MD_t + d_8 2016\_MD_t + v_t^e,\end{gathered} \tag{7.7}$$

Benchmark short-run tax-to-base buoyancy and elasticity relations

$$\begin{gathered}\Delta lnRev_t = e_0^b + e_1^b \Delta lnCons_t + e_2^b \Delta lnRev_{t-1} + e_3^b \Delta lnCons_{t-1} + \\ + k^b ECT_{t-1}^b + x_t^b,\end{gathered} \tag{7.8}$$

$$\begin{gathered}\Delta lnRev_t = e_0^e + e_1^e \Delta lnCons_t + e_2^e \Delta lnRev_{t-1} + e_3^e \Delta lnCons_{t-1} + \\ + k^e ECT_{t-1}^e + e_4 2005\_MD_t + e_5 2010a\_MD_t + e_6 2010b\_MD_t + \\ + e_7 2011\_MD_t + e_8 2016\_MD_t + x_t^e,\end{gathered} \tag{7.9}$$

Benchmark short-run base-to-GDP buoyancy/elasticity relation

$$\begin{gathered}\Delta lnCons_t = f_0 + f_1 \Delta lnGDP_t + f_2 \Delta lnCons_{t-1} + f_3 \Delta lnGDP_{t-1} + \\ + lECT_{t-1} + z_t,\end{gathered} \tag{7.10}$$

where $\Delta lnRev_t$, $\Delta lnGDP_t$, and $\Delta lnCons_t$ express the differenced logarithms of VAT revenues, GDP, and private consumption, respectively, in time t; $\Delta lnRev_{t-1}$, $\Delta lnGDP_{t-1}$, and $\Delta lnCons_{t-1}$ stand for the lagged differenced logarithms of the corresponding variables; v_t^b, v_t^e, x_t^b, x_t^e, and z_t represent the error terms in time t; ECT_{t-1}^b and ECT_{t-1}^e reflect the error correction terms, given by the lagged residuals obtained from the corresponding buoyancy and elasticity long-run relations, respectively; 2005_MD_t, $2010a\_MD_t$, $2010b\_MD_t$, 2011_MD_t, and 2016_MD_t stand for the selected VAT rate changes describing the related implemented discretionary measures; d_0, e_0, and f_0 denote the constant terms; d_1^b and d_1^e stand for the short-run buoyancy and elasticity, respectively, of VAT revenues with respect to GDP; e_1^b and e_1^e stand for the short-run buoyancy and elasticity, respectively, of VAT revenues with respect to their base, i.e., private consumption; f_1 stands for the short-run buoyancy and elasticity of the VAT revenue base, i.e., private consumption, with respect to GDP; the simple mathematical multiplications of e_1^b with f_1 and e_1^e with f_1 give the implied, by the decomposition approach, benchmark short-run buoyancy and elasticity, respectively, of VAT revenues with respect to GDP; h^b and h^e represent the speed of adjustment of any short-run, i.e., temporary, deviation in the short-run tax-to-GDP buoyancy and elasticity relation, respectively, from the long-run equilibrium; k^b and k^e represent the speed of adjustment of any short-run, i.e., temporary, deviation in the short-run tax-to-base buoyancy and elasticity relation, respectively, from the long-run equilibrium; l represents the speed of adjustment of any short-run, i.e., temporary, deviation in the short-run base-to-GDP relation from the long-run equilibrium; d_4 to d_8 represent the coefficients of the respective DTM in the benchmark short-run tax-to-GDP elasticity relation; e_4 to e_8 represent the coefficients of the respective DTM in the benchmark short-run tax-to-base elasticity relation.[211]

Moving to the extended short-run models, which also comprise the tax-to-GDP, tax-to-base, and base-to-GDP buoyancy and elasticity relations, we distinguish between short-run models controlling for ECT asymmetry, COVID-19 effects, lockdown effects, business cycle effects, and growth effects. The corresponding models are formulated as follows:

Extended short-run tax-to-GDP buoyancy and elasticity relations for ECT asymmetry

$$\begin{aligned}\Delta lnRev_t = d_0^b + d_1^{b(+)}\Delta lnGDP_t^{(+)} + d_1^{b(-)}\Delta lnGDP_t^{(-)} + d_2^b\Delta lnRev_{t-1} + \\ + d_3^b\Delta lnGDP_{t-1} + h^{b(+)}ECT_{t-1}^{b(+)} + h^{b(-)}ECT_{t-1}^{b(-)} + v_t^b,\end{aligned} \tag{7.11}$$

[211] Note that for the sake of simplicity, we keep the notation of some coefficients/variables the same in alternative model specifications. For example, d_0^b denotes the constant term in all tax-to-GDP buoyancy equations.

$$\begin{aligned}\Delta lnRev_t = d_0^e + d_1^{e(+)}\Delta lnGDP_t^{(+)} + d_1^{e(-)}\Delta lnGDP_t^{(-)} + d_2^e\Delta lnRev_{t-1} + \\ + d_3^e\Delta lnGDP_{t-1} + h^{e(+)}ECT_{t-1}^{e(+)} + h^{e(-)}ECT_{t-1}^{e(-)} + d_4 2005\_MD_t + \\ + d_5 2010a\_MD_t + d_6 2010b\_MD_t + d_7 2011\_MD_t + \\ + d_8 2016\_MD_t + v_t^e,\end{aligned} \tag{7.12}$$

Extended short-run tax-to-base buoyancy and elasticity relations for ECT asymmetry

$$\begin{aligned}\Delta lnRev_t = e_0^b + e_1^{b(+)}\Delta lnCons_t^{(+)} + e_1^{b(-)}\Delta lnCons_t^{(-)} + e_2^b\Delta lnRev_{t-1} + \\ + e_3^b\Delta lnCons_{t-1} + k^{b(+)}ECT_{t-1}^{b(+)} + k^{b(-)}ECT_{t-1}^{b(-)} + x_t^b,\end{aligned} \tag{7.13}$$

$$\begin{aligned}\Delta lnRev_t = e_0^e + e_1^{e(+)}\Delta lnCons_t^{(+)} + e_1^{e(-)}\Delta lnCons_t^{(-)} + e_2^e\Delta lnRev_{t-1} + \\ + e_3^e\Delta lnCons_{t-1} + k^{e(+)}ECT_{t-1}^{e(+)} + k^{e(-)}ECT_{t-1}^{e(-)} + e_4 2005\_MD_t + \\ + e_5 2010a\_MD_t + e_6 2010b\_MD_t + e_7 2011\_MD_t + \\ + e_8 2016\_MD_t + x_t^e,\end{aligned} \tag{7.14}$$

Extended short-run base-to-GDP buoyancy/elasticity relation for ECT asymmetry

$$\begin{aligned}\Delta lnCons_t = f_0 + f_1^{(+)}\Delta lnGDP_t^{(+)} + f_1^{(-)}\Delta lnGDP_t^{(-)} + f_2\Delta lnCons_{t-1} + \\ + f_3\Delta lnGDP_{t-1} + l^{(+)}ECT_{t-1}^{(+)} + l^{(-)}ECT_{t-1}^{(-)} + z_t,\end{aligned} \tag{7.15}$$

where, with other things remaining equal, $\Delta lnGDP_t^{(+)}$, $\Delta lnGDP_t^{(-)}$, $\Delta lnCons_t^{(+)}$, $\Delta lnCons_t^{(-)}$, $ECT_{t-1}^{b(+)}$, $ECT_{t-1}^{b(-)}$, $ECT_{t-1}^{e(+)}$ and $ECT_{t-1}^{e(-)}$ represent the obtained GDP, consumption, and ECT sub-series, respectively, on the basis of the positive or negative sign of the corresponding ECT series;[212] $d_1^{b(+)}$ and $d_1^{b(-)}$, and $d_1^{e(+)}$ and $d_1^{e(-)}$, stand for the asymmetric short-run buoyancies and elasticities, respectively, of VAT revenues with respect to GDP; $e_1^{b(+)}$ and $e_1^{b(-)}$, and $e_1^{e(+)}$ and $e_1^{e(-)}$ stand for the asymmetric short-

[212] Here again, ECT_{t-1}^b and ECT_{t-1}^e (which are then sub-divided into positive and negative components) reflect the error correction terms, given by the lagged residuals obtained from the corresponding buoyancy and elasticity long-run relations, respectively. Moreover, it should be clear that GDP and consumption sub-series are not obtained on the basis of their own sign.

run buoyancies and elasticities, respectively, of VAT revenues with respect to their base, i.e., private consumption; $f_1^{(+)}$ and $f_1^{(-)}$ stand for the asymmetric short-run buoyancy and elasticity of the VAT revenue base, i.e., private consumption, with respect to GDP; the simple mathematical multiplications of $e_1^{b(+)}$ with $f_1^{(+)}$ and $e_1^{b(-)}$ with $f_1^{(-)}$, and $e_1^{e(+)}$ with $f_1^{(+)}$ and $e_1^{e(-)}$ with $f_1^{(-)}$, give the implied, by the decomposition approach, asymmetric short-run buoyancies and elasticities, respectively, of VAT revenues with respect to GDP; $h^{b(+)}$ and $h^{b(-)}$, and $h^{e(+)}$ and $h^{e(-)}$, represent the asymmetric speeds of adjustment of any asymmetric short-run, i.e., asymmetric temporary deviation in the short-run tax-to-GDP buoyancy and elasticity relations, respectively, from the long-run equilibrium; $k^{b(+)}$ and $k^{b(-)}$, and $k^{e(+)}$ and $k^{e(-)}$, represent the asymmetric speeds of adjustment of any asymmetric short-run, i.e., asymmetric temporary deviation in the short-run tax-to-base buoyancy and elasticity relations, respectively, from the long-run equilibrium; $l^{(+)}$ and $l^{(-)}$ represent the asymmetric speed of adjustment of any asymmetric short-run, i.e., asymmetric temporary deviation in the short-run base-to-GDP buoyancy and elasticity relation, respectively, from the long-run equilibrium.

Extended short-run tax-to-GDP buoyancy and elasticity relations for COVID-19 effects

$$\begin{aligned}\Delta lnRev_t = d_0^b + d_1^{b(D)}COVID\text{-}19\_D\Delta lnGDP_t + \\ + d_1^{b(1-D)}(1\text{-}COVID\text{-}19\_D)\Delta lnGDP_t + d_2^b\Delta lnRev_{t-1} + \\ + d_3^b\Delta lnGDP_{t-1} + h^bECT_{t-1}^b + v_t^b,\end{aligned} \tag{7.16}$$

$$\begin{aligned}\Delta lnRev_t = d_0^e + d_1^{e(D)}COVID\text{-}19\_D\Delta lnGDP_t + \\ + d_1^{e(1-D)}(1\text{-}COVID\text{-}19\_D)\Delta lnGDP_t + d_2^e\Delta lnRev_{t-1} + \\ + d_3^e\Delta lnGDP_{t-1} + h^eECT_{t-1}^e + d_4 2005\_MD_t + d_5 2010a\_MD_t + \\ + d_6 2010b\_MD_t + d_7 2011\_MD_t + d_8 2016\_MD_t + v_t^e,\end{aligned} \tag{7.17}$$

Extended short-run tax-to-base buoyancy and elasticity relations for COVID-19 effects

$$\begin{aligned}\Delta lnRev_t = e_0^b + e_1^{b(D)}COVID\text{-}19\_D\Delta lnCons_t + \\ + e_1^{b(1-D)}(1\text{-}COVID\text{-}19\_D)\Delta lnCons_t + e_2^b\Delta lnRev_{t-1} + e_3^b\Delta lnCons_{t-1} + \\ + k^bECT_{t-1}^b + x_t^b,\end{aligned} \tag{7.18}$$

$$\begin{aligned}\Delta lnRev_t = e_0^e + e_1^{e(D)} COVID\text{-}19\_D \Delta lnCons_t + \\ + e_1^{e(1-D)}(1\text{-}COVID\text{-}19\_D)\Delta lnCons_t + e_2^e \Delta lnRev_{t-1} + e_3^e \Delta lnCons_{t-1} + \\ + k^e ECT_{t-1}^e + e_4 2005\_MD_t + e_5 2010a\_MD_t + e_6 2010b\_MD_t + \\ + e_7 2011\_MD_t + e_8 2016\_MD_t + x_t^e,\end{aligned} \tag{7.19}$$

Extended short-run base-to-GDP buoyancy/elasticity relation for COVID-19 effects

$$\begin{aligned}\Delta lnCons_t = f_0 + f_1^{(D)} COVID\text{-}19\_D \Delta lnGDP_t + \\ + f_1^{(1-D)}(1\text{-}COVID\text{-}19\_D)\Delta lnGDP_t + f_2 \Delta lnCons_{t-1} + f_3 \Delta lnGDP_{t-1} + \\ + lECT_{t-1} + z_t,\end{aligned} \tag{7.20}$$

where, with other things remaining equal, *COVID-19_D* represents the dummy variable, which takes the value of one from the first quarter of 2020 to the second quarter of 2022, and the value of zero otherwise; (*1-COVID-19_D*) represents the dummy variable's complement; $d_1^{b(D)}$ and $d_1^{b(1-D)}$, and $d_1^{e(D)}$ and $d_1^{e(1-D)}$ stand for the COVID-19 period and the non-COVID-19 period short-run buoyancies and elasticities, respectively, of VAT revenues with respect to GDP; $e_1^{b(D)}$ and $e_1^{b(1-D)}$, and $e_1^{e(D)}$ and $e_1^{e(1-D)}$ stand for the COVID-19 period and the non-COVID-19 period short-run buoyancies and elasticities, respectively, of VAT revenues with respect to their base, i.e., private consumption; $f_1^{(D)}$ and $f_1^{(1-D)}$ stand for the COVID-19 period and the non-COVID-19 period short-run buoyancy and elasticity of the VAT revenue base, i.e., private consumption, with respect to GDP; the simple mathematical multiplications of $e_1^{b(D)}$ with $f_1^{(D)}$ and $e_1^{b(1-D)}$ with $f_1^{(1-D)}$, and $e_1^{e(D)}$ with $f_1^{(D)}$ and $e_1^{e(1-D)}$ with $f_1^{(1-D)}$ give the implied, by the decomposition approach, COVID-19 period and non-COVID-19 period short-run buoyancies and elasticities, respectively, of VAT revenues with respect to GDP.

Extended short-run tax-to-GDP buoyancy and elasticity relations for lockdown effects

$$\begin{aligned}\Delta lnRev_t = d_0^b + d_1^{b(D)} Lockdown\_D \Delta lnGDP_t + \\ + d_1^{b(1-D)}(1\text{-}Lockdown\_D)\Delta lnGDP_t + d_2^b \Delta lnRev_{t-1} + \\ + d_3^b \Delta lnGDP_{t-1} + h^b ECT_{t-1}^b + v_t^b,\end{aligned} \tag{7.21}$$

$$\begin{aligned}\Delta lnRev_t = d_0^e + d_1^{e(D)} Lockdown\_D \Delta lnGDP_t + \\ + d_1^{e(1-D)}(1\text{-}Lockdown\_D)\Delta lnGDP_t + d_2^e \Delta lnRev_{t-1} + d_3^e \Delta lnGDP_{t-1} + \\ + h^e ECT_{t-1}^e + d_4 2005\_MD_t + d_5 2010a\_MD_t + d_6 2010b\_MD_t + \\ + d_7 2011\_MD_t + d_8 2016\_MD_t + v_t^e,\end{aligned} \tag{7.22}$$

Extended short-run tax-to-base buoyancy and elasticity relations for lockdown effects

$$\begin{aligned}\Delta lnRev_t = e_0^b + e_1^{b(D)} Lockdown\_D \Delta lnCons_t + \\ + e_1^{b(1-D)}(1\text{-}Lockdown\_D)\Delta lnCons_t + e_2^b \Delta lnRev_{t-1} + e_3^b \Delta lnCons_{t-1} + \\ + k^b ECT_{t-1}^b + x_t^b,\end{aligned} \tag{7.23}$$

$$\begin{aligned}\Delta lnRev_t = e_0^e + e_1^{e(D)} Lockdown\_D \Delta lnCons_t + \\ + e_1^{e(1-D)}(1\text{-}Lockdown\_D)\Delta lnCons_t + e_2^e \Delta lnRev_{t-1} + e_3^e \Delta lnCons_{t-1} + \\ + k^e ECT_{t-1}^e + e_4 2005\_MD_t + e_5 2010a\_MD_t + e_6 2010b\_MD_t + \\ + e_7 2011\_MD_t + e_8 2016\_MD_t + x_t^e,\end{aligned} \tag{7.24}$$

Extended short-run base-to-GDP buoyancy/elasticity relation for lockdown effects

$$\begin{aligned}\Delta lnCons_t = f_0 + f_1^{(D)} Lockdown\_D \Delta lnGDP_t + \\ + f_1^{(1-D)}(1\text{-}Lockdown\_D)\Delta lnGDP_t + f_2 \Delta lnCons_{t-1} + f_3 \Delta lnGDP_{t-1} + \\ + lECT_{t-1} + z_t,\end{aligned} \tag{7.25}$$

where, with other things remaining equal, *Lockdown_D* represents the dummy variable, which takes the value of one in the first, second, and last quarters of 2020 and the first and second quarters of 2021, and the value of zero otherwise; (*1-Lockdown_D*) represents the dummy variable's complement; $d_1^{b(D)}$ and $d_1^{b(1-D)}$, and $d_1^{e(D)}$ and $d_1^{e(1-D)}$ stand for the lockdown period and the non-lockdown period short-run buoyancies and elasticities, respectively, of VAT revenues with respect to GDP; $e_1^{b(D)}$ and $e_1^{b(1-D)}$, and $e_1^{e(D)}$ and $e_1^{e(1-D)}$ stand for the lockdown period and the non-lockdown period short-run buoyancies and elasticities, respectively, of VAT revenues with respect to their base, i.e., private consumption;

$f_1^{(D)}$ and $f_1^{(1-D)}$ stand for the lockdown period and the non-lockdown period short-run buoyancy and elasticity of the VAT revenue base, i.e., private consumption, with respect to GDP; the simple mathematical multiplications of $e_1^{b(D)}$ with $f_1^{(D)}$ and $e_1^{b(1-D)}$ with $f_1^{(1-D)}$, and $e_1^{e(D)}$ with $f_1^{(D)}$ and $e_1^{e(1-D)}$ with $f_1^{(1-D)}$ give the implied, by the decomposition approach, lockdown period and non-lockdown period short-run buoyancies and elasticities, respectively, of VAT revenues with respect to GDP.

Extended short-run tax-to-GDP buoyancy and elasticity relations for business cycle effects

$$\begin{gathered}\Delta lnRev_t = d_0^b + d_1^{b(D)} Cycle\_D \Delta lnGDP_t + \\ + d_1^{b(1-D)} (1\text{-}Cycle\_D) \Delta lnGDP_t + d_2^b \Delta lnRev_{t-1} + d_3^b \Delta lnGDP_{t-1} + \\ + h^b ECT_{t-1}^b + v_t^b,\end{gathered} \tag{7.26}$$

$$\begin{gathered}\Delta lnRev_t = d_0^e + d_1^{e(D)} Cycle\_D \Delta lnGDP_t + \\ + d_1^{e(1-D)} (1\text{-}Cycle\_D) \Delta lnGDP_t + d_2^e \Delta lnRev_{t-1} + d_3^e \Delta lnGDP_{t-1} + \\ + h^e ECT_{t-1}^e + d_4 2005\_MD_t + d_5 2010a\_MD_t + d_6 2010b\_MD_t + \\ + d_7 2011\_MD_t + d_8 2016\_MD_t + v_t^e,\end{gathered} \tag{7.27}$$

Extended short-run tax-to-base buoyancy and elasticity relations for business cycle effects

$$\begin{gathered}\Delta lnRev_t = e_0^b + e_1^{b(D)} Cycle\_D \Delta lnCons_t + \\ + e_1^{b(1-D)} (1\text{-}Cycle\_D) \Delta lnCons_t + e_2^b \Delta lnRev_{t-1} + e_3^b \Delta lnCons_{t-1} + \\ + k^b ECT_{t-1}^b + x_t^b,\end{gathered} \tag{7.28}$$

$$\begin{gathered}\Delta lnRev_t = e_0^e + e_1^{e(D)} Cycle\_D \Delta lnCons_t + \\ + e_1^{e(1-D)} (1\text{-}Cycle\_D) \Delta lnCons_t + e_2^e \Delta lnRev_{t-1} + e_3^e \Delta lnCons_{t-1} + \\ + k^e ECT_{t-1}^e + e_4 2005\_MD_t + e_5 2010a\_MD_t + e_6 2010b\_MD_t + \\ + e_7 2011\_MD_t + e_8 2016\_MD_t + x_t^e,\end{gathered} \tag{7.29}$$

Extended short-run base-to-GDP buoyancy/elasticity relation for business cycle effects

$$\Delta lnCons_t = f_0 + f_1^{(D)} Cycle\_D \Delta lnGDP_t + f_1^{(1-D)}(1\text{-}Cycle\_D)\Delta lnGDP_t + \\ + f_2 \Delta lnCons_{t-1} + f_3 \Delta lnGDP_{t-1} + lECT_{t-1} + z_t, \tag{7.30}$$

where, with other things remaining equal, *Cycle_D* represents the dummy variable, which takes the value of one in expansionary phases of the business cycle, and zero otherwise, whereby any peak (trough) signaling the end of an expansion (recession) is identified if three consecutive, out of the subsequent four quarters are characterized by negative (positive) quarterly rates of year-on-year real GDP change; (*1-Cycle_D*) represents the dummy variable's complement; $d_1^{b(D)}$ and $d_1^{b(1-D)}$, and $d_1^{e(D)}$ and $d_1^{e(1-D)}$ stand for the expansionary period and the non-expansionary period (and, thus, recessionary period) short-run buoyancies and elasticities, respectively, of VAT revenues with respect to GDP; $e_1^{b(D)}$ and $e_1^{b(1-D)}$, and $e_1^{e(D)}$ and $e_1^{e(1-D)}$ stand for the expansionary period and the non-expansionary period (and, thus, recessionary period) short-run buoyancies and elasticities, respectively, of VAT revenues with respect to their base, i.e., private consumption; $f_1^{(D)}$ and $f_1^{(1-D)}$ stand for the expansionary period and the non-expansionary period (and, thus, recessionary period) short-run buoyancy and elasticity of the VAT revenue base, i.e., private consumption, with respect to GDP; the simple mathematical multiplication of $e_1^{b(D)}$ with $f_1^{(D)}$ and $e_1^{b(1-D)}$ with $f_1^{(1-D)}$, and $e_1^{e(D)}$ with $f_1^{(D)}$ and $e_1^{e(1-D)}$ with $f_1^{(1-D)}$ gives the implied, by the decomposition approach, expansionary period and non-expansionary period (and, thus, recessionary period) short-run buoyancies and elasticities, respectively, of VAT revenues with respect to GDP.

Extended short-run tax-to-GDP buoyancy and elasticity relations for growth effects

$$\Delta lnRev_t = d_0^b + d_1^{b(D)} Growth\_D \Delta lnGDP_t + \\ + d_1^{b(1-D)}(1\text{-}Growth\_D)\Delta lnGDP_t + d_2^b \Delta lnRev_{t-1} + d_3^b \Delta lnGDP_{t-1} + \\ + h^b ECT_{t-1}^b + v_t^b, \tag{7.31}$$

$$\begin{gathered}\Delta lnRev_t = d_0^e + d_1^{e(D)}Growth\_D\Delta lnGDP_t + \\ + d_1^{e(1-D)}(1\text{-}Growth\_D)\Delta lnGDP_t + d_2^e\Delta lnRev_{t-1} + d_3^e\Delta lnGDP_{t-1} + \\ + h^eECT_{t-1}^e + d_4 2005\_MD_t + d_5 2010a\_MD_t + d_6 2010b\_MD_t + \\ + d_7 2011\_MD_t + d_8 2016\_MD_t + v_t^e,\end{gathered} \tag{7.32}$$

Extended short-run tax-to-base buoyancy and elasticity relations for growth effects

$$\begin{gathered}\Delta lnRev_t = e_0^b + e_1^{b(D)}Growth\_D\Delta lnCons_t + \\ + e_1^{b(1-D)}(1\text{-}Growth\_D)\Delta lnCons_t + e_2^b\Delta lnRev_{t-1} + e_3^b\Delta lnCons_{t-1} + \\ + k^bECT_{t-1}^b + x_t^b,\end{gathered} \tag{7.33}$$

$$\begin{gathered}\Delta lnRev_t = e_0^e + e_1^{e(D)}Growth\_D\Delta lnCons_t + \\ + e_1^{e(1-D)}(1\text{-}Growth\_D)\Delta lnCons_t + e_2^e\Delta lnRev_{t-1} + e_3^e\Delta lnCons_{t-1} + \\ + k^eECT_{t-1}^e + e_4 2005\_MD_t + e_5 2010a\_MD_t + e_6 2010b\_MD_t + \\ + e_7 2011\_MD_t + e_8 2016\_MD_t + x_t^e,\end{gathered} \tag{7.34}$$

Extended short-run base-to-GDP buoyancy/elasticity relation for growth effects

$$\begin{gathered}\Delta lnCons_t = f_0 + f_1^{(D)}Growth\_D\Delta lnGDP_t + \\ + f_1^{(1-D)}(1\text{-}Growth\_D)\Delta lnGDP_t + f_2\Delta lnCons_{t-1} + f_3\Delta lnGDP_{t-1} + \\ + lECT_{t-1} + z_t,\end{gathered} \tag{7.35}$$

where, with other things remaining equal, *Growth_D* represents the dummy variable, which takes the value of one for positive quarterly rates of year-on-year real GDP changes, and zero otherwise; (*1-Growth_D*) represents the dummy variable's complement; $d_1^{b(D)}$ and $d_1^{b(1-D)}$, and $d_1^{e(D)}$ and $d_1^{e(1-D)}$ stand for the growth period and the non-growth period short-run buoyancies and elasticities, respectively, of VAT revenues with respect to GDP; $e_1^{b(D)}$ and $e_1^{b(1-D)}$, and $e_1^{e(D)}$ and $e_1^{e(1-D)}$ stand for the growth period and the non-growth period short-run buoyancies and elasticities, respectively, of VAT revenues with respect to their base, i.e., private consumption; $f_1^{(D)}$

and $f_1^{(1-D)}$ stand for the growth period and the non-growth period short-run buoyancy and elasticity of the VAT revenue base, i.e., private consumption, with respect to GDP; the simple mathematical multiplications of $e_1^{b(D)}$ with $f_1^{(D)}$ and $e_1^{b(1-D)}$ with $f_1^{(1-D)}$, and $e_1^{e(D)}$ with $f_1^{(D)}$ and $e_1^{e(1-D)}$ with $f_1^{(1-D)}$ give the implied, by the decomposition approach, growth period and non-growth period short-run buoyancies and elasticities, respectively, of VAT revenues with respect to GDP.

For robustness, we repeat the extended short-run buoyancy and elasticity estimations controlling for ECT asymmetry, business cycle, and growth effects for the time period ending before the outbreak of the COVID-19 pandemic, i.e., up until the end of 2019. In addition, and also for robustness, alternative models accounting for COVID-19, lockdown, and economic conjuncture effects are also estimated. In the first case, the corresponding COVID-19 dummy variable assumes two different definitions and takes the value of one from the first quarter of 2020 to the last quarter of 2021, and the value of zero otherwise, and the value of one from the first quarter of 2020 to the last quarter of 2022, and the value of zero otherwise. In the second case, the corresponding lockdown dummy variable assumes a different definition and takes the value of one in the second and last quarters of 2020 and the first and second quarters of 2021, and the value of zero otherwise. In the last case, we focus more on the prolonged crisis/adjustment period for the Greek economy and include a dummy variable differentiating between periods of normal economic conditions and periods of economic crisis, including extensive economic adjustment. The crisis/adjustment dummy is defined to take the value of one from the second quarter of 2008, which signals the beginning of the severe economic crisis period in Greece, to the third quarter of 2018, which signals the end of the third economic adjustment programme for the country. With the exception of the respective dummy variable included, in all these cases investigating robustness, the corresponding extended short-run buoyancy and elasticity relations are formulated in exactly the same way (as given, for example, by equations (7.31) to (7.35)).

7.3. Empirical data

In the present Study, VAT revenue buoyancy and elasticity for Greece are estimated using quarterly data for the time period starting in the first quarter of 2000 and ending in the last quarter of 2022 (92 quarters). The General Accounting Office (GAO) is the data source for monthly raw VAT revenue data. We use receipts after refunds to calculate monthly total VAT revenues, which are then converted to quarterly data. Calculations involve the derivation of the sum of all the relevant VAT categories (following the Revenue Code Number classification), including deferred tax collections wherever necessary. Calculated VAT revenues exclude revenues from VAT on newly built properties, the inclusion of which would necessitate a corresponding matching in terms of the tax base. This matching would render necessary the inclusion of a fixed capital formation component (gross fixed capital formation in dwellings) in the tax base, which is characterized by a more considerable share (in overall gross fixed capital formation) than the very low (and in some cases negligible) share of the respective VAT revenue category (in overall VAT revenues). Furthermore, by excluding VAT on newly built properties, we manage to keep the revenue series as homogenous as possible. Note that Greek legislation provided for the imposition of VAT on newly built properties from 2006, while its suspension was legislated in December 2019 and remains in force.[213]

Eurostat and the Hellenic Statistical Authority (ELSTAT) constitute the sources for quarterly nominal and real GDP, with the latter being used to derive the business cycle and growth dummy variables as well as nominal private consumption data.[214] Following a number of relat-

[213] See Law 4646/2019 and Law 5000/2022.

[214] Note that due to the revision works (including the revision of the base year and the revision of years 2010 onwards) of the National Accounts (see the relevant ELSTAT October 2020 press release) carried out by ELSTAT, being partly completed from 2010 onwards but unfortunately still in progress for the years 1995–2009, basic macroeconomic series have a break in 2010. To cope with that issue, we have used the continuous series that were valid before the beginning of the revisions to obtain quarterly rates of change between the last quarter of 2009 and the first quarter of 2010, alongside all rates of change for the period of still non-revised data to adjust the time series backwards.

ed applications, we use nominal variables (for studies using revenues and/or the tax base in nominal terms, see, for example, Barrios and Fargnoli, 2010; Mourre and Princen, 2015; Havranek et al., 2016; Deli et al., 2018; Boschi and d'Addona, 2019, for the case of Greece; Conroy, 2020; Jalles, 2020; Berardini and Renzi, 2022; Hill et al., 2022; Cornevin et al., 2023). This choice is basically dictated by the need to avoid that any adjustment carried out through deflating VAT revenues would interfere with the procedure of differentiating between tax buoyancy and elasticity. In other words, since one of the basic contributions of this Study is the distinct investigation of the role of the most significant VAT rate changes, deflating could cause measurement errors. This relates to the fact that the evolution of price indices also includes price changes due to changes in tax rates, which may have a major impact in the case of VAT rate changes. As a consequence, VAT rate changes would create problems with the obtained buoyancy and elasticity estimates, in the sense that in the case of buoyancy, we would have partly subtracted the impact of policy measures through deflating, while we actually want to obtain the overall response of tax revenues to changes in macroeconomic aggregates, including the response to tax rate changes; in the case of elasticity, where we include individual dummy variables in order to separate the endogenous response from the response to VAT rate changes, deflating tax revenues would cause a kind of 'double clearing' and, thus, a potential measurement error. For exactly the same reason, we do not choose to use inflation as a separate control variable in the estimated relations.

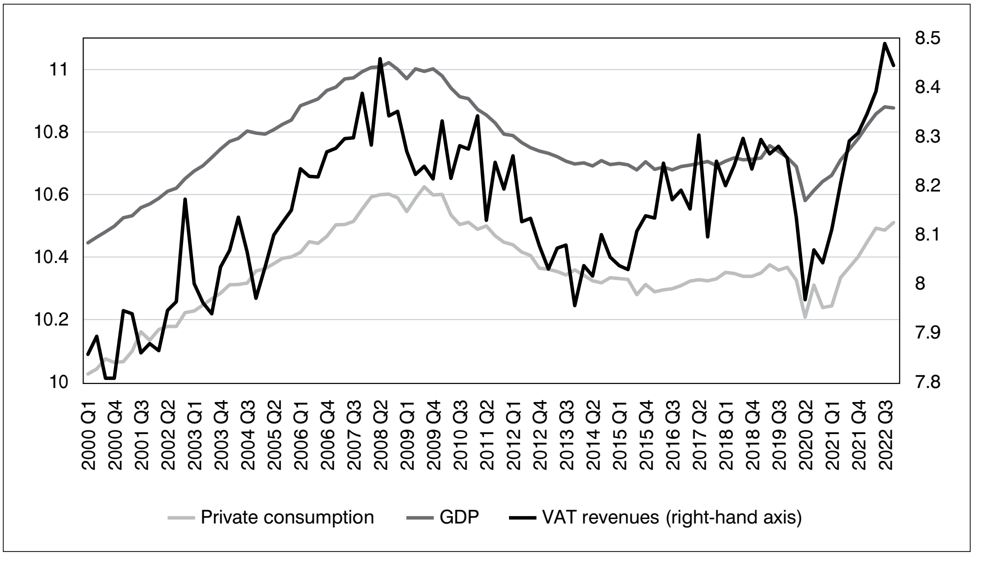
It is also important to note that apart from the above-elaborated argument, deflating nominal aggregates presupposes the use of an accurate deflator, which, however, may not be common for all variables employed in the present Study. The GDP deflator, for example, would be the correct measure for the deflation of nominal GDP but does not seem to be appropriate for deflating nominal tax revenues or private consumption expenditure (PCE). The Consumer Price Index (CPI) may present an accurate deflator for tax revenues and the PCE deflator for PCE, which, in turn, are not necessarily appropriate for deflating GDP. Moreover, it is not advisable to employ three distinct deflators, due to the differences in the underlying concepts.[215]

All necessary information for VAT rate changes used to derive the corresponding dummy variables is based on the relevant law provisions (see Table 3.1 in Chapter 3). Finally, all data series are seasonally adjusted by the use of the TRAMO/SEATS procedure and the Demetra+ software program provided by Eurostat.

Figure 7.1 depicts the course of the employed quarterly VAT revenues, GDP, and private consumption time series for the period under investigation, in seasonally adjusted terms and logarithms. It becomes obvious that the series follow a common path, with VAT revenues being by far more volatile than GDP and private consumption. Overall, an upward trend can be clearly observed from 2000 until the beginning of the deep economic crisis in the Greek economy that started in 2008. The plunge in the displayed time series due to the severe decline in economic activity appears to last up to 2015, followed by a period of smooth recovery and stabilization until the end of 2019. The latter was interrupted and reversed by the shock triggered by the outbreak of the COVID-19 pandemic in early 2020, which becomes easily visible and is more powerful in the case of VAT revenues. However, there is a remarkable subsequent rebound in 2021 and 2022, with all three variables even surpassing 2019 levels.

[215] Note, for example, that the concept of the GDP deflator differs from that of the CPI in terms of the prices (and their evolution over time) measured/reflected (of all goods and services produced domestically, in the first case, and of goods and services, produced domestically or imported, but bought only by consumers, in the second case). Another important difference concerns the use of different weighting schemes (on the basis of changing or fixed baskets of goods) for the prices of different goods. The PCE deflator provides indications on the underlying price changes related only to household (and NPISH) expenditure. It is available from Eurostat as an implicit deflator series given by the ratio of current prices to chain-linked volume series of household final consumption expenditure in the framework of National Accounts. See, indicatively, EC (2023) on differences in the projected inflation outlook, including the HCPI, the GDP deflator, and the private consumption deflator, based on Spring 2023 European Commission forecasts.

FIGURE 7.1
VAT revenues, GDP, and private consumption
(nominal terms, seasonally adjusted, logarithms)



Source: GAO, Eurostat, ELSTAT, and own calculations.

7.4. Estimation procedure

As a first control before conducting the econometric estimations,[216] we perform unit root tests for the macroeconomic variables incorporated in the models. We employ the Augmented Dickey and Fuller (1979) as well as the Phillips and Perron (1988) unit root tests, including an intercept in the relationship. The results presented in Table 7.1 indicate that the variables are not stationary in levels but are stationary in first differences in all cases.

We then proceed with the cointegrating and ECM estimation procedure. VAT long- and short-run buoyancy and elasticity relations are estimated by applying the Engle and Granger (1987) two-stage procedure (for related applications, see Twerefou et al., 2010; Kargbo and Egwaikh-

[216] All econometric estimations are conducted using the EViews 13 software.

TABLE 7.1
Unit Root Tests

	Augmented Dickey-Fuller test statistic		Phillips-Perron test statistic	
	Levels	1st difference	Levels	1st difference
lnRev	-1.64 [0.46]	-14.45 [0.00]	-2.39 [0.15]	-14.47 [0.00]
lnGDP	-2.20 [0.21]	-3.92 [0.00]	-2.20 [0.21]	-6.66 [0.00]
lnCons	-2.24 [0.19]	-3.47 [0.01]	-2.25 [0.19]	-10.06 [0.00]

Notes: Relationships with intercept. *P*-values are presented in brackets.

ide, 2012; Fricke and Süssmuth, 2014; Deli et al., 2018; Mourre and Princen, 2019). In order to avoid considering significant an apparent relation between actually unrelated series (spurious relation), the two-stage estimation is suggested (Mourre and Princen, 2015).

In the first stage, long-run cointegrating (equilibrium) relations are estimated using series in levels, and Engle and Granger (1987) and Phillips and Ouliaris (1990) cointegration testing[217] results are provided for each one of the estimated relations (see Table 7.2, Section 7.5). Given that variables are non-stationary in levels, the risk of a spurious regression can be eliminated if they are cointegrated, i.e., they tend to move together in the long run (Bruce et al., 2006; Havranek et al., 2016). We employ the Dynamic Ordinary Least Squares (DOLS) procedure proposed by Stock and Watson (1993), instead of a simple Ordinary Least Squares (OLS) estimation,[218] and use Newey-West (Newey and West, 1987) robust standard errors, to correct for other potential issues (apart from spurious regression) that could arise. These include serial correlation, non-normally distributed residuals, and endogeneity (Bruce et al., 2006). In addition to the cor-

[217] Both tests are residual-based tests for cointegration. As Conroy (2020) indicates, stationarity in the errors from the long-run relation indicates the existence of a cointegrating relation.

[218] According to Havranek et al. (2016), when series are cointegrated, OLS estimation yields consistent estimates of the regression parameters, but these estimates can be shown to be inefficient.

rection for first-order endogeneity through long-run cointegration equations, the application of DOLS aims at reducing any second-order bias (Havranek et al., 2016).[219] Following a number of related applications in the relevant empirical literature (e.g., Sobel and Holcombe, 1996; Deli et al., 2018; Boschi and d'Addona, 2019), regression models are augmented with leads and lags of the growth rates (since differenced logs) of the independent variables.[220] Furthermore, Newey-West standard errors are used since they are robust to autocorrelation and heteroskedasticity (see, for example, Sobel and Holcombe, 1996; Wolswijk, 2009; Koester and Priesmeier, 2012; Havranek et al., 2016; Köster and Priesmeier, 2017; Deli et al., 2018; Boschi and d'Addona, 2019; Conroy, 2020). The DOLS procedure and Newey-West robust standard errors are also employed to estimate all rolling and recursive long-run buoyancy regressions.

Having established that the necessary conditions regarding stationarity and cointegration are provided, ECMs (expressed in differences of the series) are estimated using OLS to determine short-run dynamics in the second stage of the estimation procedure. Recall that, if two non-stationary variables are cointegrated, i.e., if there exists a stationary combination of them, then any short-run deviation from their long-run equilibrium relation will be temporary, and they will tend to move back together (Sobel and Holcombe, 1996; Koester and Priesmeier, 2012). This adjustment or error correction mechanism has to be taken into account since it could otherwise cause a bias in the estimation of short-run relations. Such a bias is adjusted for through the inclusion of a lagged residual term[221] in all short-run relations, the so-called error correction term, showing how far apart these variables were from their long-run relationship during the preceding period of time (Sobel and Holcombe, 1996). Short-run equations are also augmented to incorporate lags of the (differenced) dependent and independent variables. According to Koester and

[219] For more details on the so-called 'second-order bias', see Fricke and Süssmuth (2013). Koester and Priesmeier (2012) argue that using DOLS, super-consistent estimates are generated for the long-run coefficients.

[220] In all cases, we include one lead and one lag in the long-run cointegrating equations to save on degrees of freedom (see Wolswijk, 2009 for the argument).

[221] Residual terms are obtained from the corresponding long-run relations.

Priesmeier (2012), this is an appropriate way to capture the 'richer' dynamics that may characterize dependent and independent variables. In the example of tax revenues being the dependent variable, the inclusion of lagged (differenced) series can be seen to control for the potential persistence of shocks to tax collection (see Havranek et al., 2016). If tax base shocks can affect tax receipts for several periods, then tax revenues are likely to be persistent (Koester and Priesmeier, 2012).[222]

Finally, and with regard to diagnostic tests conducted, we perform and report the results for appropriately defined Wald tests for the estimated buoyancy and elasticity coefficients, as coefficient diagnostic tests.[223] In particular, in all cases, we test for the assumption of coefficients being ≥ 1 or ≤ 1, depending on their size and, if necessary, we continue by testing the unity assumption. Moreover, in the cases of all the extended short-run buoyancy and elasticity models, we perform additional Wald tests to control for the hypothesis that specific coefficients are equal. In particular, in the short-run models controlling for ECT asymmetry, we test the hypothesis of equality between the coefficients on the positive and the coefficients on the negative sub-series of the corresponding macroeconomic driver. In the other extended short-run buoyancy and elasticity models controlling for COVID-19, lockdown, business cycle, and growth effects, we test the hypothesis of equality between the coefficients on the macroeconomic driver interacted with the dummy reflecting the investigated effect and the coefficients on the macroeconomic driver interacted with the dummy's complement. As further equation statistics, for all estimated short-run equations, we report the adjusted R-squared and the F-statistic from testing the hypothesis that all coefficients (excluding the constant term) are zero. Moreover, to check short-run equation residual diagnostics, we perform and report the results for serial correlation Lagrange Multiplier (LM) tests.

[222] Note that we eliminate any lags characterized by non-significant coefficients from the finally selected short-run model specifications, following the argument by Koester and Priesmeier (2012) in favor of preciseness and with the aim to keep the models as parsimonious as possible.

[223] Wald tests are carried out only in the cases of statistically significant coefficients.

7.5. Empirical results

In this section, we present and analyze the empirical results for VAT revenue buoyancy and elasticity in Greece for the period from the first quarter of 2000 to the last quarter of 2022. The aim is to compare the endogenous with the overall (including DTM) VAT revenue response to changes in GDP and the tax base and derive useful conclusions on the impact of the employed discretionary measures. We first provide long-run and benchmark short-run estimation results to differentiate between VAT revenue response to long-run growth and to short-run fluctuations of macroeconomic drivers and also to offer evidence on the time needed for the adjustment between the long- and the short-run period. To that end, we report findings from employing the one-step and, wherever possible, the decomposition approach, in order to obtain more detailed information on the decomposed underlying relations which are assumed to be more or less under the control of the government. Finally, we offer evidence from controlling for special conditions (i.e., ECT asymmetry, COVID-19, lockdown, business cycle, and growth effects) that may significantly affect short-run estimations and lead to conclusions regarding the response of VAT revenue to changes in GDP and the tax base that may differ, depending on the time period under examination.

7.5.1. Long-run estimation results

Table 7.2 reports the empirical results regarding the estimated long-run VAT revenue buoyancy and elasticity for the total period under investigation, i.e., the time period from the first quarter of 2000 to the last quarter of 2022. Apart from the results for the tax-to-GDP relation, results for the tax-to-base and base-to-GDP components are also presented, providing additional non-negligible evidence and enabling, in the case of statistically significant coefficients, the calculation of the products of the respective buoyancy and elasticity coefficients, which offers an alternative measurement of tax-to-GDP buoyancy and elasticity. The coefficients of the independent variables (*lnGDP* or *lnCons*) reflect the corresponding long-run buoyancy and elasticity, while in the elasticity relations, the coefficients of the selected DTM dummies[224] are also reported, reflecting their impact on the estimated relations.

According to Table 7.2, in all cases the estimated buoyancy and elasticity coefficients are positive, as expected according to the literature, and statistically significant. With regard to the tax-to-GDP relation, both long-run tax-to-GDP buoyancy and elasticity lie below unity, at 0.81 and 0.84, respectively. This indicates that, in both cases, changes in GDP lead to less than proportional changes in VAT revenues in the long run, thus not supporting the unity assumption, with reference to the total time period under investigation. Hence, VAT revenues are shown to increase by less than GDP, but also to decrease by less than GDP. Moreover, tax-to-GDP buoyancy and elasticity are very close, providing, thus, no evidence that the implemented discretionary measures under examination result in any additional changes in tax revenues during the period of investigation. In other words, the investigated DTM seem to have a neutral effect on tax revenues. With this difference being almost negligible (-0.03), it follows that the endogenous response of VAT revenues to changes in GDP is practically identical to the overall response, which includes the effects of the investigated DTM. In addition, taking a closer look into the significance of the coefficients on the DTM dummies in the relation that derives elasticity, only the 2016 VAT rate change seems to have a positive impact on revenues, while the 2005 VAT rate change seems to have a negative effect. Apart from these two effects potentially offsetting each other to a certain degree in the long run, the remaining VAT rate changes accounted for do not seem to play an important role. These findings are in accordance with the evidence that, overall, the examined discretionary measures do not result in additional changes in tax revenues and, hence,

[224] Recall that, in our estimations, DTM dummy variables take the value of one in the quarter of the implemented change and in the following quarter, and the value of zero otherwise. We also test the respective relations with DTM dummy variables defined in two alternative ways, i.e., taking the value of one in the quarter of the implemented change and in the following two quarters, and the value of zero otherwise, and taking the value of one in the quarter of the implemented change and in the following three quarters, and the value of zero otherwise. The empirical results do not differ qualitatively in terms of the investigated relations and are not presented in the interest of brevity. These are available upon request.

do not operate complementarily to the built-in response[225] of VAT revenues to changes in GDP during the investigated time period.

Useful insights are further provided in Table 7.2 by the results on the tax-to-base and base-to-GDP long-run buoyancy and elasticity components. Being statistically significant, the corresponding coefficients are used to obtain an alternative measurement of VAT revenue buoyancy and elasticity with respect to GDP, through their product. Recall that, in this way, additional information is offered with respect to the individual underlying relations, which may be more (tax-to-base relation) or less (base-to-GDP relation) under the control of the government. In particular, crucial evidence is offered on the key link between VAT revenues and their base, i.e., private consumption. To begin with, tax-to-base buoyancy is estimated at 0.92 and is also close to tax-to-base elasticity, which lies at 0.94. In fact, the respective coefficients do not statistically differ from one, as confirmed via the relevant Wald tests. This is an interesting finding, indicating that while the unity assumption cannot be adopted in the case of long-run tax-to-GDP buoyancy and elasticity, it can be adopted for the long-run tax-to-base relation, implying proportionality, with reference to the total time period under investigation. Similar to the tax-to-GDP relation, the difference between buoyancy and elasticity is almost negligible (-0.02), again indicating that the employed discretionary measures under investigation have a neutral effect on tax revenues. In line with the results for the tax-to-GDP relation, the 2016 VAT rate change seems to have a positive impact on revenues, the 2005 VAT rate change seems to have a negative effect, potentially causing a partial counterbalancing, and the remaining investigated VAT rate changes do not seem to exert significant effects during the examined time period. These findings imply that, whether referring to the endogenous or the overall relation of VAT revenues to their base, their response to base increases or decreases is proportional. Moreover, the base-to-GDP component, reflecting the response of the tax base to GDP changes, is also positive at 0.93 and statistically significant. At this point, it is important to recall that the tax-to-base components are

[225] Recall that tax elasticity is sometimes referred to as a measure of the built-in response or built-in responsiveness (see Jenkins et al., 2000; Bekoe et al., 2016) of revenues to changes in income. See Section 5.2.2.

TABLE 7.2
Long-run estimation results

Independent variables and statistics	Tax-to-GDP	Tax-to-base (I)	Base-to-GDP (II)	Coefficients' product: (I) × (II)
Buoyancy				
lnGDP	***0.81*** [0.00]	-	***0.93*** [0.00]	0.86
lnCons	-	**0.92** [0.00]	-	-
Adj. R-squared	0.52	0.62	0.94	-
Cointegration tests[a]	[0.01; 0.02]	[0.00; 0.00]	[0.10; 0.10]	-
Elasticity				
lnGDP	***0.84*** [0.00]	-	***0.93*** [0.00]	0.87
lnCons	-	**0.94** [0.00]	-	-
2005_MD	-0.08 [0.00]	-0.07 [0.00]	-	-
2010a_MD	-0.04 [0.32]	-0.02 [0.59]	-	-
2010b_MD	0.01 [0.71]	0.02 [0.44]	-	-
2011_MD	0.01 [0.88]	-0.02 [0.65]	-	-
2016_MD	0.13 [0.00]	0.13 [0.00]	-	-
Adj. R-squared	0.52	0.63	0.94	-
Cointegration tests[a]	[0.00; 0.01]	[0.00; 0.00]	[0.10; 0.10]	-

Notes: Table 7.2 presents the estimates for equations (7.1) to (7.5). Buoyancy and elasticity estimations include 89 observations, after adjustments. All equations include a constant term. *P*-values are presented in brackets. [a] The presented cointegration-test statistics refer to the corresponding *p*-values for the Engle-Granger and Phillips-Ouliaris *z*-statistics, respectively. Buoyancy and elasticity coefficient values marked ***bold and italics*** stand for the cases in which the conducted Wald tests indicate that the assumption of (significant) coefficients being ≥ unity can be rejected, while (significant) coefficient values marked **bold** stand for the cases in which the additional Wald tests indicate that the unity assumption cannot be rejected (in all cases, at the 10% significance level).

regarded to lie within the scope of policy and more under the control of the government (see Sections 5.2.1.2 and 5.2.2.2) than the corresponding base-to-GDP components.

Moreover, the product of the tax-to-base and base-to-GDP components leads to a buoyancy of 0.86 and an elasticity of 0.87, i.e., results that are relatively close to the one-step tax-to-GDP estimates that also lie below unity. It follows that, similar to the one-step tax-to-GDP results, the difference between buoyancy and elasticity is almost negligible (-0.01). More importantly, the results for the decomposed relations also suggest that, during the time period under investigation, the implemented VAT rate changes under examination do not seem to contribute to any additional changes in tax revenues as a response to changes in GDP and do not seem to operate complementarily to the built-in response of VAT revenues to GDP changes. Overall, the decomposition of long-run tax-to-GDP buoyancy and elasticity reveals that, for the time period under investigation, the one-step tax-to-GDP response relation similarly reflects the individual underlying relations. In addition, the decomposition provides evidence on the important relation between VAT revenues and the tax base.

Finally, it is worth referencing some empirical findings from the literature on long-run buoyancy and/or elasticity relations for relevant tax categories, which seem to be in line with our findings.[226] Boschi and d'Addona (2019) found for the case of Greece a long-run tax-to-base elasticity for indirect taxes very close to unity, a long-run base-to-GDP elasticity lower than unity, and a long-run tax-to-GDP elasticity calculated as the product of tax-to-base and base-to-GDP long-run elasticities that lies below unity. Evidence on a long-run buoyancy with respect to GDP lower than unity was provided by Lagravinese et al. (2020) for taxes on goods and services in Greece as well as for a group of OECD countries. Controlling for tax rates as a robustness check, hence, practically providing estimations for elasticity, Dudine and Jalles (2018) found a long-run elasticity with respect to GDP lower than unity for taxes on goods and services for a sample of advanced economies. Conroy (2020) estimated a VAT long-run tax-to-base elasticity for Ireland just above one; Mourre and Princen (2019) reported a long-run tax-to-base elasticity for consumption taxes to be close to or slightly above unity for EU countries. Bettendorf and van

[226] In this paragraph, we focus on clear-cut results regarding findings on long-run buoyancy and/or elasticity for Greece, European countries, and other groups of countries that include advanced economies. For all details on the respective empirical literature estimates and the associated limitations (regarding the degree of comparability), see Chapter 6.

Limbergen (2013) reported a VAT long-run tax-to-base elasticity around one, and Poghosyan (2011) found for a group of 10 new EU countries a long-run VAT elasticity with respect to the base close to one.

7.5.2. Short-run estimation results

7.5.2.1. Benchmark short-run estimation results

Table 7.3 reports the empirical results regarding the estimated benchmark short-run VAT revenue buoyancy and elasticity for the total period under investigation, i.e., the time period from the first quarter of 2000 to the last quarter of 2022. The coefficients of the independent variables ($\Delta lnGDP$ or $\Delta lnCons$) reflect the respective short-run buoyancy and elasticity, while in the elasticity relations, the coefficients of the selected DTM dummies are also displayed, reflecting their exerted effects. According to Table 7.3, the estimated tax-to-GDP buoyancy and elasticity coefficients of 1.43 and 1.57, respectively, are positive, as expected according to the literature, and statistically significant. Both short-run tax-to-GDP buoyancy and elasticity are larger than unity, indicating that VAT revenues fluctuate more than GDP over the business cycle. In other words, VAT revenues seem to respond quite strongly to short-run fluctuations of GDP, whether in the upward or downward direction.

Moreover, with tax-to-GDP buoyancy being slightly lower than elasticity (by 0.14), there is no evidence that the implemented discretionary measures result, during the time period under investigation, in considerable additional short-run fluctuations in VAT revenues, whether in the upward or downward direction. At the same time, even though almost all the coefficients of the dummy variables reflecting the implemented VAT rate changes are positive and statistically significant, they are still quite low. These results might be explained by the fact that, on the one hand, the investigated time period includes a prolonged period of economic crisis and adjustment lasting from 2008 to 2018 in Greece, during which the implemented DTM probably contribute to restraining negative short-run fluctuations of VAT revenues. On the other hand, DTM do not seem to contribute to further positive fluctuations during the period of favorable economic conditions.

TABLE 7.3
Benchmark short-run estimation results

Independent variables and statistics	Tax-to-GDP	Tax-to-base (I)	Base-to-GDP (II)	Coefficients' product: (I) × (II)
Buoyancy				
ΔlnGDP	***1.43*** [0.00]	-	**1.01** [0.00]	0.71
ΔlnCons	-	***0.70*** [0.00]	-	-
ΔlnGDP(-1)	-	-	-	-
ΔlnCons(-1)	-	-	-0.24 [0.05]	-
ΔlnRev(-1)	-0.42 [0.00]	-0.30 [0.01]	-	-
ECT(-1)	-0.15 [0.02]	-0.26 [0.00]	-0.18 [0.02]	-
Adj. R-squared	0.34	0.28	0.57	-
Prob (F-statistic)	[0.00]	[0.00]	[0.00]	-
Prob F (LM test)	[0.82]	[0.58]	[0.36]	-
Elasticity				
ΔlnGDP	***1.57*** [0.00]	-	**1.01** [0.00]	0.72
ΔlnCons	-	**0.71** [0.00]	-	-
ΔlnGDP(-1)	-	-	-	-
ΔlnCons(-1)	-	-	-0.24 [0.05]	-
ΔlnRev(-1)	-0.46 [0.00]	-0.31 [0.01]	-	-
ECT(-1)	-0.12 [0.08]	-0.25 [0.02]	-0.18 [0.02]	-
2005_MD	0.04 [0.00]	0.03 [0.03]	-	-
2010a_MD	0.06 [0.02]	0.02 [0.43]	-	-
2010b_MD	0.05 [0.00]	0.02 [0.07]	-	-
2011_MD	-0.01 [0.83]	-0.05 [0.29]	-	-
2016_MD	0.05 [0.02]	0.04 [0.18]	-	-
Adj. R-squared	0.33	0.25	0.57	-

TABLE 7.3 (continued)

Independent variables and statistics	Tax-to-GDP	Tax-to-base (I)	Base-to-GDP (II)	Coefficients' product: (I) × (II)
Elasticity (continued)				
Prob (F-statistic)	[0.00]	[0.00]	[0.00]	-
Prob F (LM test)	[0.51]	[0.63]	[0.36]	-

Notes: Table 7.3 presents the estimates for equations (7.6) to (7.10). Buoyancy and elasticity estimations include 89 observations, after adjustments. All equations include a constant term. *P*-values are presented in brackets. Buoyancy and elasticity coefficient values marked ***bold and italics*** stand for the cases in which the conducted Wald tests indicate that the assumption of coefficients being ≥ (≤) unity can be rejected, while (significant) coefficient values marked **bold** stand for the cases in which the additional Wald tests conducted indicate that the unity assumption cannot be rejected (in all cases, at the 10% significance level).

It is interesting to also note that, with the coefficient on the lagged value of (the differenced log of) VAT revenues being statistically significant, there seems to exist a degree of persistence of VAT revenue fluctuations.

In comparing the empirical results between long- and short-run tax-to-GDP buoyancy and elasticity, we observe non-negligible differences in both cases, which imply transitory short-run deviations from the long-run equilibrium relations. Moreover, higher short-run estimates than the corresponding long-run ones would seem to indicate VAT revenue overshooting in their response to fluctuations in GDP, i.e., VAT revenues being in excess of their long-run equilibrium level in the short run. With the coefficients on the lagged values of the error correction terms being negative and statistically significant, as expected, and the speed of adjustment to the long-run equilibrium buoyancy and elasticity relations at 0.15 and 0.12, respectively, there is evidence that any disequilibrium is corrected after almost 2 years (after approximately 7 and 8 quarters for buoyancy and elasticity, respectively).

The decomposition of the short-run tax-to-GDP buoyancy and elasticity provides additional interesting insights with regard, first, to VAT revenue volatility arising from short-run fluctuations in the tax base, i.e., private consumption. Tax-to-base buoyancy, estimated at 0.70, is close to tax-to-base elasticity, estimated at 0.71. However, buoyancy lies below unity, while elasticity is not statistically different from one, as confirmed via the relevant Wald test. The comparison between tax-to-base buoyancy and elasticity indicates that the discretionary measures under examination do not have an impact, during the investigated time period, on the relation between VAT revenues and the tax base since buoyancy is not greater than elasticity. Only two, the 2005 and the July 2010, VAT rate changes seem to have a rather small positive impact on the short-run tax-to-base relation, while the rest of the VAT rate changes do not appear to play an important role. All these findings seem to imply that the endogenous underlying short-run tax-to-base relation is not affected, during the examined time period, by the DTM under investigation. Once again, it is interesting to note that the lagged value of (the differenced log of) VAT revenues is statistically significant, indicating a degree of persistence of VAT revenue fluctuations.

In comparing the empirical results between long- and short-run tax-to-base buoyancy and elasticity, we observe a non-negligible difference mainly in the case of buoyancy,[227] which reveals the occurrence of intermediate short-run deviations from the corresponding long-run equilibrium relation. Moreover, the lower short-run estimate, compared to the corresponding long-run one, would indicate revenue undershooting in the VAT response to fluctuations in consumption. The coefficient on the lagged value of the error correction term is negative and statistically significant, as expected. With the speed of adjustment to the long-run equilibrium buoyancy relation estimated at 0.26, a correction of any disequilibrium after less than a year (approximately 4 quarters) is implied. Note that the tax-to-base buoyancy relation needs almost half the time that the tax-to-GDP buoyancy relation needs in order to return to its long-run equilibrium.

Second, with regard to tax base (i.e., private consumption) volatility arising from short-run fluctuations in GDP, the base-to-GDP buoyancy/elasticity component is estimated at 1.01 and is not statistically different from unity, reflecting that the base fluctuates in proportion to GDP over

[227] Recall that both long- and short-run tax-to-base elasticities are not found to be statistically different from one.

the business cycle. Given that the respective long-run estimate stands at 0.93, a transitory disequilibrium seems to occur. With the coefficient on the lagged value of the error correction term being negative and statistically significant, as expected, and the speed of adjustment to the long-run equilibrium relation at 0.18, there is evidence that any disequilibrium is corrected after almost a year and a half (after approximately 6 quarters). Moreover, in the short-run base-to-GDP relation, the coefficient of the lagged value of (the differenced log of) the tax base, i.e., of the dependent variable, is statistically significant in this case too.

Finally, deviating evidence on the short-run tax-to-GDP relation is provided when using the decomposed tax-to-base and base-to-GDP buoyancies and elasticities. The calculation of the product of tax-to-base and base-to-GDP components leads to a short-run buoyancy of 0.71 and a short-run elasticity of 0.72. Both lie below unity and differ considerably from the one-step tax-to-GDP short-run estimates (1.43 and 1.57, respectively). Since the base-to-GDP component would not be expected to greatly exceed unity, it appears that diverging results are basically related to the magnitude of the tax-to-base estimates. As a consequence, these deviating findings raise an issue with regard to which of the provided benchmark short-run estimates (the one-step tax-to-GDP, the decomposed relations, and the calculated product) more relevantly reflect the underlying relations, in order to enable a more insightful interpretation of short-run estimation results. In this context, the consideration of asymmetries and/or the occurrence of an extraordinary event, such as the outbreak of the COVID-19 pandemic, can be shown to be of utmost importance.

7.5.2.2. Extended short-run estimation results

In order to more thoroughly investigate the short-run VAT revenue buoyancy and elasticity relations, we provide a set of extended buoyancy and elasticity estimation results controlling for ECT asymmetry, COVID-19, lockdown, business cycle, and growth effects.

ECT asymmetry

First of all, in Table 7.4, we offer evidence with regard to ECT asymmetric effects that would reflect potential residual-based, i.e., ECT-based,

TABLE 7.4
Extended short-run estimation results – ECT asymmetry

Independent variables and statistics	Tax-to-GDP	Tax-to-base (I)	Base-to-GDP (II)	Coefficients' product: (I) × (II)
Buoyancy				
ΔlnGDP$^{(+)}$	***1.76*** [0.00]	-	**1.05** [0.00]	1.25
ΔlnGDP$^{(-)}$	0.46 [0.41]	-	**0.97** [0.00]	-
ΔlnCons$^{(+)}$	-	**1.19** [0.00]	-	-
ΔlnCons$^{(-)}$	-	0.34 [0.40]	-	-
ΔlnGDP(-1)	0.49 [0.08]	-	-	-
ΔlnCons(-1)	-	0.41 [0.10]	-0.24 [0.06]	-
ΔlnRev(-1)	-0.45 [0.00]	-0.34 [0.01]	-	-
ECT$^{(+)}$*(-1)*	-0.25 [0.06]	-0.41 [0.02]	-0.15 [0.41]	-
ECT$^{(-)}$*(-1)*	-0.10 [0.52]	-0.14 [0.37]	-0.27 [0.06]	-
Wald test (+)=(–)*	-	-	[0.79]	-
Adj. R-squared	0.36	0.30	0.57	-
Prob (F-statistic)	[0.00]	[0.00]	[0.00]	-
Prob F (LM test)	[0.42]	[0.97]	[0.27]	-
Elasticity				
ΔlnGDP$^{(+)}$	***1.73*** [0.00]	-	**1.05** [0.00]	1.33
ΔlnGDP$^{(-)}$	0.85 [0.15]	-	**0.97** [0.00]	-
ΔlnCons$^{(+)}$	-	**1.27** [0.00]	-	-
ΔlnCons$^{(-)}$	-	0.31 [0.50]	-	-
ΔlnGDP(-1)	0.62 [0.05]	-	-	-
ΔlnCons(-1)	-	0.52 [0.04]	-0.24 [0.06]	-
ΔlnRev(-1)	-0.51 [0.00]	-0.37 [0.00]	-	-
ECT$^{(+)}$*(-1)*	-0.20 [0.14]	-0.42 [0.04]	-0.15 [0.41]	-
ECT$^{(-)}$*(-1)*	-0.07 [0.66]	-0.11 [0.54]	-0.27 [0.06]	-

TABLE 7.4 (continued)

Independent variables and statistics	Tax-to-GDP	Tax-to-base (I)	Base-to-GDP (II)	Coefficients' product: (I) × (II)
Elasticity (continued)				
2005_MD	0.05 [0.01]	0.04 [0.04]	-	-
2010a_MD	0.06 [0.05]	0.02 [0.53]	-	-
2010b_MD	0.06 [0.00]	0.06 [0.02]	-	-
2011_MD	0.00 [0.99]	-0.03 [0.49]	-	-
2016_MD	0.05 [0.04]	0.05 [0.09]	-	-
Wald test (+)=(–)*	-	-	[0.79]	-
Adj. R-squared	0.34	0.29	0.57	-
Prob (F-statistic)	[0.00]	[0.00]	[0.00]	-
Prob F (LM test)	[0.15]	[0.95]	[0.27]	-

Notes: Table 7.4 presents the estimates for equations (7.11) to (7.15). Buoyancy and elasticity estimations include 88 observations, after adjustments. All equations include a constant term. *P*-values are presented in brackets. Buoyancy and elasticity coefficient values marked ***bold and italics*** stand for the cases in which the conducted Wald tests indicate that the assumption of coefficients being ≥ (≤) unity can be rejected, while (significant) coefficient values marked **bold** stand for the cases in which the additional Wald tests conducted indicate that the unity assumption cannot be rejected (in all cases, at the 10% significance level). *The respective Wald test controls for the equality of the coefficients on the positive and negative sub-components of the relevant independent variables.

asymmetries (arising from any disequilibrium) in the speed of adjustment as well as in the respective buoyancy and elasticity estimates. However, according to the results of Table 7.4, the ECT effect is not found to be significant in most cases. More specifically, it is not possible to carry out comparisons between the effects of positive and negative sub-series since the respective tax-to-GDP and tax-to-base buoyancy and elasticity estimations provide statistically significant coefficients only when revenues are above equilibrium. As a result, these findings do not provide any additional evidence since we cannot comment on any residual-based asymmetric short-run response of VAT revenue to GDP or tax base fluctuations and, thus, cannot even refer to the one-step or the decomposition results.

COVID-19 effects

The unprecedented conditions of the COVID-19 pandemic period create an interesting setting for analysis since such circumstances may significantly affect the short-run response of VAT revenues to fluctuations in GDP and/or the tax base. The results of Table 7.5 confirm the great importance of the COVID-19 pandemic effect in the context of the tax-to-GDP relation.[228] Both tax-to-GDP short-run buoyancy and elasticity reflecting the non-COVID-19 period are estimated at 0.86, with the corresponding coefficients being not statistically different from one. This finding would imply that VAT revenues fluctuate equally strongly to fluctuations in GDP, whether in the upward or downward direction. However, the respective short-run tax-to-GDP buoyancy and elasticity reflecting the COVID-19 pandemic period (defined to end at the second quarter of 2022) are well above unity, at 2.13 and 2.01, respectively. This finding indicates significant revenue overreaction (whether in the upward or downward direction) during the pandemic period, i.e., the fact that VAT revenues fluctuate by far more than GDP in the short-run during the COVID-19 pandemic. The comparison of the empirical findings of Tables 7.3 and 7.5 suggests that the respective high benchmark short-run estimates of Table 7.3 can be clearly attributed to the COVID-19 pandemic effect since they result from the examination of the total sample period, which includes the pandemic period. The COVID-19 effect is also confirmed in our short-run estimations via the corresponding Wald test (Table 7.5). As a result, controlling for the effects of the COVID-19 pandemic adds significantly to the analysis of the short-run tax-to-GDP buoyancy and elasticity and cannot be neglected. Of the remaining results for the tax-to-GDP relation, most (e.g., with reference to the role of the investigated DTM, the ECT terms, and the

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[228] Recall that in our estimations, *COVID-19_D* represents the dummy variable, which takes the value of one from the first quarter of 2020 to the second quarter of 2022, and the value of zero otherwise. We have also tested the respective relations with *COVID-19_D* taking the value of one from the first quarter of 2020 to the last quarter of 2021, and the value of zero otherwise, and the value of one from the first quarter of 2020 to the last quarter of 2022, and the value of zero otherwise. In terms of the investigated effects, the empirical results do not differ qualitatively and are not presented in the interest of brevity. These are available upon request.

lag of the differenced log of VAT revenues) are in accordance with the evidence provided in Table 7.3.

Moreover, VAT revenue buoyancy and elasticity in the respective tax-to-base short-run relations reflecting the COVID-19 pandemic period are estimated at 1.13 (being not statistically different from one) and 1.23, respectively, while the relevant estimates for the non-COVID-19 period are not statistically significant and do not enable the comparison of the tax-to-base components for the non-COVID-19 and the COVID-19 periods.[229] As a result, they also do not allow for any complete application of the decomposition approach and constrain any comparison of evidence between the one-step and the decomposed tax-to-GDP buoyancy and elasticity. Still, it is crucial to note that in contrast to the statistical significance of the corresponding tax-to-base short-run buoyancy and elasticity coefficients for the total of the investigated time period presented in Table 7.3, evidence in Table 7.5 for the non-COVID-19 period seems to suggest the non-existence of a short-run relation between fluctuations in VAT revenues and the tax base. Since this result could have implications in terms of short-run policy with regard to the relation between VAT and its tax base in Greece, we further investigate this issue (see the discussion below, Table 7.9, and the related discussion as well).

Despite the fact that the results from the decomposition approach cannot be fully interpreted, it is interesting to comment, first, on the evidence for the short-run base-to-GDP (buoyancy/elasticity) relation controlling for COVID-19 effects. The base-to-GDP component is estimated above unity, at 1.35, for the COVID-19 period, and below unity, at 0.73, for the non-COVID-19 period, indicating a clear COVID-19 effect in our short-run estimations that is also confirmed via the relevant Wald test. As a result, and taking also into account the corresponding benchmark base-to-GDP buoyancy/elasticity component for the total of the investigated time period provided in Table 7.3, it follows that the pandemic alters the degree of

[229] For that reason, we do not provide a detailed analysis on the related ECT terms and the potential role of DTM since we do not obtain evidence on the significance of both parts and any interpretation based on the significance of only one part would not add to the analysis. We follow this line of presentation in all similar cases throughout the present section.

tax base (i.e., private consumption) volatility arising from short-run fluctuations in GDP. Moreover, given the respective long-run estimate of 0.93, here again a transitory disequilibrium seems to occur. According to Table 7.5, the lagged value of the error correction term is negative and statistically significant, as expected, and the speed of adjustment to the long-run equilibrium relation is 0.27. This indicates that any disequilibrium is corrected after almost a year (after approximately 4 quarters), which is not far from the indication of correction after one and a half years obtained from the benchmark model. Second, it is worth noticing that the product of the tax-to-base and base-to-GDP components can only be calculated for the COVID-19 period since this is the only case with statistically significant results. As a result, the decomposition approach does not provide additional insights for the non-COVID-19 period, due to the fact that the corresponding buoyancy and elasticity products cannot be calculated.

Overall, it follows that short-run estimations carried out to control for COVID-19 effects on VAT revenue buoyancy and elasticity considerably contribute to our analysis. They lead to the conclusion that the underlying VAT revenue response relations assumed to hold outside the period of the COVID-19 pandemic (the unitary one-step tax-to-GDP buoyancy and elasticity, the non-significant tax-to-base relation, and the non-unitary short-run base-to-GDP buoyancy/elasticity as presented in Table 7.5 for the non-COVID-19 period) seem to have changed (to a non-unitary one-step tax-to-GDP buoyancy and elasticity a significant tax-to-base short-run relation, and a unitary short-run base-to-GDP buoyancy/elasticity as presented in Table 7.3 for the total period including COVID-19) due to the ensuing disturbance. In other words, they explain the dissimilar benchmark short-run results entailed in Table 7.3, which seem to arise due to the consideration of the total of the period under investigation, which obviously includes the pandemic period.

It, hence, follows that all heretofore obtained and provided short-run estimates are informative and, to a certain degree, relevant in explaining the underlying relations. Benchmark short-run estimates are relevant to the degree that they reflect the VAT revenue response for the total period under examination, which includes the COVID-19 pandemic period, and are, therefore, affected by the related disturbance. Estimates arising from the extended short-run model controlling for COVID-19 effects are

TABLE 7.5
Extended short-run estimation results – COVID-19 effects

Independent variables and statistics	Tax-to-GDP	Tax-to-base (I)	Base-to-GDP (II)	Coefficients' product: (I) × (II)
Buoyancy				
COVID19_D × ΔlnGDP	***2.13*** [0.00]	-	***1.35*** [0.00]	1.53
(1-COVID19_D) × ΔlnGDP	**0.86** [0.01]	-	***0.73*** [0.00]	-
COVID19_D × ΔlnCons	-	**1.13** [0.00]	-	-
(1-COVID19_D) × ΔlnCons	-	0.23 [0.49]	-	-
ΔlnGDP(-1)	-	-	-	-
ΔlnCons(-1)	-	-	-0.23 [0.04]	-
ΔlnRev(-1)	-0.41 [0.00]	-0.29 [0.02]	-	-
ECT(-1)	-0.17 [0.01]	-0.26 [0.00]	-0.27 [0.00]	-
Wald test on coeff. equality COVID19_D & 1-COVID19_D	[0.00]	-	[0.00]	-
Adj. R-squared	0.37	0.30	0.62	-
Prob (F-statistic)	[0.00]	[0.00]	[0.00]	-
Prob F (LM test)	[0.71]	[0.32]	[0.18]	-
Elasticity				
COVID19_D × ΔlnGDP	***2.01*** [0.00]	-	***1.35*** [0.00]	1.66
(1-COVID19_D) × ΔlnGDP	**0.86** [0.04]	-	***0.73*** [0.00]	-
COVID19_D × ΔlnCons	-	***1.23*** [0.00]	-	-
(1-COVID19_D) × ΔlnCons	-	0.22 [0.56]	-	-
ΔlnGDP(-1)	0.54 [0.08]	-	-	-
ΔlnCons(-1)	-	0.44 [0.08]	-0.23 [0.04]	-
ΔlnRev(-1)	-0.50 [0.00]	-0.36 [0.01]	-	-
ECT(-1)	-0.13 [0.06]	-0.22 [0.02]	-0.27 [0.00]	-
2005_MD	0.06 [0.00]	0.04 [0.01]	-	-

TABLE 7.5 (continued)

Independent variables and statistics	Tax-to-GDP	Tax-to-base (I)	Base-to-GDP (II)	Coefficients' product: (I) × (II)
Elasticity (continued)				
2010a_MD	0.05 [0.09]	0.01 [0.71]	-	-
2010b_MD	0.05 [0.00]	0.04 [0.03]	-	-
2011_MD	-0.02 [0.74]	-0.05 [0.26]	-	-
2016_MD	0.06 [0.03]	0.05 [0.12]	-	-
Wald test on coeff. equality COVID19_D & 1-COVID19_D	[0.01]	-	[0.00]	-
Adj. R-squared	0.36	0.30	0.62	-
Prob (F-statistic)	[0.00]	[0.00]	[0.00]	-
Prob F (LM test)	[0.20]	[0.70]	[0.18]	-

Notes: Table 7.5 presents the estimates for equations (7.16) to (7.20). Buoyancy and elasticity estimations include 89 observations, after adjustments. All equations include a constant term. *P*-values are presented in brackets. Buoyancy and elasticity coefficient values marked ***bold and italics*** stand for the cases in which the conducted Wald tests indicate that the assumption of coefficients being ≥ (≤) unity can be rejected, while (significant) coefficient values marked **bold** stand for the cases in which the additional Wald tests conducted indicate that the unity assumption cannot be rejected (in all cases, at the 10% significance level).

relevant to the degree that they distinctly reflect the VAT revenue response for different sub-periods, excluding or including the pandemic period. Note that the occurrence of the COVID-19 pandemic and the related effects are presumably a one-time event and, thus, not comparable to any asymmetry caused by recurrent situations (e.g., expansions and recessions), in which case any corresponding extended short-run model could be seen to be overall more representative than a symmetric/benchmark one.

Lockdown effects

Having documented the significance of the COVID-19 effect, we also report evidence from focusing on the impact of the lockdowns imposed due to the COVID-19 pandemic.[230] The lockdown effects are clearly reflected in our estimation results presented in Table 7.6. Short-run tax-to-GDP buoyancy and elasticity for the time period without lockdowns are estimated at 1.09 and 1.21, respectively, with estimates being not statistically different from one. These findings are in line with the results previously reported in Table 7.5 for the non-COVID-19 period, again indicating an equally strong response of VAT revenues to GDP fluctuations, in the upward or downward direction. At the same time, the respective short-run tax-to-GDP buoyancy and elasticity for periods of lockdown are well above unity, at 2.16 and 2.20, respectively. However, in contrast to the evidence provided in Table 7.3 and Table 7.5, the ECT term in the elasticity relation is not statistically significant, hence not confirming the operation of the correction mechanism to the long-run equilibrium relation. Still, the buoyancy estimate is in line with the results reported in Table 7.5 for the COVID-19 period, reflecting a revenue overreaction (whether in the upward or downward direction) during the lockdown periods, i.e., the fact that VAT revenues fluctuate during the respective period by far more than GDP in the short-run. The lockdown effect in our short-run buoyancy estimations is also confirmed via the corresponding Wald test. On the basis of these findings and the preceding analysis comparing benchmark with extended short-run tax-to-GDP (buoyancy) estimates controlling for COVID-19 effects, it follows that the consideration of lockdown effects confirms and strengthens the key role played by the pandemic and its repercussions.

Note that, here again, the coefficient on the lagged value of (the differenced log of) VAT revenues is statistically significant, implying the presence of negative persistence. In addition, the lagged value of the error correction term is negative and statistically significant, as expected, and the speed of adjustment to the long-run equilibrium buoyancy relation

[230] Recall that, in our estimations, *Lockdown_D* represents the dummy variable, which takes the value of one in the first two and the last quarters of 2020 and the first two quarters of 2021, and the value of zero otherwise. We have also tested the respective relations with *Lockdown_D* taking the value of one in the second and last quarters of 2020 and the first two quarters of 2021, and the value of zero otherwise. Apart from the estimate for tax-to-base buoyancy, the empirical results do not differ qualitatively in terms of the investigated effects and are not presented in the interest of brevity. These are available upon request.

TABLE 7.6
Extended short-run estimation results – Lockdown effects

Independent variables and statistics	Tax-to-GDP	Tax-to-base (I)	Base-to-GDP (II)	Coefficients' product: (I) × (II)
Buoyancy				
Lockdown_D × ΔlnGDP	***2.16*** [0.00]	-	***1.15*** [0.00]	1.50
(1-Lockdown_D) × ΔlnGDP	**1.09** [0.00]	-	**0.95** [0.00]	-
Lockdown_D × ΔlnCons	-	**1.30** [0.00]	-	-
(1-Lockdown_D) × ΔlnCons	-	0.40 [0.13]	-	-
ΔlnGDP(-1)	-	-	-	-
ΔlnCons(-1)	-	-	-0.24 [0.06]	-
ΔlnRev(-1)	-0.44 [0.00]	-0.32 [0.00]	-	-
ECT(-1)	-0.14 [0.03]	-0.23 [0.00]	-0.19 [0.02]	-
Wald test on coeff. equality Lockdown_D & 1-Lockdown_D	[0.00]	-	[0.30]	-
Adj. R-squared	0.35	0.29	0.57	-
Prob (F-statistic)	[0.00]	[0.00]	[0.00]	-
Prob F (LM test)	[0.76]	[0.61]	[0.39]	-
Elasticity				
Lockdown_D × ΔlnGDP	***2.20*** [0.00]	-	***1.15*** [0.00]	1.52
(1-Lockdown_D) × ΔlnGDP	**1.21** [0.00]	-	**0.95** [0.00]	-
Lockdown_D × ΔlnCons	-	**1.32** [0.00]	-	-
(1-Lockdown_D) × ΔlnCons	-	0.38 [0.20]	-	-
ΔlnGDP(-1)	-	-	-	-
ΔlnCons(-1)	-	-	-0.24 [0.06]	-
ΔlnRev(-1)	-0.47 [0.00]	-0.34 [0.00]	-	-
ECT(-1)	-0.11 [0.12]	-0.22 [0.02]	-0.19 [0.02]	-
2005_MD	0.05 [0.00]	0.04 [0.01]	-	-
2010a_MD	0.05 [0.07]	0.01 [0.80]	-	-
2010b_MD	0.04 [0.00]	0.01 [0.18]	-	-

TABLE 7.6 (continued)

Independent variables and statistics	Tax-to-GDP	Tax-to-base (I)	Base-to-GDP (II)	Coefficients' product: (I) × (II)
Elasticity (continued)				
2011_MD	-0.02 [0.65]	-0.06 [0.22]	-	-
2016_MD	0.05 [0.03]	0.04 [0.20]	-	-
Wald test on coeff. equality Lockdown_D & 1-Lockdown_D	[0.01]	-	[0.30]	-
Adj. R-squared	0.34	0.27	0.57	-
Prob (F-statistic)	[0.00]	[0.00]	[0.00]	-
Prob F (LM test)	[0.52]	[0.66]	[0.39]	-

Notes: Table 7.6 presents the estimates for equations (7.21) to (7.25). Buoyancy and elasticity estimations include 89 observations, after adjustments. All equations include a constant term. *P*-values are presented in brackets. Buoyancy and elasticity coefficient values marked ***bold and italics*** stand for the cases in which the conducted Wald tests indicate that the assumption of (significant) coefficients being ≥ (≤) unity can be rejected, while (significant) coefficient values marked **bold** stand for the cases in which the additional Wald tests conducted indicate that the unity assumption cannot be rejected (in all cases, at the 10% significance level).

is 0.14, indicating that any disequilibrium is corrected after almost two years (i.e., after approximately 7 quarters), in line with the corresponding benchmark short-run estimation.

Moreover, buoyancy and elasticity in the respective tax-to-base short-run relations reflecting periods of lockdown are estimated at 1.30 and 1.32, respectively, being not statistically different from one. However, buoyancy and elasticity tax-to-base estimates for the period excluding lockdowns are both not statistically significant. As a result, we cannot compare the evidence provided for the periods without and with lockdowns, and it is not possible to employ the decomposition approach. Still, these findings are in line with the respective evidence when controlling for COVID-19 effects (Table 7.5), again implying the non-existence of a tax-to-base short-run relation. At the same time, they seem to strengthen the argument that the finding of a significant short-run tax-to-base relation entailed in Table 7.3 (based on the benchmark estimations) may arise due to the consideration of the total of the period under investigation, which obviously includes the pandemic period.[231]

Despite the fact that the decomposition approach cannot be employed, it is worth commenting on the evidence for the short-run base-to-GDP (buoyancy/elasticity) relation controlling for lockdown effects. The base-to-GDP component is estimated above unity, at 1.15 for the time period of lockdowns and at 0.95 (being not statistically different from unity) for the time period excluding lockdowns. The first is in line with the corresponding finding of Table 7.5, taking into account COVID-19 effects. The second seems to be in contrast to the related evidence of Table 7.5 and is more in accordance with the benchmark short-run base-to-GDP result included in Table 7.3, which has been assessed to be driven by the pandemic. This can be very well explained by the fact that the period excluding lockdowns still entails some quarters affected by the COVID-19 pandemic (in contrast to the non-COVID-19 period, which totally isolates the pandemic effects), being potentially predominant in the base-to-GDP relation and, hence, driving the respective estimate.

Overall, it follows here again that the pandemic (through the imposed lockdowns) has an impact on the degree of tax base (i.e., private consumption) volatility arising from short-run fluctuations in GDP. This further affects any comparison between the long- and the short-run base-to-GDP estimates, alongside the corresponding process of convergence to the long-run equilibrium. According to Table 7.6, the lagged value of the error correction term is negative and statistically significant, as expected, and

[231] Note, however, that the evidence from Table 7.6 on the non-existence of a short-run buoyancy relation between fluctuations in the tax base and VAT revenues for the non-lockdown period differs from the significant corresponding tax-to-base buoyancy obtained when applying the alternative *Lockdown_D* dummy. Recall that the alternative *Lockdown_D* dummy takes the value of one in the second and last quarters of 2020 and the first two quarters of 2021, and the value of zero otherwise. So, the difference between the two dummies is basically the inclusion or not of the first quarter of 2020. Evidently, this is exactly what affects the results since when excluding the first quarter of 2020 from the non-lockdown period (and, hence, including it in the dummy, as is the case with results presented in Table 7.6), the lockdown effect is completely isolated. In the opposite case, i.e., when including it in the non-lockdown period, it seems to be predominant, exerting a great impact and driving the relevant short-run buoyancy relation, presumably turning a link otherwise not found to exist or to be systematic into a significant and/or systematic one.

the speed of adjustment to the long-run equilibrium relation is 0.19, indicating that any disequilibrium is corrected after a little more than a year (i.e., after approximately 5 quarters). The latter seems to be in accordance with the evidence on the time needed for adjustment provided by the benchmark short-run estimates.

In total, we can conclude that short-run estimations controlling for lockdown effects on VAT revenue buoyancy significantly contribute to our analysis. They strengthen the evidence already provided in favor of the argument that the disturbance stemming from a one-time event, in this case the COVID-19 pandemic, affected the underlying VAT revenue response relations. Similarly, they further strengthen the earlier provided explanation for the differentiated benchmark short-run results reported in Table 7.3, which seem to emerge due to the consideration of the total of the period under investigation, obviously including the pandemic period. As a consequence, our conclusion on the partial relevance of the benchmark as well as the extended short-run estimates in explaining the underlying relations, depending on the time period under consideration and, thus, the divergent economic conditions these periods might reflect, remains valid.

Business cycle effects

Recognizing that VAT revenue buoyancy and elasticity may vary over the distinct phases of the business cycle, we also test for potential business cycle effects (Table 7.7). As far as the tax-to-GDP relation is concerned, useful insights are provided mainly through the buoyancy estimation results since the ECT effect is (marginally) not found to be significant in the elasticity relation, hence not confirming the operation of the correction mechanism to the long-run equilibrium relation. Tax-to-GDP short-run buoyancy is estimated at 1.49 and 1.38 for expansionary and non-expansionary (thus, recessionary) periods, respectively, with these estimates being not statistically different from one. This implies that, during both the up- and downward phase of the business cycle, VAT revenues fluctuate equally strongly to GDP. The respective Wald test also confirms that there is no evidence of a different response of VAT revenues to short-run fluctuations in GDP during expansionary and recessionary periods. As a result, there is no evidence in favor of any potential significance of business cycle effects.

TABLE 7.7
Extended short-run estimation results – Business cycle effects

Independent variables and statistics	Tax-to-GDP	Tax-to-base (I)	Base-to-GDP (II)	Coefficients' product: (I) × (II)
Buoyancy				
Cycle_D × ΔlnGDP	**1.49** [0.00]	-	**0.93** [0.00]	-
(1-Cycle_D) × ΔlnGDP	**1.38** [0.00]	-	**1.08** [0.00]	0.89
Cycle_D × ΔlnCons	-	0.55 [0.23]	-	-
(1-Cycle_D) × ΔlnCons	-	**0.82** [0.01]	-	-
ΔlnGDP(-1)	**-**	-	-	-
ΔlnCons(-1)	-	-	-0.24 [0.06]	-
ΔlnRev(-1)	-0.42 [0.00]	-0.29 [0.02]	-	-
ECT(-1)	-0.15 [0.02]	-0.26 [0.00]	-0.19 [0.02]	-
Wald test on coeff. equality Cycle_D & 1-Cycle_D	[0.88]	-	[0.67]	-
Adj. R-squared	0.33	0.27	0.57	-
Prob (F-statistic)	[0.00]	[0.00]	[0.00]	-
Prob F (LM test)	[0.83]	[0.42]	[0.41]	-
Elasticity				
Cycle_D × ΔlnGDP	**1.43** [0.00]	-	**0.93** [0.00]	-
(1-Cycle_D) × ΔlnGDP	**1.45** [0.01]	-	**1.08** [0.00]	1.05
Cycle_D × ΔlnCons	-	0.51 [0.26]	-	-
(1-Cycle_D) × ΔlnCons	-	**0.97** [0.00]	-	-
ΔlnGDP(-1)	0.57 [0.09]	-	-	-
ΔlnCons(-1)	-	0.45 [0.08]	-0.24 [0.06]	-
ΔlnRev(-1)	-0.52 [0.00]	-0.36 [0.00]	-	-
ECT(-1)	-0.10 [0.12]	-0.21 [0.05]	-0.19 [0.02]	-
2005_MD	0.05 [0.00]	0.04 [0.01]	-	-
2010a_MD	0.07 [0.01]	0.04 [0.14]	-	-
2010b_MD	0.06 [0.00]	0.05 [0.02]	-	-

TABLE 7.7 (continued)

Independent variables and statistics	Tax-to-GDP	Tax-to-base (I)	Base-to-GDP (II)	Coefficients' product: (I) × (II)
Elasticity (continued)				
2011_MD	0.00 [0.99]	-0.05 [0.34]	-	-
2016_MD	0.06 [0.01]	0.05 [0.14]	-	-
Wald test on coeff. equality Cycle_D & 1-Cycle_D	[0.97]	-	[0.67]	-
Adj. R-squared	0.34	0.26	0.57	-
Prob (F-statistic)	[0.00]	[0.00]	[0.00]	-
Prob F (LM test)	[0.30]	[0.94]	[0.41]	-

Notes: Table 7.7 presents the estimates for equations (7.26) to (7.30). Buoyancy and elasticity estimations include 89 observations, after adjustments. All equations include a constant term. *P*-values are presented in brackets. Buoyancy and elasticity coefficient values marked ***bold and italics*** stand for the cases in which the conducted Wald tests indicate that the assumption of (significant) coefficients being ≥ (≤) unity can be rejected, while (significant) coefficient values marked **bold** stand for the cases in which the additional Wald tests conducted indicate that the unity assumption cannot be rejected (in all cases, at the 10% significance level).

Similarly, with regard to the results from the decomposition approach, the evidence from the tax-to-base and base-to-GDP relations, taking into account any potential role of business cycle effects, does not allow for a complete interpretation. This is due to the fact that buoyancy and elasticity in the respective tax-to-base short-run relations are statistically significant only for the periods reflecting recessions, estimated at 0.82 and 0.97, respectively, and not statistically different from one. For the sake of completeness, reference can be made to findings for the relevant base-to-GDP relation. The base-to-GDP buoyancy/elasticity component is estimated at 0.93 for expansionary periods, and 1.08 for recessionary periods, but again not statistically different from unity in both cases. As a result, we do not detect any significant business cycle effect in the short-run relation between private consumption and GDP.

Growth effects

Along the same line of reasoning and with the aim to control for potential effects of different economic conditions, we also test for possible growth effects (Table 7.8).[232] Useful findings are obtained basically as far as the tax-to-GDP short-run relation is concerned. Short-run tax-to-GDP buoyancy and elasticity for the period reflecting quarters with positive year-on-year real GDP changes are estimated at 1.52 and 1.82, respectively, while the respective short-run tax-to-GDP buoyancy and elasticity reflecting quarters with negative year-on-year real GDP changes are estimated at 1.36 and 1.39, respectively. With the exception of the short-run elasticity during the period of positive year-on-year real GDP changes, which is above unity, the remaining coefficients are not statistically different from one. It, hence, follows that irrespective of the sign of real GDP rate changes, in most cases VAT revenues fluctuate in proportion with fluctuations in GDP. Taking also into account the relevant Wald test, it follows that, overall, there is no evidence in favor of any potential significance of growth effects.

Here again, the results from the decomposition approach do not allow for a complete interpretation. This is due to the fact that buoyancy and elasticity in the respective tax-to-base short-run relations are statistically significant only for the period reflecting quarters with negative year-on-year real GDP changes, estimated at 0.70 and 0.69, respectively, and not statistically different from one. To complete the reference, we can comment on the relevant base-to-GDP relation. The base-to-GDP component is estimated at 0.91 for periods of positive real GDP growth, and 1.09 for periods of negative real GDP growth, again not statistically different from

[232] Moreover, we have also tested for the impact of the prolonged crisis/adjustment period for the Greek economy through the inclusion of a dummy variable differentiating between periods of normal economic conditions and periods of economic crisis and adjustment. In this case, the crisis/adjustment dummy takes the value of one from the second quarter of 2008, which signals the beginning of the severe economic crisis period in Greece, to the third quarter of 2018, which signals the end of the third economic adjustment programme for the country. The empirical results do not provide evidence of crisis/adjustment effects and are not presented in the interest of brevity. These are available upon request.

TABLE 7.8
Extended short-run estimation results – Growth effects

Independent variables and statistics	Tax-to-GDP	Tax-to-base (I)	Base-to-GDP (II)	Coefficients' product: (I) × (II)
Buoyancy				
Growth_D × ΔlnGDP	**1.52** [0.00]	-	**0.91** [0.00]	-
(1-Growth_D) × ΔlnGDP	**1.36** [0.00]	-	**1.09** [0.00]	0.76
Growth_D × ΔlnCons	-	0.71 [0.15]	-	-
(1-Growth_D) × ΔlnCons	-	**0.70** [0.03]	-	-
ΔlnGDP(-1)	**-**	-	-	-
ΔlnCons(-1)	-	-	-0.23 [0.08]	-
ΔlnRev(-1)	-0.42 [0.00]	-0.30 [0.02]	-	-
ECT(-1)	-0.15 [0.02]	-0.26 [0.00]	-0.19 [0.03]	-
Wald test on coeff. equality Growth_D & 1-Growth_D	[0.83]	-	[0.65]	-
Adj. R-squared	0.33	0.27	0.57	-
Prob (F-statistic)	[0.00]	[0.00]	[0.00]	-
Prob F (LM test)	[0.82]	[0.57]	[0.39]	-
Elasticity				
Growth_D × ΔlnGDP	***1.82*** [0.00]	-	**0.91** [0.00]	-
(1-Growth_D) × ΔlnGDP	**1.39** [0.01]	-	**1.09** [0.00]	0.75
Growth_D × ΔlnCons	-	0.75 [0.15]	-	-
(1-Growth_D) × ΔlnCons	-	**0.69** [0.04]	-	-
ΔlnGDP(-1)	-	-	-	-
ΔlnCons(-1)	-	-	-0.23 [0.08]	-
ΔlnRev(-1)	-0.47 [0.00]	-0.32 [0.02]	-	-
ECT(-1)	-0.12 [0.08]	-0.25 [0.02]	-0.19 [0.03]	-
2005_MD	0.04 [0.00]	0.03 [0.03]	-	-
2010a_MD	0.07 [0.02]	0.02 [0.45]	-	-
2010b_MD	0.04 [0.00]	0.02 [0.06]	-	-

TABLE 7.8 (continued)

Independent variables and statistics	Tax-to-GDP	Tax-to-base (I)	Base-to-GDP (II)	Coefficients' product: (I) × (II)
Elasticity (continued)				
2011_MD	-0.01 [0.81]	-0.05 [0.29]	-	-
2016_MD	0.06 [0.01]	0.04 [0.19]	-	-
Wald test on coeff. equality Growth_D & 1-Growth_D	[0.58]	-	[0.65]	-
Adj. R-squared	0.33	0.24	0.57	-
Prob (F-statistic)	[0.00]	[0.00]	[0.00]	-
Prob F (LM test)	[0.48]	[0.64]	[0.39]	-

Notes: Table 7.8 presents the estimates for equations (7.31) to (7.35). Buoyancy and elasticity estimations include 89 observations, after adjustments. All equations include a constant term. *P*-values are presented in brackets. Buoyancy and elasticity coefficient values marked ***bold and italics*** stand for the cases in which the conducted Wald tests indicate that the assumption of (significant) coefficients being ≥ (≤) unity can be rejected, while (significant) coefficient values marked **bold** stand for the cases in which the additional Wald tests conducted indicate that the unity assumption cannot be rejected (in all cases, at the 10% significance level).

unity in both cases. As a result, we do not detect any significant growth effect in the short-run relation between private consumption and GDP.

7.5.3. Long-run stability analysis

The employed methodological approach further enables us to acquire important evidence on the stability of the long-run VAT revenue buoyancy[233] estimates, as presented in Figure 7.2, which depicts the rolling as well as the recursive estimates of buoyancy for the tax-to-GDP, tax-to-base, and base-to-GDP relations. Overall, we do not observe great variability in the reported results, which seem to display robustness to sample selection, especially in the case of the recursive estimates. Base-to-GDP

[233] Recall that it is not possible to conduct rolling and recursive estimations for elasticity. See Section 7.2, Footnote 203.

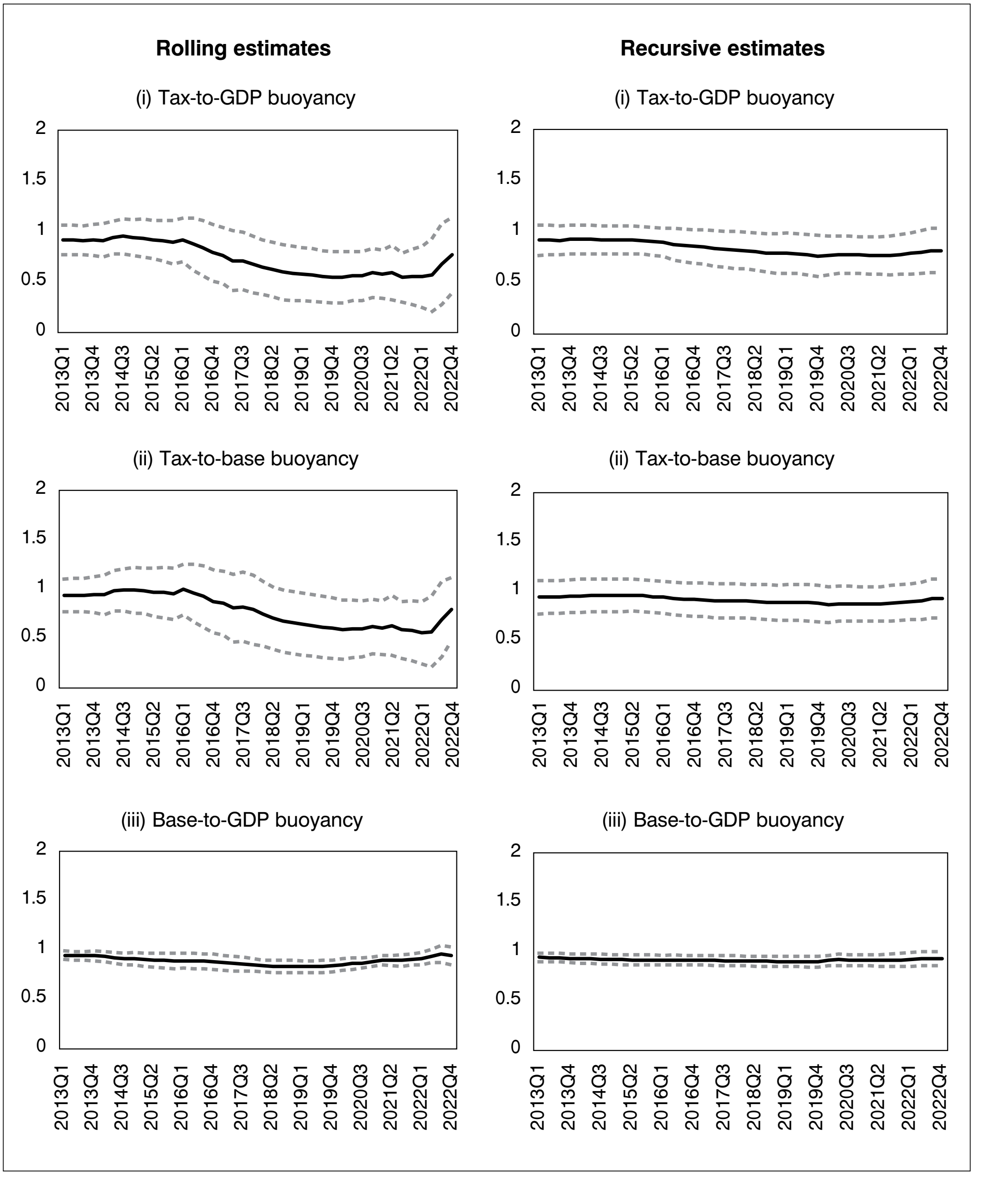
is the most stable relation, as expected, always moving close to the estimated long-run coefficient. As far as the tax-to-GDP relation is concerned, rolling estimates move around our long-run buoyancy estimate of 0.81, while recursive estimates are even more stable, moving very close to our estimate. The same holds for the tax-to-base relation, where rolling estimates move around our long-run buoyancy estimate of 0.92, and recursive estimates are even more stable, moving very close to our estimate. These findings are not unexpected since rolling estimations employ a rolling sample of 52 quarters, while recursive estimations employ a sample that increases by one observation each time up to 2022Q4.

As a result, it follows that the basic finding of a long-run buoyancy of VAT revenues with respect to GDP lower than unity is confirmed, strengthening the conclusion against the unity assumption and in favor of less than proportional changes in VAT revenues driven by changes in GDP over the long run, whether in the upward or downward direction. In addition, the stability analysis carried out confirms the soundness of the unity assumption, enhancing the proportionality conclusion with regard to changes in VAT driven by changes in the base, i.e., private consumption, over the long run.

Moreover, having already documented the significant impact of the COVID-19 pandemic on the short-run estimations, a closer look at the recursive estimations reveals that the respective long-run buoyancy estimations up to 2019Q4 are very close to our initial estimations derived when including the 2020–2022 pandemic period. This implies that there is no COVID-19 effect on the long-run buoyancy estimations and our results are, in this regard, robust to different sufficiently long sample selection periods.[234]

[234] Following a helpful reviewer's suggestion, we have further tested the tax-to-GDP and tax-to-base long-run buoyancy and elasticity relations for the existence of structural breaks, by the use of the procedure Least Squares with structural breaks (under the premise of certain non-negligible limitations, as, for example, the non-comparability of the obtained results with our basic findings, due to the different underlying estimation procedure, the problems related to the use of different, or even the absence of, tax rate changes in the elasticity equations for various sub-periods, etc.). Taking into consideration the indications resulting from the above-mentioned exercise, we included several associated points in Chapter 9, in the context of both policy recommendations and suggestions for further research.

FIGURE 7.2
Rolling and recursive estimates for long-run VAT revenue buoyancy



7.5.4. Consistency analysis: Benchmark short-run estimations for the sub-period 2000–2019

Having already documented the significant impact of the COVID-19 pandemic on the short-run estimations, we provide further crucial evidence employing data for a sub-period that excludes the 2020–2022 pandemic period from the sample. In this way, we investigate the relevance of the benchmark short-run buoyancy and elasticity estimates in connection with the extraordinary crisis triggered by the COVID-19 pandemic. As a result, we remove any possible COVID-19 effect from the short-run estimations and derive conclusions that are not affected by the extreme and unprecedented conditions of the COVID-19 pandemic.

Table 7.9 reports the empirical results regarding the estimated benchmark[235] short-run buoyancy and elasticity for the period 2000–2019. According to the reported evidence, tax-to-GDP buoyancy and elasticity are estimated at 0.92 and 1.01, respectively, and are, hence, positive, as expected according to the literature, and statistically significant. As indicated by the relevant Wald tests, both do not statistically differ from one. This finding indicates that VAT revenues fluctuate equally strongly to GDP over the short run, whether in the upward or downward direction. This result is in sharp contrast to the respective benchmark short-run evidence provided in Table 7.3 (tax-to-GDP buoyancy and elasticity estimated at 1.43 and 1.57, respectively) for the total period (i.e., up until the end of 2022, including the COVID-19 pandemic period). More specifically, with the estimated buoyancy and elasticity being significantly lower compared to the estimates based on the whole period under examination, the major impact of the COVID-19 pandemic period affecting our benchmark estimations for the total period under investigation is confirmed. In addition, the estimated buoyancy and elasticity are in line with the tax-to-GDP buoyancy and elasticity estimates of Tables 7.5 and the tax-to-GDP buoyancy

[235] Note that estimations for the sub-period 2000–2019 have been also carried out to control for ECT asymmetry, business cycle, and growth effects. However, the obtained results do not provide any additional evidence in terms of the investigation of the impact of the associated effects and are not reported in the interest of brevity. These are available upon request.

TABLE 7.9
Benchmark short-run estimation results for the sub-period 2000–2019

Independent variables and statistics	Tax-to-GDP	Tax-to-base (I)	Base-to-GDP (II)	Coefficients' product: (I) × (II)
Buoyancy				
ΔlnGDP	**0.92** [0.01]	-	***0.72*** [0.00]	-
ΔlnCons	-	0.30 [0.37]	-	-
ΔlnGDP(-1)	-	-	0.30 [0.03]	-
ΔlnCons(-1)	-	-	-0.16 [0.06]	-
ΔlnRev(-1)	-0.43 [0.00]	-0.38 [0.00]	-	-
ECT(-1)	-0.20 [0.01]	-0.25 [0.01]	-0.26 [0.00]	-
Adj. R-squared	0.32	0.29	0.50	-
Prob (F-statistic)	[0.00]	[0.00]	[0.00]	-
Prob F (LM test)	[0.86]	[0.89]	[0.49]	-
Elasticity				
ΔlnGDP	**1.01** [0.01]	-	***0.72*** [0.00]	-
ΔlnCons	-	0.29 [0.46]	-	-
ΔlnGDP(-1)	-	-	0.30 [0.03]	-
ΔlnCons(-1)	**-**	-	-0.16 [0.06]	-
ΔlnRev(-1)	-0.47 [0.00]	-0.41 [0.00]	-	-
ECT(-1)	-0.17 [0.08]	-0.23 [0.05]	-0.26 [0.00]	-
2005_MD	0.05 [0.00]	0.05 [0.00]	-	-
2010a_MD	0.05 [0.11]	0.01 [0.64]	-	-
2010b_MD	0.03 [0.01]	0.01 [0.22]	-	-
2011_MD	-0.02 [0.63]	-0.05 [0.28]	-	-
2016_MD	0.05 [0.03]	0.05 [0.11]	-	-
Adj. R-squared	0.30	0.26	0.50	-

TABLE 7.9 (continued)

Independent variables and statistics	Tax-to-GDP	Tax-to-base (I)	Base-to-GDP (II)	Coefficients' product: (I) × (II)
Elasticity (continued)				
Prob (F-statistic)	[0.00]	[0.00]	[0.00]	-
Prob F (LM test)	[0.64]	[0.87]	[0.49]	-

Notes: Table 7.9 presents the estimates for equations (7.6) to (7.10) for the sub-period 2000–2019. Buoyancy and elasticity estimations include 77 observations, after adjustments. All equations include a constant term. *P*-values are presented in brackets. Buoyancy and elasticity coefficient values marked ***bold and italics*** stand for the cases in which the conducted Wald tests indicate that the assumption of coefficients being ≥ (≤) unity can be rejected, while (significant) coefficient values marked **bold** stand for the cases in which the additional Wald tests conducted indicate that the unity assumption cannot be rejected (in all cases, at the 10% significance level).

estimate of Table 7.6 that depict coefficients not statistically different from unity for the sub-period excluding either the COVID-19 period of time or just the lockdown periods.

At the same time, the additional evidence provided for the shorter sample period does not change the implications regarding the role of the investigated DTM. More specifically, there is no evidence that the implemented discretionary measures result in any additional short-run fluctuations in VAT revenues, during the time period under investigation, since both short-run tax-to-GDP buoyancy and elasticity do not statistically differ from unity. At the same time, in three cases, the coefficients on the DTM dummy variables are found to be statistically significant.[236] These results might be related to the way DTM operate during the prolonged period of economic crisis and adjustment, lasting from 2008 to 2018 in Greece, as opposed to the period of favorable economic conditions.

Significant additional insights are provided on the basis of the tax-to-base and base-to GDP estimates for the shorter sample period. Even

[236] Note that the lagged value of the error correction term is negative and statistically significant, as expected, and the lagged value of the (differenced log of) VAT revenues is statistically significant, confirming the evidence on a certain degree of persistence of VAT revenue fluctuations.

though the full implementation of the decomposition approach is not feasible, due to the statistical non-significance of certain coefficients, the corresponding results could still be useful. The already encountered (see Tables 7.5. and 7.6) non-significance of the tax-to-base buoyancy and elasticity appears to be in sharp contrast to the respective benchmark short-run estimates obtained for the total sample period and reported in Table 7.3. However, if combined with the corresponding results presented in Tables 7.5 and 7.6, obtained when controlling for COVID-19 and lockdown effects, respectively, more valid conclusions can be drawn. Based on the entire analysis conducted, it follows that the COVID-19 pandemic exerts such a major impact that it is capable of turning a link, i.e., the one between short-run fluctuations in VAT revenues and the tax base, otherwise not found to exist or to be systematic, into an existent and/or systematic one.

This major general ascertainment can be further used to provide an answer to the question raised earlier with regard to the divergent evidence of Table 7.3 on benchmark short-run tax-to-GDP buoyancy and elasticity estimates obtained via the one-step versus the decomposition approach. On the one hand, the total of the analysis conducted leads to accepting the relevance of the one-step tax-to-GDP buoyancy and elasticity estimates for the total period under investigation, which has been proven to be driven by the pandemic impact. On the other hand, it can be concluded that both tax-to-GDP calculated buoyancy and elasticity terms from the decomposition approach seem to underreport the response of VAT revenues to GDP fluctuations for the total period of investigation, which includes the COVID-19 pandemic. Given the significant impact exerted by the COVID-19 pandemic, in particular on the tax-to-base relation, it follows that in this special case, the decomposition approach does not accurately reflect the underlying short-run response of VAT revenues to GDP fluctuations.

Finally, one comment is worthwhile with regard to tax base volatility arising from short-run fluctuations in GDP, i.e., base-to-GDP buoyancy/elasticity, as estimated when employing the shorter sample period (up to 2019). The base-to-GDP component lies at 0.72, reflecting that the base fluctuates by less than GDP over the short run. This is in contrast to the corresponding results arising on the basis of the total sample period (as reported in Table 7.3) and when controlling for lockdown effects (as reported in Table 7.6 for the non-lockdown period, which, however, still entails some quarters affected by the COVID-19 pandemic), in which cases the COVID-19 time period is not at all or not completely isolated, respectively. At the same time, the above base-to-GDP finding is in accordance with the respective non-COVID-19 period results (as presented in Table 7.5) obtained when controlling for the COVID-19 effects and completely isolating the pandemic period.

Altogether, the above offered analysis provides some explanations for a number of potentially unanticipated and divergent empirical findings reported in the present section, while it helps to more adequately assess the overall validity of the obtained empirical results. More importantly, it again underlines the decisive impact a deep and severe crisis, such as the prevalence of the COVID-19 pandemic, might exert on the relations driving the short-run response of VAT revenues to fluctuations in GDP and the tax base and, to a certain degree, even on basic macroeconomic relations, such as the short-run response of private consumption to fluctuations in GDP.

Finally, it is worth referring to a number of empirical findings from the literature on short-run elasticity relations for relevant tax categories, which appear to be in line with our findings.[237] Controlling for tax rates as a robustness check, hence, practically providing estimations for elasticity, Dudine and Jalles (2018) found a short-run elasticity with respect to GDP not statistically different from one for taxes on goods and services for a sample of advanced economies. In line with our finding, a non-significant short-run relation between tax revenues and the corresponding tax base was also reported by Boschi and d'Addona (2019) for Greece and the category of indirect taxes with regard to the elasticity relation. In a specification including the tax base as an explanatory variable of VAT revenues, where all variables are expressed in differences of logarithms, Danchev et al. (2020) found an insignificant short-run tax-to-base elasticity for Greece.

[237] Here again, this paragraph focuses on a few results regarding the findings on short-run elasticity for Greece, European countries, and other advanced economies. For all details on the respective empirical literature estimates and the associated limitations (regarding the degree of comparability), see Chapter 6.

Havranek et al. (2016) provided a similar finding of a non-significant short-run VAT elasticity with respect to its base for the Czech Republic.

7.6. Discussion and interpretation of the empirical results

The present chapter comprises a comprehensive and multidimensional empirical analysis of VAT revenue buoyancy and elasticity for the case of Greece. The time period under investigation spans from the first quarter of 2000 to the last quarter of 2022, including the prolonged economic crisis and adjustment period from 2008 to 2018 and the severe crisis period caused by the COVID-19 pandemic. On this basis, our econometric analysis substantially contributes to the related empirical literature by complementing the existing scarce evidence for the case of Greece.

Grounded on the disaggregated framework with the focus on the single tax category of VAT, our choices made with regard to the focal dimensions around which the econometric application unfolds are validated by the provided econometric evidence. The emphasis put, in the methodological approach, on specific time dimensions leads to a number of key conclusions with major implications for policymaking and the role extraordinary disturbances can play on the response relations under examination. The importance of the applied stability and consistency analysis, enabled by the sufficient length of the underlying sample period, lies in the reinforcement of the validity of the obtained empirical findings. Confirmatory empirical evidence is also provided through the conduction of a series of robustness checks. Carefully chosen and adequately transformed, whenever necessary, quarterly data, in combination with the relevant law provisions on VAT rate changes, present the basis for the application of the two-stage ECM econometric framework. The latter seems to be ideally suited to the aim of investigating long- and short-run VAT revenue buoyancy and elasticity, alongside adjustment between the two. Moreover, necessary testing procedures are implemented, appropriate estimation techniques are used, and several diagnostics are presented to (i) ensure that the basic variables are related in the long run, (ii) correct for potential estimation issues that could arise, and (iii) strengthen the soundness of the obtained estimation results.

Given the degree of detail and multidimensionality characterizing the obtained empirical evidence, crucial conclusions can be drawn with regard to the overall (buoyancy, including DTM) and the endogenous (elasticity, excluding DTM) response of VAT revenues to basic macroeconomic drivers in the long- and short-run horizon and the adjustment between the two, the ensuing role of DTM, and the major impact special conditions and intermediate and/or long-lasting shocks can exert on the referred response relations.

Our empirical findings on long-run VAT revenue buoyancy and elasticity for the total period under investigation, i.e., the time period from the first quarter of 2000 to the last quarter of 2022, reveal a less than proportional overall and endogenous response of VAT revenues to changes (whether positive or negative) in GDP, against the unity assumption, on the basis of both the one-step and the decomposition approach. In both cases, with the endogenous being very close to the overall response and taking into account the evidence on the investigated VAT rate changes, the investigated DTM are shown to have a neutral effect on tax revenues. As a consequence, in terms of fiscal sustainability, the combination of automatic and (the considered) discretionary changes in VAT revenues taking place during the investigated period does not seem to contribute to further fiscal balance effects. Furthermore, given the less than proportional VAT revenue response to GDP changes, it follows that, during the upward phase of the cycle of the investigated time period, fiscal balance improvements or any additional spending expansion could not be supported through VAT revenues. However, and taking into account that the period under investigation includes a prolonged period of recession and crisis, this might be related, at least to a certain extent, to a moderation of fiscal balance worsening during the total of the long-lasting downward phase of the cycle.

The neutral long-run effect of the investigated DTM on VAT revenues is further confirmed by our findings for the total period under investigation, i.e., the time period from the first quarter of 2000 to the last quarter of 2022, with regard to the VAT long-run revenue response to changes in the tax base, i.e., private consumption, via the evidence on the investigated VAT rate changes and the almost equal corresponding buoyancy and elasticity coefficients. With the latter leading to the adoption of the unity assumption on the basis of their size, proportionality is implied in the long-run response of VAT revenues to changes (whether positive or negative) in their base, whether referring to the endogenous or the overall response, for the time period under investigation. This important finding may have non-negligible implications for fiscal authorities, as the relation between VAT revenues and their base is regarded to lie within the scope of policy and more under the control of the government. In that sense, the obtained results suggest that, in case the aim of fiscal authorities has been to further enhance or weaken this relation (to a more or less than proportional one, depending on the underlying targets and the phase of the business cycle), resorting to increases in the standard and reduced VAT rates was not a successful or effective tool by itself.

The above long-run evidence for VAT revenue buoyancy is further confirmed via the conducted stability analysis. The implications of a less than proportional VAT revenue response driven by changes in GDP and a proportional VAT revenue response following changes in the tax base, over the long run and including the effects of the investigated DTM, are both verified. As might be expected, the stability analysis also validates the relatively stable long-run response of the tax base to GDP changes, in correspondence to the provided basic long-run empirical evidence, being close but not equal to unity. Last but not least, this kind of analysis demonstrates that there seems to be no COVID-19 effect on any of the long-run buoyancy relations and the empirical long-run results are robust to different sample selection periods.

Based on our empirical findings on short-run VAT revenue buoyancy and elasticity, the evidence provided on the short-run VAT revenue response to changes in basic macroeconomic measures unveils the utmost importance of the impact of the COVID-19 pandemic, also confirmed via our consistency analysis, while ECT, business cycle, and growth effects are not found to exist. In more detail, all basic response relations under investigation are altered due to the ensuing disturbance, leading to considerable discrepancies between the empirical results obtained when isolating and not isolating the COVID-19 time period. The combination of our short-run empirical findings resulting from the benchmark, the extended, and the shorter time period analysis reveals the way and the extent to which the exerted shock affects short-run VAT revenue buoyancy and elasticity.

When the time period under investigation includes the COVID-19 pandemic, VAT revenues seem to respond more strongly or even overreact to short-run fluctuations in GDP, whether in the upward or downward direction, potentially suggesting more buoyant spending or precautionary saving and aggravated credit constraints, respectively. In terms of fiscal policy stabilization, this finding would indicate that VAT could be classified as a good source of automatic stabilization in the short-run horizon. However, when completely isolating the pandemic effect, VAT revenues seem to fluctuate equally strongly to fluctuations in GDP, whether in the upward or downward direction, and, hence, do not acquire any additional role with regard to fiscal policy stabilization, operating neither as a good nor as a bad automatic stabilizer in the short run. Taken together, it follows that the COVID-19 pandemic exerts a considerable effect on the short-run response of revenues to GDP fluctuations in the case of VAT, altering the evidence with regard to its potential role as an automatic stabilization tool, depending on the inclusion or exclusion of the respective time period.

More importantly, the inclusion of the COVID-19 pandemic in the examined time period seems to give grounds to a short-run relation between fluctuations in VAT revenues and the tax base, which ranges from a less equivalent to an equivalent and an even stronger short-run VAT revenue response. In sharp contrast, when completely isolating the COVID-19 time period, VAT revenues do not seem to respond in any systematic way to fluctuations in the tax base in the short-run horizon. Such a finding might be associated to a certain degree with lags in VAT revenue collection and recording, leading to a missing systematic link between fluctuations in the base and VAT revenues in the short run, i.e., within one single quarter. It, hence, follows that the COVID-19 pandemic exerts such a major impact that it is capable of turning a non-existent or a non-systematic short-run link into a seemingly existent or apparently systematic one. This can be clearly attributed to the extraordinarily abrupt and deep fluctuations in the tax base, i.e., private consumption, triggered by the pandemic, obviously dragging along VAT revenue fluctuations, thus creating a link in the short-run horizon and altering the finding of an otherwise non-existent one.

Moreover, tax base, i.e., private consumption, volatility arising from short-run fluctuations in GDP also does not seem to remain unaffected by the pandemic. When the time period under investigation includes the COVID-19 pandemic, the base is shown to fluctuate in proportion or even more strongly to GDP over the business cycle. When completely excluding the pandemic period, the base responds less strongly to GDP fluctuations in the short run. This discrepancy once again underlines the decisive impact a deep and severe crisis, such as the prevalence of the COVID-19 pandemic, might exert even on basic macroeconomic relations, like the short-run response of private consumption to fluctuations in GDP.

Furthermore, the conducted short-run empirical analysis on VAT revenue response demonstrates that the implemented DTM under examination do not cause, for the time period under investigation, any additional fluctuations in VAT revenues in the short run. For the total period under investigation, with buoyancy being slightly lower than elasticity, the automatic short-run relations between VAT revenue and GDP fluctuations, and VAT revenue and fluctuations in the tax base, are not found to be enhanced by the implemented DTM under investigation, whether in the upward or downward direction, for the examined time period. Any detected significance of the investigated VAT rate changes might, however, imply that even though DTM do not seem to contribute to further positive fluctuations in VAT revenues during the period of favorable economic conditions, they might contribute to restraining negative short-run fluctuations during the prolonged 2008–2018 period of economic crisis and adjustment in Greece. When splitting time periods for the purposes of investigating the pandemic effects and ending the sample period before the outbreak of the pandemic, our findings confirm in almost all cases that the implemented DTM under investigation do not play an important role in the relevant underlying short-run relations, for the time period under investigation. Here again, any detected significance of the investigated VAT rate changes might be related to the way DTM operate during the prolonged period of economic crisis and adjustment lasting from 2008 to 2018 in Greece, as opposed to the period of favorable economic conditions.

In addition, on the basis of reasonable comparisons between long- and short-run response relations, our empirical findings suggest cases of VAT revenue undershooting or overshooting in the short run, alongside periods of disequilibrium correction ranging from almost one year to almost two years. When the total time period is investigated in the benchmark analysis, the provided evidence indicates short-run revenue overshooting in both the overall (buoyancy relation) and the automatic (elasticity relation) response of VAT revenues to fluctuations in GDP and correction of the ensuing disequilibrium after almost 2 years. At the same time, there are signs of revenue undershooting in the short-run VAT revenue overall response (buoyancy relation) to fluctuations in the tax base and disequilibrium correction after less than one year. In addition, any transitory disequilibrium between the long- and short-run relation characterizing the tax base and GDP needs almost one and a half years to adjust. When splitting time periods for the purposes of investigating the pandemic effects, the relevant indications for any discrepancy between the long- and short-run VAT revenue response to GDP and the associated time for adjustment obtained from the benchmark analysis remain generally valid. Similarity with the indications suggested by the benchmark analysis also holds in almost all cases with regard to the evidence on any discrepancy between the long- and short-run tax base response to GDP and the time needed for disequilibrium correction, with a maximum deviation of two quarters in the latter case.

On the whole, in comparing the provided short-run evidence, it is crucial to stress that the occurrence of the COVID-19 pandemic and the related effects are presumably a one-time event. Moreover, the end of the total period under investigation is close to the end of the pandemic. As a result, it is not yet possible to control for the duration and/or medium- to long-term persistence of the pandemic impact on the investigated VAT revenue response. According to the same line of reasoning, it is not feasible to conclude whether and when VAT revenue response will converge to what seems to be valid for any time interval excluding the COVID-19 pandemic period.

Overall, it follows that a thorough analysis on VAT revenue response should incorporate, alongside a basic long-run reference, both a benchmark and an extended short-run approach, accounting for any extraordinary and severe shocks affecting the economy, such as the COVID-19 pandemic. In addition, it is imperative for policymaking and policy assessment purposes to acquire knowledge on the potential role of the implemented discretionary measures for VAT. Finally, fiscal authorities should control for the stability and robustness of the underlying long-run VAT revenue response relations and regularly reconsider short-run links, in order to always obtain updated evidence and be able to, if necessary, adjust and/or revise VAT policy decisions and enhance policy effectiveness, depending on the prevailing economic conditions.

CHAPTER 8

SPECIFIC ISSUES ON VAT: TAX SHIFTING ON PRICES/ VAT PASS-THROUGH AND VAT GAP

8.1. Introduction

One of the main relations examined in this Study concerns the response of VAT revenues to changes in private consumption, which basically refers to consumer expenditure on goods and services. VAT, as a major consumption tax, is included in the prices of consumer goods, creating a tax burden for consumers (at any given tax structure) and affecting private consumption. However, in the event of a VAT increase in a market economy, this does not mean that the entire tax burden is shifted to consumers. In general, there are various factors that may affect market reactions to changes in indirect tax rates, making the distribution of the tax burden between producers and consumers uncertain (Bernal, 2018). The actual tax shifting on prices, i.e., tax pass-through and the distribution of the tax burden between consumers and producers, is an issue that has attracted considerable research attention, having significant implications for tax policy. Greece, being a country severely affected by the 2008 economic crisis, presents a case of particular interest since several VAT rate increases were imposed during the recession years with the aim to increase public revenue and reduce the deficit (see also Chapter 4).

An additional issue that is particularly relevant for the purposes of the present Study concerns the uncollected and, thus, foregone VAT revenues due to unpaid taxes. While VAT revenue response concepts are – by definition – based on the VAT revenues that are *actually* collected, it is important to keep in mind that these collected revenues are, generally, lower than the total amount of tax due, giving rise to the so-called 'VAT gap'. VAT evasion, fraud, and avoidance are the most common causes of the VAT gap and foregone revenues due to non-compliant behaviors and poor tax administration. The issue of VAT revenue loss in a country's budget is crucial since it may adversely affect public spending, sharing of the tax burden, and industry competition, limiting the capacity of the government to implement its fiscal and economic policies. This is particularly relevant for Greece, which historically exhibits one of the largest VAT gaps among the EU27 member states, representing VAT revenue losses of billions of euros every year (Bank of Greece, 2022). Thus, understanding the scale and causes of the unpaid VAT is of key importance in order to properly assess and tackle the issue of tax revenue loss in the Greek case.

Given the above, this chapter focuses on two specific VAT-related issues that appear to be of considerable policy interest in the context of the current Study, linked to private consumption and VAT revenues. The first one, examined in Section 8.2, concerns the VAT shifting on prices and the distribution of the tax burden. More specifically, drawing on the literature regarding tax shifting on prices (tax pass-through) and tax incidence, we provide empirical evidence for Greece by computing tax shifting parameters and the related consumer share of the tax burden in the case of three VAT increases during 2010 and 2011 for the category of food and non-alcoholic beverages. The second issue, examined in Section 8.3, is based on the VAT gap concept to offer insights into the scale and causes of VAT revenue loss in Greece related to non-compliance with the VAT legislation and the structure of the VAT system. To address this issue, we present and discuss the evolution of Greek VAT gap indicators over time and also in comparison with other EU member states, based on annual estimations produced by the Center for Social and Economic Research (CASE) for the European Commission (EC). Moreover, drawing on the relevant literature, we identify and discuss potential VAT gap determinants and compliance-related factors which are particularly relevant for the Greek case.

8.2. Tax shifting/VAT pass-through and the consumer share of the tax burden: Evidence from Greek VAT increases for food and non-alcoholic beverages

Changes in the structure of VAT regimes may affect prices and the way the tax burden is distributed between consumers and producers. Though the effect is largely uncertain under the conditions of a market economy, knowledge of the extent to which changes in tax rates shift on prices (i.e., tax pass-through) may be crucial for designing and conducting an effective fiscal policy. The case of Greece appears to be of particular interest since VAT rates exhibited successive increases during 2010–2011 in the context of the Stability and Growth Programme and the implementation of the support mechanism for the Greek economy, aiming at increasing public revenue and reducing the fiscal deficit (see Chapter 3).

The purpose of this section is to provide relevant empirical evidence by estimating the extent to which increases in the reduced VAT rates that took place during 2010–2011 in Greece shifted on food and non-alcoholic beverages prices and affected the corresponding consumer tax burden share. In what follows, Section 8.2.1 provides a brief review of the tax pass-through literature, emphasizing the related research gap for Greece. Section 8.2.2 describes the data and methodology used in the relevant empirical application to the Greek sector of food and non-alcoholic beverages, followed by the presentation and discussion of the empirical results in Section 8.2.3. The concluding remarks of the analysis are provided in Section 8.2.4.

8.2.1. Literature on VAT pass-through

The literature on VAT pass-through is rather extensive, providing diverse evidence from different countries and product categories based on various methodological approaches and analytical contexts.[238] VAT changes concerning broader or more limited groups of goods and services at different aggregation levels have been examined, such as food items (Besley and Rosen, 1999; Politi and Mattos, 2011; Bernal, 2018; Gaarder, 2019; Lyssiotou and Savva, 2021; Forteza et al., 2024), beer (Ardalan and Kessing, 2021), clothing (Poterba, 1996), various services categories (Carbonnier, 2007; Kosonen, 2015; Benzarti and Carloni, 2019; Benzarti et al., 2020), as well as diverse product groups including both goods and services (Benkovskis and Fadejeva, 2014; Benedek et al., 2020). Some stud-

[238] The aim of this subsection is to provide a general presentation of extant empirical literature on the issue, emphasizing the related research gap for Greece, and not to analytically review the tax pass-through literature. For an overview of selected studies on VAT pass-through, see Benedek et al. (2020).

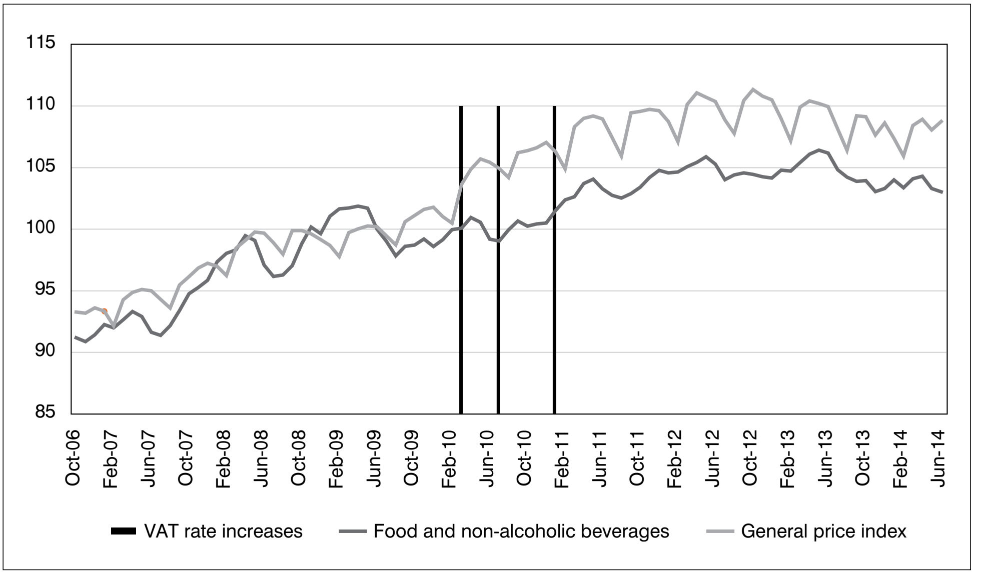
ies explore VAT changes in a large number of European countries (Benedek et al., 2020; Benzarti et al., 2020; Ardalan and Kessing, 2021), though the relevant literature is dominated by studies focusing on specific VAT reforms in individual countries, such as the US (Poterba, 1996; Besley and Rosen, 1999), Brazil (Politi and Mattos, 2011), France (Carbonnier, 2007; Benzarti and Carloni, 2019), Spain (Forteza et al., 2024), Finland (Kosonen, 2015; Benzarti et al., 2020), Poland (Bernal, 2018), Norway (Gaarder, 2019), Cyprus (Lyssiotou and Savva, 2021), and Latvia (Benkovskis and Fadejeva, 2014). The empirical results are largely mixed, with a number of studies finding evidence of less than full pass-through (e.g., Carbonnier, 2007; Kosonen, 2015), while some studies provide evidence on full pass-through or over-shifting (e.g., Gaarder, 2016; Lyssiotou and Savva, 2021).

Related research for Greece is sparse, with assessments of the consumer tax burden share being – to our knowledge – basically absent. An early attempt to explore the effects of the introduction of the VAT in Greece on prices and consumption patterns was made by Andrikopoulos et al. (1993), who used time series data on thirteen commodity groups for the period 1958–1986. Their results showed that the VAT enacted in 1987 had profound effects on the structure of prices, household demand, and the distribution of consumption expenditure between the groups of goods and services under study. More recently, Karabalis and Kondelis (2013) provided computations of the actual size of VAT pass-through to final consumer prices for the years 2010 and 2011 in Greece, focusing on five goods categories (unprocessed food, processed food, non-energy industrial goods, energy, and services). Using computations based on alternative price indices, they found that out of the total increase in VAT rates in 2010 and 2011, about 70% and 60%, respectively, was, on average, passed on to final consumer prices.

8.2.2. Data and methodological approach

For the purposes of the present section, we examine three VAT reforms that took place in Greece during 2010 and 2011 and concern changes in the VAT reduced rate. More specifically, during 2010 the reduced tax rate increased twice: from 9% to 10% on the 15th of March and from 10% to 11% on the 1st of July. A subsequent increase by 2 pp followed, with the reduced VAT reaching a rate of 13% on the 1st of January 2011 (see also Chapter 3). We investigate the potential shifting of these VAT rate increases on the prices of food and non-alcoholic beverages,[239] an important consumption category, since it represents a considerable share of the consumer basket (about 17%–20%) and mostly comprises necessity goods.[240] It also includes (sub)items that are largely subject to the reduced VAT rate.

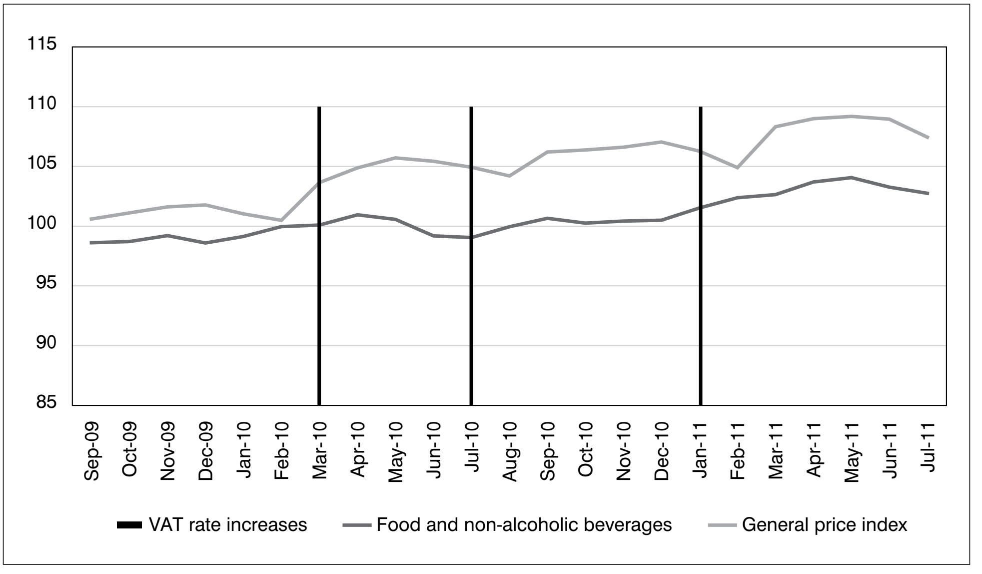
FIGURE 8.1a
Consumer price index for food and non-alcoholic beverages and the general price index, 10.2006–6.2014



[239] Food and non-alcoholic beverages correspond to the division 01 at the 2-digit level of the 'Classification of Individual Consumption According to Purpose' (COICOP).

[240] The related analysis of tax changes for other COICOP categories of potential interest (e.g., hotels and restaurants) require further information and data, given the different tax rates to which many sub-items of these categories are subject. Despite our efforts, accessing such data, collected by the Independent Authority for Public Revenue of the Hellenic Republic (AADE), was not possible, limiting our choices with respect to the examined product categories.

FIGURE 8.1b
Consumer price index for food and non-alcoholic beverages and the general price index, 9.2009–7.2011



Source: ELSTAT.

Notes: Figure 8.1a covers the whole seven-year period under study, that is, 3.5 years before the first VAT reform of 2010 and 3.5 years after the reform of 2011. Figure 8.1b covers a much shorter period around the reforms, that is, six months before the first tax reform of 2010 and six months after the reform of 2011. In both figures, the first vertical line shows the time of the first tax reform under study, i.e., the increase in the reduced VAT rate from 9% to 10% on the 15th of March 2010. The second vertical line shows the time of the second tax reform, i.e., the increase in the reduced VAT rate from 10% to 11% on the 1st of July 2010. The third vertical line shows the time of the last examined VAT reform, i.e., the increase in the reduced VAT rate from 11% to 13% on the 1st of January 2011.

To identify potential tax shifting effects on food and non-alcoholic beverages prices, we first examine graphically the evolution of the corresponding price index around the time of the reforms. Figure 8.1a shows the consumer price index for food and non-alcoholic beverages as well as the general consumer price index over the seven-year period under examination, that is, 3.5 years before the first VAT reform of 2010 and 3.5 years after the reform of 2011. For illustration reasons, Figure 8.1b focuses on a much shorter time window around the reforms, that is, six months before the first tax reform of 2010 and six months after the reform of 2011. We can see that the price index for food and non-alcoholic beverages appears to increase at least for one month following the tax reforms. On the contrary, the general price index appears to decrease shortly after the last two examined reforms, i.e., the VAT increases of July 2010 and January 2011. The most persistent increasing trend in the price index for food and non-alcoholic beverages is observed after the last VAT increase of 2011, which is the largest one (2 pp). However, given the relatively small size of the VAT increases and the fluctuations that the price index for food and non-alcoholic beverages exhibited over the examined period, as particularly shown in Figure 8.1a, these observations do not provide in any case visual evidence of tax pass-through.[241] For this reason, we turn to econometric analysis in order to estimate VAT shifting parameters and compute the related consumer share of the tax burden resulting from the increases in the reduced VAT rate in 2010 and 2011 that took place in Greece and were expected to affect mostly necessity goods (such as those included in the category of food and non-alcoholic beverages).

In methodological terms, to assess, first, the extent to which these tax increases shifted on food and non-alcoholic beverages prices and, second, the corresponding consumer tax burden share, we estimate the following equation, based on Carbonnier (2007):

$$\begin{aligned}\Delta_t(P_{dep}) = \alpha_0 + \sum_{i=1}^{4} \alpha_i \Delta_{t+1-i}(1+\tau) + \beta\Delta_t(P_{overall}) + \sum_{j=1}^{2} \gamma_j \Delta_t(Pcontrol_j) + \\ + \delta\Delta_t(IProd) + d_1 DApr + d_2 DJun + d_3 DJul + \varepsilon_t\,,\end{aligned} \tag{8.1}$$

where P_{dep} is the dependent variable, i.e., the Consumer Price Index (CPI, national index) in food and non-alcoholic beverages; τ is the tax rate; $P_{overall}$ is the general CPI excluding the category of food and non-alcoholic beverages; $Pcontrol_j$ is a vector with j (=1 2) control variables, i.e., the oil prices measured by the global price of Brent Crude oil ($ per barrel)

241 Other studies which provide visual evidence on tax shifting, generally, examine much larger VAT changes. For example, Carbonnier (2007) focuses on reclassifications of specific products and services in France, which amounted to about a 15% decrease in the VAT rate in effect.

and the Import Price Index in Food used as proxies for production costs; and *IProd* denotes the Industrial Production Index used as a proxy for the macroeconomic conditions. Moreover, *DApr*, *DJun*, and *DJul* are month dummies corresponding to the months of April, June, and July, respectively, which are included in the model to control for potential seasonal effects. Δ_t denotes the difference operator between time t and $t-1$, while the error term is represented by ε_t. Finally, α_0 is the constant term, and α_i, β, γ_j, Δ, d_1, d_2 *and* d_3 are the regression coefficients to be estimated. Subscript i takes the values 1, 2, 3, and 4 since we are interested in the effects of the tax increases on the prices of food and non-alcoholic beverages during the four months following the tax rate changes (see Carbonnier, 2007).

All time series data, except those referring to the oil prices, are provided by ELSTAT on a monthly basis and are not seasonally adjusted. The reference year for all indices is 2015. Data on oil prices come from the Federal Reserve Bank of St. Louis. The choice of the control variables is based on the relevant literature (e.g., Carbonnier, 2007; Ardalan and Kessing, 2021) and the availability of monthly data. The time period considered spans from October 2006 to July 2014, covering seven years around the reforms, that is, 3.5 years before the first tax reform of 2010 and 3.5 years after the reform of 2011. The seven-year period is chosen to secure an adequate number of observations as well as to increase the explanatory power of our model, given the relatively large number of independent variables included.[242] Apart from the standard OLS method, we use the Newey-West method to estimate heteroscedasticity- and autocorrelation-consistent standard errors (e.g., Carbonnier, 2007).

The sum of α_i estimates is used to compute the consumer share (CS) according to the following equation (Carbonnier, 2007):

$$CS = f\left(\sum_{i=1}^{4}\alpha_i\right) = \left(\sum_{i=1}^{4}\alpha_i\right)\left(\frac{1+\tau}{1+\tau\sum_{i=1}^{4}\alpha_i}\right). \tag{8.2}$$

[242] Estimating equation (8.1) for a shorter time window (i.e., six, five, or four years) does not alter our main results in any significant way. These results are available upon request.

8.2.3. Empirical results and discussion

TABLE 8.1
2010/2011 VAT rate increase shifting on prices of food and non-alcoholic beverages in Greece

Dependent variable: CPI for food and non-alcoholic beverages (differences)	Standard OLS estimation	OLS with Newey-West standard errors
VAT rate shifting during the 1st month (α_1)	0.319 [0.167]	0.319 [0.016]
VAT rate shifting during the 2nd month (α_2)	0.503 [0.032]	0.503 [0.000]
VAT rate shifting during the 3rd month (α_3)	-0.034 [0.886]	-0.034 [0.853]
VAT rate shifting during the 4th month (α_4)	-0.003 [0.990]	-0.003 [0.991]
CPI overall ($P_{overall}$)	0.080 [0.087]	0.080 [0.053]
Oil prices ($Pcontrol_1$)	-0.029 [0.000]	-0.029 [0.000]
Import Price Index in Food ($Pcontrol_2$)	0.520 [0.000]	0.520 [0.000]
Industrial Production Index (*IProd*)	-0.010 [0.310]	-0.010 [0.310]
Dummy April (*DApr*)	0.005 [0.019]	0.005 [0.001]
Dummy June (*DJun*)	-0.012 [0.000]	-0.012 [0.000]
Dummy July (*DJul*)	-0.008 [0.002]	-0.008 [0.000]
Constant	0.001 [0.130]	0.001 [0.064]
Number of observations	94	94
R^2_{adj}	0.497	0.497

Note: *P*-values are presented in brackets.

The estimation results, using both the standard OLS and OLS with Newey-West standard errors, are reported in Table 8.1. We focus on the results using OLS with Newey-West standard errors since this method, as mentioned above, provides more consistent standard errors. The tax shifting parameters α_1 and α_2 are found statistically significant and relatively high in size, and amount to 0.319 and 0.503, respectively. This means that tax increases shifted on prices during the first two months following the VAT changes under study.

Moreover, using the statistically significant tax shifting parameters, that is, α_1 and α_2, we compute CS on the basis of equation (8.2), and obtain $CS = 0.834$. This result shows that following the investigated VAT rate increases, consumers paid most of the VAT increase on food and non-alcoholic beverages, that is, 83.4%, as opposed to producers, who appear to have paid less than 20%. Hence, consumers bore a considerably larger tax burden share than producers in food and non-alcoholic beverages. However, CS is found to be less than 100%, providing evidence of under-shifting of consumption taxes on prices, in the same direction with related empirical studies (e.g., Carbonnier, 2007; Kosonen, 2015; Bernal, 2018). Also, although employing a completely different methodology, these findings are generally in agreement with those provided by Karabalis and Kondelis (2013) for the Greek case. The extreme economic conditions that prevailed in Greece in the period of the examined VAT reforms as well as market structure characteristics, such as imperfect competition (see, for example, Katz and Rosen, 1985; Delipalla and Keen, 1992), may be particularly relevant for explaining our results.

8.2.4. Concluding remarks

The issue of tax pass-through to the prices of goods and services is of high importance since it has implications for the distribution of the tax burden between producers and consumers which should be taken into consideration in designing and implementing tax policy reforms. In Greece, several indirect tax rate increases took place during the recessionary years, and more specifically over 2010–2011, in the context of the Stability and Growth Programme and the implementation of the support mechanism for the Greek economy aiming at increasing public revenue and reducing the fiscal deficit. However, the VAT shifting effects on prices and, subsequently, on the consumer tax burden share have been inadequately explored. The analysis presented in this section contributes to the tax pass-through literature by providing empirical evidence from Greece. More specifically, it estimates the extent to which three increases in the reduced VAT rates that took place during 2010–2011 shifted on food and non-alcoholic beverages prices and affected the corresponding consumer tax burden share. To this end, proper econometric models are estimated based on relevant literature, taking also into account data availability issues.

Overall, the present analysis suggests that the pass-through of VAT rate increases to the prices of food and non-alcoholic beverages was rather strong, taking place during the first two months following the VAT changes under study. As a result, consumers bore a considerably larger tax burden share, i.e., 83.4%, as compared to the corresponding share for producers, i.e., less than 20%. Even though the VAT rate increases were under-shifted on food and non-alcoholic beverages prices, the relative shares of the tax burden borne by consumers and producers may have significant implications for the Greek tax policy, taking also into account the adverse economic conditions in Greece at the time of the VAT reforms and the importance of the affected market, largely involving necessity goods.

8.3. The Greek VAT gap: Relative performance in the EU, evolution over time, and compliance-related factors

Another issue that is particularly relevant in the context of the current Study concerns the VAT gap as a principal indicator of non-compliance with the VAT legislation as well as an indicator of policy-related inefficiency in the Greek VAT system. The current section examines this significant issue by presenting and discussing the evolution of VAT gap measures in Greece over time and in comparison with other EU member states. In doing so, it provides useful insights into the size and causes of foregone VAT revenues, pointing to specific compliance-related factors in the Greek context.

This section is structured as follows. Section 8.3.1 elaborates on how (non-)compliance and tax fraud are conceptually linked to the 'tax gap' notion in the VAT context, while Section 8.3.2 focuses on VAT gap concepts, indicators, and measurement methods. Section 8.3.3 presents the evolution of Greek VAT gap indicators over time and also in comparison with other EU member states based on estimations produced by the CASE for the EC. Section 8.3.4 presents and discusses the literature focusing on VAT gap determinants and compliance-related factors in the Greek context. Finally, the last section summarizes the main points of the analysis and concludes.

8.3.1. VAT (non-)compliance and the VAT gap

The issue of tax compliance is crucial from research, economic, and policy perspectives since it relates to the impact of (in)effective tax collection on the government budget balance, public spending, sharing of the tax burden, and industry competition. While taxes are essential to raise government revenue, they constitute a burden for taxpayers, motivating non-compliant behavior which results in the government collecting a lower amount of tax than the total amount of tax due. The difference, commonly referred to as the 'tax gap', constitutes a revenue loss for the public budget, which, in turn, negatively affects fiscal policy and the economy (EC, 2018).

Focusing on VAT, the so-called 'self-enforcement mechanism' characterizing common VAT schemes (see Chapter 2) is widely considered one of the main advantages of this tax type, which *a priori* promotes voluntary tax compliance (Kaplanoglou and Rapanos, 2013). The sellers have incentives to charge the tax in order to deduct from the VAT they have collected (output VAT) the amount of tax they have already paid on purchases for their business activities (input VAT). They remit the difference to the tax authorities when output VAT is larger than input VAT or they receive refunds when there are excess credits. However, this credit mechanism allowing for refunds across the whole value chain of a commodity is considered the VAT's 'Achilles heel' (Ebrill et al., 2002), making the VAT susceptible to several types of fraud. Tax evasion is probably the most common type of fraud and refers to deliberately hiding or ignoring one's tax liability, which, in practice, can be realized by underreported sales, tax registration avoidance, non-remittance of collected VAT, false claims for credit or refund, etc. Other types of organized VAT fraud include criminal activities, often in the context of the ‘shadow’ or ‘underground’ economy, which are generally punishable under criminal law. This category also includes scams in cross-border transactions which, in the case of the EU, are based on the VAT exemption on intra-Community supplies of goods and the abuse of the right to claim the input VAT deduction (e.g., Zídková and Pavel, 2016). Indeed, the taxation mechanism of intra-Community transactions allows fraudsters to design and apply various fraud schemes, such as the ‘missing trader intra-Community fraud’, sometimes also called ‘carousel fraud’ (EC, 2018; Hoza, 2022).[243]

The cost of VAT fraud and avoidance[244] for EU member states’ budgets is particularly high, amounting to billions of euros every year (EC, 2018). In Greece, the issue appears to be chronic and more acute than in many other developed countries (e.g., DiaNEOsis, 2016; Bank of Greece, 2022), taking also into account that VAT represents a large share of total tax revenue (see Chapter 4). Indicatively, DiaNEOsis (2016) estimated the revenue loss due to VAT fraud for 2013 to 3.5% of the Greek GDP, while more recently, the related analysis for 2019 undertaken by the Bank of Greece (2022) revealed that for every €3 due under the current tax system, almost €1 was not collected. The main factors behind VAT revenue losses in Greece, generally, refer to the quality of tax administration, the complexity of legislation and its frequent changes, and the high VAT rates, along with ineffective audit mechanisms and lack of a tax compliance culture (Bank of Greece, 2022).

However, apart from VAT fraud, evasion, and avoidance, i.e., the most common causes of VAT non-compliance and foregone VAT revenue mentioned above, there exist other factors which may result in non-compliant behaviors. Such factors refer to unintended actions of taxpayers including bankruptcies, financial insolvencies, and miscalculations. A rather popular measure of VAT non-compliance, constituting, at the same time, a

[243] For a more detailed presentation and description of the forms of VAT fraud, see Keen and Smith (2006) and EC (2018).

[244] Contrary to tax evasion, tax avoidance refers to the use of *legal* methods to reduce tax liability.

measure of VAT revenue lost due to the above factors, is the so-called 'VAT gap'. Measuring VAT gaps at a national and/or international level contributes to a better understanding of the scale and structure of the public revenue loss due to non-compliance, which may be a useful step in tackling ineffective tax collection and VAT fraud (EC, 2016).

8.3.2. VAT gap: Concept, terminology, measures, and methods

The concept of the 'VAT gap', generally, refers to the public revenue lost in an economy due to unpaid VAT, and it is commonly quantified on the basis of the difference between the theoretically collectable[245] and actually collected revenue (e.g., EC/CASE, 2013). However, there exists a rather high variation in definitions, terminology, and measures used to approach this concept depending on the scope, the purpose, and the specificities of relevant analyses commonly utilized for tax authorities' and policymakers' purposes. Irrespective of this variation, the VAT gap is conceptually related to tax (non-)compliance and the performance of the tax administrations or the whole VAT system.

At the EU level, the VAT gap has received increasing attention in the last decades and has been systematically studied on an annual basis since 2013, when the first VAT gap report was prepared by the CASE for the EC (referred to as 'EC/CASE reports' hereafter).[246] Up to now, 10 relevant EC/CASE reports have been published which provide estimates of VAT gap indicators for the EU member states with a two-year time lag. Despite the revisions that the VAT gap estimations have occasionally undergone – mostly with respect to methodology – the way the VAT gap is conceptualized in the EC/CASE studies has remained more or less the same. Specifically, the VAT gap is defined as the difference between the tax revenue that would be collected in the case of full compliance (assuming an

[245] The theoretically collectable revenue is defined according to the context of the individual analyses. It commonly refers to the revenue that could be collected in the case of full compliance under the current VAT system or under a VAT system with a uniform rate applied to the entire potential tax base.

[246] In fact, the EC/CASE report of 2013 entitled 'Study to quantify and analyse the VAT gap in the EU-27 member states' followed the seminal respective study of 2009, prepared by Reckon LLP Data analysis (EC/Reckon, 2009).

unchanged tax base), referred to as the VAT Total Liability (VTTL), and the actual revenue, that is, the amount of VAT actually collected (e.g., EC/CASE, 2022). This measure is considered to capture overall non-compliance in VAT; thus, it is usually referred to as the 'VAT compliance gap'. Even though it can be measured in absolute terms, it is commonly expressed in relative terms, i.e., in relation to the VTTL, as shown in the following expression:

$$\text{VAT compliance gap} = (\text{VTTL} - \text{VAT revenue}) / \text{VTTL}. \tag{8.3}$$

A related but distinguishable VAT gap concept is that of the 'VAT policy gap', which is used to assess the relative impact of reduced rates and exemptions on revenue losses. It is defined as the difference between the potential (theoretical) revenue that could be collected in a VAT system with a uniform rate and the broadest possible base, the so-called 'Notional Ideal Revenue' (NIR), and the VTTL. The VAT policy gap is an indicator of the additional VAT revenue that could theoretically be raised if a uniform VAT rate is levied on all final consumption with perfect enforcement. It is commonly expressed in relative terms, i.e., in relation to the NIR, as shown in the following expression:

$$\text{VAT policy gap} = (\text{NIR} - \text{VTTL}) / \text{NIR}. \tag{8.4}$$

The VAT policy gap can be subsequently decomposed into the rate gap and the exemption gap in order to provide further insight into the way different elements of the VAT system contribute to the loss of VAT revenue. More specifically, the rate gap captures the loss in VAT liability due to the application of reduced rates, while the exemption gap represents the loss in liability due to the implementation of exemptions and exclusions from the tax base (EC/CASE, 2022).[247] In the EC/CASE reports, the rate gap and the exemption gap compose the policy gap in an additive way, i.e.:

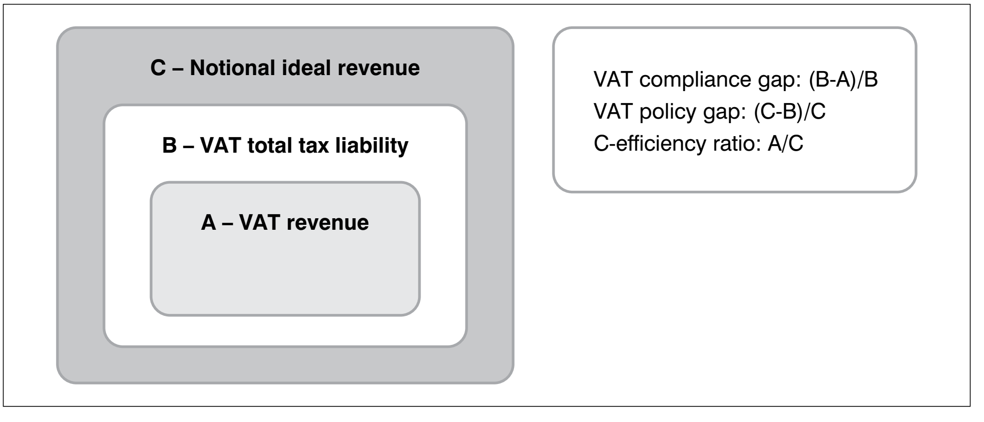
$$\text{VAT policy gap} = \text{VAT rate gap} + \text{VAT exemption gap}. \tag{8.5}$$

[247] For a more formal definition of the rate gap and the policy gap, see, for example, EC/CASE (2022).

However, alternative decompositions have been proposed, such as that of Keen (2013), who decomposes the policy gap indicator *multiplicatively* into the rate and exemption gaps.

Overall, the VAT revenue losses can be attributed to non-compliance, as measured by the VAT compliance gap, and the policy choices reflected in the design of the VAT system (i.e., different types of preferential treatment, such as exemptions, exclusions from the tax base, and reduced rates), as captured by the VAT policy gap. A measure of these revenue losses altogether is based on the concept of the 'C-efficiency (ratio)' which is, in fact, the ratio of the actual VAT revenue to the NIR. Notably, it is usually considered as an indicator of the departure of the VAT system from a perfectly enforced tax levied at a uniform rate on all final consumption (EC/CASE, 2022).[248] Figure 8.2 illustrates the key concepts referring to the VAT compliance gap, the VAT policy gap, and the C-efficiency (ratio).

FIGURE 8.2
VAT compliance gap, VAT policy gap and C-efficiency ratio



Source: Adjusted from EC/CASE (2022), Figure 1 (p. 19).

248 To be more precise, the departure from an ideal VAT system with a perfectly enforced tax levied at a uniform rate on all final consumption is given by '1 - C-Efficiency', which is, in fact, a proxy of the overall gap, i.e., both the compliance and policy gaps (e.g., EC/CASE, 2022). On the measure of C-efficiency, see also Chapter 2.

Another VAT gap measure which builds on the C-efficiency concept is the 'VAT Revenue Ratio' (VRR), which is defined as the ratio of the actual VAT revenues to the entire potential tax base (that is, total final consumption in practice) multiplied by the VAT standard rate, expressed as a percentage. In effect, VRR is used to measure the difference between the VAT revenue that would theoretically be raised if VAT were uniformly applied at the standard rate to the entire potential tax base with perfect enforcement[249] and the revenue actually collected under a country's VAT regime. The VRR measure has been computed for OECD countries since 2010, in the biennial publication of the OECD on 'Consumption Tax Trends'.[250] It provides an indicator of the overall performance of VAT that measures losses in VAT revenue associated with exemptions and reduced rates, fraud, evasion, and tax planning (OECD, 2022a). As such, it can support policymakers in assessing the revenue-raising performance of their VAT system, but it is not considered, on its own, adequate to assess either VAT compliance or administrative effort (EC/CASE, 2013).

The IMF has also been engaged with the conceptualization and quantification of the VAT gap in the context of the Revenue Administration Gap Analysis Program (RA-GAP), which is intended to develop a methodology to estimate VAT gaps and provide national administrations worldwide with technical assistance to produce their own estimates (Hutton, 2017).[251] In the IMF RA-GAP framework, the (overall) tax gap is defined with respect to a reference policy structure, i.e., a standard rate applied to all final consumption, and can be decomposed into a compliance gap and a policy gap in an analogous way, as in the EC/CASE reports.[252] Figure 8.3 shows graphically the (overall) tax gap, which is calculated as the difference between 'reference potential revenue', represented by area 'ACHE', and actual revenue, given by area 'ABFD'. Accordingly, the compliance gap is

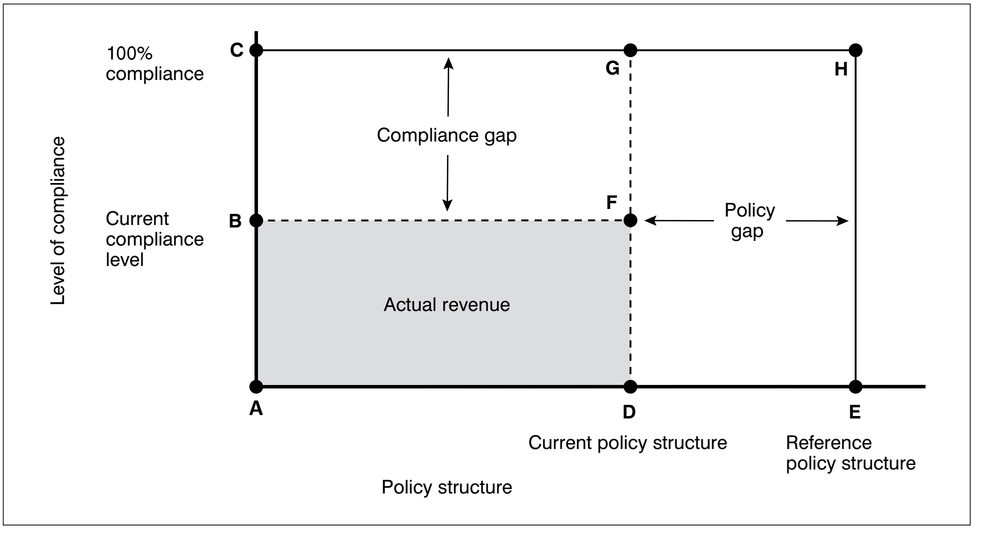
[249] This is, in fact, the NIR using the terminology adopted in EC/CACE reports.

[250] More information is available at: <https://www.oecd-ilibrary.org/taxation/consumption-tax-trends_19990979>.

[251] In the EU, member states who particularly benefited from the RA-GAP include Estonia, Finland, Denmark, Portugal, and the Slovak Republic (EC, 2016).

[252] Note, however, that under the IMF RA-GAP, the term 'VAT (or tax) gap' refers to the *overall* gap, while in the EC/CACE reports, it refers to the VAT *compliance* gap.

FIGURE 8.3
Compliance gap and policy gap in the IMF RA-GAP



Source: Hutton, E. (2017), Figure 1 (p. 5).

computed by the difference between potential revenue under the current policy structure, that is, 'current potential revenue' (area 'ACGD'), and actual revenue (area 'ABFD'). The policy gap can be expressed as the difference between the reference potential revenue (area 'ACHE'), and current potential revenue, (area 'ACGD'), or as the difference between the (overall) tax gap and the compliance gap.

From a methodological perspective, the studies that estimate VAT gaps employ, in general, two types of approaches: (a) 'top-down' approaches, which comprise macro or indirect methods, and (b) 'bottom-up' approaches, which involve micro or direct methods. 'Top-down' approaches rely on aggregate (macro-level) data sources, primarily National Accounts, for estimating the size of the entire tax base and, consequently, the theoretical tax liability required for computing the tax gap. On the contrary, 'bottom-up' approaches use micro-level data sources, such as tax returns, audits, random enquiry programs, risk registers, or surveys, which usually concern a fraction of the tax base. Although these approaches can provide valuable insights into compliance behaviors and risks, allowing for the identification of the sources of the tax gap, their results may concern specific taxpayer groups and are costlier to execute than top-down approaches (e.g. Hutton, 2017).[253] A further distinction is commonly made between a 'consumption-side' or 'demand-based' approach and a 'production-side' or 'value-added-based' approach within the first type, i.e., top-down approaches. Consumption-side methodologies focus on the last link in the VAT chain, while production-side methodologies consider VAT liability and payments by each sector of economic activity, thus enabling the production of VAT gap estimates on a sector-by-sector basis.[254] Despite this advantage in comparison to consumption-side approaches, production-side approaches have been associated with difficulties and problems regarding the misalignment of data sources, the unavailability of data, and the margin of error in estimations (EC/CASE, 2022).[255]

8.3.3. Greek VAT compliance gap and policy gap: Relative performance in the EU and evolution over time

To our knowledge, published research focusing on the measurement of the VAT compliance and/or policy gap in the Greek case is scarce. Recently, Eriotis et al. (2021) computed the VAT gap for Greece over the 2000–2018 period based on the VRR proposed by the OECD, as described above. They also used the approach of Keen (2013) to decompose the inefficiency measures derived from the VRR estimates into compliance and policy gaps. The VRR values reported in the article vary between 0.36 and 0.52, suggesting that the overall inefficiency in the Greek VAT system was 48%–64% in the examined period. The

[253] For a thorough comparative analysis of 'top-down' and 'bottom-up' approaches, see, indicatively, EC/CASE (2022).

[254] A 'consumption-side' approach is adopted in the EC/CASE VAT gap reports, while a 'production-side' approach is used in the IMF RA-GAP.

[255] Other approaches based on econometric techniques and more sophisticated methodologies have also been applied in the VAT gap literature, though they have been largely questioned for their usefulness for tax administration purposes (Hutton, 2017; EC/CASE, 2022). For an interesting application of the Stochastic Frontier Analysis framework in the VAT gap estimation, see Nerudová and Dobranschi (2019).

compliance and policy gap values ranged between 0.22 and 0.39, with the compliance gap exceeding the policy gap in most of the years under study. For 2018, the last examined year, the estimates provided by Eriotis et al. (2021) showed that the Greek VAT system was characterized by 56% inefficiency, decomposed into a compliance gap of 31% and a policy gap of 25%.

The analysis that follows is based on estimates for the VAT compliance and policy gaps in Greece provided by the EC/CASE.[256] These estimates are produced on an annual basis with a two-year lag using a standardized approach[257] which enables the comparative analysis of the Greek VAT gap indicators over time as well as against other EU member states. For consistency and comparison reasons, the analysis is solely based on the data provided in the last, i.e., the 10th, relevant publication (EC/CASE, 2022). The estimates presented cover the five-year period 2016–2020, while a VAT compliance gap forecast is also provided for 2021 using a simplified methodology.[258] In addition, the 2022 EC/CASE publication provides updated and backwards revised VAT compliance gap estimates that cover the 2000–2015 period.[259]

Focusing, first, on the relative position of Greece in the EU27 with respect to VAT compliance, Figure 8.4 shows that in 2020, Greece exhibited the fourth largest compliance gap, i.e., 19.73% (of the VTTL), which amounted to €3,178 million. Only three countries showed higher compliance gaps, namely Italy, Malta, and Romania, with the latter's gap exceeding 35%. The compliance gap for the whole EU27 was considera-

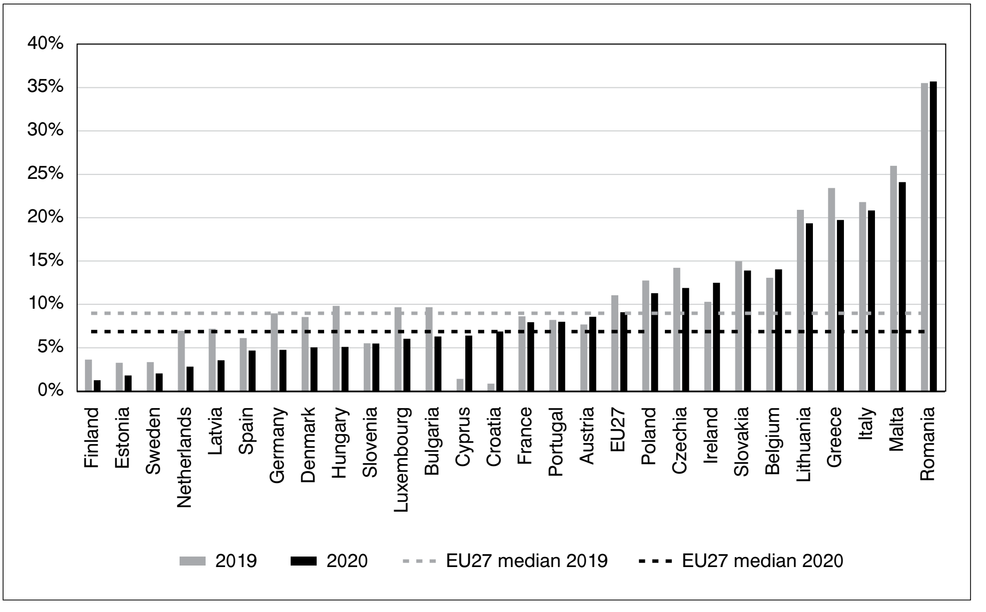
[256] AADE in Greece, as most other EU member states' administrations, has prepared its own national VAT gap estimates on an annual basis since 2018. However, for the purposes of the current Study, these estimates were not considered since they (a) are not publicly available, (b) cover a relatively short time period (2014–2022), and (c) may lead to inconsistent comparative analyses across member states who use respective estimations for other member states derived from different sources.

[257] For a detailed description of the methodology and the data used in the EU VAT gap calculations, see EC/CASE (2022).

[258] These are the so-called 'fast estimates'. For more information, see EC/CASE (2022), p. 178.

[259] For more information on the sources of the relevant revisions, see EC/CASE (2022), p. 178.

FIGURE 8.4
VAT compliance gap (% of VTTL) for the EU27 countries, 2019 vs 2020



Source: EC/CASE (2022).

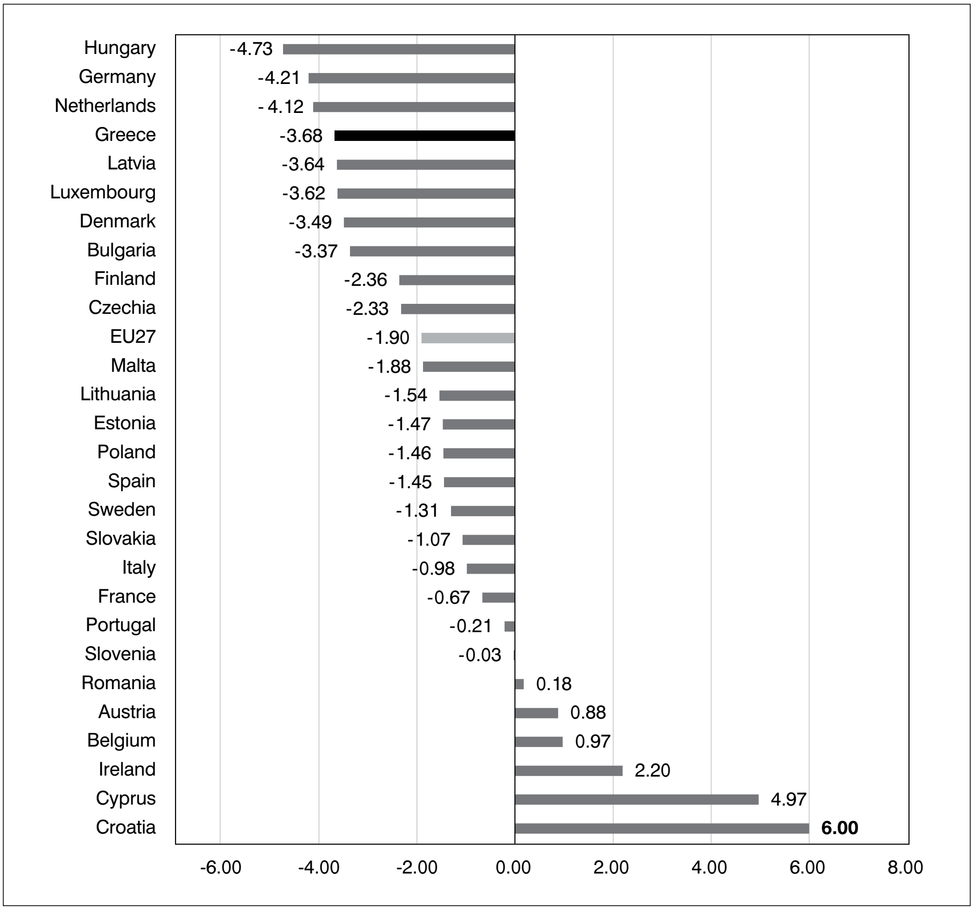
bly smaller, i.e., 9.05%,[260] while the EU27 median was even lower, i.e., 6.86%.[261] However, as shown in Figure 8.5, the Greek VAT compliance gap decreased by 3.7 pp compared to 2019, implying significant improvement in compliance between 2019 and 2020. In fact, this gap reduction was the fourth largest in the EU27, after Hungary, Germany, and the Netherlands, exceeding the corresponding decrease of 1.9 pp in the EU27 compliance gap.

The relative performance of Greece with respect to VAT compliance has been traditionally poor, as demonstrated by Figure 8.6, which

[260] The EU27 VAT compliance gap has been computed as the difference between VTTL and VAT revenues in the EU27, expressed as a percentage of VTTL.

[261] This is because the EU27 VAT compliance gap is largely affected by the extreme gap values in the least compliant VAT systems.

FIGURE 8.5
Change in the VAT compliance gap for the EU27 countries between 2019 and 2020 (in pp)

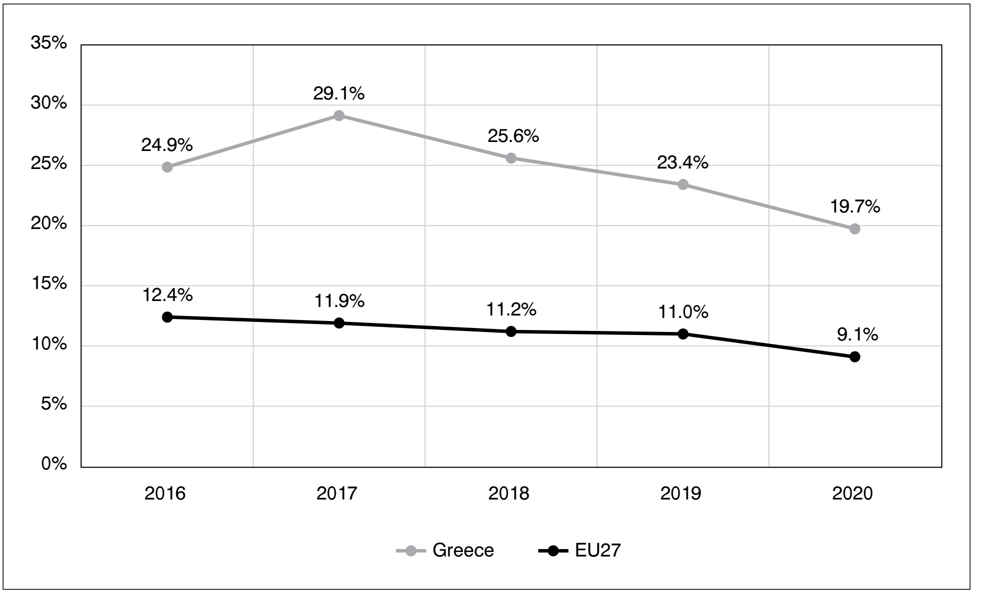


Source: EC/CASE (2022).

shows the evolution of the Greek VAT compliance gap compared to that of the corresponding EU27 measure over the five-year period under study (2016–2020).[262] The Greek VAT gap appears to be more than

[262] Estimations for the EU27 VAT gap are not provided in the relevant report before 2016.

FIGURE 8.6
VAT compliance gap (% of VTTL) for Greece and the EU27, 2016–2020

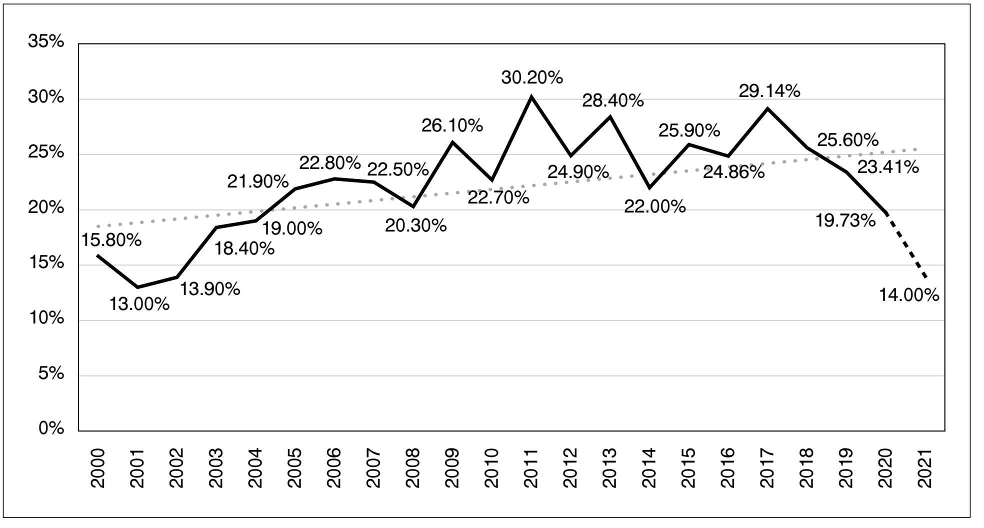


Source: EC/CASE (2022).

double the EU27 VAT gap in all examined years; however, a convergence trend is observed after 2017. Following a sharp increase by 4.2 pp in 2017, the Greek VAT gap decreased at a faster rate than the corresponding measure in the EU27 in the subsequent years. More specifically, the compliance gap in Greece decreased by 9.4 pp between 2017 and 2020, while the corresponding reduction for the EU27 was only 2.8 pp, indicating a greater improvement in VAT compliance in Greece compared to other EU27 member states. This improvement is largely attributed to the increasing use of electronic payment instruments since 2015 (Bank of Greece, 2022).[263]

[263] For a list of the most important policy initiatives and measures undertaken by Greek governments since 2010 to promote electronic payments and, more generally, to improve VAT collection, combat VAT fraud, and enhance tax compliance, see Appendix B. We thank two anonymous referees for the related suggestions.

FIGURE 8.7
VAT compliance gap for Greece (% of VTTL), 2000–2021



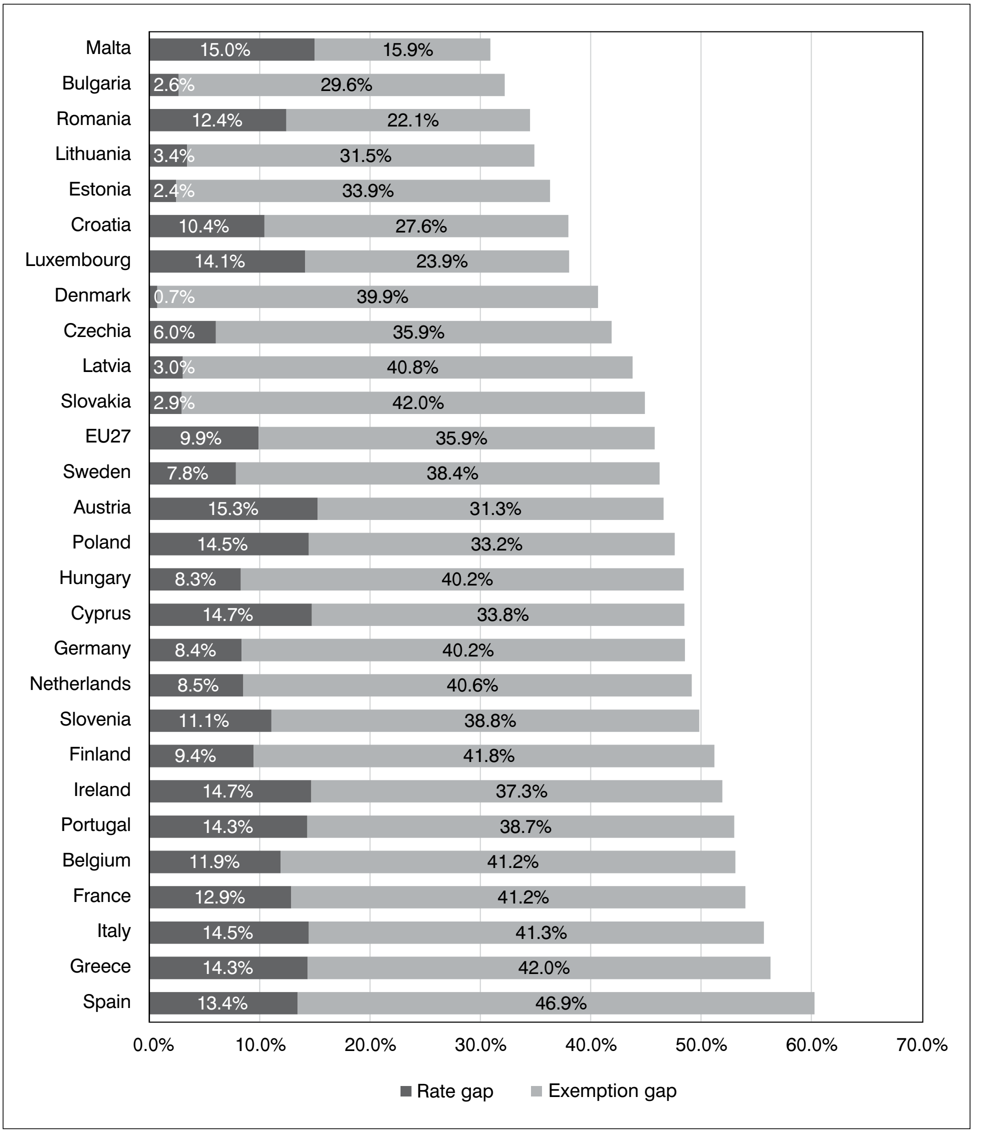
Source: EC/CASE (2022).

Notes: The dotted line shows the linear trend over the whole period. The dashed line shows the forecast for 2021 based on the 'fast estimates' as described in the EC/CASE 2022 report.

Additional information is provided if we examine the evolution of the Greek VAT compliance gap in a longer term, that is, from 2000 onwards, illustrated in Figure 8.7. Evidently, the compliance indicator exhibited considerable fluctuation over the 2000–2021 period, attaining its highest value in 2011 (30.2%) and its lowest value in 2001 (13.0%). The gap has shown a significant upward tendency, even before the economic crisis, with its value increasing by more than 7 pp between 2001 and 2008. The particularly high values (above 20%) after 2008 were driven by collapsing revenues, despite a number of rate increases, as a result of the strong recession in the economy (EC/CASE, 2013). However, the rather sharp downward trend which has been observed since 2017 is expected to persist in 2021 as well, with the forecasted value for 2021 indicating a further considerable decline in the compliance gap by 5.7 pp.

Turning next to policy-related sources of inefficiency in the VAT system, Figure 8.8 shows the policy gap and its decomposition into the rate

FIGURE 8.8
VAT policy gap, rate gap, and exemption gap for the EU27 countries (% of NIR), 2020



Source: EC/CASE (2022).

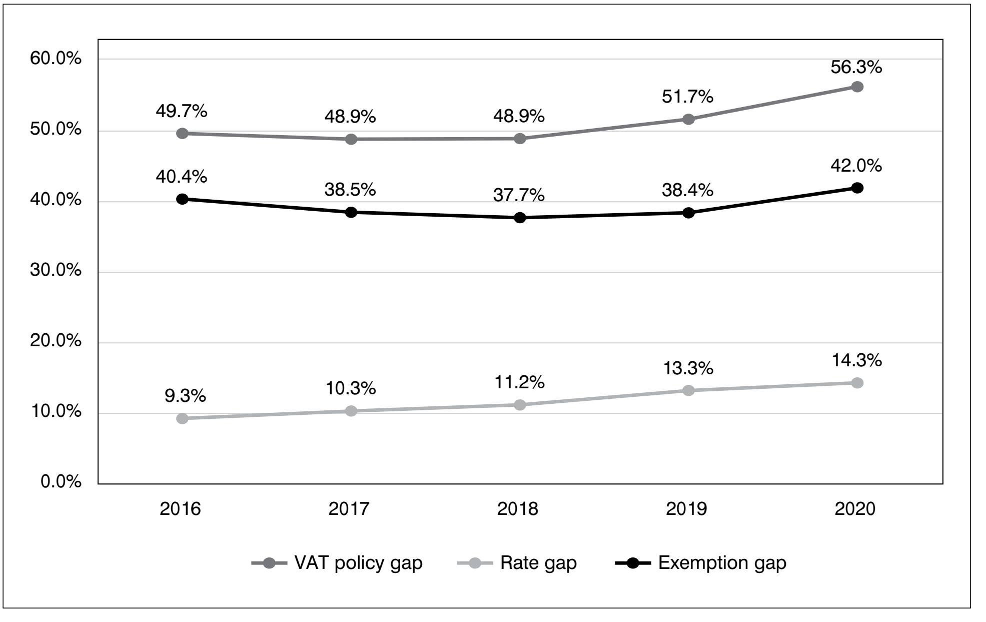
Note: The gap values for the EU27 have been computed as the average value of the corresponding gap measures for all member states.

and the exemption gap (as percentages of the NIR) for all member states in 2020. We observe that Greece exhibited the second highest policy gap in the EU27 after Spain, that is, 56.3%, which amounted to €20,747 million. This means that the VAT that could be levied in the case of full compliance generates 43.7% of what could have been generated if all the exemptions and reduced rates had been abolished and all final consumption had been taxed. However, it must be noted that in 2020, the policy gap indicators are rather high in most member states, ranging from 30.9% in Malta up to 60.3% in Spain. The average EU27 policy gap increased to 45.8% in 2020 from around 44.5% of the previous year, as a consequence of the additional measures introduced to mitigate the economic impact of the COVID-19 pandemic (EC/CASE, 2022).

The decomposition of the policy gap provides further insight into the causes of this gap, that is, the extent to which the revenue loss is due to the application of reduced and super-reduced rates and the extent to which it is due to exemptions. As shown in Figure 8.8, of the 56.3% policy gap in Greece, in 2020, about 14.3% can be attributed to reduced rates and 42.0% to exemptions, with the average values for the EU27 being 9.9% and 35.9%, respectively. Greece was among the nine member states in the EU27 with a rate gap of over 14% and one of the three member states (along with Slovakia and Spain) with the highest exemption gap (over 42%).

Examining the Greek policy gap over time (2016–2020) based on Figure 8.9, we observe a small decrease in its percentage value between 2016 and 2017, and no change between 2017 and 2018. This rather stabilizing trend was driven by changes in its components in the opposite direction, i.e., increases in the rate gap and reductions in the exemption gap during the respective years. However, a clear upward trend in all gap measures related to policy choices is observed in the subsequent years, that is, since 2018. The increase of 2.8% in 2019 may relate to the reclassifications of selected food and drink services from the standard 24% rate to the reduced 13% rate, along with the reclassification of domestic gas and electricity from the reduced 13% rate to the super-reduced rate of 6% (EC/CASE, 2021). In the following year, the policy gap increased even more substantially, i.e., by 4.6 pp, a change largely attributed to temporary rate cuts on a broad list of goods and services in re-

FIGURE 8.9
VAT policy gap, rate gap, and exemption gap (% of NIR) for Greece, 2016–2020



Source: EC/CASE (2022).

sponse to the COVID-19 pandemic effects in 2020 (EC/CASE, 2022).[264] Overall, the C-efficiency of the Greek VAT system was relatively low in 2020 (37.5%), due to the combined effect of high policy and compliance gaps (EC/CASE, 2022), as described above.

8.3.4. Determinants of the Greek VAT gap and compliance-related factors

In general, the empirical literature exploring the factors that are likely to affect the VAT gap is rather extensive. At the EU level, a number of studies have examined the impact of a variety of economic, social, and institution-

[264] For more details, see also Chapter 3.

al factors on VAT gap measures using data from the EU member states (including Greece). In general, these studies exhibit great discrepancies in terms of model specification, data, methodology, and results.[265] For instance, the study of EC/Reckon (2009), using data from 23 EU member states over the 2000–2006 period, found that VAT gaps were significantly higher in countries with weaker legal institutions as well as higher perceived levels of corruption. The econometric results presented in the 2013 EC/CASE report, for a longer period (2000–2011), showed that the VAT gap widened as tax rates increased (at least in countries with weaker tax enforcement) and during recessions. Focusing also on the 2000–2011 period for the 27 EU member states and considering 21 potential determinants of VAT compliance, the empirical study of Zídková and Pavel (2016) revealed that decreases in the ratio of VAT revenues to GDP and increases in the standard VAT rate, as well as in the difference between the standard and reduced VAT rates, resulted in a growing VAT gap.

The econometric analysis in the 2018 EC/CASE report for 28 EU member states and the period 2000–2015 pointed to a number of factors as significant drivers of the VAT gap, including the productive structure of the economy, unemployment, the dispersion of tax rates, and tax administration. These results were largely confirmed by the subsequent 2019 EC/CASE study. The EC/CASE studies that followed in the years 2020–2022 significantly extended the set of explanatory variables used in the VAT gap model, grouping them in four categories, namely, tax policy characteristics, macroeconomic variables, economic structure, and tax fraud proxies. The econometric analyses of the 2020 and 2021 EC/CASE reports underlined the role of GDP growth, general government balance, and the share of information and technology expenditure over total administrative costs in explaining the size of the VAT gap. The last EC/CASE study, which reported a significant decline in the EU27 VAT gap in 2020 following the outbreak of the COVID-19 pandemic, identified government policies, and more specifically, the support measures implemented by

[265] Reviews of the empirical evidence on the determinants of the VAT gap are included in the relevant studies of EC/Reckon (2009), Zídková and Pavel (2016), and Kelm (2022).

member states to deal with the pandemic's effects, as the main driving force of the increased compliance. Finally, Kelm (2022), using data from 21 EU countries over the 2000–2016 period, found that the business cycle and the country's share of intra-EU trade were significant determinants of the VAT gap in the EU countries.

Despite the considerable research at the EU level, the relevant empirical evidence focusing on Greece is rather limited. Using data over the 1997–2018 period, Eriotis et al. (2021) explored the potential influence of 12 economic, fiscal, and social factors on the Greek VAT gap measured on the basis of the OECD's VRR indicator, thus capturing revenue losses due to both non-compliance and policy choices. Overall, they provided empirical evidence on the significant role of five out of the 12 examined variables in 'shaping' the Greek VAT gap. On the one hand, the ratio of VAT to total taxes and the number of tax audits were found to decrease the Greek VAT gap. On the other hand, the gross value added/GDP ratio, the final government consumption expenditure, and the difference between the standard and reduced VAT rates appeared to increase the VAT gap measure employed in the study. On the basis of their last finding, they argued against the use of a 'significantly-lower-than-the-standard reduced VAT rate', since increasing the difference between the normal rate and reduced rates and the existence of zero rates would widen the VAT gap (Eriotis et al., 2021).

In a follow-up study, Christou et al. (2021) examined the potential effect of the sectoral distribution of the Greek economy on the VAT gap during the same period, that is, 1997–2018. To this end, they used the computations of the VRR from Eriotis et al. (2021) as a measure of the Greek VAT gap. They also used the value-added shares of the economic sectors to the total value-added as proxies of the relative size of the economic sectors. In total, fifteen explanatory variables were constructed, corresponding to fifteen economic sectors, based on the NACE rev. 2 statistical classification of economic activities. Their econometric results showed that the relative size of four economic sectors had a significant effect on the Greek VAT gap. More specifically, they found that increases in the value-added share of the Catering and Accommodation services sector, the Public Administration sector, and the Agriculture sector were associated with increases in the VAT gap, while increases in the relative size of the Manufacturing sector were associated with decreases in the VAT gap. The authors explained their results on the grounds of the sector-specific and country-specific characteristics of the Greek enterprises and organizations. In particular, the effects of the shares of the Public Administration and Agriculture sectors leading to VAT gap increases were attributed to the fact that all government expenditure is exempt from VAT in Greece and to the difficulty of taxing the Agriculture sector, along with a special VAT scheme based on exemptions and reduced rates which is applied to the agricultural products. Also, the contribution of the Catering and Accommodation services to the Greek VAT gap was attributed to the high levels of non-compliance due to tax evasion or even connection with the shadow economy. Finally, the effect of the relative size of the industrial sector leading to VAT gap decreases was explained on the grounds of the accounting practices used by manufacturing firms and the knowledge of their tax obligations.

In an attempt to explain the particularly high levels of non-compliance with the tax law in Greece, Kaplanoglou and Rapanos (2013) underscored the role of the structural characteristics of the Greek economy[266] in conjunction with major persistent failures and disfunctions of the Greek tax system, including weak tax administration and enforcement mechanisms, inefficient tax collection, and the lack of effective dispute resolution mechanisms. Indeed, early evidence provided by Kaplanoglou and Newbery (2003) specifically questioned the Greek indirect tax structure on the basis of its complexity and flux, which resulted in high administration costs, lax tax enforcement, and low compliance. Subsequent relevant studies highlighted the adverse distributional effects of the indirect tax hikes adopted during the Greek economic crisis, yet emphasized that it could not be safely argued that the household indirect tax burden was reduced due to the widespread indirect tax evasion implied by the EC's VAT compliance gap estimates (Kaplanoglou, 2015; Kaplanoglou and Rapanos, 2018; Kaplanoglou, 2022). Being also critical of the Greek VAT system, Kalliampakos and Kotzama-

[266] The business sector in Greece is dominated by self-employment and micro firms, making tax auditing a challenging task for the tax administration.

ni (2018) proposed a tax reform for Greece comprising a standard VAT rate of 20% and a reduced rate of 10%, arguing for its anticipated effectiveness in terms of increased VAT collectability, on the one hand, and anticipated improved compliance due to reduced tax evasion and avoidance, on the other hand.

Another major factor that is considered critical for voluntary tax compliance is the level of trust in national institutions and/or the government, which seems to be particularly low in the case of Greece due to perceived corruption and the unfairness of the tax system (Kaplanoglou and Rapanos, 2013; Skintzi, 2015). In a more general context, Kaplanoglou et al. (2016) examined firms' tax compliance behavior using experimental data from a survey of 550 micro and small enterprises in Greece during 2013. Their results suggested that trust in the government plays a much more important role than the fear of tax authorities in intended compliance. Nevertheless, toughening the profile of tax authorities, that is, the strategy that has been followed in Greece, may be the only viable short-term response to increase enforced tax compliance. In a similar line, Tagkalakis (2013b) found that the intensification of tax audits in Greece can be a useful enforcement tool of tax law contributing to the deterrence of tax evasion and to the rise in tax collection efficiency.

In a different setting, examining the determinants of VAT efficiency – based on the C-efficiency notion – during 2000–2012 in Greece, Tagkalakis (2014a) found a positive relationship between VAT efficiency and economic activity, showing that VAT efficiency declines during contractions. Importantly, he identified increased tax evasion as a significant channel through which adverse economic conditions negatively affect VAT efficiency. Discussing potential policy implications of his results, Tagkalakis (2014a) highlighted the need for strengthening the tax enforcement mechanism to combat tax evasion, while he appeared skeptical about further increasing tax obligations since this would not necessarily translate into increased revenue, especially in recession periods. Finally, Hondroyiannis and Papaoikonomou (2017) and, more recently, Danchev et al. (2020) provided empirical evidence suggesting that the greater use of electronic payments in transactions since 2015 had a significant positive impact on tax compliance boosting fiscal revenues in Greece.

8.3.5. Concluding remarks

The effective collection of taxes is widely considered a cornerstone of a fair taxation system, which is closely related to effective tax administration and high tax compliance. Unpaid taxes cause revenue loss in a country's budget, which may adversely affect public spending, sharing of the tax burden, and industry competition, limiting the capacity of governments to implement their fiscal and economic policies. Thus, understanding the scale and causes of the unpaid taxes is crucial in order to properly assess and tackle the issue of tax revenue loss.

Focusing on VAT revenue loss, the credit mechanism underlying the VAT collection process makes this indirect tax susceptible to several types of fraud, despite the voluntary tax compliance that it is considered to promote. Indeed, VAT fraud and avoidance cost EU member states' budgets billions of euros every year, positioning the issue of reducing VAT revenue loss high in policy agendas at national and EU levels. In this direction, the computation of VAT gap indicators can be very useful and policy-relevant since they provide information on the tax revenue loss due to non-compliance and policy choices. Such indicators may capture revenue loss attributed to a variety of reasons, including deliberate actions of taxpayers such as tax fraud, tax evasion and avoidance; unintended actions such as bankruptcies, financial insolvencies, and miscalculations; as well as administrative errors and tax planning failures.

Although the VAT gap is considered a rough indicator of VAT compliance, there exists a rather high variation in definitions, terminology, and measures used to approach this concept depending on the scope, the purpose, and the specificities of the relevant analysis. The most commonly used relevant concepts are the 'VAT compliance gap', 'VAT policy gap', 'VAT Revenue Ratio' and the 'C-efficiency (ratio)'. The 'VAT compliance gap' is used to measure revenue losses due to non-compliance, while the 'VAT policy gap' measures foregone revenues due to policy choices reflected in the design of the VAT system. The 'VAT Revenue Ratio' and the 'C-efficiency (ratio)' refer to the overall performance of a VAT system in capturing revenue losses due to both non-compliance and policy choices. From a methodological perspective, VAT gaps can be quantified using 'top-down' approaches, which are based on aggregate (macro-level) data sources, and 'bottom-up' approaches, which are based on micro-level data sources. Most studies employ 'top-down' approaches, since 'bottom-up' approaches suffer from limitations related to data and the high cost of execution. The VAT gap estimates provided in the annual EC/CASE reports use 'top-down' approaches and distinguish between revenue loss due to non-compliance (VAT compliance gap) and revenue loss due to policy choices regarding VAT exemptions, exclusions, and reduced rates (VAT policy gap).

The VAT compliance gap recorded for Greece is historically one of the largest among the EU27 member states, exhibiting an increasing trend over the period 2000–2020, despite several year-to-year fluctuations. The particularly high VAT compliance gap values (above 20%) after 2008 were largely driven by collapsing revenues, as a result of the strong recession in the economy. However, a rather sharp downward trend of the compliance gap measure has been observed since 2017, indicating substantial improvement in compliance, which is largely attributed to the increasing use of electronic payment instruments. According to the most recently available estimate for 2020, Greece exhibited the fourth largest compliance gap in the EU27, that is, 19.73% with the corresponding measure for the EU27 being lower than half, i.e., 9.05%. However, a strong convergence trend is evident in the last years, with the Greek VAT compliance gap shrinking more than three times faster than the corresponding EU27 indicator. Regarding foregone revenue due to policy choices, in 2020, Greece exhibited the second highest policy gap in the EU27, that is, 56.3% (EU27 average at 45.8%), of which 14.3% was attributed to reduced rates and 42.0% to exemptions. As in most EU member states, the policy gap exhibited a substantial increase by 4.6 pp in 2020 compared to 2019, which was largely attributed to temporary rate cuts on a broad list of services as a response to the COVID-19 pandemic effects. The relatively high policy and compliance gaps are reflected in the overall poor performance of the Greek VAT system, as indicated by the rather low C-efficiency indicator (37.5% in 2020).

The empirical literature on the VAT gap determinants, in general, highlights a variety of macroeconomic, social, and institutional factors as being particularly relevant. Limited related evidence from Greece points to a number of potential drivers of the Greek VAT gap, including the business cycle, the productive structure of the Greek economy, the number of tax audits, and the difference between the standard and the reduced rate. In the more general context of tax compliance, related research tends to attribute the high levels of non-compliance to the structural characteristics of the Greek economy, in conjunction with major, persistent failures and dysfunctions of the Greek tax system as well as the complexity and frequent changes of VAT laws. Increasing the trust in national institutions and intensifying tax audits and the use of electronic payments are, in contrast, found to be important for enhancing VAT compliance and increasing tax revenues. Overall, the analysis in this section shows that despite the improvement that Greece has achieved in reducing VAT evasion and fraud in the last years, as reflected in the narrowing of its VAT gap, more effort is required in order to increase efficiency in the VAT collection mechanisms and boost tax revenues, reducing, at the same time, both compliance and administrative costs.

CHAPTER 9

CONCLUSIONS AND IMPLICATIONS

Given the long-persisting challenges in terms of fiscal aggregates and recent public budget developments associated with the COVID-19 pandemic in Greece, the investigation of the response of tax revenues to prevailing economic conditions and implemented discretionary tax measures is a vital tax policy component and, undoubtedly, a topic of utmost significance for the country. Academics, researchers, and, not least, policymakers have traditionally engaged in the analysis of tax revenue response relations, mainly expressed through the concepts of tax revenue buoyancy and elasticity, due to their association with crucial aspects in terms of theory, policy and application. Over time, in-depth research has concluded that the higher the degree of emphasis on individual – rather than total – tax revenues and, especially, on major tax categories, the greater the benefit in terms of accuracy and adequacy. Such a conclusion clearly implies that, for key tax policy instruments such as the VAT, upon which governments have come to heavily rely during times of favorable economic conditions as well as during episodes of severe crises and extraordinary disturbances, the subject of revenue buoyancy and elasticity should be placed among the top positions of the research agenda of academics and policymakers.

Based on the above considerations, the fundamental research idea underlying the present Study is to provide scholars and fiscal authorities with an inclusive framework for a thorough analysis of the response of VAT revenues to changes in macroeconomic aggregates and implemented policy measures in Greece, i.e., for a comprehensive analysis of VAT revenue buoyancy and elasticity in the country. The offered inclusive research setting evolves around the conduction of a battery of econometric estimations of VAT revenue buoyancy and elasticity, supported and reinforced by an in-depth analysis of a number of associated aspects, with the ensuing conclusions and implications drawn being more than fundamental to the correct understanding and interpretation of the empirical evidence.

Putting the VAT at the center of our research for Greece is justified by certain factors, which are analyzed and discussed in detail in the present Study and acquire particular importance. These concern, on the one hand, the specific defining and structural features of the VAT, which are widely recognized as attractive and advantageous, alongside an enhanced capability and effectiveness in raising public revenues. On the other hand, these factors are associated with the significance of VAT in the framework of the common VAT system within the EU – promoting tax harmonization and regulated by European and national law – as well as by the substantial reliance of the Greek national tax system and Greek fiscal policy on VAT. These factors imply that VAT belongs to the most central tax categories to be investigated in the context of estimating tax revenue buoyancy and elasticity. The need to focus on VAT is even more enhanced by the fact that it acquires such a decisive role in public finance, despite several non-negligible points of criticism. The latter mainly concern VAT implementation itself, at the basis of welfare considerations, and the way it is designed in praxis, which may partly operate counter to its merits and might even hinder the appropriate functioning of the VAT regime in the country.

For VAT, as for any other tax category, considered in the EU framework, the concepts of buoyancy, which includes the revenue response to the implemented DTM, and elasticity, which refers to the response at any given tax structure, are naturally linked to the underlying tax regime itself and its intertemporal adjustments. This implies that the purposes of the present Study are closely related to the choices made by various Greek governments with regard to the VAT structure, at any point in time. These choices present a powerful tool in the hands of national fiscal authorities in order to meet country-specific objectives, since the basic provisions enacted by the respective EU framework leave European countries with a wide-ranging space to individually design and adjust national VAT regimes. This handling space given to Greek governments (expressed, for example, via a multi-rate structure, preferential regimes, frequent changes in the legislative framework, including reclassifications and rate changes, mainly, rate increases in the last years) has significant implications itself.

On the one hand, it ensures the necessary degree of flexibility to achieve fiscal and sectoral targets, taking into account not only equity and distributional but also feasibility and practical considerations. It further enables adaptability to the dynamic environment and to any extraordinary and abnormal economic conditions. On the other hand, it tends to increase complexity, rendering the underlying VAT regime in the country more burdensome for taxpayers than actually desirable and, thus, endangering its actual effectiveness, in particular regarding the central goal of raising significant public revenues.

The pivotal role of VAT revenues in the public budget arises from our analysis with respect to a number of additional aspects associated with their relative importance, i.e., as compared to revenues from other tax categories. This supplementary dimension strengthens the choice of putting revenues from VAT at the foreground of the analysis of the present Study for Greece by investigating buoyancy and elasticity specifically for this revenue category. These aspects basically concern (a) the relative course and performance of VAT revenues (whether in volumes, or as a percentage of GDP, a share in indirect taxes, a share of GG total tax revenues including or excluding SC), (b) the relative reliance of total tax receipts on VAT revenues and, as a result, on indirect taxes in Greece (compared to other individual tax categories and/or the EU27 and individual European countries) during the last two decades, and (c) the relative susceptibility of VAT revenues to fluctuations in economic conditions and severe unforeseen disturbances, such as the prolonged economic crisis in Greece and the COVID-19 pandemic. They further relate to two noteworthy observations: (i) that of a partly convergent and a partly non-convergent path of VAT revenues with respect to the course of basic macroeconomic aggregates and GG total tax receipts, and (ii) that of a divergent degree of reactivity of VAT revenues to the implemented DTM. All these aspects imply that VAT revenues have come to constitute the principal revenue component in more general tax categories, such as indirect and consumption taxes, dominating the corresponding developments and determining their relative position in total tax receipts and, as a result, in public revenues as a whole. They further suggest that the principal role played by developments in VAT revenues forms the basis for significant interventions concerning the VAT regime by Greek governments during unfavorable or, more generally, extraordinary economic conditions. More importantly, they imply that the extent to which VAT revenues move in line with other major macroeconomic and tax aggregates and the way they respond to the implemented DTM are not to be considered as self-evident.

The present Study does not represent a one-dimensional reference, but draws, instead, on a plethora of key aspects out of both the associated conceptual and theoretical framework, but also out of important observations from central fields of related applications. All these aspects go along with major implications not only for the methodological design of the present Study but also for any ensuing assessment and interpretation. The numerous elements shaping the conceptual framework (e.g., the distinctive content of the definitions, the role of the size of buoyancy and elasticity, the disaggregation between individual categories, the decomposition of buoyancy and elasticity, the aspect of time, etc.) imply multidimensionality, away from the very simple notion of one all-applicable response number. These elements further suggest interconnectedness (e.g., between buoyancy and elasticity, response concepts for the total tax system and individual tax categories, decomposed buoyancies and elasticities, the long and the short run, benchmark and extended analysis, etc.), which evidently drives, in such a synthetic analysis, all the corresponding interpretations. The central elements of the relevant theoretical framework, which integrates the concepts of revenue buoyancy and elasticity within certain fundamental taxation and fiscal notions – such as the adequacy criterion of the revenue yield (involving the long-standing discussion on stability versus flexibility, and extending to the differentiation between the long and the short run) and compensatory finance and policy (involving the controversy on compensatory budget effects caused by either automatic or policy adjustments) – imply a certain degree of distinctiveness in terms of the theoretical background, also to be taken into account in the process of interpretation. A number of important observations from central fields of related applications, which integrate the concepts of revenue buoyancy and elasticity – such as revenue forecasting and the discussion on discretionary versus automatic components (e.g., in the context of assessing the potential stabilizing effects of automatic stabilizers versus discretionary policy measures, of calculating fiscal multipliers to assess the effects of fiscal policy on output, and of the cyclical adjustment of the budget balance) – indicate the challenges faced by researchers and policymakers. They imply the need for a more inclusive analysis of the two revenue response concepts and, in particular, for a much more sophisticated examination than the often-encountered simplifying and approximating assumptions, to avoid inaccurate assessments of the fiscal stance, potentially leading to erroneous policy decisions.

Several conclusions arising from the features and context of the existing empirical evidence in the related literature are brought to the foreground, indicating great room for improvement and supplementation. The apparent richness of research examining the response of revenues from VAT (and/or other closely related and similar in conception taxes, such as indirect, consumption, sales taxes, and taxes on goods and services) to changes in key macroeconomic variables is accompanied by a significant degree of heterogeneity (either among groups of countries or within individual countries). Broadly heterogenous results imply a considerable degree of incomparability and, hence, inconclusiveness, basically due to the underlying discrepancies in terms of the data used, methodologies employed, and periods of time under investigation. In-depth engagement with the respective empirical research, through a thorough review of the associated findings, leads to the additional conclusion of a non-negligible degree of selectivity (e.g., emphasis is frequently put only on more general tax categories, only on buoyancy or elasticity, only on the long or the short run, ignoring asymmetries and stability considerations, etc.), often on the basis of restrictions and limitations faced. Such selectivity, however, implies that the reported evidence is, in most cases, neither exhaustive nor comprehensive enough, providing only partial and limited coverage of the underlying subject. The validity of these ascertainments is evidently not counteracted by the empirical evidence offered in the related literature for the case of Greece, for which the existing research for VAT revenue buoyancy and elasticity remains, overall, insufficient and scarce. More importantly, the occurrence of the COVID-19 pandemic, with its severe repercussions for the course of VAT revenues and major macroeconomic aggregates, not incorporated in already existing empirical literature, implies the need for updated and more extended research, focusing and analyzing in detail any potential impact on the underlying response relations.

The conclusions drawn in the above and their associated implications dictate the line of methodological reasoning and shape the econometric framework for unfolding the multi-dimensional and comprehensive empirical analysis of VAT revenue buoyancy and elasticity for Greece in the present Study, aiming to satisfy the objectives set and ensure a major degree of contributiveness across several dimensions. To this end, the interpretation of the ensuing empirical evidence is intrinsically linked not only to the time period under investigation (2000 to 2022), which includes the prolonged severe economic crisis and the period of the COVID-19 pandemic, but also to the quarterly frequency of the underlying data and the estimation procedure employed. The interpretation of the empirical results is further inherently associated with the methodological cornerstones of the empirical application, such as (a) the disaggregated framework investigating the individual category of VAT, (b) the separate analysis of buoyancy and elasticity, taking into account the role of DTM, (c) the distinction between the one-step and the decomposition approach, (d) the analytical consideration of time dimension issues such as: the distinction between the long and the short run; the investigation of potential ECT asymmetry, COVID-19, lockdown, business cycle, and growth effects; and the employed stability and consistency analyses, and (e) the conducted robustness checks.

The obtained extensive and robust estimates of VAT revenue buoyancy and elasticity, which are consistent with economic rationales, validate the methodological choices made and lead to crucial conclusions with vital implications for policymaking. Also very importantly, they provide essential indications as to the role severe crises and, especially, sudden extraordinary disturbances can exert on the response relations under examination.

Long-run estimation empirical results obtained for the total period under investigation, i.e., the time period from the first quarter of 2000 to the last quarter of 2022, in combination with the findings from the stability analysis (for buoyancy relations), indicate: (i) a less than proportional overall and endogenous VAT revenue response relation to changes in GDP (via both the one-step and decomposition approaches), (ii) a proportional overall and endogenous VAT revenue response relation to changes in the tax base (i.e., private consumption), and (iii) a neutral effect on VAT revenues of the investigated standard and reduced rate increases. As a result, they clearly imply the following:

- The unity (and, hence, the proportionality) assumption should by no means be unanimously taken as a given. This validates the choice to investigate in detail the distinctive underlying response relations via both the one-step and the decomposition approach and proves that this is the appropriate method to obtain reliable evidence for any period under investigation.
- Caution is needed when interpreting any proportionality or non-proportionality (in the upward or downward direction) finding of the VAT revenue response to GDP changes, depending on whether the reference is to the upward or the downward phase of the cycle and on the duration of any of these phases. This validates the assertion that the desirability of high buoyancy and/or elasticity is not self-evident and depends on a number of important factors to be taken into account.
- It should not be taken for granted that complementing the endogenous relation with the implementation of a number of VAT standard and reduced rate increases will necessarily lead, in terms of fiscal sustainability, to additional fiscal balance effects in the long run. This validates the necessity to examine VAT revenue buoyancy and elasticity separately, in order to perform a more comprehensive analysis and discern crucial information on the role of the implemented DTM.
- Governments should pay more attention to relations considered to lie within the scope of policy and more under their control, such as the relation between VAT revenues and their base, and depending on the targets set and the size of the corresponding response measure, they should be ready to resort to additional policy tools, in case the implemented DTM have not been as effective as required. This validates the option to apply the decomposition approach, alongside the one-step approach, allowing the direct investigation of the relation between VAT revenues and private consumption.

Short-run estimation empirical results from both benchmark and extended analysis, in combination with the findings from the consistency analysis, indicate (i) non-negligible differentiations between long and short-run relations (expressed through revenue under- or overshooting in the short run, i.e., within a quarter, depending on the underlying relation) and a notable time period needed for adjustment, and (ii) no additional fluctuations in VAT revenues in the short-run caused by the investigated standard and reduced rate increases. Most importantly, they prove the utmost significance of the impact of the COVID-19 pandemic, which appears to even lead to fundamental changes of the otherwise (i.e., if totally excluding the COVID-19 effects) valid relations. All these aspects imply the following:

- It is clearly inaccurate to confuse or *a priori* consider as identical the results from any short-run analysis to findings from a long-run analysis, since different fundamentals drive relations in the two time horizons. This validates the necessity for a separate long- and short-run VAT revenue response analysis.
- It should be not considered as a given that complementing the endogenous relation by the implementation of a number of VAT standard and reduced rate increases will necessarily turn, in terms of fiscal policy stabilization, VAT revenues to a better or worse automatic stabilizer in the short run. This validates the necessity to examine VAT revenue buoyancy and elasticity separately also for the short run, in order to perform a more comprehensive analysis and discern crucial information on the role of the implemented DTM.
- The dynamic and ever-changing economic environment, and especially severe crises and unexpected extraordinary disturbances, affecting important short-run response relations, such as the one between fluctuations in VAT revenues and basic macroeconomic variables and even between fluctuations in major macroeconomic aggregates themselves, should be put to the foreground in any short-term analysis, to avoid policy conduction on a potentially falsely founded basis. This validates the choice to conduct diverse extended and consistency analysis, alongside the benchmark one, to be able to discern the way in which major shocks may alter apparently otherwise valid associations.

Taking all the above into consideration, the present Study principally documents that a wide-ranging VAT revenue buoyancy and elasticity analysis is absolutely crucial for VAT policy conduction by Greek governments. Nevertheless, fiscal authorities targeting a more complete VAT policy framework should not view the key findings, hereby provided, in isolation from other important VAT-related issues. After all, the VAT system is characterized by intrinsic interconnections, as well as several inefficiencies, which in certain cases directly and/or indirectly involve the VAT base or the major fiscal aggregate of VAT revenues. This line of reasoning suggests that, given the interconnection through the tax base, policymakers should complement knowledge on the VAT revenue response in Greece with detailed information on the issue of the degree of pass-through of VAT rate changes to prices of goods and services and, as a consequence, of the distribution of the tax burden between consumers and producers. Information of that kind is expected to be particularly valuable for major categories of goods and services (e.g., in terms of weights, inherent characteristics, and the sectoral dimension), whether during normal or during unfavorable and turbulent economic conditions. Such a conclusion is implied by the evidence provided in the present Study on the under-shifting of 2010–2011 increases in reduced VAT rates on food and non-alcoholic beverages prices, with consumers bearing a far larger tax burden share than producers. Such information represents a prerequisite for more suitable VAT policymaking, to the degree that any VAT rate shifting or VAT burden distribution should not counteract the targeting underlying the implementation of the VAT reforms through non-anticipated changes in consumer (and/or producer) behavior and, hence, cause undesirable turns in the course and changes in the composition of the tax base (possibly, alongside unwanted VAT revenue developments). Based on our analysis, the same line of reasoning implies that given the severe inadequacies causing substantial VAT revenue losses in Greece, like the broad non-compliance with the VAT legislation and the policy-related inefficiency in the Greek VAT system, policymakers should combine knowledge on the VAT revenue response in the country with detailed information on the VAT gap. Information of that kind, including the conceptualization and quantification of foregone revenues, alongside the vital analysis of potential causes of non-compliant behavior and policy-related inefficiency in Greece, is certainly a prerequisite for increasing the level of collected VAT revenues. Obviously, any policy decision by Greek governments to intervene with the way VAT revenues respond to changes in major macroeconomic aggregates, including any potential DTM implementation, is inherently associated with and cannot be taken in isolation from any policy effort to enhance VAT revenue collection performance, with the aim of closing the substantial VAT gap.

In that direction, digitization can play a pivotal role in assisting tax authorities to reduce tax fraud and avoidance by enhancing the accuracy, efficiency, and transparency of tax administration processes. By adopting digital technologies, tax authorities can implement real-time data collection and monitoring systems, enabling the detection of suspicious patterns or irregularities in taxpayer activities more efficiently. For instance, advanced data analytics and artificial intelligence (AI) can be used to cross-reference taxpayer information from various sources, identify discrepancies, and flag potential cases of fraud or avoidance. Moreover, digitization simplifies tax filing by allowing for automated processes, reducing the likelihood of human error or manipulation in reporting income and deductions. Electronic invoicing (e-invoicing) and digital records of transactions provide a more transparent and verifiable record of financial activities. Additionally, blockchain technology can ensure data integrity by preventing unauthorized modifications and enhancing the security of tax-related transactions. Overall, these digital tools increase the ability of tax authorities to prevent, detect, and address tax fraud and avoidance, while fostering a more compliant and transparent tax environment. In addition, enhancing tax-payer education and awareness, which can be achieved by simplifying tax laws and making tax-related information more accessible, as well as fostering a culture of transparency and trust between taxpayers and the government, can improve voluntary compliance. To gain and maintain public confidence, tax systems must be perceived as fair, equitable, efficient, and effective.[267]

Overall, the challenging task of the provision of an inclusive framework for a thorough analysis of the response of VAT revenues to chang-

[267] We thank an anonymous referee for the related suggestion.

es in macroeconomic aggregates and implemented policy measures in Greece, i.e., of a comprehensive analysis of VAT revenue buoyancy and elasticity, would not be complete without setting out a number of more general, but still vital, implications, justifying the recommendation of certain directions for policy and associated research conduction:

- One of the central implications ensuing from the in-depth analysis of the present Study is that the more precise, thorough, and sophisticated the knowledge and understanding becomes on the way VAT revenues respond to changes in macroeconomic aggregates and policy measures in Greece, the more targeted and efficient the involvement of policymakers with VAT revenue response relations will be. In that sense, Greek governments are advised to rely on robust and accurate evidence on VAT revenue buoyancy and elasticity, resulting from the utilization of all the available tools, instruments, and distinct dimensions, with the aim to avoid simplifying assumptions and decisions based on generalizing and approximating results. Otherwise, apart from being inadequate in terms of methodological and technical involvement, reliance on any incomplete framework would entail a huge risk of distorting the decision-making process associated with any field of application involving the use of VAT revenue buoyancy and elasticity.
- Perhaps the most straightforward implication of the extensive analysis of the present Study is that the more regularly and targeted re-estimations and updates of the VAT revenue response relations are conducted, the more reliable the evidence offered will be. Past evidence and/or evidence on specific time periods can only be time period-indicative and time period-dependent, and therefore not necessarily representative of alternative total time periods or involved sub-periods of interest from the policy perspective. This argument is expected to be reinforced in the cases of frequent shifts between prevailing regimes, long-persisting and severe crises, as well as extraordinary disturbances. According to this line of reasoning, and on the basis of the manifestation of the exceptional impact of the COVID-19 pandemic, an important

recommendation for Greek governments is to integrate the analysis of revenue buoyancy and elasticity within a system of continuous assessment and monitoring, including the consideration of potentially underlying structural changes. This will ensure more prompt and adequate adaptation and adjustment to a dynamic and constantly evolving economic environment.

- A more general key implication is that the more complete the revenue response analysis becomes in its total, the more accurate the assessment process and the procedure of choosing between potential areas of intervention will be. As a result, a strong recommendation to Greek governments is to make sure that detailed evidence on revenue buoyancy and elasticity is provided not only for the key category of the VAT but for all individual tax categories, or at least for the major and most important ones. The acquisition of complete evidence creates the necessary relativity perspective for governments, allowing for an assessment of the relative importance of a stronger or weaker endogenous VAT revenue response to changes in central macroeconomic aggregates and the relative space left for further intervention and implementation of measures related to the VAT.
- A more far-reaching implication is that the more the results from a comprehensive and updated analysis on VAT (and, obviously, any other tax category) revenue buoyancy and elasticity are integrated into the general policy targeting of any Greek government as economic conditions evolve (especially to the degree that they concern the possible impact of policy measures), the higher the compatibility among the individual elements of the overall policy-making process in the country will be, increasing overall policy effectiveness and limiting policy failure. Therefore, Greek governments are advised to create mechanisms that strengthen the connection between all the relevant research and decision-making centers to minimize or even eliminate the risk of potentially neutralizing or even counteracting effects. By limiting offsetting outcomes in terms of any broader revenue raising, tax, sectoral and/or structural, equity, and distributional policy goals set as well as

in terms of the national obligations for fiscal aggregates in force, the ensuing information exchange will restrain the need for additional interventions and for even more burdensome measures and will, hence, enhance policy efficacy.

- Last but not least, due to existing data availability restrictions and limitations, the provision of robust estimates of revenue buoyancy and elasticity, consistent with economic rationales, for any tax category, is not self-evident and remains a challenging task. Consequently, a more technical implication is that the greater the ability to provide additional confirmation and deepen any already established empirical evidence on revenue response relations, the greater the trustworthiness of the associated conclusions and interpretations will be. To that end, Greek governments are strongly advised to guarantee the improvement of relevant data availability, quality, and reliability, including the provision of consistent quantitative data on the impact of implemented policy measures, through enhanced support for relevant research in terms of both technical and economic assistance. Evidently, all the above-formulated central implications and policy recommendations are fundamentally linked to the availability of relevant data, which represents a prerequisite for any detailed and sophisticated analysis of the endogenous and/or the overall response of tax revenues to changes in major macroeconomic variables.

As far as future research is concerned, first, it is essential to repeat the thorough analysis on VAT revenue response relations for the case of Greece, as conducted in the present Study, with extended samples. To that end, additional observations should be included at the end of the sample, potentially encompassing longer periods of 'economic normality' and extending the post-COVID time period as much as possible, with the aim of conducting comparative exercises. In that way, for the purposes of comparative long-run analysis, it will be possible to investigate the underlying response relations by significantly limiting or even totally excluding the prevailing influence of decisive developments, such as the deep and prolonged economic crisis, alongside the imposed economic measures and capital controls. For the purposes of short-run analysis, and given the detected deviations between short-run response relations including and short-run response relations totally excluding the COVID-19 time period, it will be feasible to obtain additional evidence on the question of whether the pandemic has actually exerted a more persistent effect on the underlying short-run relations or its impact has gradually faded out and pre-COVID response relations have been re-established. Second, it is crucial to complement the inclusive revenue response analysis framework provided in this Study for VAT by corresponding individual analyses for all major tax categories. Combining these disaggregated-level analyses will provide knowledge on the tax revenue response in Greece on an aggregate level, i.e., for the total tax system, and enable conclusions on the potential necessity for intervention as a whole. Apparent revenue-generating weaknesses in the case of one tax category, for example, may be counterbalanced by corresponding strengths in the cases of other tax categories, rendering any intervention unnecessary. Even in the event of inevitable intervention, the combination of the disaggregated-level analyses will enhance the intervention precision and adequacy and, thus, improve the overall effectiveness of tax policy implementation.

Third, given the significance in terms of policy of the specific issues examined in the present Study, the related analyses could motivate further research (a) associating buoyancy findings with the impact of potential changes in VAT rates, and (b) examining VAT-gap determinants.[268] More specifically, with respect to (a), within the pass-through context and taking into consideration data availability issues, exploring the effects of potential changes, e.g., a reduction of the VAT rate in Greece, on prices and VAT revenues (based on buoyancy estimates) for important categories of goods, such as food, could provide insightful guidance for fiscal policymaking. Finally, with respect to (b) and given the high levels of non-compliance with the VAT regulations in Greece, undertaking a sound econometric analysis on the potential antecedents of the VAT gap would constitute an interesting and useful direction for

[268] We thank an anonymous referee for the related suggestions.

future research. To the extent that the availability of data would enable a proper empirical investigation of the issue, a variety of macroeconomic, structural, and policy-related factors could be considered as potential determinants of the Greek VAT gap, including the business cycle, sectoral characteristics, the VAT structure and exemptions, the efficiency of VAT administration and collection mechanisms, and the VAT evasion and fraud.

APPENDICES

APPENDIX A

TABLE A1

Standard VAT rate applied by member states

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Belgium	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
Bulgaria	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Czechia	22	22	22	22	19	19	19	19	19	19	20	20	20	21	21	21	21	21	21	21	21	21	21
Denmark	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Germany	16	16	16	16	16	16	16	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Estonia	18	18	18	18	18	18	18	18	18	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Ireland	21	20	21	21	21	21	21	21	21	21,5	21	21	23	23	23	23	23	23	23	23	23	23	23
Greece	18	18	18	18	18	19	19	19	19	19	23	23	23	23	23	23	23	24	24	24	24	24	24
Spain	16	16	16	16	16	16	16	16	16	16	18	18	18	21	21	21	21	21	21	21	21	21	21
France	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	20	20	20	20	20	20	20	20	20
Croatia	22	22	22	22	22	22	22	22	22	22	23	23	25	25	25	25	25	25	25	25	25	25	25
Italy	20	20	20	20	20	20	20	20	20	20	20	20	21	21	22	22	22	22	22	22	22	22	22
Cyprus	10	10	13	15	15	15	15	15	15	15	15	15	17	18	19	19	19	19	19	19	19	19	19
Latvia	18	18	18	18	18	18	18	18	18	21	21	22	22	21	21	21	21	21	21	21	21	21	21
Lithuania	18	18	18	18	18	18	18	18	18	19	21	21	21	21	21	21	21	21	21	21	21	21	21

Luxembourg	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	17	17	17	17	17	17	17	17
Hungary	25	25	25	25	25	25	20	20	20	25	25	25	27	27	27	27	27	27	27	27	27	27	27
Malta	15	15	15	15	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Netherlands	17.5	19	19	19	19	19	19	19	19	19	19	19	19	21	21	21	21	21	21	21	21	21	21
Austria	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Poland	22	22	22	22	22	22	22	22	22	22	22	23	23	23	23	23	23	23	23	23	23	23	23
Portugal	17	17	19	19	19	21	21	21	20	20	21	23	23	23	23	23	23	23	23	23	23	23	23
Romania	19	19	19	19	19	19	19	19	19	19	24	24	24	24	24	24	20	19	19	19	19	19	19
Slovenia	19	19	20	20	20	20	20	20	20	20	20	20	20	22	22	22	22	22	22	22	22	22	22
Slovakia	23	23	23	20	19	19	19	19	19	19	19	20	20	20	20	20	20	20	20	20	20	20	20
Finland	22	22	22	22	22	22	22	22	22	22	23	23	23	24	24	24	24	24	24	24	24	24	24
Sweden	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25

Source: European Commission (2022).

TABLE A2

Reduced VAT rates applied by member states

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Belgium	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12
Bulgaria	-	-	-	-	-	-	-	7	7	7	7	9	9	9	9	9	9	9	9	9	9	9	9
Czechia	5	5	5	5	5	5	5	5	9	9	10	10	14	15	15	10/15	10/15	10/15	10/15	10/15	10/15	10/15	10/15
Denmark	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Germany	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Estonia	5	5	5	5	5	5	5	5	5	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Ireland	12.5	12.5	12.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	9/13.5	9/13.5	9/13.5	9/13.5	9/13.5	9/13.5	9/13.5	9/13.5	9/13.5	9/13.5	9/13.5	9/13.5
Greece	8	8	8	8	8	9	9	9	9	9	5.5/11	6.5/13	6.5/13	6.5/13	6.5/13	6.5/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13
Spain	7	7	7	7	7	7	7	7	7	7	8	8	8	10	10	10	10	10	10	10	10	10	10
France	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5/7	5.5/7	5.5/10	5.5/10	5.5/10	5.5/10	5.5/10	5.5/10	5.5/10	5.5/10	5.5/10
Croatia	-	-	-	-	-	-	10	10	10	10	10	10	10	5/10	5/13	5/13	5/13	5/13	5/13	5/13	5/13	5/13	5/13
Italy	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	5/10	5/10	5/10	5/10	5/10	5/10	5/10
Cyprus	5	5	5	5	5	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9
Latvia	-	-	-	9	5	5	5	5	5	10	10	12	12	12	12	12	12	12	5/12	5/12	5/12	5/12	5/12

Lithuania	5	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9
Luxembourg	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	8	8	8	8	8	8	8	8
Hungary	12	12	12	12	5/15	5/15	5/15	5	5	5/18	5/18	5/18	5/18	5/18	5/18	5/18	5/18	5/18	5/18	5/18	5/18	5/18	5/18
Malta	5	5	5	5	5	5	5	5	5	5	5	5/7	5/7	5/7	5/7	5/7	5/7	5/7	5/7	5/7	5/7	5/7	5/7
Netherlands	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	9	9	9	9
Austria	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10/13	10/13	10/13	10/13	10/13	10/13	10/13
Poland	7	7	7	7	7	7	7	7	7	7	7	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8	5/8
Portugal	5/12	5/12	5/12	5/12	5/12	5/12	5/12	5/12	5/12	5/12	6/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13
Romania	-	-	-	-	9	9	9	9	9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9
Slovenia	8	8	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	9.5	9.5	9.5	9.5	9.5	9.5	5/9.5	5/9.5	5/9.5	5/9.5
Slovakia	10	10	10	14	-	-	-	10	10	10	6/10	10	10	10	10	10	10	10	10	10	10	10	10
Finland	8/17	8/17	8/17	8/17	8/17	8/17	8/17	8/17	8/17	8/17	9/13	9/13	9/13	10/14	10/14	10/14	10/14	10/14	10/14	10/14	10/14	10/14	10/14
Sweden	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12	6/12

Source: European Commission (2022).

APPENDIX B

Policy initiatives to enhance tax compliance in Greece:

- According to a 2010 Law,[269] consumers of goods and services were not allowed to make payments greater than 1.500€ in cash (the amount was reduced to 500€ in 2017[270]). In addition, to reinforce tax compliance, the government offered tax cuts to tax-payers based on receipts for the goods and services they purchased.
- In 2017, the General Secretariat of Public Revenue was replaced by the Independent Authority for Public Revenue (IAPR).[271] The IAPR is only subject to parliamentary scrutiny and enjoys operational independence, and administrative and financial autonomy. Its mission is to determine, certify, and collect tax, customs, and other public revenues.[272]
- In 2017, the installation of card terminals (POS) became mandatory for businesses and professionals of several sectors corresponding to a list of specific Activity Code Numbers (KADs).[273]
- In 2021, myDATA (my Digital Accounting & Tax Application), an electronic transaction-based reporting regime platform, was launched, introducing e-invoicing and e-bookkeeping.[274]
- In September 2023, the Council Directive 2021/514 was incorporated into the national legislation, extending the administrative cooperation between Greek tax authorities and the tax authorities of the other member states of the EU as far as the VAT and other indirect taxes are concerned.[275]

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269 Law 3842/2010.

270 Law 4446/2016.

271 Law 4389/2016.

272 <https://www.aade.gr/en/aade/mission-responsibilities>.

273 Law 4446/2016.

274 For the relevant legislation, see <https://www.aade.gr/mydata-ilektronika-biblia-aade/mydata-shetikes-diataxeis>.

275 Law 5047/2023.

REFERENCES

Aaron, H. (Ed.) (1981). *The Value-Added Tax: Lessons from Europe*. Washington, DC: The Brookings Institution.

Adams T. S. (1921). Fundamental Problems of Federal Income Taxation. *Quarterly Journal of Economics*, 35(4), 527–556.

Agapitos, G. (1990). *The harmonization of The Value Added Tax*. Foundation for Economic & Industrial Research (IOBE), Athens [in Greek].

Ahmed, Q. M. and Mohammed, S. D. (2010). Determinant of Tax Buoyancy: Empirical Evidence from Developing Countries. *European Journal of Social Sciences*, 13(3), 408–414.

Akbar, M. and Ahmed, Q. M. (1997). Elasticity and buoyancy of revenues and expenditure of Federal Government. *Pakistan Economic and Social Review*, 35(1), 43–56.

Alavuotunki, K., Haapanen, M., and Pirttilä, J. (2019). The effects of the value-added tax on revenue and inequality. *The Journal of Development Studies*, 55(4), 490–508.

Anderson, J. E. and Shimul, S. N. (2018). State and local property, income, and sales tax elasticity: estimates from dynamic heterogenous panels. *National Tax Journal*, 71(3), 521–546.

Andrikopoulos, A. A., Brox, J. A., and Georgakopoulos, T. A. (1993). A short-run assessment of the effects of VAT on consumption patterns: the Greek experience. *Applied Economics*, 25(5), 617–626.

Ardalan, A. and Kessing, S. G. (2021). Tax pass-through in the European beer market. *Empirical Economics*, 60(2), 919–940.

Arsić, M. and Altiparmakov, N. (2013). Equity aspects of VAT in emerging European countries: A case study of Serbia. *Economic Systems*, 37(2), 171–186.

Bağci, S. A. (2022). Estimating Tax Buoyancy of OECD Countries. *Global Agenda in Social Sciences: Global Studies*, (Eds.) Aydın, M., Şiriner, İ., and Koç, Ş. A., Vol. 9, 441–458.

Bank of Greece (2022). *Summary of the annual report for the year 2021.* Bank of Greece, Athens.

Barrios, S. and Fargnoli, R. (2010). *Discretionary measures and tax revenues in the run-up to the financial crisis.* EC, European Economy Economic Paper No. 419.

Bekoe, W., Danquah, M., and Senahey, S. K. (2016). Tax reforms and revenue mobilization in Ghana. *Journal of Economic Studies*, 43(4), 522–534.

Belinga, V., Benedek, D., de Mooij, R., and Norregaard, J. (2014). *Tax Buoyancy in OECD Countries.* IMF, Working Paper No. 110.

Benedek, D., De Mooij, R. A., Keen, M., and Wingender, P. (2020). Varieties of VAT pass through. *International Tax and Public Finance*, 27(4), 890–930.

Benkovskis, K. and Fadejeva, L. (2014). The effect of VAT rate on inflation in Latvia: evidence from CPI microdata. *Applied Economics*, 46(21), 2520–2533.

Benzarti, Y. and Carloni, D. (2019). Who Really Benefits from Consumption Tax Cuts? Evidence from a Large VAT Reform in France, *American Economic Journal: Economic Policy,* 11(1), 38–63.

Benzarti, Y., Carloni, D., Harju, J., and Kosonen, T. (2020). What goes up may not come down: asymmetric incidence of value-added taxes. *Journal of Political Economy*, 128(12), 4438–4474.

Berardini, F. and Renzi, F. (2022). *Mind the Gap! The (unexpected) Impact of COVID-19 Pandemic on VAT Revenue in Italy.* Bank of Italy, Occasional Paper No.669.

Bernal, A. (2018). Do Small Value-Added Tax Rate Decreases on Groceries Imply Lower Prices for Consumers? *Eastern European Economics*, 56(1), 81–98.

Berney, R. E. and Frerichs, B. H. (1973). Income elasticities for state tax revenues: techniques of estimation and their usefulness for forecasting. *Public Finance Quarterly*, 1(4), 409–425.

Besley, T. J. and Rosen, H. S. (1999). Sales taxes and prices: An empirical analysis. *National Tax Journal*, 52(2), 157–178.

Bettendorf, L. and van Limbergen, D. (2013). *The stability of tax elasticities in The Netherlands.* CPB Netherlands Bureau for Economic Policy Analysis, Discussion Paper No. 256.

Bilquees, F. (2004). Elasticity and Buoyancy of the Tax System in Pakistan. *The Pakistan Development Review*, 43(1), 73–93.

Bird, R. and Gendron, P. P. (2005). VAT Revisited. A New Look at the Value Added Tax in Developing and Transitional Countries. A Report to the Project on Fiscal Reform in Support of Trade Liberalization, U.S. Agency for International Development, USAID Workshop for Practioners on Tax, May. 4.

Bird, R. M. and Gendron, P. (2006). Is VAT the best way to impose a general consumption tax in developing countries? *Bulletin for International Taxation*, 60(7), 287–96.

Birhanu, B. (2018). Estimating Tax Buoyancy and Stability in Ethiopia. *International Journal of Economics & Management Sciences*, 7(4), 1000539.

Blanchard, O. J. (1990). *Suggestions for a New Set of Fiscal Indicators.* OECD, Economics Department Working Paper No. 79, OECD Publishing, Paris.

Blanchard, O. and Perotti, R. (2002). An empirical characterization of the dynamic effects of changes in government spending and taxes on output. *Quarterly Journal of Economics*, 117(4), 1329–1368.

Boschi, M. and d'Addona, S. (2019). The Stability of Tax Elasticities over the Business Cycle in European Countries. *Fiscal Studies*, 40(2), 175–210.

Bouabdallah, O., Checherita-Westphal, C., Freier, M., Nerlich, C., and Slawińska, K. (2020). Automatic fiscal stabilisers in the euro area and the COVID-19 crisis. Article in *ECB Economic Bulletin*, Issue 6.

Bouthevillain, C., Cour-Thimann, P., van den Dool, G., de Cos, P. H., Langenus, G., Mohr, M., Momigliano, S., and Tujula, M. (2001). *Cyclically adjusted budget balances: an alternative approach.* ECB, Working Paper No. 77.

Brautigam, D., Fjeldstad, O.-H., and Moore, M. (2008). *Taxation and State-Building in Developing Countries: Capacity and Consent*. Cambridge University Press.

Bretherton, R. F. (1937). The Sensitivity of Taxes to Fluctuations of Trade. *Econometrica*, 5(2), 171–183.

Bruce, D., Fox, W. F., and Tuttle, M. H. (2006). Tax Base Elasticities: A Multi-State Analysis of Long-Run and Short-Run Dynamics. *Southern Economic Journal*, 73(2), 315–341.

Brückner, M. (2012). An instrumental variables approach to estimating tax revenue elasticities: Evidence from Sub-Saharan Africa. *Journal of Development Economics*, 98(2), 220–227.

Buettner, T. and Kauder, B. (2010). Revenue Forecasting Practices: Differences across Countries and Consequences for Forecasting Performance. *Fiscal Studies*, 3193, 313–340.

Caldara, D. and Kamps, C. (2017). The Analysis of SVARs: A Unified Framework to Measure Fiscal Multipliers. *Review of Economic Studies*, 84(3), 1015–1040.

Carbonnier, C. (2007). Who pays sales taxes? Evidence from French VAT reforms, 1987–1999. *Journal of Public Economics*, 91(5-6), 1219–1229.

Charlet, A. and Buydens, S. (2012). The OECD International VAT/GST Guidelines: past and future developments. *World Journal of VAT/GST Law*, *1*(2), 175–184.

Choudhry, N. N. (1979). Measuring the Elasticity of Tax Revenue: A Divisia Index Approach. *Staff Papers* (International Monetary Fund), 26(1), 87–122.

Christou, A., Eriotis, N., Lomis, I., Papadakis, S., and Thalassinos, E. (2021). The Greek VAT gap: the influence of individual economic sectors. *European Research Studies Journal*, 24(4B), 838–850.

Chung, I. H., Williams, D. W., and Do, M. R. (2022). For Better or Worse? Revenue Forecasting with Machine Learning Approaches. *Public Performance and Management Review*, 45(5), 1133–1154.

Cnossen, S. (1998). Global trends and issues in value added taxation. *International Tax and Public Finance*, *5*(3), 399–428.

Cnossen, S. (2015). Mobilizing VAT revenues in African countries*. International Tax and Public Finance*, 22(6), 1077–1108.

Cohen, L. (1959). An Empirical Measurement of the Built-in Flexibility of the Individual Income Tax. *The American Economic Review*, 49(2), 532–541.

Cohen, L. (1960). A more recent measurement of the built-in flexibility of the individual income tax. *National Tax Journal*, 13(2), 122–126.

Conroy, N. (2020). Estimating Ireland's Tax Elasticities: a Policy-Adjusted Approach. *The Economic and Social Review*, 51(2), 241–274.

Cornevin, A., Corrales, J., Corrales, M. J. S., and Angel, J. P. (2023). *A Deep Dive into Tax Buoyancy: Comparing Estimation Techniques in a Large Heterogeneous Panel.* International Monetary Fund, Working Paper No. 23/71.

Creedy, J. and Gemmell, N. (2003). The revenue responsiveness of income and consumption taxes in the UK. *The Manchester School*, 71(6), 641–658.

Creedy, J. and Gemmell, N. (2004). The Income Elasticity of Tax Revenue: Estimates for Income and Consumption Taxes in the United Kingdom. *Fiscal Studies*, 25(1), 55–77.

Creedy, J. and Gemmell, N. (2006). *Modelling Tax Revenue Growth*. Edward Elgar Publishing, Cheltenham, UK.

Danchev, S., Gatopoulos, G., and Vettas, N. (2020). Penetration of Digital Payments in Greece after Capital Controls: Determinants and Impact on VAT Revenues. *CESifo Economic Studies*, 66(3), 198–220.

Davies, D. G. (1962). The sensitivity of consumption taxes to fluctuations in income. *National Tax Journal*, 15(3), 281–290.

Davies, D. G. (1963). The Sensitivity of Taxes and the Distribution and Stabilization of Income. *Southern Economic Journal*, 30(1), 73–75.

de la Feria, R. and Krever R. (2013). Ending VAT Exemptions: Towards a Post-Modern VAT. In: de la Feria, R. (Ed.), *VAT Exemptions: Consequences and Design Alternatives*, 3-36. The Hague: Kluwer Law International.

Deli, Y., Rodriguez, A. G., Kostarakos, I., and Varthalitis, P. (2018). *Dynamic tax revenue buoyancy estimates for a panel of OECD countries.* ESRI, Working Paper No. 592.

Delipalla, S. and Keen, M. (1992). The comparison between ad valorem and specific taxation under imperfect competition. *Journal of Public Economics*, 49(3), 351–367.

de Mello, L. (2009). Avoiding the value added tax: Theory and cross-country evidence. *Public Finance Review*, 37(1), 27–46.

de Mooij, R. and Swistak, A. (2022). Back to Basics: Value-Added Tax Continues to Expand. *Finance & Development* (International Monetary Fund), 59(001), 52–53.

diaNEOsis (2016). *Tax evasion in Greece. Causes, extent and proposals to combat it.* Ernst & Young [in Greek].

Dickey, D. A. and Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, 74(366a), 427–431.

Dudine, P. and Jalles, J. T. (2018). How buoyant is the tax system? New evidence from a large heterogeneous panel. *Journal of International Development*, 30(6), 961–991.

Ebrill, L. P., Keen, M., Bodin, J. P., and Summers, V. (2001). *The Modern VAT*. Washington: International Monetary Fund.

Ebrill, L. P., Keen, M., Bodin, J. P., and Summers, V. (2002). The allure of the value-added tax. *Finance & Development* (International Monetary Fund), 39(002), 44–47.

Edelberg, V. (1940). Flexibility of the Yield of Taxation – Some Econometric Investigations. *Journal of the Royal Statistical Society*, 103(2), 153–190.

Ehdaie, J. (1990). *An Econometric Method for Estimating the Tax Elasticity and the Impact on Revenues of Discretionary Tax Measures.* The World Bank, Policy, Research, and External Affairs Working Paper No. 334.

Emran, M. S. and Stiglitz, J. E. (2005). On selective indirect tax reform in developing countries. *Journal of Public Economics*, 89(4), 599–623.

Engle, R. F. and Granger, C. W. (1987). Co-Integration and Error Correction: Representation, Estimation, and Testing. *Econometrica*, 55(2), 251–276.

Eriotis, N., Missiakoulis, S., Papadakis, S., and Vasiliou, D. (2021). Greek tax reality and the VAT gap: Influential factors. *Journal of Accounting and Taxation* 13(1), 28–44.

European Commission/Reckon LLP (EC/Reckon, 2009). *Study to Quantify and Analyse the VAT Gap in the EU-25 Member States. Report 2009*, Publications Office of the European Union, Luxembourg.

European Commission/CASE, Barbone, L., Belkindas, M., Bettendorf, L., et al. (EC/CASE, 2013). *Study to quantify and analyse the VAT Gap in the EU-27 Member States. Report 2013*, Publications Office of the European Union, Luxembourg.

European Commission (EC, 2016). *The Concept of Tax Gaps, Report on VAT Gap Estimations*, FISCALIS Tax Gap Project Group (FPG/041), Luxembourg.

European Commission (EC, 2018). *The Concept of Tax Gaps, Report III: MTIC Fraud Gap estimation methodologies,* FISCALIS 2020 Tax Gap Project Group, subgroup VAT fraud (FPG/041), Brussels.

European Commission (2020). VAT rates applied in the Member States of the European Union-Situation at 1st January 2020.

European Commission (2022). *Taxation trends in the European Union.*

European Commission/CASE, Poniatowski, G., Bonch-Osmolovskiy, M., Śmietanka, A., Pechcińska, A. (EC/CASE, 2022). *VAT gap in the EU – Report 2022*, Publications Office of the European Union, Luxembourg.

European Commission (2023). *European Economic Forecast,* Spring 2023. European Economy, Institutional paper 200.

Fedeli, S. (1998). The effects of interaction between direct and indirect tax evasion: The cases of VAT and RST. *Public Finance*, *53*(3-4), 385–418.

Follette, G. and Lutz, B. (2010). Fiscal Policy in the United States: Automatic Stabilizers, Discretionary Fiscal Policy Actions, and the Economy. Board of Governors of the Federal Reserve System, Divisions of Research & Statistics and Monetary Affairs, *Finance and Economics Discussion Series* No. 43.

Forteza, N., Prades, E., and Roca, M. (2024). *Analysing the VAT cut pass-through in Spain using web-scraped supermarket data and machine learning.* Bank of Spain, Working Paper No 2417.

Fox, W. F. and Campbell, C. (1984). Stability of the state sales tax income elasticity. *National Tax Journal,* 37(2), 201–212.

Fricke, H. and Süssmuth, B. (2014). Growth and Volatility of Tax Revenues in Latin America. *World Development,* 54, 114–138.

Friedlaender, A. F., Swanson, G. J., and Due, J. F. (1973). Estimating sales tax revenue changes in response to changes in personal income and sales tax rates. *National Tax Journal*, 26(1), 103–110.

Gaarder, I. (2019). Incidence and distributional effects of value added taxes. *The Economic Journal*, 129(618), 853-876.

Georgakopoulos A. T. (1978). *The Value Added Tax: In theory and practice*. Business Books, Athens [in Greek].

Georgakopoulos A. T. (1986). *The Value Added Tax in Greece*. Glorybook-Economist, Athens [in Greek].

Giesecke, J. A. and Nhi, T. H. (2010). Modelling value-added tax in the presence of multi-production and differentiated exemptions. *Journal of Asian Economics*, 21(2), 156–173.

Gillani, S. F. (1986). Elasticity and Buoyancy of Federal Taxes in Pakistan. *The Pakistan Development Review*, 25(2), 163–174.

Giorno, C., Richardson, P., Roseveare, D., and van den Noord, P. (1995). *Potential output, output gaps and structural budget balances.* OECD Economic Studies No. 24.

Girouard, N. and C. André (2005). *Measuring Cyclically-adjusted Budget Balances for OECD Countries.* OECD, Economics Department Working Paper No. 434.

Goldberger, A. S. (1964). *Econometric theory.* John Wiley and Sons, Inc., New York.

Grinberg, I. (2010). Where Credit is Due: Advantages of the Credit-Invoice Method for Partial Replacement VAT. *Tax Law Review*, 63(2), 309–358.

Groves, H. M. and Kahn, C. H. (1952). The Stability of State and Local Tax Yields. *The American Economic Review*, 42(1), 87–102.

Gupta, S., Jalles, J. T., and Liu, J. (2022). Tax Buoyancy in Sub-Saharan Africa and its Determinants. *International Tax and Public Finance*, 29(4), 890–921.

Harrison, G. and Krelove, R. (2005). *Vat Refunds: A Review of Country Experience.* IMF Working Paper No. 05/218, International Monetary Fund.

Haughton, J. (1998). *Estimating tax buoyancy, elasticity and stability.* African Economic Policy Paper, Discussion Paper No. 11.

Havranek, T., Irsova, Z., and Schwarz, J. (2016). Dynamic elasticities of tax revenue: evidence from the Czech Republic. *Applied Economics*, 48(60), 5866–5881.

Hellerstein, W. (2016). A Hitchhiker's Guide to the OECD's International VAT/GST Guidelines, *Florida Tax Review*, 18(10), 589–637.

Hellerstein, W. and Gillis, T. H. (2010). The VAT in the European Union. *Tax Notes*, 127, 461–471.

Hill, S., Jinjarak, Y., and Park, D. (2022). *Buoyant or sinking? Tax revenue performance and prospects in developing Asia.* Asian Development Bank (ADB), Economics Working Paper Series No. 656.

Hodzic, S. and Celebi, H. (2017). Value-added tax and its efficiency: EU-28 and Turkey. *UTMS Journal of Economics*, 8(2), 79–90.

Hondroyiannis, G. and Papaoikonomou, D. (2017). The effect of card payments on VAT revenue: New evidence from Greece. *Economics Letters*, 157, 17–20.

Hoppe, T., Schanz, D., Sturm, S., and Sureth-Sloane, C. (2021). The tax complexity index–a survey-based country measure of tax code and framework complexity. *European Accounting Review.* 10.1080/09638180.2021.1951316.

Hoza, B. (2022). Determinants of the VAT gap - part 2. *Scientific Journal of Bielsko-Biala School of Finance and Law*, Bielsko-Biała, PL, 26(4), 125–130.

Hutton, E. (2017). The Revenue Administration – Gap Analysis Program: Model and Methodology for Value-Added Tax Gap Estimation. IMF, *Technical Notes and Manuals* 17/04.

Indraratna, Y. (1991). The Measurement of Tax Elasticity in Sri Lanka: A Time Series Approach. Central Bank of Sri Lanka, *Staff Studies* No. 33, 73–110.

IMF (2020). *Challenges in Forecasting Tax Revenue.* Fiscal Affairs, Special Series on Fiscal Policies to Respond to COVID-19.

in't Veld, J., Larch, M., and Vandeweyer, M. (2013). Automatic Fiscal Stabilisers: What They Are and What They Do. *Open Economies Review*, 24, 147–163.

Isaac, M.K. and Samwel, K. C. (2015). Decomposition of the Tax-to-Income Elasticity of Major Taxes in Kenya. *Research Journal of Finance and Accounting*, 6(3), 81–87.

Jalles, J. T. (2017). Tax Buoyancy in Sub-Saharan Africa: An Empirical Exploration, *African Development Review*, 29(1), 1–15.

Jalles, J. T. (2020). Tax capacity and growth in the Asia-Pacific region. *Journal of the Asia Pacific Economy*, 1–25.

James, K. (2011). Exploring the origins and global rise of VAT. *The VAT Reader (Tax Analysts)*, 15–22.

Jenkins, G. P., Jenkins, H., and Kuo, C. Y. (2006). *Is the Value Added Tax Naturally Progressive?* Working Paper, No. 1059, Queen's Economics Department, Queen's University, Department of Economics, Kingston (Ontario).

Jenkins, G. P., Kuo, C.-Y., and Shukla, G. P. (2000). *Tax analysis and revenue forecasting – Issues and Techniques.* Harvard Institute for International development, Harvard University.

Jooste, C. and Naraidoo, R. (2011). Nonlinear Tax Elasticities And Their Implications For The Structural Budget Balance. *The Journal of Applied Business Research*, 27(4), 113–126.

Kalliampakos, G. and Kotzamani, E. (2018). An alternative proposal for VAT on consumption in Greece. *Journal of Tax Administration*, 4(1), 55–80.

Kaplanoglou, G. (2015). Who pays indirect taxes in Greece? From EU entry to the fiscal crisis. *Public Finance Review*, 43(4), 529–556.

Kaplanoglou, G. (2022). Consumption inequality and poverty in Greece: Evidence and lessons from a decade-long crisis. *Economic Analysis and Policy*, 75, 244–261.

Kaplanoglou, G. and Newbery, D. M. (2003). Indirect taxation in Greece: evaluation and possible reform. *International Tax and Public Finance*, 10, 511–533.

Kaplanoglou, G. and Rapanos, V. T. (2013). Tax and trust: The fiscal crisis in Greece. *South European Society and Politics*, 18(3), 283–304.

Kaplanoglou, G., Rapanos, V. T., and Daskalakis, N. (2016). Tax compliance behaviour during the crisis: the case of Greek SMEs. *European Journal of Law and Economics*, 42, 405–444.

Kaplanoglou, G. and Rapanos, V. T. (2018). Evolutions in consumption inequality and poverty in Greece: The impact of the crisis and austerity policies. *Review of Income and Wealth*, 64(1), 105–126.

Karabalis, N. and Kondelis, E. (2013). Indirect tax increases and their impact on inflation over 2010–2012. *Economic Bulletin*, (38), 7–19.

Kargbo, B. I. B. and Egwaikhide, F. O. (2012). Tax Elasticity in Sierra Leone: A Time Series Approach. *International Journal of Economics and Financial Issues*, 2(4), 432–447.

Katz, M. L. and Rosen, H. S. (1985). Tax analysis in an oligopoly model. *Public Finance Quarterly*, 13(1), 3–20.

Keen, M. (2008). VAT, tariffs, and withholding: Border taxes and informality in developing countries. *Journal of Public Economics*, 92(10-11), 1892–1906.

Keen, M. (2013). The Anatomy of the VAT. *National Tax Journal*, 66(2), 423–446.

Keen, M. and Lockwood, B. (2006). Is the VAT a money machine? *National Tax Journal*, 59(4), 905–928.

Keen, M. and Lockwood, B. (2010). The value added tax: Its causes and consequences. *Journal of Development Economics*, *92*(2), 138–151.

Keen, M. and Mintz, J. (2004). The optimal threshold for a value-added tax. *Journal of Public Economics*, 88(3-4), 559–576.

Keen, M. and Smith, S. (1996). The future of value added tax in the European Union. *Economic Policy*, 11(23), 373–420.

Keen, M. and Smith, S. (2006). VAT fraud and evasion: What do we know and what can be done? *National Tax Journal*, 59(4), 861–887.

Kelm, R. (2022). Determinants of the VAT Gap in EU Member States from 2000 to 2016. *Central European Journal of Economic Modelling and Econometrics*, 14, 351–379.

Khadan, J. (2019). Tax buoyancy in the Caribbean: Evidence from heterogenous panel cointegration models. *Research in Applied Economics*, 11(4), 36–48.

Khan, M. Z. (1973). The Responsiveness of Tax Yield to Increases in National Income. *The Pakistan Development Review*, 12(4), 416–432.

King, J. R. (1995). Alternative Methods of Revenue Forecasting and Estimating. In: Shome, P. (Ed.), *Tax Policy Handbook*, 254-257, IMF, Washington, D.C., USA.

Koester, G. and Priesmeier, C. (2012). *Estimating dynamic tax revenue elasticities for Germany.* DB, Discussion Paper No. 23.

Kosonen, T. (2015). More and cheaper haircuts after VAT cut? On the efficiency and incidence of service sector consumption taxes. *Journal of Public Economics*, 131, 87–100.

Köster, G. and Priesmeier, C. (2017). *Revenue elasticities in euro area countries. ECB,* Working Paper No. 1989.

Kowal, A. and Przekota, G. (2021). VAT Efficiency - A Discussion on the VAT System in the European Union. *Sustainability*, 13(9), 4768.

Kremer, J., Braz, C. R., Brosens, T., Langenus, G., Momigliano, S., and Spolander, M. (2006). *A disaggregated framework for the analysis of structural developments in public finances.* ECB, Working Paper No. 579.

Kyobe, A. and Danninger, S. (2005). *Revenue Forecasting – How is it done? Results from a Survey of Low-Income Countries.* IMF, Working Paper No. 24.

Lagravinese, R., Liberati, P., and Sacchi, A. (2020). Tax buoyancy in OECD countries: New empirical evidence. *Journal of Macroeconomics*, 63, 103189.

Larch, M. and Turrini, A. (2009). *The cyclically-adjusted budget balance in EU fiscal policy making: A love at first sight turned into a mature relationship.* EC, European Economy, Economic Paper No. 374.

Leahy, E., Lyons, S., and Tol, R. S. (2011). The distributional effects of value added tax in Ireland. *The Economic and Social Review,* 42(2), 213–235.

Lee, D., Kim, D., and Borcherding, T. E. (2013). Tax structure and government spending: does the value-added tax increase the size of government? *National Tax Journal*, 66(3), 541–569.

Legler, J. B. and Shapiro, P. (1968). The responsiveness of state tax revenue to economic growth. *National Tax Journal*, 21(1), 46–56.

Lindholm, R. W. (1970). The value added tax: A short review of the literature. *Journal of Economic Literature*, *8*(4), 1178–1189.

Lusher, D. W. (1956). The stabilizing effectiveness of budget flexibility. In: Universities-National Bureau Committee for Economic Research (Ed.), *Policies to Combat Depression*, 77–122, NBER.

Lyssiotou, P. and Savva, E. (2021). Who pays taxes on basic foodstuffs? Evidence from broadening the VAT base. *International Tax and Public Finance,* 28(1), 212–247.

Mansfield, C. Y. (1972). Elasticity and Buoyancy of a Tax System: A Method Applied to Paraguay. *Staff Papers* (International Monetary Fund), 19(2), 425–446.

Mascagni, G., Dom, R., Santoro, F., and Mukama, D. (2023). The VAT in practice: equity, enforcement, and complexity. *International Tax and Public Finance*, 30(2), 525–563.

Masten, I. and Grdović Gnip, A. (2016). Stress testing the EU fiscal framework. *Journal of Financial Stability*, 26, 276–293.

Mawia, M. and Nzomoi, J. (2013). An empirical investigation of tax buoyancy in Kenya. *African Journal of Business Management*, 7(40), 4233–4246.

McGowan, J. R. and Billings, B. A. (1997). An analysis of the European community VAT: Implications for US tax policy. *Journal of International Accounting, Auditing and Taxation*, *6*(2), 131–148.

Mertens, K. and Ravn M. O. (2014). A reconciliation of SVAR and narrative estimates of tax multipliers. *Journal of Monetary Economics*, 68 (Supplement), S1–S19.

Metcalf, G. E. (1995). Value-added taxation: A tax whose time has come? *Journal of Economic Perspectives*, *9*(1), 121–140.

Missos, V. (2021). *The effects of the system of social protection on poverty and inequality in Greece and the EU.* KEPE Report No. 82, Athens [in Greek].

Morris, R., Braz, C. R., de Castro, F., Jonk, S., Kremer, J., Linehan, S., Marino, M. R., Schalck, C., and Tkacevs, O. (2009). *Explaining government revenue windfalls and shortfalls - An analysis for selected EU countries.* ECB, Working Paper No. 1114.

Mourre, G. and Princen, S. (2015). *Tax Revenue Elasticities Corrected for Policy Changes in the EU.* EC, European Economy Discussion Paper No. 18.

Mourre, G. and Princen, S. (2019). The Dynamics of Tax Elasticities in the Whole European Union. *CESifo Economic Studies*, 65(2), 204–235.

Mourre, G., Astarita, C., and Princen, S. (2014). *Adjusting the budget balance for the business cycle: the EU methodology.* EC, European Economy Economic Paper No. 536.

Mourre G., Isbasoiu, G.-M., Paternoster, D., and Salto, M. (2013). *The cyclically-adjusted budget balance used in the EU fiscal framework: an update.* EC, European Economy Economic Paper No. 478.

Mukarram, F. (2001). Elasticity and buoyancy of major taxes in Pakistan. *Pakistan Economic and Social Review*, 39(1), 75–86.

Müllbacher, S., Hyee, R., Bettendorf, L., Rojas-Romagosa, H., Veenendaal, P., Baldini, M., Barbone, L., Bonch-Osmolovskiy, M., and Adam, S. (2013). *A study on the economic effects of the current VAT rates structure. Addendum: Country Analyses,* Final Report, Study on behalf of the European Commission, TAXUD, in consortium with CAPP, CASE, DEPII, ETLA, IFO, IFS.

Musgrave, R. A. (1959). *The theory of public finance – A study in public economy.* McGraw-Hill Book Company, Inc., New York, USA.

Musgrave, R. A., Domar, E. D., Robinson, R. I., Wallich, H. C., Mitchell, G. W., and Litterer, O. F. (1945). Public finance and full employment*. Postwar Economic studies* No. 3.

Musgrave, R. A. and Miller, M. H. (1948). Built-in Flexibility. *The American Economic Review*, 38(1), 122–128.

Musgrave, R. A. and Musgrave, P. B. (1989). *Public finance in theory and practice* (fifth edition). McGraw-Hill Book Company International Editions, Singapore.

Narayanan, H. (2020). Value Added Tax–Vat A Centenarian [1920-2020] In This COVID-19. *International Journal of Research*, 8(09), 29–42.

Nerudová, D. and Dobranschi, M. (2019). Alternative method to measure the VAT gap in the EU: Stochastic tax frontier model approach. *PLoS ONE,* 14(1), e0211317.

Ndedzu, D., Macheka, A., Ithiel, M. M., and Zivengwa, T. (2013). Revenue productivity of Zimbabwe's tax system. *Asian Journal of Social Sciences & Humanities*, 2(4), 144–156.

Newey, W. K. and West, K. D. (1987). A Simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix. *Econometrica*, 55(3), 703–708.

OECD (2017). *International VAT/GST Guidelines*. OECD Publishing, Paris.

OECD (2020). *Consumption Tax Trends 2020: VAT/GST and Excise Rates, Trends and Policy Issues*. OECD Publishing, Paris.

OECD (2022a). *Consumption Tax Trends 2022: VAT/GST and Excise, Core Design Features and Trends*. OECD Publishing, Paris.

OECD (2022b). *Revenue statistics: The Impact of COVID-19 on OECD Tax Revenues*. OECD Publishing, Paris.

OECD (2023). *Revenue Statistics 2023: Tax Revenue Buoyancy in OECD Countries*. OECD Publishing, Paris.

Olukuru, J. and Mandela, B. (2017). Tax Buoyancy: A Comparative Study Between Kenya and South Africa. In: Biekpe, N., Cassimon, D., and Mullineux, A. W. (Eds.), *Development Finance – Innovations for Sustainable Growth*, 51–72, Palgrave Macmillan, Cham, Switzerland.

Osoro, N. E. and Leuthold, J. H. (1994). Changing Tax Elasticities Over Time: The Case of Tanzania. *African Development Review*, 6(1), 31–40.

Pechman, J. A. (1956). Yield of the individual income tax during a recession. In: Universities-National Bureau Committee for Economic Research (Ed.), *Policies to Combat Depression*, 123–148, NBER.

Pechman, J. (1985). *Who Paid the Taxes, 1966-85?* The Brookings Institution, Washington, DC.

Perotti, R. (2012). The Effects of Tax Shocks on Output: Not so Large, But Not Small Either. *American Economic Journal: Economic Policy*, 4(2), 214–237.

Phillips, P. C. and Ouliaris, S. (1990). Asymptotic Properties of Residual Based Tests for Cointegration. *Econometrica*, 58(1), 165–193.

Phillips, P. C. and Perron, P. (1988). Testing for a Unit Root in Time Series Regression. *Biometrika*, 75(2), 335–346.

Poghosyan, T. (2011). *Assessing the Variability of Tax Elasticities in Lithuania.* IMF, Working Paper No. 270.

Politi, R. B. and Mattos, E. (2011). Ad valorem tax incidence and after-tax price adjustments: evidence from Brazilian basic basket food. *Canadian*

Journal of Economics/Revue canadienne d'économique, 44(4), 1438–1470.

Poterba, J. M. (1996). Retail price reactions to changes in state and local sales taxes. *National Tax Journal,* 49(2), 165–176.

Price, R. W., T.-T. Dang, and Guillemette, Y. (2014). *New Tax and Expenditure Elasticity Estimates for EU Budget Surveillance.* OECD, Economics Department Working Paper No. 1174, OECD Publishing.

Price, R., Dang, T.-T., and Botev, J. (2015). *Adjusting fiscal balances for the business cycle: New tax and expenditure elasticity estimates for OECD countries.* OECD, Economics Department Working Paper No. 1275, OECD Publishing, Paris.

Princen, S., Mourre, G., Paternoster, D., and Isbasoiu, G.-M. (2013). *Discretionary tax measures: pattern and impact on tax elasticities.* EC, European Economy Economic Paper No. 499.

Provopoulos, G.A. (1983). *The Value Added Tax: What it is and how it is applied*. Foundation for Economic & Industrial Research (IOBE), Athens [in Greek].

Romer, C. D. and Romer, D. H. (2009). *A narrative analysis of postwar tax changes.* University of California, Berkeley.

Romer, C. D. and Romer, D. H. (2010). The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks. *The American Economic Review*, 100(3), 763–801.

Sen, P. (2006). A Note on Estimating Tax Elasticities. *The Indian Economic Journal*, 54(1), 171–182.

Seydou, S. S. (2020). Elasticity and buoyancy of tax system in Cote d' Ivoire. *Journal of Economics and International Finance*, 12(3), 142–150.

Seyfried, W. and Pantuosco, L. (2003). Estimating the Sensitivity of State Tax Revenue to Cyclical and Wealth Effects. *Journal of Economics and Finance*, 27(1), 114–124.

Shome, P. (1988). On the Elasticity of Developing Country Tax Systems. *Economic and Political Weekly*, 23(34), 1750–1754.

Singer, N. M. (1968). The use of dummy variables in estimating the income-elasticity of state income-tax revenues. *National tax Journal*, 21(2), 200–204.

Skintzi, G. (2015). Study on the profitability of VAT revenues. *Greek Economy* (Centre of Planning and Economic Research), 19, 29–37 [in Greek].

Slitor, R. E. (1948). The Measurement of Progressivity and Built-in Flexibility. *The Quarterly Journal of Economics*, 62(2), 309–313.

Smith, P. E. (1962). Built-in flexibility of the individual income tax: quarterly estimates. *National Tax Journal*, 15(2), 194–197.

Sobel, R. S. and Holcombe, R. G. (1996). Measuring the growth and variability of tax bases over the business cycle. *National Tax Journal*, 49(4), 535–552.

Stock, J. H. and Watson, M. W. (1993). A Simple Estimator of Cointegrating Vectors in Higher Order Integrated Systems. *Econometrica*, 61(4), 783–820.

Sullivan C. K. (1965). *The tax on value added*. New York and London: Columbia University Press.

Tagkalakis, A. O. (2013a). Assessing the variability of indirect tax elasticity in Greece. *Economics Bulletin*, 33(3), 2098–2109.

Tagkalakis, A. O. (2013b). Audits and tax offenders: recent evidence from Greece. *Economics Letters*, 118(3), 519–522.

Tagkalakis, A. O. (2014a). *The determinants of VAT revenue efficiency: recent evidence from Greece.* Bank of Greece, Working Paper No. 181.

Tagkalakis, A. O. (2014b). *Assessing the variability of indirect tax elasticity in Greece.* Bank of Greece, Working Paper No. 171.

Tagkalakis, A. (2014c). Tax Buoyancy in Greece, Bank of Greece *Economic Bulletin*, 40, 7–30.

Tait, A. A. (1988). *The Value-Added Tax: International Practice and Problems*. Washington: International Monetary Fund.

Tait, A. A. (1991). *Value-Added Tax: Administrative and Policy Issues*. Washington: International Monetary Fund.

Tamaoka, M. (1994). The regressivity of a value added tax: tax credit method and subtraction method—a Japanese case. *Fiscal Studies*, 15(2), 57–73.

Tanchev, S. and Todorov, I. (2019). Tax Buoyancy and Economic Growth: Empirical Evidence of Bulgaria. *Journal of Tax Reform*, 5(3), 236–248.

Terra, B. and Kajus, J. (2022). *A Guide to the European VAT Directives*. IBFD Publishing.

Țibulcă, I.-L. (2022). The impact of the COVID-19 pandemic on tax revenues in the EU. *Economic Research-Ekonomska Istraživanja*, 35(1), 2442–2459.

Timsina, N. (2007). Tax Elasticity and Buoyancy in Nepal: A Revisit. *NRB Economic Review*,19, 9–21.

Tran-Nam, B. and Evans, C. (2014). Towards the development of a tax system complexity index. *Fiscal Studies*, *35*(3), 341–370.

Triantafyllou, A. K. (1987). *The Value Added Tax: Interpretation and analysis of the provisions of Law 1642/1986*. Greek Productivity Center (ELKEPA), Athens [in Greek].

Tsouma, E., Economou, F., Kountouri, I., Panagopoulos, Y., and Skintzi, G. (2020). *Excise taxes on tobacco products and alcoholic beverages in Greece: revenues and elasticities.* KEPE Study No. 81, Athens, Greece [in Greek].

Twerefou, D. K., Fumey, A., Assibey, E. O., and Asmah, E. E. (2010). Buoyancy and elasticity of tax: evidence from Ghana. *Journal of Monetary and Economic Integration*, 10(2), 36–70.

Ueda, M. J. (2017). *The evolution of potential VAT revenues and C-efficiency in advanced economies.* IMF Working Paper No. 17/158, International Monetary Fund.

van den Noord, P. (2000). The Size and Role of Automatic Fiscal Stabilizers in the 1990s and Beyond. OECD, *Economics Department Working Paper* No. 230, OECD Publishing, Paris.

Vickrey, W. (1945). The Effect of Averaging on the Cyclical Sensitivity of the Yield of the Income Tax. *Journal of Political Economy*, 53(3), 275–277.

Vickrey, W. (1949). Some limits to the income elasticity of income tax yields. *The Review of Economics and Statistics*, 31(2), 140–144.

Wagner, A. (1958). Three extracts on public finance. In: Musgrave, R. and Peacock, A. T. (Eds.), *Classics in the theory of public finance*, 1–15. Macmillan & Co. Ltd., London, UK.

Walter, J. E. (1951). Tax Sensitivity. *Southern Economic Journal*, 17(4), 422–437. [Chapter 5]

Warwick, R., Harris, T., Phillips, D., Goldman, M., Jellema, J., Inchauste, G., and Goraus-Tańska, K. (2022). The redistributive power of cash transfers vs VAT exemptions: A multi-country study. *World Development*, 151, 105742.

Wawire, N. H. W. (2017). Determinants of value added tax revenue in Kenya. *Journal of Economics Library*, 4(3), 322–344.

Weidenbaum, M. L. and Christian, E. S. Jr (1989). *The Allure of Value-Added Taxes: Examining the Pros and Cons*. Formal Publication 89, Murray Weidenbaum Publications.

Weidenbaum, M. L., Raboy, D. G., and Christian Jr, E. S. (Eds.) (1990). *The value-added tax: orthodoxy and new thinking*. Springer Science & Business Media.

Wilford, W. T. (1965). State tax stability criteria and the revenue-income elasticity coefficient reconsidered. *National Tax Journal*, 18(3), 304–312.

Williams, W. V., Anderson, R. M., Froehle, D. O., and Lamb, K. L. (1973). The stability, growth and stabilizing influence of state taxes. *National Tax Journal*, 26(2), 267–274.

Wolswijk, G. (2007). *Short- and long-run tax elasticities – The case of the Netherlands.* ECB, Working Paper No. 763.

Wolswijk, G. (2009). The short-and long-run tax revenue response to changes in tax bases. *Economics Bulletin*, 29(3), 1960–1970.

Yousuf, M. and Huq, S. M. J. (2013). Elasticity and Buoyancy of Major Tax Categories: Evidence from Bangladesh and its Policy Implications. Ministry of Finance, *Finance Division Research Study* No. 3, 49–82.

Zervas, A. (2018). Tax Elasticities and the Macroeconomic Effects of Fiscal Policy in Greece. *Applied Economics Quarterly*, 64(1), 59–98.

Zídková, H. and Pavel, J. (2016). What Causes the VAT Gap? *Ekonomický časopis*, 64(9), 811–826.

Zodrow, G. R. (1999). The Sales Tax, the VAT, and Taxes in Between—or, Is the Only Good NRST a "VAT in Drag"? *National Tax Journal*, 52(3), 429–442.

Zu, Y. (2022). Developing VAT treaties: international tax cooperation in times of global recovery. *Legal Studies*, *42*(1), 159–177.

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