CENTRE OF PLANNING AND ECONOMIC RESEARCH

No 29

Stabilization Policy and Long Term Growth: Are they Related?

by

H. DELLAS

November 1993

Harris Dellas
University of Maryland
and Catholic University (Belgium)

Stabilization Policy and Long Term Growth: Are they Related?

CENTRE OF PLANNING AND ECONOMIC RESEARCH

The Centre of Planning and Economic Research (KEPE) was 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, 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: (a) The preparation of short, medium and long-term development plans, including plans for regional and territorial development and also public investment plans, in accordance with guidelines laid down by the Government. (b) The analysis of current developments in the Greek economy along with appropriate short-term and medium-term forecasts; also, the formulation of proposals for appropriate stabilization and development measures. (c) The further education of young economists, particularly in the fields of planning and economic development.

The Centre has been and is very active in all of the above fields, and carries out systematic basic research in the problems of the Greek economy, formulates draft development plans, analyses and forecasts short-term and medium-term developments, grants scholarships for post-graduate studies in economics and planning and organizes lectures and seminars.

Within the framework of these activities, the Centre also publishes studies from research carried out at the Centre, reports which are usually the result of collective work by groups of experts which are set up for the preparation of development programmes, and lectures given by specially invited distinguished scientists.

The Centre is in continuous contact with similar scientific institutions abroad and exchanges publications, views and information on current economic topics and methods of economic research, thus further contributing to the advancement of the science of economics in the country.

DISCUSSION PAPER SERIES

This series of Discussion Papers is designed to speed up the dissemination of research work prepared by the staff of KEPE and by its external collaborators with a view to subsequent publication. Timely comment and criticism for its improvement is appreciated.

CONTENTS

LIST OF TABLES

ABSTRACT

Moderate recessions encourage human capital accumulation and can, under plausible conditions, improve the *long term average* quality of the labor force by a) decreasing the opportunity cost of investment in human capital; b) reducing the relative employment opportunities of unskilled entrants into the labor force; and c) encouraging human capital accumulation as a *hedge* against cyclical risk ((b) and (c) are due to the uneven impact of the cycle on the low skilled). Severe recessions, on the other hand, may affect adversely both the incentive and the ability to acquire human capital because of lower labor hoarding and large negative income effects. The examination of several measures of formal human capital accumulation (rates of school enrollment) in the US revealed a clear countercyclical pattern, a positive response of schooling to relative employment opportunities and also produced evidence of permanent effects arising from recessions.

I am grateful to seminar participants at EUI Florence, IGIER Milan, IAE Barcelona and Baruch, Bologna, Brown, Columbia, Erasmus, Leuven, Maryland, Rochester, Rome and Tilburg Universities for useful suggestions. Part of this research was done while the author was a visiting scholar at the Centre of Planning and Economic Research (KEΠE) in Athens, Greece.

1. INTRODUCTION

When one thinks about the debates on stabilization policy, what comes to mind is the extensive, long lasting disputes that followed the introduction of rational expectations into economics in the 1970s and concerned the effectiveness of monetary policy. The main conclusion that emerged was that the popular belief of *long run* policy effectiveness was unsustainable; while, under certain conditions, policy could be effective in the short run.

My objective in this paper is to bring back to center stage the focal point of the earlier debates and ask whether there are any reasons to believe that macroeconomic stabilization policy can affect *long term* growth. The practical motivation for resurrecting this question is obvious. If there is no association between cyclical fluctuations and the trend of output, then stabilization policy may be thought as a rather *minor* operation relative to growth affecting policies. Lucas [1985] has made a strong point about it. Using a simple model calibrated with data from the actual US economy, he reached the conclusion that "...eliminating [all post war] aggregate consumption variability [in the US] would be the equivalent in utility terms of an increase in <u>average</u> consumption of something like one or two tenths of a percentage point..." And, he continued, "...I want to propose taking these numbers seriously as giving the order-of- magnitude or the potential marginal social product of additional advances in business cycle theory..."

Lucas' calculations were based on a Solow type of model which asserts the complete dichotomy between the short and the long run (the same model also accounts for the methodology adopted in popular detrending techniques). As observed by McCallum [1986])[1] they may not be valid if cyclical policies also impact on the long run rate of economic growth. The objective of this paper is to address this issue by offering a general evaluation of the long term effects of stabilization policy.

We suggest a plausible mechanism relating stabilization policy to the <u>trend</u> of consumption[2] which is based on the existence of two relationships: one between cyclical fluctuations and the long term *average* quality of the labor force; and another between the latter and economic growth. The second relationship is hardly disputable, hence we focus exclusively on the study of the first one. The basic argument developed here is that there exists a range of recessions which is associated with increases in the accumulation of human capital; and that those increases may not simply represent a change in the

timing of human capital investment activities that is due to intertemporal substitution but may well reflect permanent improvements in the average quality of labor (that is, there may be less than perfect offsetting during subsequent expansions).

Recessions have two important characteristics which matter for aggregate human capital accumulation. First, they are associated with a decrease in the opportunity cost of investing in human capital[3] (via formal education, job training etc.) because of the procyclicality of the real wage and the countercyclicality of unemployment. And second, they have a disproportionate impact on the employment of the low skilled individuals. This well established stylized fact has two implications. The first one is that low skilled new entrants to the job market have a lower probability of finding a job relative to more skilled new entrants. The relatively greater unavailability of low skill jobs during recessions reduces the flow of low skilled into the labor force pool and may also induce some to continue on with their education. This, in turn, can change the composition of the labor force in favor of the high human capital segment.

The second implication works through risk-insurance considerations. If cyclical risk afflicts principally the unskilled (as the evidence from labor hoarding practices strongly indicates) then one can postulate that investment in human capital may serve as a means of increasing cyclical job security (hedging against aggregate risk).

One, however, may immediately raise two issues regarding these effects. The first concerns the *net* result of economic recessions as there exist other features of economic downturns which work in the opposite direction for both the incentive and the ability to acquire human capital. The channels suggested above are partly based on the premise that substitution effects dominate income effects in the demand for education. This is always true when capital markets are perfect; and likely to be true even under liquidity constraints in the case of "moderate" economic downturns. But under borrowing constrains, the negative income effect may dominate during prolonged, severe recessions, because of the significant drop in disposable income[4]. Moreover, a firm's labor hoarding practices depend on the degree of adversity it faces. For severe enough recessions, the firm may not afford to hoard or may go out of business. Hence, severe recessions can undermine the insurance function of human capital by inflicting great damage even to those higher up in the

distribution of skills. These two qualifications suggest that while some adversity may raise the demand for investment in human capital, too much of it can prove detrimental. In the latter part of section 2 we determine theoretically the range of recessions in which the exercise of stabilization policy actually increases the incentive to acquire human capital.

Finally, to these possible negative effects of recessions on the demand for education, one may want to add the possibility of human capital loss as a result of cyclical unemployment (forgetting by not doing or forgone learning opportunities on the job).

To evaluate the relative importance of these counteracting forces we turned to the examination of the cyclical properties of various measures of formal human capital acquisition. More specifically, we examined the cyclical properties of various school enrollment rates; and whether the rate of school enrollment varied with the relative ratio of unemployment for high and low skilled individuals[5]. The results indicated that one need not be concerned about the qualifications raised above regarding the possible adverse effects of recessions on schooling. College and graduate school enrollment rates were found to be countercyclical while high school drop out rates procyclical. School enrollments for older age groups (twenty five to thirty four year old) exhibited countercyclicality too, and they also responded positively to the ratio of unemployment in low formal human capital sectors -such as manufacturing or construction- to the overall unemployment rate.

Unfortunately, we were not able to assess the magnitude of human capital loss that can be attributed to cyclical unemployment because of the lack of relevant studies in labor economics. It seems highly unlikely, however, that such loss could be significant enough as to offset the positive effect of increased schooling on the quality of the labor force.

The second issue that can be raised in relation to the effects of recessions concerns their persistence. Establishing the sign of the cyclical pattern of human capital accumulation by netting out all the opposing effects described above is not sufficient for claiming the existence of a relationship between the cycle and the average *long term* quality of labor and hence between macroeconomic stabilization policy and long term growth. To take this extra step, one must show that cyclical perturbations can have permanent effects, in the sense that whatever cyclical patterns emerge do not cancel out intertemporally. We show that this obtains theoretically under plausible

conditions such as risk aversion or the presence of linear labor adjustment costs. Given the nature of the available data it is hard to calculate reliably the persistence of the effects of recessions on human capital accumulation. Schooling variables are of annual frequency and they do not go far enough into the past, so they are not very suitable for the investigation of the existence of asymmetries in the effects of the business cycle. Nonetheless, we carried out a simple test whose results indicated the presence of some asymmetries, and in particular, the dominant role of recessions. It must also be noted that there exists in the literature some indirect evidence which is consistent with the scenario of recessions improving permanently the average quality of the labor force. This evidence regards the relationship between cyclical disturbances and long term productivity. A number of authors (see e.g. Bean [1991], Gali and Hammour [1991], Saint-Paul [1993]) have found that recessions seem to improve long term productivity[6].

The rest of the paper is organized as follows. Section 1 discusses some empirical aspects of the labor market bearing to unemployment risk as well as the effects of earnings risk on educational and occupational decisions. Section 2 presents a model of the optimal choice of the level of human capital under labor heterogeneity when the distribution of cyclical risk is different across levels of labor skills. Section 3 tests the empirical implications of the model and section 4 offers a few concluding remarks.

2. THE EMPIRICAL EVIDENCE ON THE INCIDENCE OF CYCLICAL RISK

Even in a perfectly homogeneous economy, human capital will tend to increase during recessions as the opportunity cost of investment in skills becomes lower (because of the procyclical wage). This case is straightforward to analyze. In the present paper we have chosen instead to focus on an economy with heterogeneous workers, a case which seems to be both more interesting and realistic. Under heterogeneity the concerns about (employment and income) risk as well as the opportunity cost of investment in human capital are manifested in the choice of the level of training, education etc. If the amount of cyclical risk faced by individual workers varies systematically with their level of human capital then stabilization policy brings about different benefits to different individuals.

To examine the relevance of "job risk" in occupational decisions one would like to identify workers according to their endowment of human capital. Then, to proceed to examine whether a decomposition of each worker's (or group of workers) risk into idiosyncratic and aggregate risk varies systematically with their endowment of skills. And finally, to investigate if higher moments of the earnings distribution affect educational and occupational choices. To carry out these three tasks one needs an operational definition of both human capital and of risk. As a measure of risk one can use either the cyclical volatility of earnings; or employment stability and in particular the probability of temporary layoffs and of the duration of the layoff. These two measures are obviously closely related, specially in the absence of extensive unemployment-welfare programs.

The available empirical evidence from labor economics is rather scarce. There exists some empirical work relating the probability of layoffs to levels of human capital as well as to industry type (which is of interest if industries differ regarding the mix of their labor force). There exists also some information regarding the employment-output elasticity by both occupational type and economic sector. And there is some (very limited) work on the relationship between the volatility of earnings and occupational and human capital choices.

Abowd and Ashenfelter [1980] find that high school dropouts are the most likely to suffer layoffs, followed by high school graduates, college dropouts and college graduates. They also find that the durable manufacturing

industries and the construction industry exhibit the highest unemployment risk followed by nondurable manufacturing. Government and professional service industries have very little risk. Finally, they document the existence of a wage differential to compensate for higher unemployment risk[7].

A decomposition of the variance of unemployment risk by type (idiosyncratic versus aggregate) across human capital levels as well as industries is not available. Such information would enable us to do two things. First to assess the overall importance of stabilization policy in mitigating unemployment risk (policy could be important if a sizable fraction of unemployment risk were attributed to aggregate factors; it might be less effective if idiosyncratic shocks were the main source of employment variation). And second, to evaluate whether stabilization policy impacted on the *allocation* of risk across human capital levels and industries (that would be the case if the idiosyncratic aggregate component mix differed significantly across the various units under consideration). With regard to the first issue, Davis and Haltiwanger [1990] uncover strong idiosyncratic effects on unemployment variation but they also find that aggregate shocks played an even larger quantitative role in accounting for movements in the unemployment rate. Unfortunately they do not report any information that would help us calculate the relative mix of these two effects across occupations and industries. Blanchard and Diamond [1989] report an even greater role for aggregate shocks. Based on this work we conclude that cyclical employment risk is significant[8].

From Abowd and Ashenfelter's results one can advance the claim that unemployment risks are higher for low human capital individuals and also in manufacturing[9]. Similar conclusions can be drawn from the work of Abraham and Houseman [1989] who find that the employment-output elasticity of production workers (blue collar) significantly exceed that of non production workers (mostly white collar); and from Hamermesh [1991] who finds that the output employment elasticity follows a pattern identical to that described for the allocation of unemployment risk across industries by Abowd and Ashenfelter[10].

One of the links between recessions and the average quality of labor suggested in this paper requires that concerns about job security or the volatility of earnings play a significant role in occupational and educational choices. The only available study is by Orazem and Mattila [1991] who report that second moment considerations are indeed relevant. In a study of high

school graduates from Maryland they find that career choices (investment in human capital, choice of occupation etc.) are sensitive to the second moment of the earnings distribution. For instance they assert that the probability of selecting a particular occupation is adversely related by the volatility of earnings in that occupation. They also report that the higher moments of the distribution of earnings differ significantly across occupations; a finding that is in line with those above regarding output-employment elasticities as well as layoff probabilities.

In the following section we present a model that captures the empirical elements described above.

3. A MODEL OF OCCUPATIONAL CHOICE OVER THE BUSINESS CYCLE

The model constructed in this section addresses three important questions concerning the relationship between economic fluctuations and the educational-occupational decisions of the individuals: First, what the cyclical characteristics of those decisions are; second, whether the cyclical patterns in these variables represent a pure timing (transitory) phenomenon, with the effects of recessions being canceled out completely during subsequent expansions; and third, how these decisions are affected by the expectation of recurrent business cycles (rather than the actual occurrence of a particular cycle). Out of necessity, the model employed is fairly stylized and hence leaves out some relevant factors; those factors' role, however, is discussed at the end of the section.

Let there be two types of labor, skilled and unskilled; and two types of firms: one whose best match is with the skilled and another that matches better with the unskilled (perhaps due to the nature of the available technology and firm specific elements). Both types of firms produce the same good and the production function is linear, hence skilled and unskilled workers would be perfect substitutes in production in the absence of differential matching technology. We make this assumption on technology so that we do not have to worry about indeterminacies in the composition of employment in individual firms[11]. The hiring and firing of the two types of

labor is subject to different adjustment costs, with those of the skilled exceeding those of the unskilled[12].

There are two sources of employment variation in the economy. One is the state of the business cycle and it affects all workers but in a manner that depends on the worker's level of skills (cyclical risk); the other is skill specific (idiosyncratic). For the latter, we assume that at any point in time, a constant fraction of each of the two segments of the labor force is laid off. This fraction may differ across the two groups of workers. This assumption intends to capture skill specific -idiosyncratic- risk factors. We will start with the case where there is only one type of labor, N, which receives a wage w. We will then associate different types of labor with different values of the parameters of the model. The simplest modeling specification is one that assumes that each firm employs a single worker who supplies effort elastically at the wage w (up to a maximum level of N units of labor; in this section we will assume that the demand for labor never exceeds N). At each point in time the firm chooses the quantity of labor input subject to given adjustment costs. The standard labor model with adjustment costs (Nickell [1986]) makes the assumption that those costs have a strictly convex shape. We will discuss later whether and how the results differ under a linear cost structure. The adjustment function is described by a function $g(I(t), \beta N(t))$ with

$$\dot{N}(t) = I(t) - \beta N(t)) \qquad (1)$$

where $\dot{N}(t)$ the net rate of change in the labor input ("hiring/firing") in period t, N(t) is the total amount of labor input employed ("level of employment") in period t, β is the fraction of non-cyclical employment loss and I_t is the gross change in employment. The function g has standard properties with regard to both of its arguments

$$g' > 0, \quad g'' \geq 0, \quad g(0, 0) = g'(0,0) = 0$$

In period m, the firm chooses an employment policy to maximize the present value of its earnings stream given by

$$(2) \qquad \int_m^{\infty} e^{-r(t-m)} [q(t)f(N(t)) - w(t)N(t) - g[I(t), \beta N(t))]dt$$

where f(N(t)) is the production function and q is the price of the good.

Tractability requires the imposition of some tight restrictions on the specification of g, f and q. We will assume that

$$g(\ ) = A[(I(t)]^2/2 + A\beta N(t) \qquad A > 0$$

$$f(N(t)) = KN(t) \qquad K > 0$$

$$q(t) = E + Bsint \qquad E > B > 0$$

The justification for this particular choice of g and f is that they lead to a linear Hamiltonian in the state variable (N(t)), a fact that makes analytical solutions feasible[13]. The product price is assumed to exhibit (deterministic) cyclical fluctuations. For simplicity we will also set w(t) = w for all t (a lifetime labor contract with a fixed wage).

The Hamiltonian is (λ is the multiplier associated with (1)))

$$(3) \quad \mathcal{H} = K[E + Bsint]N(t) - wN(t) - A[(I(t)]^2/2 - A\beta N(t) + \lambda(t)[I(t) - \beta N(t)]$$

Maximization with regard to I and the manipulation of the FOC gives the following optimal employment rule

$$(4) \quad A[\dot{N}(m) + \beta N(m)] = e^{(r+\beta)m} \int_m^{\infty} e^{-(r+\beta)t}[(E + Bsint)K - w - A\beta]dt$$

After some manipulation, the solution for the level of employment is found to be

$$(5) \qquad N(t) = R_0 + R_1 sint + R_2 cost + R_3 e^{-\beta t}$$

where

$$R_0 = \frac{EK - w - A\beta}{\beta A(r + \beta)} > 0$$

$$R_1 = \frac{(1 + r\beta + \beta^2)BK}{A(1 + \beta^2)[1 + (r + \beta)^2]} \qquad R_2 = \frac{- rBK}{A(1 + \beta^2)[1 + (r + \beta)^2]}$$

The first term in (5) is the long term level of employment and must be positive if the firm is to stay in business in the long run. Large adjustment costs as well as the anticipation of large non-cyclical employment losses contribute to a low level of average employment. The coefficient R_3 captures the transitory non-oscillatory dynamics along the path to the long term equilibrium. These dynamics play no role in our analysis, so we will select the initial conditions in such a manner that $R_3 = 0$, that is the firm is assumed to be already in its long term equilibrium. R_1 and R_2 describe cyclical fluctuations in the level of employment. As those cyclical fluctuations are dominated by the sinoid function (the absolute value of R_1 dwarfs that of R_2 for a small r) we will ignore the cosine term in the discussion that follows.

An interesting feature of (5) is that the coefficient of cyclical volatility of employment, R_1, depends negatively on the level of idiosyncratic risk (β). Nevertheless, the dependence is unidirectional, hence stabilization policy (which is defined as the selection of a value for B) does not affect the level of idiosyncratic employment fluctuations.

(5) shows that the higher the adjustment costs (the larger A) the smaller the fluctuations in the level of employment. In the limit ($A \to \infty$) N becomes a perfectly fixed factor. It can also be seen that an increase in the amplitude of the cycle driving force (an increase in B) has an ambiguous relative impact on the size of the fluctuations of the two types of labor. While the lower A associated with the unskilled tends to cause larger cyclical fluctuations in the employment of that group, there is an offsetting force coming from the higher productivity (K) of the high skilled workers. Moreover, there is no clear presumption regarding how β differs across different skill levels. One can argue that whether the rate of non-cyclical employment loss is greater for the unskilled relative to the skilled will depend (in a more specialized model) on the flexibility of the workers in a changing environment as well as

on the nature of technological progress. For instance, if technological progress is skilled biased but builds on current skills then the rate of permanent displacement may be higher among the unskilled. If, on the other hand, skills are technology specific and technologies depreciate fast, then β may turn out to be greater for the skilled.

We can now turn to the career decision of a would be worker in period m. We will make the following assumptions:

a) The individuals start out with the same level of initial resources but differ regarding their latent "ability" to acquire skills. They are uniformly distributed over the unit interval [0, 1], each individual being identified by his "natural" ability level j, j ε [0, 1]. The ability level measures the capacity of the agent to convert a given amount of effort or resources into human capital. For a j type the cost of acquiring skills is ϕ_j with $d\phi_j/dj > 0$. The idea here is that different people have different *learning* abilities or breeding so that the total resource cost (effort, tuition, duration of studies, quality of educational institution attended etc.) of education varies systematically with j.

b) each individual accumulates all of his human capital when he makes an irreversible occupational decision (skilled or unskilled) at the beginning of his career. No further accumulation follows the initial investment.

c) no capital markets exist.

d) leisure is not valued.

In selecting between the two possible career paths each individual compares the streams of utility associated with the two paths. Assuming a linear utility function, the cut off point for "natural" ability which determines who becomes skilled and who remains unskilled is determined by setting the following equation equal to zero

$$(6) \quad W_{Hj} = \int_m^\infty e^{-r(t-m)}[w_H N_H(t)]dt - \int_m^\infty e^{-r(t-m)}[w_L N_L(t)]dt - \phi_j$$

where the subscripts H and L refer to high and low skilled respectively; and ϕ_j is the cost of investing[14] in human capital for an individual of ability level j. Using (5), (6) can be written as

$$(7)\quad (w_H R_{0H}/N_H - w_L R_{0L}/N_L)/r + (w_H R_{1H}/N_H - w_L R_{1L}/N_L)\frac{r\sin m + \cos m}{1 + r^2} - \phi_j$$

An individual invests in human capital in period m if (7) is greater than zero. If the value of j that satisfies (7) as an equality is j^* then all individuals with $j > j^*$ ($j < j^*$) remain unskilled (become skilled)[15].

We can now use equation (7) to answer the questions raised above. Namely, how educational-occupational decisions are affected by the state of the business cycle; and by the severity of expected, recurrent economic fluctuations (the amplitude of the cycle) holding the current state of the cycle fixed. And whether the effects are skewed[16] so that recessions have a permanent effect on the composition of the labor force.

The sign of the trigonometric term roughly mimics (for small r) that of the employment dynamics. In particular, it is positive (negative) when employment is increasing (decreasing). Hence, the incentive to become skilled is counter or pro-cyclical depending on whether the coefficient of the trigonometric term is negative or positive. But that coefficient measures the difference in cyclical earnings between the two groups. If the difference in labor adjustment costs is sufficiently large as to offset the fact that $w_H > w_L$, then $w_L R_{1L} - w_H R_{1H}$ can be negative and the cyclical losses (earnings) of the unskilled are greater than those of the skilled (this is always true when the skilled are a fixed factor while the unskilled are not; or when the difference in the probability of a cyclical layoff is skewed against the low skilled). In such a case the second term in (7) is positive, the incentive to acquire human capital is countercyclical and periods of falling employment (recessions) lead to a reduction of the flow of unskilled into the labor pool. Recessions improve the average quality of labor. Note, however, that because of the cyclical symmetry of (7), those effects are not permanently lived.

The second question is whether the amplitude of the cycle, B, matters for the long term composition of the labor force. It can be easily seen -by integrating (7) over the business cycle- that the linearity of the model together with the perfect symmetry of cycle driving force imply that this is not the case. Subsequently, the exercise of stabilization policy (a decrease in B) is of no consequence for the long term despite the fact that it affects productivity in the short and medium term.

In order to create a link between the cycle and the long term average quality of labor it is necessary to move away from linear symmetry. The most obvious way is to allow the utility function to be concave. Denoting the utility function by u we have that the marginal skilled worker is determined by setting $W_{Hj} = 0$, where W_{Hj} is given by

$$(8) \quad W_{Hj} = \int_m^\infty e^{-r(t-m)} u[w_H N_H(t) + X(m) - \phi_j]dt - \int_m^\infty e^{-r(t-m)} u[w_L N_L(t) + X(m)]dt$$

where X(m) represents the initial resources of the individual. To rule out corner solutions we will assume that $X(m) > \phi_j$ for all j. Differentiating (8) with regard to B and using (5) gives

$$(9) \quad dW_{Hj}/dB = \int_m^\infty e^{-r(t-m)} [u'_H w_H R_{H1}/B - u'_L w_L R_{L1}/B] \sin t \, dt$$

Condition (9) has two interesting features. First, $u'_H < u'_L$ (the high skilled enjoy a higher level of income than the low). This implies that it is no longer necessary that the low skilled suffer greater cyclical income losses ($R_{H1} w_H < R_{L1} w_L$) in order for investment in human capital to be countercyclical and increasing in the severity of the recessions. And second, unlike (6), where the coefficient of the trigonometric term is independent of the state of the business cycle, the term inside the brackets in (9) varies with the cycle because of u'. Moreover, greater cyclical volatility (a higher B) has a disproportionate effect on the utility level of the low skilled because of the concavity of the utility function together with the fact that the low skilled have lower average income. Subsequently, there is no longer intertemporal offsetting over the business cycle and one can view investment in human capital as providing insurance against cyclical variability. Macroeconomic stabilization offers "free" insurance independent of skills and diminishes the incentive for self help through the acquisition of human capital.

A similar argument applies to the long term effects of the state of the business cycle -for a given B- when the utility function is concave. The effect of the state of the cycle is not symmetric (because of concavity) and

hence the gains in the quality of labor experienced during a recession are not completely negated by the losses witnessed during the subsequent expansion.

Before concluding this subsection we must note that our analysis has been of partial equilibrium nature. This means that we have implicitly assumed that an increase in the number of skilled workers has negligible effects on both the probability of employment and the earnings of the members of that group. This may not be true in the general equilibrium of the model. The direction of these effects will depend on the existence of intratemporal and intertemporal externalities associated with skills (on the slope of social marginal product of labor), on whether the unemployment rate for any labor group depends solely on the adjustment costs for that group rather than on the number of workers etc[17]. In any case, it should be clear that whatever those effects do, they cannot change the *sign* of the relation between the phase and the amplitude of the cycle and the incentive to accumulate human capital; it is only the quantitative aspects that may be affected.

Finally, let us mention that the channel proposed in this paper to link the cycle to the long term prospects is suggested for the first time in the literature; but one can claim the existence of some related theoretical predecessors to it. Darwin clearly stressed the role of adversity as a mechanism for the improvement of fitness and hence for long term prospects (see also Dellas [1991a]. Adversity (recessions) mostly affect the unfit (the low skilled workers or inefficient firms). An endogenous occupational -educational adjustment that increases skills improves fitness and hence increase the likelihood that one will escape adversity unharmed (without a loss of job). In a somewhat similar vein, the historian R. Toynbee [1939] has forcefully emphasized the fundamental importance of adversity in the development of human civilizations. In his monumental work, "A study of history," Toynbee argues that "challenge (adverse conditions) and response" is the formula that captures the entire human history (vol. II, p.260)[18].

Linear Adjustment Costs

The analysis so far has relied on the assumption of strictly convex adjustment costs. The real world, however, may not be as convex. For instance, a linear adjustment cost technology is often thought to be more realistic (see Nickell [1986]). There may also be discontinuous jumps in

employment corresponding to business closures. One then would like to know whether our results would differ under such an alternative specification.

The case of a linear adjustment cost technology with different fixed costs for hiring-firing across levels of skills can be analyzed as above. What is of interest in this case is that there is a range for the cycles in goods prices (or wages) in which there are no changes in employment. But as the amplitude of the cycles increases, the fixed costs for adjustment are exceeded and a piece wise employment cycle takes place. Under some conditions, the higher fixed cost associated with skilled labor *may* imply that for sufficiently small price cycles, skilled labor is a fixed factor while the unskilled faces cyclical risk. Within this range (if it exists), higher volatility unambiguously increases investment in human capital. Consequently, perfect macroeconomic stabilization deteriorates the average quality of labor. For large enough cycles, both factors are subject to cyclical risk and the incentive to accumulate human capital may actually decrease with further increases in the amplitude of the cycle.

More formally, setting for simplicity the rate of idiosyncratic employment losses, β, equal to zero and assuming that the cost of firing and hiring skilled labor is given by γ_H and ζ_H respectively and unskilled labor γ_L and ζ_L respectively, the Hamiltonian for type i firm (i = H, L) is given by

$$(10)\quad \mathcal{H}_i = q(t)K_iN_i(t) - w_iN_i(t) - A_i^{\nu}|I_i(t)| + \lambda_i(t)I_i(t)$$

$$\text{where } A_i^{\nu} = \begin{cases} \gamma_i & \text{if } I < 0 \\ \zeta_i & \text{if } I > 0 \end{cases}$$

Because of the linearity of both the production function and the adjustment costs, the model has a bang-bang solution with either full (that is, N(t) = N, the maximum level of labor input) or zero employment at any point in time. The timing of cyclical hiring and firing of factor i is determined by the following equations

(11a) $\lambda_i(t) = \zeta_i$ and $\dot{\lambda}(t) > 0$ for hiring, with $I_i(t) = N_i$

(11b) $\lambda_i(t) = -\gamma_i$ and $\dot{\lambda}(t) < 0$ for firing, with $I_i(t) = -N_i$

$$\text{where } \lambda_i(t) = \frac{EK_i - w_i}{r} + \frac{BK_i}{1 + r^2} \cdot (\sin t - r \cos t)$$

and N_i is total labor effort type i can supply.

Due to the fact that the two functions $\lambda_H(t)$ and $\lambda_L(t)$ will in general differ, one cannot compare employment dynamics across the two types of labor without any further assumptions on K_i and w_i. For instance, there exists a set of parameters for the model which makes employment of the skilled more volatile than that of the unskilled. As we are not interested in taxonomy, we impose parameter values leading to employment behavior that is consistent with the observed labor hoarding practices. Namely, we assume that

$$\text{(i)} \qquad [\gamma_H + \frac{EK_H - w_H}{r}]/K_H > [\gamma_L + \frac{EK_L - w_L}{r}]/K_L$$

$$\text{(ii)} \qquad \min\{\lambda_L(t) - \lambda_H(t)\} \leq 0$$

Condition (i) says that the effects of economic downturns on employment are felt first by the low skilled (they are the first to be fired). Condition (ii) implies that it is more likely that skilled rather than unskilled labor will be perfectly insulated from the business cycle.

Let B^* be defined by the condition $\min\{\lambda_L(t)\} = -\gamma_L$ and B^{**} by the condition $\min\{\lambda_H(t)\} = -\gamma_H$. Condition (ii) implies that $0 < B^* < B^{**}$. Subsequently, for $0 < B < B^{**}$, both factors are fixed; for $B^* < B < B^{**}$ the unskilled are subject to employment variation while the skilled are perfectly hoarded during recessions; and for $B^{**} < B^*$ both factors experience cyclical unemployment. What is of particular interest in this model with linear adjustment costs is that the incentive to invest in human capital may no longer be a monotone function of the severity of the business cycle. Postulate, for instance, a linear utility function. The incentive to accumulate human capital is zero in the $[0, B^*]$ interval, positive in the $[B^*, B^{**}]$ range and zero again when $B > B^{**}$. Thus, the effectiveness of human capital as a hedge against risk (and the incentive to acquire human capital) may be weaker in an economy that allows for large cyclical swings *relative* to

one which only experiences small to moderate ones. Hence the linear example formalizes the idea that moderate adversity (output instability) can be conducive to growth enhancing activities but too much of it can be detrimental. This line of argument can find support in Toynbee's study of the history of human civilizations. And it may offer support to those who, while objecting to frequent and unqualified cyclical macroeconomic intervention, they argue that events of great severity -such as the great depression- may represent legitimate calls for mitigating policies.

There may also be other reasons for reinforcing the argument that stabilization policy may be growth enhancing if it is used against severe, prolonged recessions. The model presented here has abstracted from the possibility that the demand for education may depend on one's personal or family disposable income. If own or family resources are not sufficient to finance education and there exist borrowing constraints then recessions may prevent schooling. This may be particularly true if a recession is severe so that the drop in disposal income is of such a magnitude that the income effects on the demand of education -for at least some groups- dominate the substitution effects described above. A similar argument applies to people who go to school part time and loose their jobs during recessions. If the -negative- income effects are more likely to become dominant the more severe and prolonged a recession has been[19] then there may be an argument in favor of mitigating economic downturns. Evaluating the relative importance of income and substitution effects on the demand for education is an empirical issue and it can be inferred from the cyclical behavior of school enrollment rates.

Finally, there is another element that our model has abstracted from. Namely, that unemployment may be associated with foregone learning by the doing on the job as well as "forgetting" by not doing (skill depreciation). Both effects affect adversely human capital accumulation and must be taken into account in calculating the net effects of the business cycle. It is not technically feasible to incorporate these elements into the model of this paper, but they may be analyzed within a model of homogeneous labor with predictable results. Ultimately, the relative size of those opposing forces[20] and hence the net effect of recessions on the average quality of labor can only be determined empirically.

4. THE EMPIRICAL ANALYSIS

The model has several empirical implications. The first set of them regards the cyclical behavior of human capital accumulation. If the recessions in the post world war II period have, on average, been rather moderate then one ought to observe that:
a) school enrollment rates have been countercyclical and also an increasing function of the ratio of the unemployment rates for the unskilled and skilled. b) college enrollment rates have been countercyclical. c) high school drop out rates have been procyclical and also negatively associated with the ratio of unemployment of high and low human capital segments of the labor force.

The remaining implications regard the *net* long term effects of these cyclical effects. Under risk aversion or linear labor adjustment costs the model predicts that a) the effects of recessions is permanent, that it there is no perfect intertemporal offsetting; and b) recessions -at least over some range- will be associated with long term gains in both the level and the growth rate of productivity; and also that the amplitude of disturbances will be positively related to the average rate of economic growth.

Some aspects of the latter set of empirical implications have already been investigated in the literature. Bean [1991] and Gali and Hammour [1991] find that demand shocks have the predicted effect on long term productivity. Kormendi and McGuire [1985] find a positive relationship between the rate and the standard deviation of economic growth. Note, however, that our analysis suggests that it is the volatility of the shocks that should be positively related to growth, not necessarily the volatility of output[21].

The first set of implications of the theory have not been studied before. But there exists a widespread belief -at least among those who have served on school admission committees- that school enrollment is countercyclical. In this section we report some empirical findings regarding the relationship between school enrollment, high school drop out rates and the rate of unemployment (and GDP growth). We examined aggregate US high school drop out rates, school enrollment rates for various age groups (18 to 25, 25 to 29 and 30 to 35 years old) and graduate school enrollment; and also college enrollment data by state. When the variables under consideration were nonstationary we used first differences.

Table I

Unemployment[22] and high school drop out rates, 1967-1990

$$\Delta(DROP)_t = -.04 - .095\ \Delta(UN1619)_t \qquad R^2 = .11 \qquad DW = 2.21$$
$$(.09)\quad (.048)$$

Drop = annual high school drop out rate, grades 10-12 (Source: Bureau of Census, Current Population Report); Un1619 = unemployment rate for ages 16-19 (Source: Bureau of Labor Statistics); Δ is the difference operator. The numbers in parentheses in this and all other tables are standard deviations.

Table II

School enrollment and the cycle[23]

$$\Delta(c2529)_t = .43 - 8.7\ GDP_t^{24} \qquad R^2 = .17 \quad DW = 2.1 \qquad (1947\text{-}90)$$
$$(.12)\quad (2.8)$$

c2529 = percentage of population of persons 25 to 29 years old enrolled in school (Source: Bureau of Census, Current Population Report); GDP = GDP growth rate.

Table III

Graduate school enrollment

$$GS_t = .35 + .68\ GS_{t-1} + .026\ UNET \qquad R^2 = .86 \quad DW = 2.6 \qquad (1967\text{-}90)$$
$$(.12)\quad (0.08)\qquad (.01)$$

GS = graduate school enrollment in period t (Source: Current Population Report); UNET = aggregate rate of unemployment (Source: BLS);

Table IV

Relative unemployment and school enrollment

$$\Delta(c2529)_t = \underset{(.47)}{-.8} + \underset{(.28)}{.58}\ (UNEM)_t \qquad R^2 = .08 \qquad DW = 2.7 \qquad (1958\text{-}90)$$

$$\Delta(c3034)_t = \underset{(.4)}{-1.0} + \underset{(.25)}{.7}\ (UNEM)_t \qquad R^2 = .18 \qquad DW = 2.8 \qquad (1947\text{-}90)$$

$$\Delta(DROP)_t = \underset{(1.3)}{2.8} - \underset{(0.7)}{1.5}\ (UNEC)_t \qquad R^2 = .14 \qquad DW = 2.6 \qquad (1967\text{-}90)$$

UNEM = ratio of the unemployment rate in manufacturing to the aggregate unemployment rate for persons over twenty five years of age; UNEC = ratio of unemployment in construction to the overall unemployment rate (Source: BLS)

These tables suggest that formal human capital accumulation is countercyclical as predicted by the theory. Moreover, it seems that relative employment opportunities play a significant role in the decision to go to school as can be seen from table IV where we used a measure of relative employment opportunities instead of the economy wide rate of unemployment. In particular, in the first two regressions reported we used the ratio of unemployment in manufacturing to the unemployment rate of adults over twenty five years of age, UNEM (use of the rate of unemployment in construction in place of that in manufacturing produced almost identical results), and in the third regression we used the ratio of unemployment in construction to the overall rate of unemployment (again the results are not altered when one used unemployment in manufacturing in the numerator of the ratio; or unemployment of the 16 to 19 year old in the denominator). The justification for running these regressions is that the unemployment rate in manufacturing (or, even more so, in construction) during the sample period can be taken to capture reasonably well the employment opportunities of workers with low levels of formal schooling. Hence investment in formal education may represent a means of improving employment prospects for that category of the labor force. The

results offer support to this view as school enrollment increases significantly with increases in the relative unemployment rate.

The general conclusion that emerges from these tables is that there exist groups in the population whose investment in formal schooling is affected by the state of the business cycle. Moreover, as predicted by the theory, all those groups invest in human capital accumulation in a countercyclical way[25].

We now turn to the examination of the cyclical behavior of college enrollment rates at the state level. Table V reports the results of a regression of the growth of rate of college enrollment in state i in period t on the first difference of the state unemployment rate for that period[26]. State specific dummy variables were employed to capture cross-sectional differences. A countercyclical pattern was obtained again (the sign and statistical significance of the estimated coefficient is robust to alternative specifications regarding the inclusion of time/ state dummies, correction for heteroskedasticity etc.). Moreover, the same pattern emerged when we used real output growth in place of the unemployment rate[27].

Table V

College enrollment by state 1971-1989

$$Colenr_{it} = \underset{(1.4)}{3.7} + \underset{(.09)}{1.17}\ \Delta(STUN)_{it} \qquad R^2 = .21 \qquad N = 950$$

Colenr = growth rate of college enrollment for all 4-year colleges in state i in year t; Δ(STUN) = the change in the unemployment rate between periods t-1 and t in state i (Source: Colenr is from "Historical Trends: State Education facts 1969 to 1989," National Center for Educational Statistics, US Department of Education; STUN was taken from "Employment and Earnings and Geographical Profile of Employment and Unemployment" BLS). Standard errors in parenthesis.

It has already been discussed in detail that a countercyclical pattern for schooling is not sufficient to imply that recessions have permanent effects on the average quality of labor. In order to examine whether a countercyclical pattern does not reflect pure timing in the sense that the effects of expansions and slumps are asymmetric, we resorted to a very simple empirical test. We constructed two dummy variables. One was assigned the value of one when the independent variable in the regressions reported above showed a deterioration in the unemployment outlook (for example when Δ(unemployment) > 0) and zero otherwise; and the other was assigned a value of one when the unemployment prospects improved (for example when Δ(unemployment) < 0) and zero otherwise. We then run some of the regressions reported above using the dummies as the right hand side variables. The results are reported in table VI.

Table VI

Testing for business cycle symmetry

$\Delta(DROP) = -.287\ D1619IN + .1\ D1619DE \qquad R^2 = .12$
$\qquad\qquad (.149) \qquad\quad (.88) \qquad\qquad DW = 2.2$

$\Delta(c3034) = 1.03\ DUNEMIN - .33\ DUNEMDE \qquad R^2 = .18$
$\qquad\qquad (.42) \qquad\quad (.18) \qquad\qquad DW = 2.9$

$\Delta(C2529) = .78\ DUNEMIN - .22\ DUNEMDE \qquad R^2 = .10$
$\qquad\qquad (.48) \qquad\quad (.20)$

$Colenr = 2.7 + 2.3\ DSTUNIN \qquad R^2 = .15$
$\qquad\quad (.4) \quad (.27)$

$Colenr = 5.04 - 2.29\ DSTUNDE \qquad R^2 = .15$
$\qquad\quad (.97) \quad (.27)$

D1619IN = 1 (= 0) if Δ(UN1619) > (<) 0; D1619DE = 1 (= 0) if Δ(UN1619) < (>) 0
DUNEMIN = 1 (= 0) if Δ(UNEM) > (<) 0; DUNEMDE = 1 (= 0) if Δ(UNEM) < (>) 0
DSTUNIN = 1 (= 0) if Δ(STUN) > (<0); DSTUNDE = 1 (= 0) if Δ(STUN) < (>) 0

The effects of increases and decreases in state unemployment on college enrollment are perfectly symmetric. In the other cases, however, the effect of increases in unemployment on formal schooling completely dominate any offsetting effects arising from decreases. Recessions and expansions are not symmetric with regard to human capital accumulation. Moreover the net effect over the business cycle is positive as can be seen by taking into account possible asymmetries in the frequencies of expansions and recessions or differences in the duration of the two phases. In the sample there are fewer increases than decreases in the unemployment rate (there are 25 cases with DUNEMD = 1 and 16 with DUNEMI =1; 14 cases with D1619D = 1 and 9 with D1619I = 1.). Weighting the estimated coefficients by the relative frequencies (or equivalently, integrating over the business cycle) leads to the conclusion that recessions have permanent effects on the average quality of the labor force. Note, however, that unless one uses a cross sectional sample one cannot make any counterfactual claims regarding the effects of an increase in the amplitude of the cycle in the US on the level of formal schooling.

One can take the analysis one step further and attempt to examine the feed back from school enrollment to output growth. We run a regression of the average over the sample period rate of real state output growth on the average growth of college enrollment (table VII).

Table VII

Output growth and college enrollment by state

$$YA(i) = \underset{(.09)}{.45\ CEA(i)} + \underset{(.11)}{.5\ EMA(i)} - \underset{(.10)}{.46\ GAP(i)_{1963}} - \underset{(.37)}{.52\ EMER(i)} \qquad R^2 = .81,\ N = 50$$

YA(i) = average real GDP growth in state i; CEA(i) = average rate of four year college enrollment; EMA(i) = average rate of employment growth; GAP(i) = difference in labor productivity (output per employee) between state i and the US average in 1963; EMER(i) = the ratio of employment to adjusted college enrollment in 1970 (the college enrollment rate was adjusted to include residents of the state attending college in other states). All averages were calculated over the period 1970-89. Standard errors are given in parenthesis.

The statistically significant, positive association indicates that a higher rate of growth in human capital leads to a higher rate of output growth. However, some caution must be exercised in making any strong claims regarding this effect because post secondary education is a normal good. Causality may well be running in the opposite direction. For instance, even if human capital did not matter for economic growth, one could observe a positive relationship between schooling and growth as a result of a series of income shocks. One cannot get around this difficulty by relying on regressions of, say, average output growth over a sub period on average college enrollment rates during previous sub periods because of the existence of positive autocorrelation in state output growth rates. Note that the coefficient of EMER, which is inversely related to human capital per employee, is negative as expected but it is also statistically insignificant. The negativity of the coefficient of GAP implies the existence of cross state convergence in real output levels as predicted by the Solow of growth model.

In addition to the formal schooling variables examined above there are other venues for human capital accumulation such as participation in vocational training[28], in training activities sponsored or encouraged by the employers etc. If labor hoarding does take place then one should expect the hoarded employees to intensify their training activities during periods of low demand (because of the low opportunity cost). Unfortunately, the lack of data measuring the intensity of such activity prevents us from studying its cyclical properties.

As mentioned in section 2, there exist cyclical influences on human capital and the average quality of labor that run in the opposite direction. Unemployment may prevent workers from learning on the job and it may also cause "forgetting by not doing." Determining the strength of these opposing factors is an empirical matter which cannot, however, be settled directly given the nature of the available data. This is because there exist no measures of human capital loss attributed to cyclical unemployment. The only strategy left is to take an indirect route and *infer* which effect dominates by studying the long term implication of recessions for productivity. Gali and Hammour [1991] have undertaken the most serious attempt so far to link recessions to subsequent long term productivity. Using a Blanchard-Quah methodology they establish that demand shocks tend to be negatively associated with future productivity in the post world war II period in the US (similar

results are reported by Bean [1990] and Saint-Paul [1993]). This finding can be viewed as offering indirect support to the theory presented in this paper. It is true that it is equally consistent with the alternative recessions-as-reorganization-of-the-firm theories, but the R & D variable identified by these alternative theories does not seem to follow the required countercyclical pattern (see Saint-Paul [1993]).

5. CONCLUDING REMARKS

It has been suggested that economic stabilization is a rather unimportant activity relative to growth influencing policies (Lucas [1985]). This claim has been based on the premise that cyclical policies cannot influence long term growth prospects. In this paper we have have argued that economic stabilization may impact on the long run growth of output through its effects on human capital and the average quality of labor. This effect works through a variety of channels. Moderate recessions allow displaced workers to make investments in human capital via formal schooling. They also discourage low skilled individuals from entering the labor force (because of the relative unavailability of low skill jobs during economic downturns) and redirect some of these individuals to schooling. Finally, the fact that the effects of recessions tend to be heavily skewed against the low skilled may induce agents to seek insurance against cyclical risk via the accumulation of skills. All of these effects contribute to the improvement of the average quality of labor and can link economic fluctuations of the type experienced in the post world war II period to long term growth.

Regarding the possible empirical links between recessions and long term growth we were able to establish that, as far as schooling is concerned, formal investment in human capital follows a countercyclical pattern. Moreover, the effects of recessions do not seem to be completely negated by offsetting behavior during expansions. Hence recessions can be claimed to promote the long term average quality of labor (and growth). This conclusion is consistent with the indirect evidence that comes from other studies in the literature which have documented the existence of positive long term effects of recessions on productivity.

NOTES

[1]It was the conventional wisdom in pre-Keynesian economics that the exercise of stabilization policy was detrimental to long term growth (e.g. Schumpeter [1991]. See Delong [1990] for a detailed discussion.

[2]It must be noted that there exist a few *stationary* models which allow transitory shocks to have permanent effects on the level of output (Blanchard and Summers [1988], Drazen [1985], Galor and Tsiddon [1992]). There also exist nonstationary models that permit an *individual* shock to have permanent effects on the conditional growth rate (King, Plosser and Rebello [1988], Stadler [1990]. However, the unconditional average growth rate is invariant to the business cycle in those models.

[3]The idea that recessions represent a good opportunity for undertaking activities which tend to enhance long term productivity is also present in Aghion and Saint-Paul [1991] and Hall [1991]. These authors single out as the driving force a closely related activity, namely investment in reorganization by firms, while we emphasize investment in human capital by the individuals. Davis and Haltiwanger [1990] have also suggested that "...business cycle slumps are times when the economy takes a "pit" stop to retool, reallocate and restructure..."

[4]Regarding the relationship between unemployment and long term growth, Bean and Pissarides [1992], argue that unemployment can have adverse effects on growth because it reduces savings and investment.

[5]One would also like to examine the cyclical behavior of training programs *within* the firms. While the labor hoarding phenomenon suggests that it must be countercyclical, the lack of relevant data has not allowed us to study it.

[6]It is true that this empirical evidence is also consistent with alternative theories that do not involve human capital accumulation (such as those of Caballero and Hammour [1991], Dellas [1991a], Aghion and Saint-Paul [1991]). It is encouraging, however, for the model of this paper, that R & D, the natural candidate of the alternative firm reorganization approach, does not seem to exhibit the required countercyclical pattern (Saint-Paul [1993]).

[7]They found that the overall compensating differential was 3.82 percent. Of this differential 3.22 was attributable to risk compensation arising from the variability of unemployment *given* its average level.

[8]Davis and Haltiwanger [1991] also report that the manufacturing's rate of job destruction averages 11.3% per year. While this is the gross rate and it also includes non-cyclical elements the fact that aggregate shocks are important implies that a significant fraction of this constitutes cyclical risk.

[9]The latter observation is of interest if manufacturing has a higher concentration of low human capital workers. In section 3 we find that the ratio of unemployment in manufacturing to total unemployment is positively related to school enrollment rates for "older" age groups.

[10]Laylard et all (1990) report unemployment rates by skill in the US and UK (Table 3, p.45). The unemployment rates are inversely related to the level of skills and there exist significant differences across skill groups. While these findings seem to work in favor of the theory developed in section 2, we must note that the figures reported do not distinguish between cyclical and non cyclical components.

[11]Assuming imperfect substitutability in production would resolve the indeterminacy problem but would make the analysis considerably harder. Nevertheless. allowing for the joint use of inputs is certainly interesting (see Leban and Lesourne [1980]) and needs to be investigated more thoroughly.

[12]Nickell [1986] discusses the existence of enormous differences in the cost of hiring and firing across different groups. He refers to a study by Rees [1973] based on a group of manufacturing firms in Rochester N.Y. which indicates that the average cost for professional, managerial and technical workers are twelve times as great as those for the unskilled and for skilled workers they are more than five times as large.

[13]The linearity of production implies that the only thing that limits the scale of production is the presence of adjustment costs.

[14]The assumption of instantaneous acquisition of human capital is made only for simplicity and it does not affect the qualitative properties of the results.

[15]The appropriate choice of the parameters and the functional forms in the model can guarantee the existence of an interior solution with $0 < j^* < 1$.

[16]Skewness seems to be an important feature of the business cycle. For example, Davis and Haltiwanger [1991] document the existence of great asymmetries in cyclical job destruction. Caballero and Hammour [1991] and Dellas [1991a] construct models where such skewness matters.

[17]Dellas [1991b] shows that the main results of this paper also obtain in a simplified, general equilibrium version of the present model.

[18]Toynbee presents several cases to corroborate the challenge and response "law". One regards China. Great ingenuity and effort had to be expanded to make the valley of the Yellow River habitable as well as to defend it against devastating floods. The valley of Yangtse, on the other hand, was both fertile and immune to natural terrors. Yet, the chinese civilization was born in the Yellow River valley. Similarly, the great ancient greek civilization started and flourished mostly in the arid, inhospitable land of Attica than in the neighboring fertile land of Beotia.

[19]The income effects can be incorporated into our framework by allowing $x - \phi$ to be a function of the business cycle; or by adding another cyclical cost term, $z(t)$, to equation (6) (or (8)). Such a term, can take the form $z(m) = Q_0 - Q_1 \sin(m)$ $(Q_0 > Q_1 > 0)$; or, if one wants to allow the length of the recession -in addition to the severity of its current state- to play a role in the demand for education as $z(m) = \int_{m-T}^{m} z(t)dt$, $m > T > 0$, $z(t) = Q_0 - Q_1 \sin(t)$. $Z(t)$ can be thought as measuring an income adjusted direct cost of education (for instance, it can be related to current income or income accumulated in the previous periods by the individual or his parents as well as to direct educational expenses). If $z(t)$ is procyclical enough then it may induce a procyclical pattern for the investment in human capital.

[20]There are also some other relevant considerations, such as the cyclical properties of crime and its relation to unemployment, etc.

[21]Because the endogenous response of the economy that improves the composition of the labor force ought to make the average worker (and output) less susceptible to the cyclical effects of the shocks.

[22]The regression of the drop out rate on GDP growth and on the overall rate of unemployment (UNEM) produced the following equations:

$$MDROP = -.2 + 6.7\ GDP \qquad R^2 = .12 \qquad D\text{-}W = 2.48$$
$$(3.4)$$

$$MDROP = -.003 - .19 \qquad R^2 = .16 \qquad D\text{-}W = 2.16$$
$$(.08)$$

[23]We only report here the regressions which produced statistically significant results. All those omitted used either the relevant unemployment rate for each age group or the GDP growth rate. They all exhibited a countercyclical pattern.

[24]The regression of Δ(c2529) on the overall rate of unemployment, UNEM, produced the following equation:

$$\Delta(c2529)_t = .14 + .19\ \Delta(UNEM)_t \qquad R^2 = .11 \qquad DW = 2.2 \qquad (1947\text{-}90)$$
$$(.07)$$

[25]We also looked at the relationship between school enrollment and various measures of real wages (such as real hourly or weekly earnings etc.) to see whether the opportunity cost theory of schooling operated through channels other than unemployment; we did not find any such relationship. Note, however, that the regression reported in table II may be capturing such effects.

[26] We are grateful to Hugh Courtney for supplying the data on state unemployment.

27

College enrollment by state 1970-1989

$$Colenr_{it} = -.24\ Y_{it} \qquad R^2 = .14 \qquad N = 1000$$
$$(.03)$$

where Y is the growth rate of real GDP for state i in period t.

[28]The period span of available data on vocational enrollment is too short to be useful.

REFERENCES

Abowd, J. and O. Ashenfelter "Anticipated unemployment, temporary layoffs, and compensating wage differentials," in "Studies in Labor Markets" (ed. S. Rosen): University of Chicago Press.

Abraham, K. and D. Houseman (1989) "Job security and work force adjustment: How different are U.S. and Japanese practices?" *Journal of the Japanese and International Economies*, 500-521.

Aghion, P. and G. St-Paul (1991) "On the virtue of bad times," *mimeo.*

Bean, C., (1990) "Endogenous growth and the procyclical behavior of productivity," *European Economic Review,* 355-363.

Bean, C. and C. Pissarides (1992) "Unemployment, consumption and growth," *mimeo, CEP.*

Blanchard, O. and P. Diamond (1989) "The Beveridge curve", *Brookings Papers on Economic Activity,* 1-60.

Blanchard, O. and L. Summers (1988) "Beyond the natural rate hypothesis," *American Economic Review,* 182-187.

Caballero, R. and M. Hammour (1991) "The cleansing effect of recessions," *mimeo,* Columbia University.

Davis, S. and J. Haltiwanger (1990) "Gross job creation and destruction: Microeconomic evidence and macroeconomic implications," *NBER Macroeconomics Annual.*

Dellas, H., (1991a) "Recessions, ability discrimination and growth," *mimeo.*

Dellas, H., (1991b) "Stabilization policy and long term growth," *mimeo.*

Delong, B. (1990) "Liquidation cycles," *NBER* working paper, No 3546.

Drazen, A. (1985) "Cyclical determinants of the natural level of economic activity," *International Economic Review.*

Gali, J. and M. Hammour (1991) "Long run effects of business cycles," *mimeo.*

Galor, O. and D. Tsiddon (1992) "Transitory productivity shocks and long-run output," *International Economic Review.*

Hall, R., (1991) "Recessions as reorganizations," *NBER Macroeconomics Annual.*

King, R., C. Plosser and S. Rebello (1988), "Production, growth and business cycles," *Journal of Monetary Economics*

Kormedi, R. and P. McGuire (1985) "Macroeconomic determinants of growth: Cross country evidence," *Journal of Monetary Economics,* 141-163.

Laylard, R., S. Nickell and R. Jackman, (1990) "*Unemployment: Macroeconomic performance and the labor market,*" Oxford University Press.

Lucas, R. (1985) "Models of business cycles," *mimeo*.

McCallum, B. (1986) "On real and sticky price theories of the business cycle," *Journal of Money Credit and Banking*, 397-414.

Nickell, S. (1986) "Dynamic models of labor demand," O. Ashenfelter and R. Layard, eds. *Handbook of labor economics*, North Holland.

Orazem, P. and P. Mattila (1991) "Human capital, uncertain wage distributions and occupational and educational choices," *International Economic Review*, 103-122.

Rees, A. (1973) "*The economics of work and pay*," Harper and Row.

Saint-Paul, G., (1993) "Productivity growth and the structure of the business cycle," *European Economic Review*, forthcoming.

Schumpeter, J. (1991) *Essays*, ed. by R. Clemence, Transaction Publishers.

Stadler, G. (1990) "Business cycle models with endogenous technology," *American Economic Review*, 763-778.

Toynbee, A. (1939) *A Study of History*, Oxford University Press.

IN THE SAME SERIES

No 1 G. Alogoskoufis, Competitiveness, Wage Rate Adjustment and Macroeconomic Policy in Greece. Athens, 1990 (in Greek).

No 2 L. Athanassiou, Adjustments to the Gini Coefficient for Measuring Economic Inequality. Athens, 1990.

No 3 J. Dutta and H. Polemarchakis, Credit Constraints and Investment Finance: Evidence from Greece. Athens, 1990.

No 4 C. Kanellopoulos, The Underground Economy in Greece: What Official Data Show. Athens (in Greek 1990 - in English 1992).

No 5 N. Antonakis and D. Karavidas, Defense Expenditure and Growth in LDCs - The Case of Greece, 1950-1985. Athens, 1990.

No 6 J. Geanakoplos and H. Polemarchakis, Observability and Constrained Optima. Athens, 1992.

No 7 L. Athanassiou, Distribution Output Prices and Expenditure. Athens, 1992.

No 8 N. Christodoulakis, Certain Macroeconomic Consequences of the European Integration. Athens, 1992.

No 9 V. Rapanos, Technological Progress - Income Distribution and Unemployment in the less Developed Countries. Athens, 1992.

No 10 V. Rapanos, Joint Production and Taxation. Athens, 1992.

No 11 D. Maroulis, Economic Analysis of the Macroeconomic Policy of Greece during the Period 1960-1990. Athens, 1992 (in Greek).

No 12 C. Kanellopoulos, Incomes and Poverty of the Greek Elderly. Athens, 1992.

No 13 G. Agapitos and P. Koutsouvelis, The Harmonization within EEC: Single Market and its Impacts on Greece's Private Consumption and Vat Revenue. Athens, 1992.

No 14 C. Carabatsou-Pachaki, Elaboration Principles/Evaluation Criteria for Programmes. Athens, 1992 (in Greek).

No 15 C. Carabatsou-Pachaki, Reforming Common Agricultural Policy and Prospects for Greece. Athens, 1992 (in Greek).

No 16 P. Paraskevaides, Effective Protection, Domestic Resource Cost and Capital Structure of the Cattle Breeding Industry. Athens, 1992 (in Greek).

No 17 Kl. Efstratoglou, Export Trading Companies: International Experience and the Case of Greece. Athens, 1992 (in Greek).

No 18 C. Carabatsou-Pachaki, Rural Problems and Policy in Greece. Athens, 1993.

No 19 St. Balfoussias, Ordering Equilibria by Output or Technology in a Non-linear Pricing Context. Athens, 1993.

No 20 St. Balfoussias, Demand for Electric Energy in the Presence of a two-block Declining Price Schedule. Athens, 1993.

No 21 P. Paraskevaides, Regional Typology of Farms. Athens, 1993 (in Greek).

No 22 P. Paraskevaides, Evaluation of Regional Development Plans in the East Macedonia-Thrace's and Crete's Agricultural Sector. Athens, 1993 (in Greek).

No 23 C. Eberwein and Tr. Kollintzas, A Dynamic Model of Bargaining in a Unionized Firm with Irreversible Investment. Athens, 1993.

No 24 P. Paraskevaides, Income Inequalities and Regional Distribution of the Labour Force Age Group 20-29. Athens, 1993 (in Greek).

No 25 A. Gana, Th. Zervou and A. Kotsi, Poverty in the Regions of Greece in the late 80's. Athens, 1993 (in Greek).

No 26 G. Georganta, The Effect of a Free Market Price Mechanism on Total Factor Productivity: The Case of the Agricultural Crop Industry in Greece. Athens, 1993.

No 27 H. Dellas, Recessions and Ability Discrimination. Athens, 1993.

No 28 Z. Georganta. Accession in the EC and Its Effect on Total Factor Productivity Growth of Greek Agriculture. Athens, 1993.