CENTER OF PLANNING AND ECONOMIC RESEARCH

LECTURE SERIES

25.

MONETARY POLICY, UNEMPLOYMENT AND WAGE RATES: THE U.S. POSTWAR EXPERIENCE

By

GEORGE D. DEMOPOULOS

Rochester Institute of Technology and
Center of Planning and Economic Research

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Opinions or value judgements in this book are those of the author and do not necessarily represent those of the Center of Planning and Economic Research.

CENTER OF PLANNING AND ECONOMIC RESEARCH

The Center of Planning and Economic Research (KEPE) was founded in 1961 as an autonomous Public Organisation, under the title «Center of Economic Research», its basic objective being research into the problem of the operation, structure and development of the Greek economy. Another of its objectives was the training of young Greek economists in modern methods of economic analysis and researeh. For the establishment and operation of the Center considerable financial aid was provided by the Ford and Rockefeller Foundations, and the United States Mission to Greece.

During 1964, the Center of Economic Research was reorganized into its present form, as the Center of Planning and Economic Research. In addition to its function as a Research and Training Institute, the Center, in its new form, was assigned the following tasks by the State: (1) The preparation of draft economic development plans, (2) the evaluation of public investment programmes and, (3) the study of short-term development in the Greek economy and advising on current problems of economic policy.

For the realization of these aims, the KEPE, during its first years of operation (1961-66) collaborated with the University of California at Berkeley. The latter helped in the selection of foreign economists who joined the Center, to carry out scientific research into the problems of the Greek economy and in the organization of an exchange proyramme, including visits of American students to the Center, and the post-gra-

duate training of young Greek economists at American Universities.

The research activity of the KEPE into the problems of the Greek economy, is presented in two series of publications, the «Research Monograph Series» and the «Special Studies Series A and B». The «Research Monograph Series» includes studies which, in addition to their practical interest, also have a theoretical interest. The «Special Studies Series A and B» mainly includes studies of an empirical content. More specifically, Series A includes stvdies referring to fundamental problems of economic and social conditions in Greece and is distinguished from Series B by the fact that it includes a more systematic and detailed analysis of the subjects covered.

The Center has also developed a broad programme of scholarships for post-graduate studies in economics. Thus, in collaboration with foreign universities and international organizations, a number of young economists from Greece are sent abroad each year, to specialize in the various fields of economics. In addition, the KEPE organises a series of training seminars and lectures, frequently given by distinguished foreign scholars invited for that purpose to Greece. The lectures presented at these seminars are published in two series under the title: «Training Seminar Series» and «Lecture Series».

In addition to the above, the KEPE maintains contact with similar institutions abroad, and exchanges publications and information concerning development in methods of economic research, thus contributing to the promotion of the ecience of economics in the country.

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The subject matter of this book is based on a lecture delivered at the Center of Planning and Economic Research in December 1969.

Upon the request of the Center, the lecture was extended in the present form to bring out some basic insights of the Monetarist and Nonmonetarist approaches to the inflation problem. This was done in the summer of 1970, while the author was visiting the Center.

I

INTRODUCTION

One of the controversial topics in economics is the attempt to construct non - monetary models of inflation on the basis of the Phillips curve. This school of thought assumes that inflation is independent of monetary factors and hence monetary policy. Diametrically opposed is the monetarists' approach, which states that monetary variables are the most crucial in determining the rate of inflation. If this is so, monetary variables, which are generally considered a part of the study of demand-pull inflation, should exert an independent influence on the rate of change in wages.

It, therefore, seems reasonable to test the monetarists' thesis with a wage-change model which includes the explicit rôle of monetary policy. Simultaneously, the tests should indicate the consistency of the impact of monetary variables on the labour market in terms of time lags and magnitude.

The methodology of this study involves, first a brief outline of the features of the modern

theories of inflation, accomplished in Section II. In the same section, Lipsey's theoretical justification of the Phillips curve is presented, based on a simple demand and supply model. The last part of the section reviews the Phillips curve literature, giving the flavour of the different approaches and indicating how our approach differs. In Section III, a simplified monetary model is presented, derived from a structural aggregate wage-price model. The section puts into focus the theoretical implications of the study. Section IV presents the major empirical findings for 1948 through 1967, and three non-overlapping subperiods, and compares them with estimates of previous empirical studies. The wage-change model and variants of it are estimated with quarterly data, by ordinary least-squares, and with fixed-point lags, unconstrained lags, and Almon-distributed lags. The section presents the theory-policy issues and conclusions of the study. Appendix A reports a simple aggregate wage-price model; the symbols of the model are also defined.

II

INFLATION THEORY AND THE PHILLIPS CURVE

A. SOME ELEMENTS OF INFLATION THEORY

Inflation theory may be divided into two categories: the first explains why excess-demand emerges and takes the name of demand-pull inflation, while the second deals with the issue of price and wage rises which come from sources other than excess demand, and is called cost-push inflation.[1] The inflationary approaches discussed below, except for the monetarist point of view, are of the cost-push type in the Phillips curve tradition.

Thus, according to the nonmonetarists' approach, the behaviour of wages as a key to un-

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1. P.A. Samuelson and R.M. Solow, "Analytical Aspects of Anti-Inflation Policy", *American Economic Review, Papers and Proceedings*, Vol. L, No. 2 (May, 1960), pp. 177-194. For an excellent discussion of cost and demand inflation see: J.D. Pitchford, *A Study of Cost and Demand Inflation* (Amsterdam: North-Holland Publishing Company, 1963).

derstanding price movements and inflation emerges from the observable post-World War II phenomenon that wages behaved roughly parallel to prices, which leads to the hypothesis that the price movements are determined by the trilateral monopoly of union, employers and monetary authorities.[1] According to this argument, the monetary authorities play a relatively indirect rôle in the determination of wages and prices, and collective bargaining plays a direct and dominant rôle. The monetary authorities passively confirm and support the decisions reached elsewhere. In spite of the dilemma of conflicting objectives, political exigencies compel the monetary authorities to favour the goal of maximum employment.

A second approach to the inflation-unemployment problem — the monetarists approach, which places central responsibility on the monetary authorities — emerges from the belief of some economist that "inflation is always and everywhere a monetary phenomenon, resulting from and accompanied by a rise in the quantity of money relative to output".[2] The argument

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1. M. Bronfenbrenner and F. D. Holzman, "Survey of Inflation Theory", *American Economic Review*. Vol. LIII, N. 4 (September, 1963), pp. 593-661.

2. Milton Friedman, "What Price Guideposts ?", *Guidelines, Informal Controls, and the Market Place*. edited by G.P. Schultz and R.Z. Aliber (Chicago : The University of Chicago Press, 1966), p. 18.

further runs that this is not to mean that there is a precise rigid relation between the quantity of money and prices, since in spite of the historical evidence that "substantial changes in prices always occurred together with substantial changes in the quantity of money relative to output",[1] there is a difference in the systematic relation between changes in the money stock and in prices during a given inflationary episode or series of such episodes.

Consider, for example, changes in the rate of monetary growth: there is a considerable time-lag before any change in the money stock has an appreciable affect on the price level or the level of nominal income. Furthermore, the rate of monetary growth may differ temporarily from the rate of growth in the price level, due to the nature of the inflationary episode and the effects of fiscal policy.

Even more obvious is the situation in which the rate of monetary growth is faster than the rise in the price level. In spite of the existing price rise, the public increases its holdings of money balances as long as they consider the price rise to be a temporary phenomenon and the interest rates not to be too high. When, however, a price increase is further anticipated, the public

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1. *Ibid.*, p. 25.

starts reducing their money balances which leads to an increase in prices, wages and the level of nominal income, and a reduction in the real value of money balances. At this stage of the inflationary episode, the price level starts growing faster than the rate of monetary growth because of the increase in velocity.[1]

It follows from this reasoning that changes in the rate of monetary growth play the central rôle in an inflationary process and are not only a necessary determinant of the rate of growth in the price level and the level of economic activity but are also sufficient. Thus, an increase in the rate of growth of the money stock relative to income simultaneously raises wage rates and lowers the rate of unemployment. A decrease has the opposite effect. If this relationship is reasonably stable, monetary variables should have a significant rôle in a wage-change model. The theoretical implications of the monetarists' and nonmonetarists' positions in their attempts to construct inflationary models are presented in Section III.

B. R.G. LIPSEY'S THEORETICAL JUSTIFICATION OF THE PHILLIPS CURVE

The theory supporting the Phillips curve grows out of a disequilibrium analysis in a partial

1. Milton Friedman, *Guidelines*, pp. 26-27; R.T. Selden, "Cost-Push Versus Demand-Pull Inflation, 1955-57", *Journal of Political Economy*, Vol. LXVII, No. 1 (February, 1959), pp. 1-20.

equilibrium framework, which is then aggregated in some impressive fashion.[1] Lipsey's disequilibrium wage-adjustment model is based on a simple demand and supply analysis and is therefore applicable to any market. Given that

$$D_t = aP_t + b \qquad (2.2.1)$$

$$S_t = AP_t + B \qquad (2.2.2)$$

are linear demand and supply curves in a labour market which is assumed to be stable in the Walrasian sense, then a positive excess demand tends to raise the market price,[2] i.e.,

$$P_t - P_{t-1} = k(D_{t-1} - S_{t-1}) \qquad (2.2.3)$$

where k= a positive constant. Combining (2.2.1) and (2.2.2) and substituting into (2.2.3) we have:

$$P_t - P_{t-1} = k[(a-A)P_{t-1} + b-B] \qquad (2.2.4)$$

$$\text{or } \frac{P_t - P_{t-1}}{P_{t-1}} = k\left[a-A + \frac{b-B}{P_{t-1}}\right] \qquad (2.2.5)$$

which gives the rate of change in the market price.

Since excess demand for labour is not directly observable, he relates it with the rate of unemployment. Then, the rate of change in the market

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1. R.G. Lipsey, "The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1862-1957: A Further Analysis", *Economica*. N.S. XXVII (February, 1960) pp. 1-31.

2. E. Kuh, "A Productivity Theory of Wage Levels - An Alternative to Phillips Curve", *Review of Economic Studies*, Vol. XXXIV (d), No. 100 (October, 1967), pp. 333-360.

price, i.e., expression (2.2.5) may be expressed as a function of the rate of unemployment. This is the curvilinear Phillips curve.

Lipsey is given the credit for developing a careful theoretical model of the relation between wage changes and unemployment. He departs, however, from a consistent economic theory, since he applies micro-assumptions to explain macro-phenomena. His theoretical model relates excess demand in an individual labour market with the percentage of the labour force unemployed in that market. However, to obtain an economy-wide relationship between wage changes and unemployment, he applies an aggregate disequilibrium adjustment model whose demand and supply functions are not consistent with the corresponding structural functions of the individual labour markets. This inconsistent reasoning is the basis of his argument concerning a possible upward movement in the aggregate relation between wage changes and unemployment. The upward movement will be greater the more uneven the distribution of unemployment between individual labour markets.

Thus Lipsey's disequilibrium wage-adjustment model fails to give a clear theoretical meaning to excess demand. The extent to which unemployment is a good proxy remains unclear. Hence,the

derived relationship between wage changes and unemployment is subject to question.[1]

C. REVIEW OF THE PHILLIPS CURVE EMPIRICAL STUDIES

Many variations of the Phillips curve have been applied to empirical data. The review here does not attempt to cover all of the studies, nor does it cover all of the details of a small group of studies. Its purposes are to give the flavour of the different approaches and to indicate how our approach differs from those which have preceded it. The empirical findings from many of the better known studies are presented in a table at the end of the section.

1. BRITISH DATA

A.W. Phillips[2] attempted to analyse the trade - off between unemployment and inflation. He chooses to describe the data by a curve of the form $\log W = \log a + \log b + c \log U$ which satisfactorily accounts for the relationship be-

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1. J. M. Holmes and D.J. Smyth, "Some Remarks Concerning the Relation Between Unemployment and Excess Demand: An examination of the Theory of the Phillips Curve", *Department of Economics, State University of New York at Buffalo*, Discussion Paper No. 30 (November, 1968).

2. A.W. Phillips, "The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1967", *Economica*. N.S., Vol. XXV (November, 1958), pp. 283–299.

tween wage change and unemployment. However, he could not fit this form to the negative observations of the data, since negative logarithms would be required. Instead, he compressed his data into six groups based on unemployment levels and fitted his curve by trial and error. The resulting regression was the original hypothesis on the trade-off between wage change and unemployment. The statistical evidence for the period 1861 to 1957 supports the hypothesis that the proportionate change in money wage rates "can be explained by the level of unemployment and the rate of change of unemployment". We refer to this relationship as a wage-change equation.

Two strong conclusions follow from Phillips' study, first, there is a stable relationship between the rate of change of money rates and unemployment and, second, the relationship is highly nonlinear. Phillips found that given the continuation of past fluctuations in unemployment, the amount of unemployment necessary to maintain stable wage rates was about 5.5 per cent, while an annual increase in wage rates of 2 per cent could be associated with a level of unemployment of 2.5 per cent if productivity grew at an annual rate of 2 per cent; prices would then remain stable. He also examined the cost-of-living index as a possible variable influencing the rate of

change of wages but found it to have little effect' except when the index rose rapidly as a result of rising import prices.

Phillips' approach is not in accordance with a consistent economic theory. The coefficients of this curve are neither structural or reduced from coefficients and hence not identified.

R.G. Lipsey[1] modified the basic Phillips model and first put forward the theoretical justification of the relation between wages and unemployment. He uses annual data and ordinary least squares techniques. The results not only support Phillips' assertion that unemployment may be treated as a measure of excess demand, but also its significance is well established throughout the period studied, i.e., 1862-1913, 1923-1939, and 1948-1957. The coefficient of the price level, however, was found to be the most significant explanatory variable in the post-World War II period.

Lipsey's findings suffer from the limitations of the annual data. Annual figures cannot account for short lags between the variable and, therefore, one is uncertain about the reliability of the results. Quarterly data, however, do not remedy his theory because, as noted earlier, he did not have a well developed theory based on

1. R.G. Lipsey, *Op. Cit.*, p. 13.

macro-demand and supply analysis from which a reduced wage-change equation may be deduced.

L.R. Klein and R.J. Ball[1] presented a wage-price system for the United Kingdom in the form of simultaneous equations. Using quarterly time series, they tested the hypothesis that money wage changes can be explained by the rate of change of unemployment, the rate of change of the price level, a dummy variable reflecting union power, and seasonal factors. The wage and price variables are expressed in terms of annual first differences rather than in terms of percentage changes. The unemployment variable, however, enters the equation in a linear form. Since the rate of unemployment is a trendless variable, while wages and prices have an upward trend, their method is questionable. This procedure leads to an upward and a downward bias in the regression coefficients of the price and unemployment variables respectively. Thus, while the coefficient of the rate of change of the price level is statistically significant at the level of 1 per cent, that of the rate of unemployment is quite low. As a result, the value of the rate of unemployment is also decreased.

Their study, however, forms a complete eco-

1. L.R. Klein and R.J. Ball, "Some Econometrics of the Determination of Absolute Prices and Wages", *The Economic Journal*, Vol. LXIX (September, 1959), pp. 465-482.

nometric model since it recognizes the simultaneity between prices and wages, and determines jointly their absolute levels. Another novelty of the study is that the time series used are on a quarterly basis. In spite of these innovations over the earlier empirical studies, and the consistent estimation techniques used (limited information method), the estimates of the study are questionable on the grounds of the arguments presented earlier.

L.A. Dicks–Mireaux and Dow[1] tested the logarithmic relation between the percentage change in money wages and a measure of the excess demand for labour and the rate of the price level changes using quarterly British data for the period 1946 - 1956. Their measure of the excess demand for labour was a combination of unemployment and vacancy data.[2]

Their study has an advantage over Phillips and Lipsey; it is conducted with quarterly data and hence avoids the limitations and inaccuracies of annual data.It is not in agreement with Lipsey's and Klein and Ball's studies though conducted on an aggregate basis. Dicks-Mireaux and Dow

1. L.A Dicks-Mireaux and J.C.R. Dow, "The Determinants of Wage Inflation: United Kingdom, 1946-56", *Journal of the Royal Statistical Society,* Vol. 122, Part II (1959), pp. 145-184.

2. Vacancy data may be a more direct measure of the excess demand for labour. For the United States economy, however, there are no vacancy data that are reliable and comprehensive.

report, for example, a coefficient of 3.64 for the combined vacancy-unemployment variable, indicating that wage changes are very sensitive to variations in the excess demand for labour. Lipsey reports a coefficient of only 0.43, while Klein and Ball, whose study covers the same period as that of Dicks-Mireaux and Dow, report a coefficient of 0.091. On the other hand, the first study reports a coefficient of 0.52 for the price variable, indicating that the wage-price elasticity is significantly below unity, while Klein and Ball report a wage-price elasticity which does not differ significantly from unity; Lipsey reports a coefficient of 0.69 which is not too far from Klein and Ball's estimate.

The novelty which this study offers is obvious; the measure of excess demand for labour as a percentage of unemployment and vacancy data. It does not deal, however, with the simultaneity problem of wages and prices.[1] Nor is it concerned with structural equations. The divergence, therefore, of the estimates of the study from those of earlier studies is not surprising.

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1. The price-wage simultaneity is presented in an empirical study by L.A. Dicks-Mireaux, "The Interrelationship Between Cost and Price Changes, 1946-1959: A Study of Inflation in Post-War Britain", *Oxford Economic Papers*, Vol. XIII, No. 3 (October, 1961), pp. 267-292.

2. UNITED STATES DATA

L.R. Klein and A.S. Goldberger[1] have estimated a wage-change equation within a broad econometric model for the American economy. Wage changes are explained as a linear function of current employment, the previous year's change in the general price index, and a time trend.

The estimating procedure is the limited information maximum likelihood method. The price coefficient of the estimated wage-change equation indicates that a 1 per cent increase in the price level is associated with only a 0.5 to 0.6 per cent increase in money wage rates. The employment coefficient is not considerably higher than that of the price rate; it is only 0.75. The coefficient of the time trend is the same as that of the price rate, i.e., 0.56.

Klein and Goldberger claim that their wage-change equation determines the level of absolute wages and prices in the system and, therefore, replaces the explicit rôle of the classical monetary equation. On the other hand, however, they make the assumption that their wage-change equation is free of money "illusion" though the homogeneity properties cease to exist.

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1. L.R. Klein and A.S. Goldberger, *An Econometric Model of the United States*, 1929-1952, (Amsterdam: North Holland Publishing Company, 1955).

R.J. Bhatia[1] tested the Phillips curve hypothesis for the United States. The variables which appear in his wage-change equations are the average unemployment rate, the rate of change of unemployment, and the rate of change in the cost of living.

He finds that the relation between wage changes and changes in the rate of unemployment is notvery evident for the post-World War II period. The rate of changes in prices, however, is statistically significant in this period. Bhatia reports for the period 1948-1958 a coefficient of 0.64 for the price variable while for the unemployment level a coefficient of 0.37. The unemployment coefficient, however, is not significant while that of price changes is statistically significant. There is, therefore, a closer association between changes in money wage rates and changes in the rate of the price level than between changes in wages and changes in the unemployment rate. The findings do not support an obvious relationship between wage changes and unemployment for the United States economy under the period studied.

In a second study[2] he tests the hypothesis

1. R.J. Bhatia, "Unemployment and the Rate of Change of Money Earnings in the United States, 1900-1958", *Economica*, Vol. XXVIII (August, 1961) pp. 286-296.

2. R.J. Bhatia, "Profits and the Rate of Change in Money Earnings in the United States, 1935-1959", *Economica*, Vol. XXIX (August, 1962), pp. 255-262.

that wage changes can be explained by the level and the rate of change in the profits. He finds that the profits-hypothesis seems to be more significant than the unemployment-hypothesis for explaining wage changes in the post–World War II period.[1]

Bhatia's results, however, suffer from the use of annual data and therefore are not in agreement with the results of other studies discussed here. Consider, for example, the unemployment-hypothesis. Not only is the standard error of the unemployment coefficient larger than the coefficient itself, but also the squared partial correlation coefficient accounts only for 0.05 for this variable. Another objection which may be raised is that no theoretical framework was provided from which Bhatia's regression equations are derived. Hence one cannot rely upon the estimates of these equations.

O. Eckstein and T. A. Wilson[2] have studied the behaviour of wage changes for the American manufacturing industry over the period

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1. A similar quantitative analysis is shaped for the British economy by R.G. Lipsey and M.D. Steuer, "The Relation Between Profits and Wage Rates", *Economica,* Vol. 28 (May, 1961), pp. 137-155. The conclusion reached here is that the unemployment-hypothesis is preferable to the profit-hypothesis.

2. O. Eckstein and T.A. Wilson, "The Determination of Money Wages in American Industry", *Quarterly Journal of Economics* (August, 1962), pp. 379-414.

1948 to 1960.Their study focuses on a key group of eight heavy manufacturing industries.

They test the hypothesis that wage changes in individual industries can be better explained by the unemployment rate and the profit rate of the key group of industries than by the industry's own unemployment and profit rates. The results support their hypothesis for the durable goods manufacturing industries throughout the period studied. This implies that unique demand and supply functions of particular labour markets are of relatively little consequence. This is in contrast to the theory developed by Bent Hansen, according to which the relative wage change in a particular labour market is proportional to the relative excess demand of that market and its unique structural characteristics.[1]

The impact, however, of economy-wide variables on particular labour markets depends on prevailing economic conditions. National developments, for example, characterized by the rapid economic growth, low level of unemployment and inflationary pressures compel particular labour markets to be tied to national markets. Under depressed economic conditions, how-

1. B. Hansen, "Full Employment and Wage Stability", in J.T. Dunlop, ed., *The Theory of Wage Determination* (London: MacMillan & Co., Ltd., 1957), pp. 66-78; *A Study in the Theory of Inflation* (New York: Rinehart & Co., Inc., 1951).

ever, accompanied by high unemployment and no inflation, the structural characteristics of particular labour markets predominate and the impact of economy-wide variables becomes much less.

The economy-wide variables, however, do not explain wage changes in all manufacturing industries. A number of those studied by Eckstein and Wilson do not respond to the given set of economy-wide variables.This evidence, as well as the observation that they are applied to a limited number of workers, i.e., production markets in manufacturing, lead to the conclusion that the explanatory power of economy-wide variables is a limited, although fruitful, device for studying certain aspects of wage change behaviour.

C. L. Schultze and J. L. Tryon[1] have studied wage changes in connection with a broad econometric study of the United States economy. The rate of change in compensation per man-hour in a group of industries is explained by the level of aggregate unemployment, the profit rate, and the rate of change in consumer prices. The authors present a second wage-change equation which includes lagged change in wages as an additional explanatory variable.

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1. C.L. Schultze and J.L. Tryon, "Prices and Wages", *The Brookings Quarterly Econometric Model of the United States,* ed. by J.S. Duesenberry, G. Fromm, L.R. Klein, and E. Kuh (Chicago: Rand McNally & Company, 1965), pp. 282-333.

This version substantially improves the regression results. It departs, however, from the basic Phillips curve procedure, representing a different "concept of wage adjustment dynamics".

For the durable manufacturing sector, the authors report a coefficient of 0.88 for the price variable, while for the unemployment level a coefficient of only 0.001. Though both coefficients are statistically significant, their sizes do not support the unemployment-hypothesis for explaining wage changes for the period studied.

Thus, the study abandons the simple excess demand hypothesis embodied in the wage-change determination. The introduction of the lagged wage variable as an independent variable in the wage-change equation, offers a new procedure in the wage adjustment mechanism.

R. G. Bodkin[1] attempts first to explain wage-change behaviour as a function of the level of unemployment, changes in the consumer price level and a time trend for the United States for the period 1904 to 1957. His findings suggest no obvious non-linearity in the relationship between wage changes and the level of unemployment. He also finds that the price level change has greater explanatory power than the unemployment variable.

1. R.G. Bodkin, *The Wage-Price Productivity Nexus* (Philadelphia: University of Pennsylvania Press, 1966).

Bodkin also demonstrates that other variables such as profits, changes in the level of unemployment and changes in productivity are not significant in the wage-change equation. Especially, he finds that there is an intercorrelation between the unemployment and the profits variables. On the other hand, introducing the productivity variable into the wage adjustment equation, he finds that unemployment and productivity appear to serve as proxies for each other.

Since his main concern is to estimate the level of unemployment which, given annual productivity changes, would cause price level stability, he simulates the economy with different variants of the wage-change equation. The estimates, however, vary substantially. For example, an unemployment rate of 3 per cent would increase prices by 1.76 per cent, while complete price stability requires an unemployment rate of about 19 per cent.[1] Therefore, unemployment plays an insignificant rôle in holding the price increase.

Though Bodkin presents a theoretical macrostatic economic model, he has not attempted to derive a reduced-form wage-change equation. His model, however, has important policy implications.

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1. *Ibid.*, p. 279.

G.L. Perry[1] uses a Phillips curve analysis to explain wage changes in manufacturing industries in the United States for the period 1948 to 1960. He admits that there are reservations with respect to adding individual industry observations into national aggregates, but skirts the problem by assuming that each industry responds to changes in the independent variables with the same wage behaviour. The author uses overlapping quarterly data and simple least-squares estimating techniques. The overlapping observations increase the degree of autocorrelation. This, however, leads to serious problems in interpreting the results.[2] The observations used in the present study suffer from the same shortcoming.

He starts with the wage change-unemployment relation. The scatter diagrams suggest that the relation is non-linear though the fit is not very good. To allow for non-linearity, Perry uses the inverse of the average unemployment. Then, on the basis that wage changes are affected by changes in the price level, Perry added the consumer price index variable to the model. Fi-

1. G.L. Perry, *Unemployment, Money Wage Rates, and Inflation*, (Cambridge: The M.I.T. Press, 1966).

2. For the specific assumptions which must be made about the statistical properties of overlapping data, see: G.D. Demopoulos, "A Note on a Methodological Question with Overlapping Quarterly Data". Submitted to *The American Statistician*, March, 1970.

nally, a further improvement in the wage-change equation was obtained when he added the rate of profit and the change in the rate of profit. The last variable introduces expectation elements, and thus dynamizes the equation. The estimates obtained show statistically significant effects on wage changes.

When, however, he divides the data into two sub-periods, i.e., II/48 – II/53 and III/53 – III/60, he reports statistically significant differences in the parameters of the wage-change equations. This implies that the structure of the economy had changed. The estimates of the unemployment rate and consumer price index may be compared. The first drops from 33.954 in the first sub-period to 18.421 in the second, while the consumer price index coefficient increases from - 0.025 to 0.680. That is, after 1953, the unemployment rate was less significant and changes in the consumer's price index more significant.

Perry provides further evidence of change in the structure of the economy. He tested the hypothesis that money wage behaved differently in the presence of guideposts in the recent years,[1] finding that wage-price guidelines had mode-

1. G.L. Perry, "Wages and the Guideposts", *American Economic Review,* Vol. LVII, No. 4 (September, 1967), pp. 897-904.

rated money wage increases well below what otherwise would have occurred.

Perry extends his study to durable and nondurable manufacturing sectors using the same methodology in deriving his results as with the all-manufacturing case, demonstrating that economy-wide variables are better suited to explain wage changes in a group of industries than variables specific to the group, in agreement with Schultze and Tryon as well as Eckstein and Wilson.[1]

He also demonstrates that there is little possibility of simultaneously achieving the goals of low unemployment and price stability. He constructs an empirical linear trade-off relationship between unemployment rates and changes in the price level. This function indicates that with productivity and profit rates growing at annual rates of 3.0 and 11.8 per cent respectively, a 6.4 unemployment rate is needed for complete price stability. On the other hand, a full-employment rate of 3.0 per cent unemployment would require a 5.7 per cent increase in profit rates to yield an unchanged price level, assuming that productivity is growing at a 3.0 per cent annual rate.[2]

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1. C.L. Schultze and J.L. Tryon, *Op. Cit.*; O. Eckstein and T.A. Wilson, *Op. Cit.*
2. *Ibid.*, p. 59, p. 109.

Perry's aggregate wage-change model suffers from the lag structure which it specifies. A simple lag structure cannot completely catch up the effects of the consumer price index which are extended well beyond the period of a quarter. The present study specifies a more complex and unbiased lag structure — the Almon technique— which eliminates for the most part the controversial specifications of wage-change models of previous studies.

Perry may legitimately claim that his study has included all of the important factors influencing the wage adjustment mechanism, but cannot claim that he has based his work on structural equations leading to fully identified coefficients.

N.J. Simler and A. Tella[1] added to Perry's basic model a variable to account for labour reserves remaining outside of the labour force; in effect a hidden unemployment variable. Their hypothesis substantially improves the capacity of the model to predict wage changes. They also tested the hypothesis that the use of aggregate private non-farm wage changes in the basic Perry model gives more significant results

1. N.J. Simler and Alfred Tella,"Labour Reserves and the Phillips Curve", *The Review of Economics and Statistics*, Vol. XLX, No. 1 (February, 1968), pp. 32-49.

than changes in manufacturing wages, and found this to be the case.[1]

On these grounds, the authors have tested a Labour Reserve Model in which changes in the compensation per man-hour in the private non-farm economy are explained by the "adjusted" unemployment rate described above, the percentage change in the consumer price index, the profit rate and the change in the profit rate. The model "...provides a more satisfactory explanation of aggregate wage changes than the basic Perry model..."[2]

To test for the structural hypothesis, Simler and Tella construct empirical linear trade-off relationships between aggregate wage changes and the reported unemployment rate, as well as the "adjusted" unemployment rate. The findings, however, do not support the structural hypothesis found in Perry's study. Instead, the authors attribute the change in the structure of the economy to a rise in the secondary labour force.

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1. For a similar hypothesis see A.J. Tella and P.A. Tinsley, "The Labour Market and Potential Output of the FRB-MIT Econometric Model: A Preliminary Report", *Staff Economic Studies, Federal Reserve Bulletin*, (August, 1968).

2. A.D. Butler and G.D. Demopoulos have demonstrated that even after their correction, there is still much instability associated with "Labour Reserves", and that perhaps this variable needs to be entered into the model in a more complicated fashion. See, the authors', "Labour Force Behaviour in a Full Employment Economy", *Industrial and Labour Relations Review* (April, 1971).

Their findings may have a corollary explanation with respect to wage-price guideposts. Perry, for instance, reports that the guideposts had moderated wage changes in manufacturing. The same, however, may not be true with respect to wage changes when measured as compensation in the private non-farm economy.

E. Kuh[1] advances the hypothesis that changes in wage rates are determined by changes in the average value productivity of labour and the unemployment rate. Two elements are transformed and related to the productivity variable: the product price and profits. Thus, either one acts as a proxy for productivity. A lagged dependent variable enters the wage-change equation.

Kuh presents his hypothesis, which he calls Productivity Distributed Lag (PDL), as an alternative to the Phillips curve theory. According to his theory "money wage rates will be only weakly affected by the unemployment level", while increases in labour productivity are associated with increases in wages, even when unemployment exists. It is, therefore, concluded that the usual Phillips curve approach is not an appropriate explanation of wage changes.

Another characteristic of his productivity distributed lag model (PDL) is that the consumer

1. E. Kuh, *Op. Cit.*, pp. 333-360.

price index variable reflects "transient" changes, in that it does not affect the level of wages in a steady state, while changes in the same variable in the usual Phillips curve formulation reflect real wage bargaining. In the context of his theory, the unemployment variable departs from the dynamic significance found in Phillips curve, but it does not lose its strategic rôle. It is supposed, however, to affect the level rather than the rate of change in wages.

Kuh uses logarithms of quarterly overlapping data of average hourly compensation in the private non-farm economy, and in durable and non-durable manufacturing industries. He employs the standard single equation least-squares techniques and tests the period 1950 to 1960. Generally, the fit is better with the private non-farm data than with durable or non-durable manufacturing data.

The author's main innovation over earlier studies is the substitution of average productivity of labour for the rate of profit. The use of average productivity is, however, questionable since it "... necessitates the abandonment of the assumption of competition..." and therefore the relation between the demand for labour, the product price, and the rate of profit "becomes ambiguous".[1]

1. J.M. Holmes, "An Explanation for the Phillips Curve Phenomena Derived from Traditional Theory Generalized", *Department of Economics, State University of New York*, Discussion Paper No. 36 (November, 1968), p.8.

Though Kuh recognizes the necessity of developing a theoretical model of simultaneous structural equations, because of the feedback effects between wages and prices, he does not advance such a theoretical framework. Instead, he accepts the solution of simple regression equations, thus being not too far from the Phillips curve work, which is largely apart from related theoretical econometric studies.

TABLE 2. 3. 1

ESTIMATES OF THE COEFFICIENTS U_t, P_t AND R_t

	Inter-cept	Reg. Coeff. of U_t	Std. Error	Reg. Coeff. of P_t	Std. Error	Reg. Coeff. of R_t	Std. Error	R^2	Period Covered	Estim. Tech-nique	Dep. Var.
British Data											
R.G. Lipsey	–1.210	6.450		.210				.850	1862–1913	OLS	W_t
	.740	.430		.690				.910	1923–57	»	»
Klein & Ball	10.260	–.091	.013	.854	.092				1948–56	LIM	»
Dicks-Mireaux	.008	2.620[1]	.840	.540	.110			.420	1946–56	OLS	»
& Dow	.011	3.640[1]	.400	.520	.050			.890	1950–56	»	»
U.S. Data											
Klein & Gold-berger	4.110	–.750	.630	.560	.300				1929–52	LIM	»
Eckstein & Wilson	2.240			.940	.280	.040	.300	.962	1948–60	OLS	»
	3.760	–.140	.220	.890	.170			.966	»	»	»
Schultze &	.018	.001	.000	.880	.110	.130	.050	.710	1950–60	»	W_{DC}
Tryon	.039	.000	.000	.760	.110	.040	.080	.690	»	»	W_{NC}
R. G. Bodkin	–.015	–.198	.105	.620	.063			.824	1900–57	»	W_t
	–.025	–.142	.126	.599	.068	.121	.157	.819	»	»	»
G.L. Perry	–4.313	14.711[2]	2.188	.367	.054	.424	.068	.870	1948–60	»	»
	–.767	7.166[2]	1.382	.532	.058	.240	.064	.839	»	»	W_D
	–5.230	12.458[2]	2.170	.313	.054	.548	.068	.882	»	»	W_N

Simler & Tella	−.091	.076[2]	.014	.509	.046	.003	.000	.872	1948–64	OLS	W_t^*
E. Kuh's	−.195	−.273	3.208[3]	.391	7.482[3]	.419	4.671[3]	.769	1950–60	»	W_t^*
Phillip's	.012	−.378	2.813[3]	.512	6.118[3]	.158	2.588[3]	.696	»	»	W_{DC}
Version	.137	−.453	3.644[3]	.544	8.234[3]	−.154	1.433[3]	.702	»	»	W_{NC}
PDL Version	−.197	−.195	2.257[3]	.213	3.984[3]	.385[4]	3.387[3]	.855	»	»	W_t^*

where

U_t = the aggregate unemployment rate; P_t = annual rate of change in consumers price index; R_t = the profit rate; W_t = percentage change in money wage rates in manufacturing; W_t^* = percentage change in money wage rates in non-farm economy; W_D = percentage change in money wage rates in durable industries; W_N = percentage change in money wage rates in non-durable industries; W_{DC} = percentage change in average hourly compensation in durable industries; W_{NC} = percentage change in average hourly compensation in non-durable industries;

1. Represents a combined vacancy–unemployment variable.
2. Coefficients are for U_t^{-1}, also for Simler & Tella but with decimal shifted.
3. Figures are t – values.
4. Productivity coefficient.

D. SUMMARY AND CONCLUSION

We have seen that the extensive Phillips curve literature is based on regression equations. These studies consider the wage relation in the context of a wide variety of explanatory variables, involve some disaggregation in some instances, and thus introduce various modifications of the "wage-change" equation. They examine the influence of the rate of unemployment, the change in the rate of unemployment, the cost-of-living index, the level and the rate of change of the profit rate, changes in productivity, the level of employment, the impact of trade unions, etc. These variables are included in alternative modifications of the wage-change equation to determine whether such refinements improve the relationship.

It is, therefore, not surprising that there is much divergence among the estimates reported from the regression equations. This suggests that the specifications in the regression equations are not derived rigorously from well specified structural economic models.[1] They attempt, however, to explain dynamic aspects of a "specific" kind of inflation theory and compare trade-offs between unemployment and

1. Those wage-change equations derived from economy-wide econometric models are not subject to this criticism. The divergence

price-wage stability. But, does a simple wage-change formula provide an adequate explanation of the relationship between inflation and unemployment?[1] How can a policy maker rely upon the coefficients of these regressions which are neither structural or reduced form coefficients and hence are not identified?

Though unemployment is endogenously determined in a complete macro-model, the Phillips curve studies treat it as both a predetermined and an instrumental variable. They do not, however, justify this treatment for the obvious reason that their wage-change equations are not derived from any system of structural equations.[2]

Another point which appears to be insufficiently recognized is the wage-price simultaneity. "Even though wages determine prices and prices

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among their estimates is due to other reasons. See the author's study: "Wage Change and Monetary Variables: A Quarterly Econometric Study", unpublished doctoral dissertation submitted to the State University of New York at Buffalo, June, 1969.

1. Perry's formula has shown that the structure of the economy changes at least every six or eight years. Thus, a simple wage change formula with four or five explanatory variables appears not to be stable for a longer period of time, suggesting that a more complicated simultaneous equation model is needed. See A.D. Butler and G.D. Demopoulos, *Op. Cit.*, pp. 22-25.

2. It will be shown in Section III, how unemployment may be considered as a predetermined variable.

determine wages in the short-run, neither determines the absolute level of prices or wages in the long-run. It will be the exogenous variables ... of the reduced form that will causally determine wage and price levels."[1] The statement leads back to the previous conclusion that a structural model is needed for the determination of wages.[2]

Furthermore, though it is recognized that monetary variables matter in the determination of the absolute level of price and wages, it has often been stated that a different approach would be needed to take into account their effects in a useful way, never specifying, however, how this may be done. On the other hand, it is admitted that the introduction of an explicit monetary system will cause

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1. E. Kuh, *Op. Cit.*, p. 342.

2. A small number of very recent studies have attempted to build wage equation on a full-scale model. See A.J. Tella and P.A. Tinsley, *Op. Cit.*; R.E. Lucas and L.A. Rapping, "Real Wages, Employment and Inflation", Unpublished Paper, *Graduate School of Industrial Administration, Carnegie-Mellon University* (October, 1968); Saul H. Hymans, "The Steady-State Phillips-Curve for the U.S. Economy", Michigan Economic Research Paper, No. 3, *Department of Economics, University of Michigan*, (November, 1968): The last two papers presented at the Dec., 1968, Meetings of the Econometric Society under the titles "Real Wages, Employment and the Price Level: An Integrated Theory of Aggregate Supply", and "Determination of Aggregate Wage and Price Behaviour by Simulation Techniques", respectively; S.W. Black and H.H.Kelejian,"A Macro Model of the U.S. Labour Market", Working Paper No. 10, *Princeton University*, (September, 1968). These are not discussed here.

a loss of transparency.[1] We may therefore conclude that the introduction of money variables requires a structural model which clearly delineates their relationships.

We have constructed a complete structural model,[2] but we have not followed the preferred econometric estimating procedure of deriving a reduced-form wage-change equation. Instead, the simultaneous nature of the relationships between the labour market and other sectors of the economy (commodity and money markets) has been represented by using the structural price and wage adjustment equations which, combined with an identity, yield a partial reduced form wage-change equation in money terms. This is done in the next section.

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1. R.M. Sollow and J.E. Stiglitz, "Output, Employment, and Wages in the Short Run", *Quarterly Journal of Economics*. Vol. LXXXII, No. 4 (November, 1968), pp. 537-560.

2. See Appendix A.

III

A SIMPLE AGGREGATE WAGE-PRICE MODEL

A. WHY A MODEL IS NEEDED

We have seen in the previous section that regression analysis has been adopted to explain the relationship between inflation and unemployment. The regression equations, however, are not derived from a structural model and hence their coefficients are not identified.

We have pointed out that the instability of the trade-off function and the uncertainty of how much impact the policy variables may have are both sufficiently recognized in the literature. On the other hand, wage-price simultaneity appears to be insufficiently recognized, and the same is true for the long-run absolute levels of prices and wages which are likely to be determined exogenously. Previous empirical and theoretical studies, however, have not been directed towards the relation of exogenous variables to the long-run determination of wages and prices. Instead, they recommend that a different approach is needed to meet this question.

We feel, therefore, that a structural model is needed for the study of the wage-price nexus, from which a simplified equation of wage change may be derived and estimated. The model, in its simple form, is presented in Appendix A. The model's structure and its properties are explicitly described elsewhere.[1]

B. A SIMPLIFIED MONETARY SYSTEM*

Ideally, the next step should be fitting the structural model, then deriving a wage-change equation from it as a reduced form in terms of the predetermined and exogenous variables $\overline{C}_{t-1}$, $\overline{I}_{t-1}$, $\overline{Y}^{D}_{t-1}$, P_{t-1}, $\overline{Y}^{S}_{t-1}$, $\overline{K}_{t-1}$, L_{t-1}, N^{D}_{t-1}, $\overline{W}_{t-1}$, and M_{t-1}.[2] The argument throughout Section II pointed in this direction. However, lack of resources, mainly the amount of time required, militates against this preferred approach.

A much less satisfactory short-cut is taken in-

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1. See, for example, G.D. Demopoulos, "The Interaction of Real and Monetary Factors in an Aggregate Model", Working Paper, *Graduate School, College of Business, Rochester Institute of Technology* (March, 1970).

* Similar models were devised by L.R. Klein, "Wage and Price Determination in Macroeconometrics", *Prices: Issues in Theory, Practice and Public Policy,* ed. Almarin Phillips and O.W. Williamson (Philadelphia: University of Pennsylvania Press, 1967); J.D. Pitchford, *Od. Cit.*; R.M. Solow and J.E. Stiglitz, *Op. Cit.*

2. All symbols are defined in Appendix A.

stead. The wage-change equation and the price-change equation are intuitively interpreted in terms of the structural model, and then solved simultaneously to derive a simplified wage-change equation which serves as the basis of the empirical work.

The intuitive interpretation begins with the wage equation of the structural model expressed in terms of percentage changes as

$$\frac{\dot{\bar{W}}}{\bar{W}_t} = g\left(\frac{N_t^D - L_t}{L_t}\right) + j\ \frac{\dot{P}}{P_t} + u_{1t} \quad (3.2.1)$$

which says that the annual rate of change in real wages is a function of excess demand in the labour market and the current level of change in prices. The proxy for excess demand used here is the measured unemployment rate.[1]

The equation postulates that excess demand or excess supply is cleared each period by rising or falling market prices. That is, real wage rates will rise in response to excess demand for labour, and fall in response to excess supply. The effect of the change of the price level on real wages may be either positive or negative.

The price equation of the structural model

1. The proxy would be made more complete by adding an adjusted unemployment rate, vacancies, change in employment and/or the variance of unemployment, but the disadvantage of multicolinearity seemed to outweigh the gain in comprehensiveness.

expressed in terms of percentage changes as

$$\frac{\dot{P}}{P_t} = h\left(\frac{\overline{Y}^D_{t-1} - \overline{Y}^S_{t-1}}{\overline{Y}^S_{t-1}}\right) + k\frac{\dot{\overline{W}}}{\overline{W}_t} + y\frac{\dot{M}}{M_{t-1}} + u_{2t} \quad (3.2.2)$$

says that the annual rate of change in the absolute level of prices depends on the previous excess demand for commodities, the current change in real wages, and the last period's change in the money supply. Clearly, one would expect the effect of change in real wages on prices to be between minus infinity and plus infinity (depends on whether the demand or supply effect is stronger). The expected values of the other partials are positive. The price-change equation allows for monetary policy to be present.[1]

Equations (3.2.1) and (3.2.2.) may be solved simultaneously:

$$\frac{\dot{\overline{W}}}{\overline{W}_t} = (1-jk)^{-1}\left[g\left(\frac{N^D_t - L_t}{L_t}\right) + jh\left(\frac{\overline{Y}^D_{t-1} - \overline{Y}^S_{t-1}}{\overline{Y}^S_{t-1}}\right) + jy\left(\frac{\dot{M}}{M_{t-1}}\right) + (u_{1t} + ju_{2t})\right] \quad (3.2.3)$$

1. Solow and Stiglitz dealing with a short-run macromodel ignore monetary policy. See R.M. Solow and J.E. Stiglitz, *Op. Cit.*, pp. 537-560.

$$\frac{\dot{P}}{P_t} = (1-jk)^{-1}\left[h\left(\frac{\overline{Y}^D_{t-1} - \overline{Y}^S_{t-1}}{\overline{Y}^S_{t-1}}\right) + gk\left(\frac{N^D_t - L_t}{L_t}\right) + y\left(\frac{\dot{M}}{M_{t-1}}\right) + (u_{2t} + ku_{1t})\right] \qquad (3.2.4)$$

Multicolinearity appears as an obvious problem in (3.2.3) and (3.2.4) which we deal with in the following fashion. Assuming unchanging technology, excess demand in the commodity market is likely to generate an excess demand in the labour market, since one of the variables in (3.2.3) and (3.2.4) is the real wage.[1] Therefore, $(\overline{Y}^D_{t-1} - \overline{Y}^S_{t-1} / \overline{Y}^S_{t-1})$ is dropped for further consideration.[2] If, however, excess demand for commodities is to be given, it follows that excess demand for labour is considered as a predetermined variable too. Then, (3.2.3) and (3.2.4) are reduced form equations.

To derive a wage-change equation in money terms, the system of (3.2.3) and (3.2.4) may be completed by adding a money wage variable and equation.[3]

1. See, also, the demand for labour equation (A.9); it depends on both the demand for commodities and the real wage rate.

2. The results of a test for the independence of $\dot{M}/M_{t-1}$ and $[(N^D_t - L)/L_t]$ are reported in Section IV; they indicate that M/M_{t-1} and $[(N^D_t - L_t)/L_t]$ may be used together if care is taken with regard to the lagged relationship of the two.

3. See, also, J.D. Pitchford, *Op. Cit.*, and R.M. Solow and J.E. Stiglitz, *Op. Cit.*

$$\frac{\dot{W}}{W_t} = \frac{\dot{\bar{W}}}{\bar{W}_t} + \frac{\dot{P}}{P_t} \qquad (3.2.5)$$

which expresses the approximate relationship between the rates of change of prices and wages and the real wage rate.

Our basic equation follows from substituting (3.2.3) and (3.2.4) into (3.2.5):

$$\frac{\dot{W}}{W_t} = \frac{1+k}{1-jk} g \left(\frac{N_t^D - L_t}{L_t} \right) + \frac{1+j}{1-jk} y \left(\frac{\dot{M}}{M_{t-1}} \right) + \frac{1}{1-jk} e_t \qquad (3.2.6)$$

Although the equation is a very oversimplified view of the simultaneous nature of the relationships between the labour market and other sectors of the economy, it does provide predictions concerning the explicit rôle of monetary policy in the trade-off analysis. That is, it states that inflation is not independent of monetary factors and hence it is not like the Phillips curve models which, by implication, treat inflation as being nonmonetary.[1] The rate of inflation, in accordance with these models, is determined by the institutional factors governing the responses of wages and prices to each other. Wages determine

1. The Phillips curve is, of course, one of many structural equations in some, not fully spelled out, economic model. Any attempt to construct a nonmonetary inflation theory on this basis is futile and wrong. Hence, (3.2.6.) is based on the reduced-form approach.

prices and prices determine wages in the short-run, but this suggests a model which has limited value for explaining long-run relationships.

The monetarists' position[1] regarding the causes of inflation implies that a trade-off model cannot be specified without explicitly stating the monetary policy that is being followed. This then says that monetary variables should be explicitly inserted into the model.[2]

C. SUMMARY STATEMENT OF THE MODEL

Equation (3.2.6) is restated in econometric form for estimation purposes as:

$$\dot{w}_t = h_o + h_1 U_t^{-1} + h_2 \dot{m}_{t-1} + v_t \qquad (3.3.1)$$

where $\dot{w}_t$ = the annual rate of change in money wages;

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1. For an analysis of this view, see Karl Brunner, "The Rôle of Money and Monetary Policy", *Monthly Review*, Federal Reserve Bank of St. Louis (July, 1968), pp. 9–24; David I. Fand, "Keynesian Monetary Theories, Stabilization Policy and the Recent Inflation". Paper presented to the *Conference of University Professors,* Ditchley Park, Oxfordshire, England (September, 1968).

2. Since the objective of this study is to estimate the contribution of the rate of growth of monetary variables to wage rate determination, other variables, such as the rate change in the price level, rate of profits, change in the rate of profits, output per man-hour, the rôle of expectations, etc., which may directly or indirectly be affected by monetary policy actions, were left out of the model. The reader may wish to take a look at the Phillips curve literature (Section II).

U_t^{-1} = the inverse of the measured unemployment rate;

$\dot{m}_{t-1}$ =the annual rate of change in the money supply;

and v_t is the error term.

Since the importance of the monetary variable may be overstated and the lag attached to it may be affected because the commodity demand variable has been suppressed, an additional simplified equation (3.3.2) is derived from (3.2.6), which serves best for the empirical work; it may be written as:[1]

$$\dot{w}_t = j_o + j_1 \dot{m}_{t-1} + e_t \qquad (3.3.2)$$

where e_t is the error term.

Equations (3.3.1) and (3.3.2) concentrate our attention on the magnitude and variability, or instability, of the response of w to m, by itself and in conjunction with U.

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1. For the assumptions which permit (3.3.2) to be derived from (3.2.6), see A.S. Goldberger, *Op. Cit.*, pp. 72-73; L.C. Andersen and J.L. Jordan, "Monetary and Fiscal Actions: A Test of Their Relative Importance in Economic Stabilization", *Monthly Review*, Federal Reserve Bank of St. Louis (November, 1968), pp. 11-24; G.D. Demopoulos, "Wage Change and Monetary Variables: A Quarterly Econometric Study", *Op. Cit.*, pp. 56-60.

IV

RESULTS AND THEIR IMPLICATIONS TO THEORY AND POLICY

A. EMPIRICAL RESULTS

This section reports tests of (3.3.1) and (3.3.2), on data series covering the period 1948-67 and three subperiods, I/49-II/53, II/53-II/60, and II/60-IV/67. The compensation per man-hour series[1] in the private non-farm economy include monetary supplementary benefits and were kindly supplied by the Bureau of Labour Statistics.[2] The unemployment rate as a percentage of the civilian labour force,adjusted for seasonal variation, was taken from the Survey of Current Business.[3]

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1. The model was tested also with straight-time average hourly earnings of production workers in manufacturing as the variable to be explained. Though the results seem somewhat different from those in Tables I and II, they do not change our conclusions and therefore are not reported here.

2. U.S. Department of Labour, Bureau of Labour Statistics: (i) *Letter* to George D. Demopoulos, dated August 9, 1968,(ii) *Employment and Earnings Statistics for the United States 1909-67*, (iii) *Monthly Labour Review, 1967.*

3. U.S. Department of Commerce, *Survey of Current Business*, Business Statistics, 1965 Biennial Edition; A Supplement to the Survey of Current Business, and later issues.

The money supply series defined as currency, plus demand deposits seasonally adjusted, were kindly supplied by the Board of Governors of the Federal Reserve System.[1]

In Table I we report estimates of the coefficients of (3.3.2) for the period, and three subperiods. The delineation of the time periods is made on the basis of historical considerations, independent of the statistical tests that were performed.

First, comparing the three sets of equations in Table I, the imposition of the Almon lag structure does not change the results significantly.[2] Rather, the coefficients suggest that the effect of the money supply on wages does operate with a distributed lag. The largest response of w to changes in m occurs in the third quarter.[3]

Second, since both the explanatory variable

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1. Board of Governors of the Federal Reserve System, *Federal Reserve Bulletin* (June, 1964,August 1967 and June 1968), Washington, D.C.

2. We have experimented with alternative lag structures, i.e., Koyck's, Pascal's and Fishers' distributions, but they produced misleading results. The Almon lag permits the estimation of a greater range of distributed lag patterns without introducing any collinearity into relation. See G.D. Demopoulos, "Distributed Lags: Theory and Evidence", Working Paper, *Department of Economics, State University of New York at Buffalo* (July, 1969).

3. L.C. Anderson and J.L. Jordan, *Op. Cit.,* have found that relatively short lags and strong effects are attributable to monetary policy actions. Their approach consists of regressing current changes in G.N.P on current and lagged changes in the money supply.

and the dependent variable are expressed as percentage changes per year,[1] then each set of estimates indicates a long-run effect, i.e., the elasticity. Thus, the partial effect of monetary expansion on wage rates in not only positive but also quantitatively significant. For example, a 10 per cent increase in the money supply, for the full period, results in 3.0 and 4.0 per cent increase in wages for the Almon and fixed-point lag estimates respectively. The rate of monetary inflation, however, does not have significaant effect in subperiods 1 and 2 for the Almon equations, and in subperiod 2 for the fixed-point equations. However, the overall money elasticity after four quarters is positive.

1. Data of similar construction have been used in many of the better known wage-change models. Since there is a question with overlapping quarterly data, we have tested the model with first-difference percentage changes as well. These estimates are reported in G.D.Demopoulos, *Od. Cit.*

TABLE I

Estimates of $\dot{w}_t = j_o + j_1 \dot{m}_{t-1} + e_t^+$

PERIOD	R^2/SEE	Sum of Coefficients	t	t – 1	t – 2	t – 3
	Equations using unconstrained lag coefficients					
0. I/49–IV/67	.24/1.5	.51	.19 (.67)	.17 (.31)	–.25 (–.44)	.40 (1.32)
1. I/49– II/53	.46/2.3	.73	.58 (.62)	.08 (.05)	.24 (.15)	–.17 (–.19)
2. II/53–II/60	.11/1.3	.04	–.32 (–.73)	.65 (.86)	–.82 (-1.07)	.52 (1.17)
3. II/60–IV/67	.48/0.9	.47	.15 (.55)	.17 (.34)	–.42 (–.79)	.57 (2.10)**
	Almon lag with fourth degree polynomial					
0. I/49–IV/67	.24/1.5	.52	.28 (1.61)	–.04 (–.03)	–.03 (–.02)	.31 (1.71)*
1. I/49– II/53	.46/2.2	.73	.49 (.08)	.30 (.05)	.02 (.01)	–.08 (–.01)
2. II/53– II/60	.06/1.6	.05	–.01 (–.04)	–.14) (–.55)	–.02 (–.09)	.22 (.27)
3. II/60–IV/67	.47/0.9	.48	.28 (2.09)	–.15 (–1.23)	–.07 (–.53)	.42 (3.09)**

TABLE I (Cont'd)

PERIOD	Equations using fixed-point lags				
	R^2/SEE	Lag (n)	j_o	j_1	«t – val. j_1»
0. I/49–IV/67	.20/1.5	t – 2	3.83	.39	4.33****
1. I/49– II/53	.45/2.1	t	3.52	.75	3.65***
2. II/53– II/60	.04/1.2	t – 3	4.15	.16	1.02
3. II/60–IV/67	.41/0.9	t – 3	3.50	.37	4.46****

*) (.05
**) Two-tailed test of (.025
***) significance at (.005
****) (.0005

NOTE: Values of t-statistics are indicated in parentheses for the first two sets of equations. R^2 adjusted for degrees of freedom. SEE is the Standard Error of the Estimate. Constant terms included but not shown for the first two sets of equations.

+ Using overlapping quarterly data, the variables were transformed into annual percentage changes as follows:

$\dot{w}_t = W_t - W_{t-4} / W_{t-4}$, and $\dot{m}_t = M_t - M_{t-4} / M_{t-4}$. Excess for labour in a given quarter is measured as $U_t = 1(U_t + U_{t-1} + U_{t-2} + U_{t-3})/4$

++They are "best" selected regressions among the estimated 7-lagged equations, the criterion being the significance of the coefficient of the money variable which in all periods coincides with the highest R^2.

Third, the explanatory power of the monetary variable is quite high in subperiods 1 and 3 ($R^2=.46$) and quite low in subperiod 2 ($R^2=.05$); but overall money elasticity is still positive. All sets of equations pass the Chow test for the three subperiods.[1] Hence, the looseness in the relationship between m and w is due to the instability of the coefficients of m across the subperiods.

In turning to the estimates of (3.3.1), the following questions are raised. First, are U and m independent? Second, may an Almon or an unconstrained lag structure be imposed in (3.3.1)? Third, may (3.3.1) be used in predicting the rate of inflation?

The results[2] indicate that the correlation between U and m is small up to the second lagged quarter; it becomes larger in the following quarters, reaching its maxium in t-4. Therefore, U and m may be used together up to the second period lag coefficient of m. In the light of this lag pattern, fixed point lag equations are reported only in Table II.

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1. The Chow statistic takes the values 35.4, 33.24, and 39.40 for the unconstrained, Almon, and fixed-point lag equations respectively, to be compared to the 0.99 per cent level of significance of 2.82, 3.09 and 4.92. Therefore, the null hypothesis that $j_{10}=j_{11}=j_{12}=j_{13}$ is rejected. G.C. Chow, "Tests of Equality Between Sets of Coefficients in Two Linear Regressions", *Econometrica*, Vol. 28 (July, 1960), pp. 591-605.

2. The coefficients of determination are as follows:

$R^2\dot{U}m_{t-0}=.04$, $R^2\dot{U}m_{t-1}=.14$, $R^2\dot{U}m_{t-2}=.29$, $R^2\dot{U}m_{t-3}=.46$, $R^2\dot{U}m_{t-4}=.57$, $R^2\dot{U}m_{t-5}=.55$, $R^2\dot{U}m_{t-6}=.43$, and $R^2\dot{U}m_{t-7}=.26$

Each set of estimates indicates that the long-run elasticity of the money supply has decreased, compared with the estimates of Table I.[1]

TABLE II

Estimates of $\dot{w}_t = h_0 + h_1 \; U_t^{-1} + h_2 \; \dot{m}_{t-1} + v_t$

PERIOD	Lag (n)	R^2/SEE	h^0	h^1	«t-val. h_1»	h_2	«t-val. h_2»
0. I/49–IV/67	t	.36/1.4	.95	14.52	4.74***	.27	3.03**
1. I/49– II/53	t	.45/2.1	3.63	–.55	.06	.76	3.01**
2. II/53– II/60	t–2	.31/1.1	1.94	12.98	3.43**	–.15	.98
3. II/60–IV/67	t–2	.70/0.6	–.04	20.95	5.73***	.12	1.65*

*) (.05
**) Two-tailed test of (.005
***) significance at (.0005

NOTE: They are the "best" selected regressions among the estimated 7-lagged equations, the criteria being the following: the signs of regression coefficients must be theoretically correct; the serial correlation they yield be negligible; and they must be significant at the .1 level.

1. This is due to the fact that since wage rate changes are explained in (3.3.1) by a causal relation between w and U and a small correlation between m and U, one should expect a highly significant correlation between w and U. That is, the effects of m are partially absorbed in the U coefficients. See A.J. Tella and P.A. Tinsley, "The Labour Market and Potential Output of the FRB–MIT Econometric Model: A Preliminary Report", Staff Economic Studies, *Federal Reserve Bulletin* (August, 1968), p. 16.

On the other hand, the persistent statistical importance of the unemployment rate across subperiods suggests that the variables do not interact in the same way throughout the period studied. For example, money supply is more important in subperiod 1 than in any other, and more important in subperiod 3 than in 2. The unemployment rate is less important in subperiods 1 and 2 than in subperiod 3. The instability of the individual coefficients across the three subperiods is present as measured by the Chi-square statistic 43.33, to be compared to the .005 critical value (6 degrees of freedom) of 18.55. Also, the estimated equations do pass the Chow test at the 0.99 percent level of significance [F0.01 (4,69)], of 3.60, compared to the calculated value of 65.70.

The tests reveal that there is statistically significant evidence of a change in the structural relation among the three subperiods. Thus, to test whether a greater rate of inflation is associated with a given rate of employment, or to put the same thing in another way, whether the economy has become more inflation-prone since the mid-1950's, the following tests were performed.[1]

1. The average annual percentage changes of the

1. N.J. Simler and A.J. Tella, *Op. Cit.,* used similar techniques for comparing two periods.

explanatory variables for one subperiod may be substituted into the estimated equation for the other subperiod. Table III summarizes the results of this test.

TABLE III

Actual (a) and Predicted (p) Average Annual Percentage Changes (AAPC) in Wages. Subperiods I/49-II/53, II/53-II/60, and II/60-IV/67.

(AACP) of II/53-II/60 into Equation 1	4.76 (p) $<$ 5.65 (a)
(AAPC) of I/49-II/53 into Equation 2	4.74 (p) $>$ 4.53 (a)
(AAPC) of II/60-IV/67 into Equation 2	4.12 (p) $<$ 4.53 (a)
(AAPC) of II/53-II/60 into Equation 3	4.75 (p) $>$ 4.44 (a)

If (i) the structure found by the estimated equation 1 were associated with the observations which actually occurred in subperiod 2, then the wage change would have been less than the actual average change of the period and (ii), if the structure found by the estimated equation 2 were associated with the observations which actually occurred in subperiod 1, then the wage change would have been more than the actual average change of the period. The same holds true for subperiods 2 and 3. Thus, subperiod 2 seems to be more inflationary than subperiod 1

and less inflationary than subperiod 3.

2. A more reliable test of our hypothesis is to obtain the stationary solutions of the estimated equations and then derive the straight Phillips curves. Since we cannot solve for the steady-state solution of (3.3.1) with much confidence because of the instability of the coefficients across the periods,[1] we estimate the divergence of change of subperiods 2 and 3 as follows:[2] The estimated equations 2 and 3 are, respectively:

$$\dot{w}_t = 1.94 - .15\dot{m}_{t-2} + 12.98\ U_t^{-1} \qquad \text{(3.3.1, Eq.2)}$$

$$\dot{w}_t = -.04 + .12\dot{m}_{t-2} + 20.95\ U_t^{-1} \qquad \text{(3.3.1, Eq.3)}$$

Setting a 3 per cent annual rate of growth of money, these become the straight Phillips curve equations:

$$\dot{w}_t = 1.49 + 12.98\ U_t^{-1} \qquad \text{(3.3.1, Eq.2')}$$

$$\dot{w}_t = .32 + 20.95\ U_t^{-1} \qquad \text{(3.3.1, Eq.3')}$$

It is clear that the Phillips curve has become steeper. The significant coefficient of the money supply in subperiod 3 has the effect of increasing the slope of the Phillips curve. The trade-off between w and U is shown in Table IV.

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1. The coefficients for U and m are negative in subperiods 1 and 2 respectively but in fact insignificantly different from zero. Hence, it seems safe to assume the true coefficients are positive.

2. The steady-state solution of (3.3.1), $\dot{w}_t = \frac{h_0 - h_2 r}{1-h_2} + \frac{h_1}{1-h_2} U_t^{-1}$ where $\dot{m} = \dot{w} - r$, and r is the anticipated rate of inflation, does not yield significantly different results than those reported in Table IV.

TABLE IV

Relation between w and U from Equations (2) and (3)

% U	% w	
	II/53-II/60	II/60-IV/67
8	3.11	2.94
.	....	....
.	....	....
5	4.09	4.51
4	4.74	5.56
3	5.82	7.30
	George Perry Estimates[a]	
	II/48-II/53[b]	III/53-II/60
6	1.7	0.6
4	3.9	5.4
3	1.7	10.1
	Simler and Tella Estimates[a]	
	II/48-II/57	III/53-II/64
5	3.89	5.47
4	4.86	6.41
3	6.49	7.98

a. Their estimated equation includes the following explanatory variables: the rate of change of the cost of living index, the civilian unemployment rate, the rate of profits, and change in the rate of profits. In Perry's equation the dependent variable is straight-time average hourly earnings of production workers in manufacturing. See G.L. Perry, *Op. Cit.*, p. 76, p. 47.

b. The living-cost coefficient is taken as zero. *Ibid.*, p. 76.

Hence, the relation for subperiod 3 is more steeply sloped relative to subperiod 2 rather than unambiguously more inflationary. It predicts, however, higher wage increases at lower unemployment rates.

B. THEORY–POLICY ISSUES AND CONCLUSIONS

The objective of this paper has been an evaluation of the impact of monetary variables in a wage-change model. Our justification emerges from the monetarists' position that money is important in causing and controlling inflations. According to the evidence presented in the text; (1) the partial effect of monetary expansion on wage rates is not only positive but also quantitatively significant, (2) the Phillips curve is not stable over the three subperiods of the period I/49-IV/67, (3) the economy has become more inflation-prone since the mid-1950's and, (4) monetary policy actions represented by the behaviour of the narrowly defined money supply have a relatively large and immediate effect.

What is to be concluded from our findings? Although we are not firmly wedded to the precise estimates presented in this study, it seems that:
1. The impact of monetary variables is consistently related to the labour market. This implies that the actual movements in prices and wages

are influenced by many factors besides the unemployment rate. As long as there is no satisfactory theory relating price movement to a steady unemployment rate, it is difficult to infer reliable associations between inflation and excess demand in the labour market.

Thus the imposed restrictive monetary policies were unsuccessful in halting the creeping inflation during subperiod 2. Even when money supply increases were held to minimal amounts, they had a positive and significant relation to wage change, in the simple quantity equation (3.3.2). This held during a period of fluctuating unemployment. If unemployment could be maintained at a low and stable rate, the rôle of money supply changes might appear differently. This would suggest that constructing programmes which improve the trade-off between inflation and unemployment requires attention to the structure of labour markets and development of manpower and human resources in order to avoid inflation.

2. Monetary policy worked in a more inflationary economy; it failed to account for the relatively short-lags and strong effects attributable to changes in key monetary variables. This is the result of the monetary policy followed by U.S. policy makers since 1960. According to this policy monetary actions should be directed towards

the goals of high employment and growing investment through an interest-rate oriented policy; it also attributes small and long delayed effects to monetary actions.

According to the finding presented above, a money-supply oriented policy, which highlights the rôle of monetary actions and the price level stability as the basis for approaching a more rational economic stabilization policy, should not be neglected. There are times during which movement in the market interest rates may not be a reliable indicator for stabilization purposes. Movements in the actual levels of prices and wages should be given at least an equal consideration.

3. The persistent statistical importance of the money supply changes suggest that the actual levels of prices and wages are likely to be substantially influenced by exogenous variables. This is in contrast with much of the economic stabilization theory and practice followed during the period under study. Until we succeed in identifying these variables in a properly specified reduced form equation, we must use extreme caution in interpreting Phillips curves estimates.

APPENDIX A

A. A SIMPLE AGGREGATE WAGE–PRICE MODEL

In this appendix an aggregate wage-price model is presented, based on the behaviour of the economic units. The model's structure and properties are described elsewhere (see Footnote 1, Section III). Let :

$$\overline{Y}_t^D \equiv \overline{C}_t + \overline{I}_t \qquad \text{(A. 1)}$$

$$\overline{C}_t = C\left(\overline{Y}_t^S, r_t, \frac{M}{P}_t\right) \qquad \text{(A. 2)}$$

$$\overline{I}_t = I\left(\overline{Y}_t^s, r_t \overline{K}_{t-1}\right) \qquad \text{(A. 3)}$$

$$\frac{M}{P}_t = M^D\left(\overline{Y}_t, r_t\right) \qquad \text{(A. 4)}$$

$$P_t - P_{t-1} = P\left[\left(\overline{Y}_{t-1}^D - \overline{Y}_{t-1}^S\right), \left(\overline{W}_t - \overline{W}_{t-1}\right), \dot{M}_{t-1}\right] \qquad \text{(A. 5)}$$

$$\overline{Y}_t^S = Y\left(N_t^D, \overline{K}_t\right) \qquad \text{(A. 6)}$$

$$\overline{K}_t \equiv \overline{K}_{t-1} - \delta\, \overline{K}_{t-1} + \overline{I}_t \qquad \text{(A. 7)}$$

$$L_t = L\left(\overline{W}_t ; P_t^P\right) \qquad \text{(A. 8)}$$

$$N_t^D = N^D\left(\overline{Y}_t^D, \overline{W}_t\right) \qquad \text{(A. 9)}$$

$$\overline{W}_t - \overline{W}_{t-1} = W\left[\left(N_t^D - L_t\right), \left(P_t - P_{t-1}\right)\right] \qquad \text{(A. 10)}$$

The endogenous variables of this system are:

$\overline{Y}_t^D$ = real income demanded

$\overline{C}_t$ = real consumption

$\overline{I}_t$ = real investment

$\overline{Y}_t^S$ = real output supplied

r_t = market rate of interest

P_t = general price level

N_t^D = labour demand including vacancies

$\overline{K}_t$ = real stock of capital

L_t = labour supply

$\overline{W}_t$ = real wage rate

The exogenous and predetermined variables are:

M_t = nominal money supply

P_t^P = population parameter

$\dot{M}_{t-1}$ = first-difference of money supply, a period earlier, $M_{t-1} - M_{t-2}$

$\overline{K}_{t-1}$ = real stock of capital, a period earlier

δ = depreciation rate

$\overline{Y}_{t-1}^D$ = real income demanded, a period earlier

$\overline{Y}_{t-1}^S$ = real output supplied, a period earlier