Cycles in Demand-Pull Inflation: an Econometric Approach.

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CYCLES IN DEMAND-PULL INFLATION: AN
ECONOMETRIC APPROACH.

The Louisiana State University and Agricultural
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Economics, general

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CYCLES IN DEMAND-PULL INFLATION:
AN ECONOMETRIC APPROACH

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Economics

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August, 1972
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ACKNOWLEDGMENT

The author would like to express his sincere gratitude to Dr. James Richardson, Dr. G. Randolph Rice, Dr. Roger Burford, and Dr. Robert A. Flammang for their assistance in the preparation of this manuscript. A special note of thanks also is extended to Dr. Jan W. Duggar for his guidance and many hours spent with the author smoothing out the details of this work, as well as for his patience and understanding.

A final acknowledgment is given to Mrs. Jo Anne Martin for the typing of this manuscript, and to my wife for her endurance and understanding.
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ABSTRACT

The phenomenon of inflation has become one of the central themes of current economic thought. This study addresses itself to the problem of gradual inflation in comparatively stable economies. It is an attempt to build a rather simple econometric model with which to track the time-path of the rate of inflation as a function of a number of aggregate variables. The fundamental postulate of this model is that the rate of change of the price level is a function of the intensity of current and past demand pressure. This would seem to be a rather simplistic explanation of inflation, but authors have very often overlooked the full significance of this relation. Although the model is tested against the post-war experience of the U. S. economy, it is believed that the same analytical framework may be used against data for other developed countries.

The model consists of three behavioral equations and three definitional relations. The first behavioral equation postulates that the nominal interest rate is a function of current real income, current and lagged rates of change in real income, the current rate of change of the real money stock, and past rates of price change. The
second behavioral equation assumes that changes in nominal demand are functionally related to current changes in real activity and in the real interest rate, to current and past changes in monetary and fiscal aggregates, and the state of expectations about future prices. The third and last equation makes the current rate of price change a function of current and lagged demand pressure. The three definitional relations consist of a price expectations definition, a real interest rate definition, and a demand pressure definition.

As it may be observed, the model is recursive. The nominal interest rate is determined by real magnitudes, past rates of price change and changes in the money stock. Once the pattern of coefficients of past price changes affecting the current nominal interest rate level is estimated, the price expectations and real interest rate proxies are determined. These two instrument variables, in turn, determine, together with monetary and fiscal aggregates and a real activity variable, the current change in nominal spending. The difference between changes in nominal demand and the potential change in output—which is exogenously determined—provides a measure of market demand pressure, the magnitude through which the different forces affecting the current rate of inflation are assumed to be channeled.
The model was tested against quarterly data for the U. S. economy between 1952/III and 1970/IV. The results of the nominal interest rate equation showed that the total effect of past rates of price change on nominal interest rates was, as expected, substantially larger in the 1960's than in the 1950's. This phenomenon seemed to indicate the convenience of constructing different real interest rate and price expectations proxies for both decades. The results of the nominal spending equation show that short-run changes in velocity of circulation are largely affected by forces independent from changes in the money stock. The price expectations proxy for the 1960's and current changes in the Industrial Production Index significantly affect changes in nominal spending even in the presence of changes in monetary and fiscal aggregates. Finally, the parameter estimates of the price equation show that, although a given increase in demand pressure raises the rate of inflation within approximately one year, the immediate effect runs in the opposite direction. This cyclical phenomenon can be even more clearly seen by considering the components of demand pressure separately.
CHAPTER I

INTRODUCTION

Inflation and the Present Study

The phenomenon of inflation has become one of the central themes of current economic thought. To a great extent, this has resulted from the fact that most countries in the world have been experiencing inflationary processes of diverse intensity since World War II. The subject of inflation has not only been approached from the standpoint of its immediate causes in, and short-run effects upon, comparatively stable economic systems. It has also been integrated with the body of economic growth theory and policy discussions. This study addresses itself to the first problem. The topic of inflation, insofar as it relates to economic growth problems, would require an investigation of a somewhat different type.

The purpose of the present work is to build a rather simple econometric model with which to track the time-path of changes in the price level as a function of a number of aggregate variables.
The model is tested against the experience of the U. S. economy during the fifties and sixties, although it is thought that the same analytical framework can be applied to the investigation of similar inflationary processes taking place in other developed countries.

The basic postulate of the present model is that the rate of price change is primarily a function of demand pressure. In its general form this model resembles a previous one developed by Andersen and Carlson. However, this model attempts to explicitly introduce other determinants of short-run changes in velocity of circulation of money, besides monetary and fiscal aggregates. Although statistical results are not completely satisfactory, it is believed that they may throw some light on the determinants of inflationary processes such as those experienced by the U. S. economy during the last two decades.

Chapters I and II contain a general survey of the literature on inflation. The first of them presents a summarized review of the different explanations given of the processes through which inflation occurs. Chapter II presents several econometric works dealing especially with inflation. This review of previous quantitative analyses is by no means exhaustive, but it is rather an attempt to

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point out the different approaches taken by authors to explain the rate of change of the aggregate price level. Special attention is given to the Andersen-Carlson model. The reason for doing so is that the present model, as stated before, largely represents an attempt to utilize a different conceptual framework.

Chapter III presents the formal model. It consists of three behavioral equations and three definitional ones. The three behavioral equations are: a nominal interest rate equation, a nominal spending equation and a price equation. The other three equalities define the market real interest rate, the state of expectations about future price increases and demand pressure. The model assumes that the change in nominal spending depends upon changes in monetary and fiscal aggregates, changes in real activity, changes in real interest rates and price expectations. The rate of price change, in turn, is a function of demand pressure, i.e., the relation between changes in nominal demand and the potential increase in output. The nominal interest rate equation is introduced into the model to construct instrument variables representing the market real interest rate and the extent of expectations about future prices.

The model is tested in Chapter IV against quarterly data for the U. S. economy for the period 1952/III-1970/IV. The statistical results show the importance of changes in real activity and price expectations in determining movements in nominal spending, even
in the presence of changes in monetary and fiscal aggregates. The estimates of the parameters of the price equation seem to point out the cyclical character of the inflationary processes experienced by the U. S. economy during the fifties and sixties. The rate of price change does not seem to be a smoothly increasing function of current and lagged demand pressure, but inversely related, although not significantly, to current demand pressure and responding significantly to changes in this variable in the expected direction only after at least two quarters of the change in demand pressure. The superior fits obtained when the components of the demand pressure instrument variable are included separately in the price equation seems to express the importance of both demand and supply elements in the dynamics of gradual inflationary processes.

Chapter V contains a summary of major findings of the study and some conclusions to be derived from it. Unfortunately, the possibility of simulating the path of the rate of price change in response to changes in other variables cannot be properly undertaken due to the incomplete character of the model. In order to make the model complete it would be necessary to introduce an equation explaining changes in real output as a function of policy and other variables. Once this is done, the path to be followed by the jointly determined variables of the model to changes in policy
variables can be traced through the derived reduced form matrix of coefficients. The possibility of testing the forecasting ability of the model, on the other side, is seriously hampered by the fact that, since mid-1971 to the present, the freeze imposed by the U. S. government on factor and product prices has made the comparison between predicted and actual values largely meaningless.

The Nature of Inflation

Generally, the literature has identified two types of inflationary processes. The first type, characterized by violent rises in the price level and, what is even more important, very rapid accelerations in the rate of price increase, has been named hyper-inflation. The second type, present under the form of much smaller price increases than the previous one, is referred to as creeping inflation. This second type of inflationary process is the one which poses the most difficult problems both theoretically and in policy making. The difficulties arise due to the lack of a clear and well-defined set of circumstances under which a gradual inflationary process originates and develops.

The Hyper-Inflationary Process

There is no substantial disagreement among economists regarding the basic causes and remedies of those violent rises in the price level which have normally been associated with periods of
major disturbances and changes in the whole political and social structure of a given country. Such processes are primarily characterized by enormous increases in the money supply and by a rapid acceleration in the state of expectations about future price increases.²

Cagan has analyzed a number of hyper-inflationary processes and tried to determine a common characteristic lying behind all of them.³ He observed that actual real cash holdings seemed to have dropped between the initial and final stages of every hyper-inflationary process he analyzed. Assuming that actual and desired real cash balances are always at equilibrium, this implies a decrease in the real demand for money. Since none of the real variables which are thought to influence desired real cash balances changed substantially within the starting and closing months of any hyper-inflationary process, the rate of depreciation of money or, conversely, the rate of expected price increases, remains as the only plausible explanation for such a fall in the demand for real cash balances. Actually, he found real cash balances in logarithmic

² Obviously, in almost all of the cases of hyper-inflation, increases in the money stock and price expectations have had their roots in the breakdown of the social and political structure of the country.

form to be correlated closely with the expected rate of change in prices, defined as a function of the current rate of price change.

However, as Ball has stated, it seems clear that such tremendous increases in expectations about future price increases would not be long-lived without a corresponding increase in the money supply to finance the increased volume of nominal transactions. Even though the initiative could sometimes be taken by an upward shift in the state of expectations about future prices, thus creating a situation of excess demand for goods in the short run, actual price increases would catch up with expected price increases if government authorities were able to exert some restraint in the rate of growth of the money stock. But, in fact, periods of hyper-inflation have been preceded by substantial increases in the money stock issued to finance uncommon exogenous events, such as wars, or amidst periods of major social and political disturbances. Thus, a hyper-inflation may be explained in a Classical or Keynesian fashion with similar accuracy. The remedies advocated for it are fiscal and monetary restraint with which to stop the rapidly mounting excessive demand over a practically constant real output level.

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Theories of Gradual Inflation

The debate, on the other hand, is far from settled regarding the nature of the more gradual and recurrent price increases which developed economies have experienced for the last two decades, and which has been given the name of creeping inflation. This process is not characterized, as in the previous case, by violent increases in the money stock and seemingly uncontrollable accelerations in the rate of price increases, but by substantially smaller price rises which are not preceded by abnormally large upward movements in the money supply, or substantial disruptions of the aggregate demand-aggregate supply relationship. It seems that such an inflationary process follows a cycle, with periods of more rapid price increases being followed by periods of less rapid increases, or even almost constant prices.

This type of inflation has been primarily explained in three different ways. One group of economists maintains that, although without the clearness with which it works in the case of hyper-inflation, the ultimate cause of the moderate price increases suffered by developed economies after World War II is a "demand-pull" type of phenomenon. It appears that, at times, aggregate demand tends to grow too rapidly as a consequence of expansionary monetary and fiscal policy measures and a rising velocity of circulation.
Within a Keynesian framework, assuming an economy close to full employment, expansionary fiscal policy has a direct impact upon nominal aggregate demand through income and wealth effects. Now, as the economy is already close to full employment, the component of nominal aggregate demand which is primarily affected is the price level, with real output remaining substantially unaffected. Monetary policy may also, under the same theoretical framework, become a generator of inflation. Increases in the money stock generate, through portfolio adjustments, a downward movement in interest rates, which, in turn, induces a larger amount of investment demand and other types of expenditures. This brings about, through the multiplier effect, a rise in nominal income. Furthermore, as in near-full employment conditions the speculative demand for money is thought to be highly unresponsive to interest rates, a given increase in the money supply will exert

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a larger effect upon interest rates, and ultimately upon nominal income, than under conditions of large-scale unemployment. As in the case of expansionary fiscal policy, the assumption of an economy working at near-full capacity will cause a given increase in nominal income to affect primarily prices and not real activity.

On the other hand, the modern version of the Quantity Theory approach does not accept this explanation of "demand-pull" inflation. Fiscal policy per se, according to economists belonging to this group, does not have any consistent and predictable influence on aggregate demand. The major effect of increased government expenditures is to bid resources away from the private sector towards the public sector. If those increased expenditures are financed through taxes or the issuing of securities, then the effect will be a higher interest rate in the money and bond markets due to the increased excess demand for funds. It is only when increased expenditures are financed through the issuing of new money that

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there will likely be an expansionary effect upon nominal income. Changes in the money supply, on the other hand, are considered to have a direct impact upon the level of expenditures. In other words, the Modern Quantity Theory approach--also referred to as the "monetarist" position--maintains that fiscal policy exerts a noticeable influence upon the aggregate level of activity only when there is an accommodating movement in monetary aggregates.

A very important difference between the monetarist and neo-Keynesian approaches to economic policy is the way through which monetary changes affect nominal income. The neo-Keynesian view of the transmission mechanism emphasizes the importance of interest rates as indicators of the adjustments made by individuals across a wide variety of financial assets in response to any given action of the Federal Reserve. An expansionary action by the monetary authorities will, through portfolio adjustments, lower the yield on financial assets which, assuming a constant expected yield on real capital, will expand the purchase of real capital goods. It

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8 However, according to Tobin, this argument rests crucially upon the assumption of a tight linkage between money and nominal income. See James Tobin, "Liquidity Preference and Monetary Policy," Review of Economics and Statistics, Vol. 29 (May, 1947), pp. 124-31.
also generates, through wealth and credit availability effects, an expansion in the purchase of consumption goods. 9

According to the monetarist position, on the other hand, changes in the nominal money stock have a direct influence upon nominal income. While the level of nominal cash balances is exogenously determined, the amount of real cash balances which people desire to hold is determined endogenously. 10 In equilibrium, actual and desired real cash balances are equal. Assuming a change in the money stock, individuals try to adjust their actual real balances to new desired levels. Thus, in the case of a money stock increase--which brings about an excess of actual ever-desired real cash balances--the demand for physical assets increases at the expense of the demand for money in an attempt to bring actual real cash balances down to desired levels. So, according to the Modern Quantity Theory approach, money is directly substituted for physical assets as well as for bonds, thus bringing their prices up and their implicit yields down until prices have risen sufficiently to make

9 See Warren L. Smith, op. cit., pp. 62-65. Although offsetting effects will appear, there is no necessity for interest rates to go back to their initial levels.

10 It is crucially important for the monetarist line of thought that the nominal amount of money, although having some interest elasticity, be primarily determined by the monetary authorities.
actual real balances equal to desired ones. \(^{11}\) In the case of a fall in the money stock the process is reversed. The monetarist position, then, asserts that an increase in the money stock will only temporarily bring interest rates down, but as soon as individuals adjust their actual real cash balances to desired levels, interest rates are brought back to their previous levels. \(^{12}\)

In the case of widespread unemployment, the impact of an increased demand for real goods will be primarily upon real output, which increases the demand for real cash balances itself. In this case, the new equilibrium between desired and actual real cash balances will be located at a lower price level and a higher real income level than if all the pressure of an increased demand for physical assets is felt by the price level. In this second case, however, an inflationary process does not necessarily develop, according to the monetarists, if there are not further increases in the nominal amount of money. Recurrent increases in the money stock are the fuel for the appearance of expectations about future price increases, which, in turn, bring about further decreases in the

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\(^{11}\) This is important because, if as the monetarists say, interest rates are brought down by an increase in the price of physical assets and not the other way around, the interest rate effect of an increase in the money supply does not precede the nominal income effect.

\(^{12}\) This assumes a perfectly constant velocity of circulation of money.
demand for real cash balances. Thus, in terms of the Equation of Exchange, the Modern Quantity Theory suggests that velocity of circulation, although not constant, is a stable function of certain economic variables, and that in an economy close to full employment prices will follow very closely movements in the money stock.

The lack of purely competitive conditions in labor and product markets has led a second group of economists to suggest that creeping inflation is not primarily a "demand-pull" phenomenon, but rather a result of autonomous upward shifts in costs and profits. They do not deny the logical possibility of demand-pull inflation but rather maintain that excessive aggregate demand has not been the main determinant of the post-war creeping inflationary processes which appeared in most developed countries. The causal link of rising prices is traced down to the non-competitive behavior of business organizations and labor unions. The "cost-push" view of inflation stresses the fact that business firms do not consider prices as determined by the market. Oligopolistic market structures allow business firms to set prices based upon a given or

predetermined rate of return on the capital invested, or, as a variation of the same principle, based upon a mark-up rate over per-unit variable cost. These "administered prices" are not directly dependent upon demand conditions, but rather respond to movements in costs and profit rates. Wage rates, on the other side, are also highly unresponsive to market conditions. Trade unions are said to base their wage demands upon movements in wages in related industries as well as on prices and profits. Wage increases which exceed productivity gains are granted, which shifts upwards the per-unit cost curve of business firms. Under competitive conditions this would not necessarily raise prices because they are determined primarily by demand conditions; but the lack of competition allows firms to translate upward shifts in the average cost curve to higher prices.  

According to "cost-push" theorists, once either wages or prices begin to increase, an inflationary spiral can be brought about by the above-mentioned behavior of unions and business firms. This type of inflationary spiral may be made even more pronounced if, simultaneously, real income decreases. If prices and wages are completely unresponsive to demand conditions, and the money

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supply remains constant, it is conceptually possible at least, that real income may even fall by a substantial amount while prices and wages are still going up.

A third explanation of the nature of creeping inflation contains elements of the "demand-pull" and the "cost-push" views of inflation. A general rise in prices may come about--according to this position--by an initial shift in demand from one product to some others without a necessary increase in aggregate demand. If the increase in prices which can be expected for the product whose demand has risen was to be accompanied by a fall in the prices of these goods whose demand has fallen, then inflation may not occur. However, market imperfections in the form of downward stickiness of prices and wages in the declining industries will cause the price level to rise. So, structural shifts in the composition of a constant level of aggregate demand, together with the downward rigidity of prices and wages, bring the price level up and initiate an inflationary process through further price and wage increases throughout the economy. 15

The three different explanations on the basic causes of gradual inflation have important bearings not only upon the logical consistency of the various theoretical models, but also upon the policy measures which would have to be pursued in order to suppress such price increases. While the problem of excess aggregate demand can be successfully attacked through restrictive monetary and fiscal policy, price increases brought about by forces independent of demand are thought to be highly unresponsive to monetary and fiscal restraint, at least until a substantial amount of unemployment is present in the market. Thus, while these economists who suggest that inflation is purely a demand phenomenon advocate monetary and fiscal restrictions, those who point to administered prices as the cause of inflation consider that the above type of policy will have its effects primarily on real output and employment and not on prices.

The center of the debate regarding the possibility of a pure "cost-push" inflation lies upon the fact of whether or not an autonomous increase in costs—which brings about an upward movement in prices—may start an inflationary chain without a corresponding increase in the money supply or an upward shift in the demand for commodities. "Cost-push" theorists assert that an autonomous wage increase will raise prices, but, as personal income also increases, consumers will be able to maintain their previous levels
of real demand. \(^\text{16}\) The continuance of inflation is insured, according to this view, by the fact that the disappearance of real gains pursued originally by the workers will call for new wage increase demands, thus maintaining the pressure on prices and creating the spiral. \(^\text{17}\)

However, besides denying the conclusion that higher wages bring about higher personal income and a successful maintenance of real demand, "demand-pull" theorists question how far this type of inflation may continue with a constant stock of money, or even with the money supply rising in acceleration with the rate of growth of real output. \(^\text{18}\) It may be that, at the initial stages of the wage-price spiral, there are idle cash balances which, when prices begin to rise, are returned into circulation due to the higher opportunity cost of holding money. But sooner or later such idle cash balances will disappear as interest rates continue rising.


\(^{17}\)All variations of the "cost-push" view of inflation are crucially dependent upon the assumption that velocity of circulation is affected by supply forces.

Except for the unlikely case of no upper limits to velocity of circulation of money in the short run, higher wages and prices would, if the money stock remains constant, exert an unbearable pressure on interest rates. This pressure, in turn, would have to affect unfavorable investment demand and real output. Under conditions of constant money supply, the only possible manner in which prices and wages could continue increasing would be for real income to fall. However, although this case is, as said before, conceptually possible, prices and wages would have to be very unresponsive to market conditions for such an inflationary spiral to continue after an adjustment period. 19

It seems that the possibility of a pure "cost-push" inflation relies heavily upon the definition of inflation as a once-and-for-all increase in the price level, and not as a process which, once started, feeds itself and continues to raise prices. This is the position taken by some "cost-push" theorists. 20 In this sense, a period of continuing inflation would require recurrent autonomous

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19 On the other hand, the problem of upper limits to velocity of circulation or substantial decreases in real output would have to be understood as limits within which a creeping inflation works, which does not seem to have been the case for at least the U. S. experience, where inflation rates have seldom been higher than 5 or 6 percent per year.

wage and price increases, and this would have to be matched by the resistance of consumers to lower their levels of real demand. Such a desire to keep real demand constant is what causes velocity of circulation to increase. But if the money supply does not increase accordingly, the rate of increase would have to increase up to a point in which all holdings of idle money disappear and transaction balances are kept to a minimum. At this point, any further increase in velocity has to come from changes in the technology of handling transaction balances, which are rather unlikely to increase in the short run. 21 The position of "demand-pull" theorists regarding the role of the price-wage spiral in an inflationary process can be summarized through the following statement:

The recent treatment of the spiral as an independent causal explanation is, moreover, misleading... because it mistakes the instrumentality by which inflation occurs for its causes and puts emphasis upon direct legal regulation of wages and prices rather than on monetary and fiscal control of the quantity and velocity of money. 22

On the other hand, it seems that "demand-pull" theorists, especially monetarists, rely too much upon a rather rigid relation between velocity of circulation and the money stock. It has to be

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21R. J. Ball, op. cit., p. 216.

kept in mind that, although conceptually it is very unlikely that any inflationary process will become substantial with the money stock constant, the inflationary experience of the U. S. and other developed countries seems to have taken place amidst increases in the money stock which cannot be considered abnormal. Actually, the model developed in the present investigation shows that a substantial part of total variations in nominal spending can be explained by reasons other than movements in monetary aggregates.

Whatever the initial cause of inflation, it seems true that in every inflationary process aggregate demand increases rather rapidly, leading the way for increases in real output. The phenomenon which appears as posing an unsolvable problem for policy making is the fact that, as restrictive monetary and fiscal policy measures are put into effect in an attempt to reduce inflation, the most immediate contraction seems to be in production and not in the price level itself. It would seem that, in the later stages of inflation, production is more responsive than spending to any unfavorable outlook in business conditions. Thus, it is a widely held belief among economists that full employment and price stability cannot be simultaneously pursued. The alternatives posed by this interpretation of inflation to policy makers have been expressed through a Phillips curve analysis.
The Unemployment-Inflation Nexus

A. W. Phillips found that, in the United Kingdom, the rate of change in money wages seems to be highly correlated with the level of unemployment in what can be graphically represented as a hyperbolic relation.\(^2\) That is, although continuous, the relation is such that when the unemployment rate falls below a given level, the slope of the relation between changes in money wage rates and the level of unemployment becomes rather steep, and when the unemployment rate is larger than such a level, the relation becomes substantially more horizontal. Subsequent to Phillips' work, a tremendously large number of studies have attempted to confirm or refute--using different time periods, introducing new variables, etc.--what was presented by Phillips, and to develop a conceptual framework based upon behavioral relations which could consistently explain or reject this empirically observed phenomenon.

Subsequent studies introduced other variables expected to affect the change in money wage rates besides unemployment. Apart from import prices, already used by Phillips, other authors

introduced the price level, the level of profits—or, in the Kuh variation, productivity changes—and changes in these variables. The unemployment rate, as well as changes in it, is suggested to stand for excess demand in the labor market, once certain assumptions are introduced regarding the distribution of employment among different groups of workers, and the vacancy rate is taken to be a constant. On the other hand, variables such as import prices, the cost of living, and profit rates are introduced in order to explain the extent of supply-induced wage increases. Kuh rejected the inclusion of profits arguing that this variable is only a proxy for more fundamental forces, namely, productivity changes.


Different studies have not only differed regarding the explicitly included variables but also in the level of aggregation, as well as in the length of the time period used. While some, including Phillips, used annual data, others used quarterly observations, and even others, as in the case of Eckstein and Wilson, considered the wage rounds in leading industries to be the proper time period for analyzing wage changes. The results, regarding the size and significance of the coefficients attached to the different variables, has varied substantially from author to author. Some investigations have shown results which suggest that unemployment is the basic variable explaining money wage rate changes. Others concluded that some of the above-mentioned variables are also relevant in bringing about changes in the money wage rate, excluding, in some cases, much of the influence of the unemployment rate on wages.

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Although some of the variation in results may be attributed to the different specifications of the equation, it seems that different Phillips curves may be obtained depending upon the variables included, the time period involved, etc.\textsuperscript{31} All these shortcomings seem to imply that the generality with which policy decisions can be made based upon a hard unemployment-money wage rate change relation is crucially limited by the validity of the assumptions involved in the particular model. If this statement holds for the unemployment-wage rate relation, similar qualifications have to surround attempts to quantify the so-called trade-off between inflation and unemployment.

**Expectations and the Phillips Curve**

Aside from the statistical problems and empirical findings about the trade-off relation, there have been multiple attempts to find a consistent explanation for short-run deviations around a presumably stable relation between prices and unemployment.\textsuperscript{32}


Considerable effort has also been devoted to the search for a theoretical apparatus which--built up from a set of individual behavioral decisions within a dynamic environment--would accept or reject the existence of a stable long-run Phillips curve. Phelps and Friedman have suggested, working within different frameworks of analysis, that only in the short run can there possibly be a trade-off between inflation and unemployment. Once time is allowed for individuals to adjust their expectations of future price increases to the going rate of inflation, any rate of price change is only consistent with the natural rate of unemployment, that is, the unemployment rate which is consistent with the long-run equilibrium between aggregate demand and aggregate supply.

Phelps developed the idea of the need for an accelerating rate of inflation in order to maintain the trade-off between unemployment and inflation from the behavior of business firms within a dynamic

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environment. The basic assumption in Phelps' model is that the individual firm always tries to maintain a desired differential between the money wage rate it offers and that offered by other firms. This differential is a function not only of the unemployment, but also of the vacancy rate, the quit rate, and other variables affecting the labor market. Hence, if the firm wants to expand its labor force, and assuming that other firms are not expected to raise their wages, it does so by increasing its money wages, thus increasing its desired differential. So, if money wage rates throughout the economy are expected to remain constant during the contract period, the level of activity is increased with an increase in money wages. However, if money wage rates are expected to increase by a certain amount during the contract period, the individual firm will have to increase the nominal wages it is paying by the same proportion if it expects to maintain the same level of activity. In the presence of expectation of future wage increases, the only way for the firm to attract a larger labor force is by offering a wage increase which is larger than that expected to occur throughout the economy.

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Thus, Phelps suggests that when expectations of future wage increases are borne out throughout the economy, a given reduction in unemployment can only be bought at the price of accelerating increases in money wages. In the absence of money illusion, the only possible steady-state solution between money wage changes and the unemployment rate in Phelps' model is a vertical Phillips curve intersecting the unemployment axis at the natural rate of unemployment.

Friedman's scheme is developed from the assumption of a given behavior on the part of workers. An initial increase in the money stock will cause an expansion in real activity. Initially, workers are hired at the going nominal wage rate. However, as prices begin to go up, thus lowering real wages, workers will begin to demand higher nominal wages in order to bring real wage rates back to previous levels. Once workers begin to incorporate future price increases into their wage demands, the maintenance of a rate of unemployment which is lower than the natural rate needs an accelerating increase in the money stock and thus an accelerating rate

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35It is important to notice that, contrary to Friedman's, Phelps' conclusions do not rely crucially upon a price-wage tight relation, but on the continuous attempts by firms to maintain their desired differential. Expected price increases are only relevant if they are expected to be translated into wage rises.

of inflation. Only an accelerating rate of inflation will keep real wages below the level of real wages expected by workers and, thus, allow for the maintenance of an unemployment rate below that consistent with equilibrium. In the case of an increase in the money stock which is lower than that necessary to maintain the natural rate of unemployment, deflation will occur and the rate of unemployment will again move in the direction of the natural rate.

Friedman's model implies, as Phelps' model does, that the introduction of expectations in the behavior of individuals makes a vertical Phillips curve the only consistent with long-run equilibrium of the economy. As Friedman suggests, this phenomenon is more clearly observed in those countries where, while the inflation rate remains within a certain range for an extended period of time, there are periods of high employment, as well as high unemployment.

The "accelerationist" theory of inflation described above, added to the lack of convincing statistical results, seems to introduce serious doubts upon the existence of a stable trade-off between inflation and unemployment. Another criticized aspect of the Phillips curve analysis is that it appears to suggest a chain of causality--running from unemployment to prices and wages--to relations which are most likely determined simultaneously within the economic system, thus introducing a spurious explanation of
inflation. On the other hand, if the Phillips curve merely attempts to say that, within the short run, unemployment varies inversely to changes in prices and wages, it only points out the movement which these magnitudes are expected to follow during business expansions and recessions, but without unveiling any of the fundamental moving forces of an inflationary process. This relation does have its importance in pointing to the wage-setting mechanism. It certainly gives support to the idea stressing the importance of economic forces against institutional elements in the process of wage determination. Yet, this is rather far from implying a permanent trade-off between unemployment and inflation. It appears that it may be possible to build a model which points to more fundamental variables, as well as their lag relationships, in order to explain creeping inflationary processes.

CHAPTER II

REVIEW OF THE QUANTITATIVE LITERATURE
ON INFLATION

Preliminary Remarks

Among different quantitative attempts to explain the dynamics of inflation, it is possible to first draw a difference between those which are embodied within large econometric models and those which are limited to one or a few equations. The first type of model is primarily designed towards understanding the determination of a large number of economic magnitudes; as a consequence, these models contain many behavioral relationships which are integrated with each other within a simultaneous context. Their aim is, one would say, more ambitious than that of the second type of models. While large models try to specify explicitly, with as much detail as possible, the working of the whole economic system and each one of its relevant components, partial models are generally designed to test a given hypothesis regarding the determination of one or a few variables, and to track as closely as possible their time path.
In other words, while large econometric models can be said to try to simulate the dynamic path of the whole economy with specific assumptions as to how each component relates with each other, models belonging to the second type can be considered as simulations of the working of only parts of the system. Since the channels through which the assumed explanatory variables affect the dependent ones are not explicitly incorporated into the latter models, the coefficients attached to the former are considered to represent the direct, as well as the indirect, effect which they are supposed to exert upon the dependent ones. This is the reason for referring to them as reduced-form models, their most typical example being single-equation models. However, some models, though containing more than one equation, are aggregated enough to ignore the specific channels through which exogenous variables affect those determined within any one of them, thus belonging more properly into the category of reduced-form models than in that of structural ones.

On conceptual grounds, structural models are more properly equipped than reduced-form ones in order to test a given hypothesis of the working of the system, or any of its component parts. Reduced-form models may be consistent with two or more alternative hypotheses regarding the channels through which exogenous variables influence endogenous ones; then, it is difficult, through them, to accept or reject a given hypothesis with clarity. Besides
this undeniable conceptual superiority of structured models against reduced-form ones, it would seem that the former may show more accurate results and have better predictive power than the latter because each economic magnitude is determined within the simultaneous interplay of the different component sectors of the economy. Indeed, one of the most widely noticed shortcomings of simple models, especially the single-equation ones, is that they overlook the possible interactions between the variable to be ultimately explained and those assumed to determine it. This is considered to lead to biased estimates of the parameters corresponding to the explanatory variables, an error called simultaneous-equation bias.

However, there seem to exist several qualifications regarding the use of estimation methods dealing with systems of simultaneous equations. Authors have often made references to the limited knowledge presently existing about statistical problems arising from such estimation methods.¹ Monte Carlo simulations have also thrown doubts regarding the actual superiority of these methods compared to single-equation estimation methods when the sample size is small as is often the case in economics.² Finally, there is


no absolute agreement among different authors either on the specific role which, according to theoretical considerations, the variables play in the economic system or about the channels through which different variables relate to each other. When the model builder tries to specify a very detailed network of behavioral relations, the risk of overlooking variables and/or misspecifying these relations increases with the degree of detail. These are the reasons why—despite its conceptual limitations—single-equation methods of estimation may be used instead of more complex methods to track the time-path followed by a given variable.

Among estimation methods for simultaneous equation systems, limited-information methods perform better than full-information methods when the model suffers from misspecification errors. The reason is that full-information methods of estimation take into account not only the restrictions placed upon the particular equation, as limited-information methods do, but those placed upon the whole model. Full-information methods are, thus, vulnerable to any misspecification existing anywhere in the model, while limited-information methods are only vulnerable to misspecifications existing in the particular equation. This, added to identification problems, may explain why none of the large econometric models used full-information methods to estimate their parameters, but
they have been estimated through limited-information and single-equation methods.

Apart from problems arising from different methods of estimation, the fact that large econometric models are not primarily intended to emphasize a particular equation, but each of them is submerged into the interrelation of the system, the present review will be limited to specific models built to deal with changes in the price level. It will be sufficient to keep in mind that large econometric models including price equations follow a non-monetary approach, i.e., attribute to changes in real forces a primary role in bringing about movements in the price level. None of the large econometric models attaches great significance to monetary aggregates.  

The next section presents several quantitative attempts to explain inflation in terms of the relation existing between costs and prices. These models belong to so-called non-monetary theories of inflation because the source of inflation is not considered to be primarily connected with market disturbances arising from excessive increases in the money stock. They range from those giving primary importance to cost-push forces arising from the

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monopolistic power of business firms to those combining cost and demand forces, but always within the context of an intimate relation between costs and prices. The third, on the other hand, reviews models which bring monetary aggregates explicitly into the model as a force bringing about inflation. These models emphasize the role which an excess demand for commodities has in inflationary processes, and dismissing cost-price links as unimportant independent forces.

**Models Based on the Cost-Price Relation**

The present section includes an analysis of models which emphasize the effect of industrial concentration on the price level, those which primarily concentrate on alternative pricing mechanisms within the business firm, and those implying the trade-off between unemployment and inflation.

**Industrial Concentration and Inflation**

An effort to measure the relation between the degree of industrial concentration and the rate of inflation was undertaken by Weiss, through a cross-sectional study.\(^4\) Weiss' study was developed partly as a response to a previous investigation by DePowdin

and Selden. These authors argued that the "administrative prices" hypothesis could not be relied upon as a leading force bringing about the middle fifties' inflation. Their conclusion rested upon a correlation analysis which related 1959 industry wholesale price indexes based in 1953 to four-firm concentration ratios in corresponding industries. Their results showed that, regardless of different formulations utilized, the relation between wholesale price changes and concentration was insignificant. The primary reason for higher prices in certain industries, according to DePowdin and Selden, was the increase in demand in those sectors, relative to others.

Weiss, on the other hand, concluded that, after allowing explicitly for changes in per unit material cost and per unit labor cost, the effect of changes in real output changes on wholesale prices became statistically insignificant, and the effect of industrial concentration emerged as a significant determinant of the different relative increases in wholesale prices in different industries between 1953 and 1959. Weiss obtained these results from the following equation:

$$P_i = a + b Q_i + c MC_i + d LC_i + e C_i$$

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where $P_i$, $Q_i$, $MC_i$, and $LC_i$ are, respectively, the indexes of 1959 wholesale prices, real output, per unit material cost and per unit labor cost, for industry "i," taking 1953 as the base year, and $C_i$ as the 1954 four-firm concentration ratio of industry "i." Weiss reduced the 155 four-digit industries selected in the DePowdin-Selden analysis to 81, the reason being that the 1957 changes in the Standard Industrial Classification made the remaining industries to be substantially different between 1959 and 1953. He showed—although not very convincingly because he used the same method he is criticizing—that there is no substantial distortion in favor of the "administered prices" hypothesis when the sample is modified as above. He tested the equation under alternative formulations of the per unit labor cost variable. In all of them, per unit costs and concentration ratios showed statistically significant effects upon the wholesale price index, while the real output index becomes insignificant. However, when a wage rate index is introduced in the equation in place of per unit labor cost, the statistical significance of the concentration ratio disappears. Weiss attributes this to the high degree of correlation existing between wage rate changes and industrial concentration, and explains it by suggesting that any wage increase was used, during the middle fifties, as an excuse for raising prices and profit margins, the process being more pronounced in more concentrated industries.
Weiss seems to have correctly criticized DePowdin and Selden for identifying changes in real output with demand elements only. On the other hand, besides problems related to the sample selected, he appears to have completely ignored the role played by demand. The fact that cost elements appear as important in affecting prices—especially in a regression of the type used by Weiss—does not exclude the possibility that demand forces moved up both costs and prices in some industries more rapidly than in others. It seems that industries which face higher per unit costs will generally charge higher prices for their articles, but this does not necessarily imply that cost elements set prices regardless of the state of demand. It is known from price theory that, except in the very unlikely case of perfectly elastic supply of factors of production, the price of those factors increases as the demand for them shifts up. What Weiss has observed was that industries which experienced the largest price increases within a six-year time-span have also experienced the largest rises in per unit cost, but without clearly justifying any causal relationship.

Regarding concentration, there is no indication in the study of how demand behaved during that period for the more concentrated industries, vis-a-vis the less concentrated industries. Moreover, according to theory, firms which exert a large degree of monopoly power are indeed able to set a price higher than that established by
a firm under more competitive conditions, but once the higher price is set there is no reason why monopoly prices will rise at a faster rate than competitive ones. Monopolistic conditions will result in higher price levels, but it does not seem clear that they will result in a faster rate of price increases than competitive ones. Philips carried out a similar investigation of several European countries, but found no significant relation between concentration and price changes.  

Alternative Pricing Mechanisms and Inflation

The two studies presented here focus upon real forces, but, unlike the previous one, elaborate their models upon the dynamics of the pricing mechanism within the business form.

Eckstein-Fromm Model. This model concentrates upon the relative importance of the full-cost and the competitive pricing mechanisms in bringing about inflationary pressures. As Eckstein and Fromm explain, it is not the mere fact that unit costs and prices go together which determines what type of pricing mechanism is

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predominant in a given situation. The crucial phenomenon to be analyzed for a meaningful conclusion is to what extent firms change prices based on changes in standard unit cost, compared to actual unit cost; that is, to what extent prices respond to, or are independent from, short-run changes in productivity. If firms base their price decisions on standard unit cost, then they can be said to set prices not directly tied to the state of the business cycle. On the other hand, if actual unit cost is what primarily influences the firm's price setting mechanism, then competitive conditions are likely to be dominant, except in the case where firms are steadily working at full capacity, in which case there is not much room for distinguishing between full-cost and competitive pricing.

Eckstein and Fromm built an equation explaining the wholesale price index for total manufacturing and for durable and non-durable manufacturing, as a function of cost and demand variables. The equations were tested for quarterly levels of the variables, as well as for their quarterly changes and for percent change of overlapping four-quarter intervals, against the post-war American experience. They hypothesized that, if competitive conditions prevail in the market, pricing decisions would be based upon changes in actual unit labor and material cost, the difference between actual and desired inventories, the industry operating rate and the backlog
of orders. On the other hand, in the case of oligopolistic market behavior, the variables primarily affecting administered prices would be changes in standard unit labor and material cost, changes in the capital-output ratio and changes in the target rates of return or mark-up. Drawing from previous studies, they define standard unit labor cost as:

$$ULC^N = a \frac{W}{ebt}$$

where both parameters $a$ and $b$ are derived from another equation of actual unit cost as a non-linear function of average hourly earnings, the current and one-quarter lagged industry operating rates and time. Thus, standard unit labor cost is, according to the above definitional equation, dependent only upon average hourly earnings and time.

After expressing their doubts about the statistical properties of the price equation when the variables are specified in levels or in overlapping quarterly changes resulting from multicollinearity and autocorrelation, the authors present results obtained under different specifications of the equation. From the results, Eckstein and

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8Ibid., p. 1166.

Fromm suggest that a mixed model seems to behave better than a purely competitive one in manufacturing as a whole and durable manufacturing. In these two sectors, both cost and demand elements were consistently significant, and specifications containing standard unit cost and the difference between actual and standard unit labor cost resulted in better fits than those containing only actual unit labor cost. Moreover, although lagged price changes are important, this variable loses much of its significance when the variables are expressed in quarterly changes and the one-quarter lagged change in standard unit labor cost and in the unfilled orders to sales ratio are introduced, thus implying a rapid adjustment of prices to change in cost and demand conditions.

The finding that standard unit labor cost appeared to carry more explanatory power than actual unit labor cost, the fact that the sum of the beta coefficients of cost variables was slightly larger than that of demand variables, plus the significant negative coefficient attached to the profit rate in the case of durable manufacturing, led Eckstein and Fromm to conclude that there are certain signs of target-return or full-cost pricing behavior in manufacturing as a whole and durable manufacturing. In the case of non-durable manufacturing, on the other hand, actual unit labor cost behaved as well as standard unit labor cost. The authors attributed this to more competitive conditions in these industries compared to durable
manufacturing, and to the stability of operation rates in non-durable manufacturing industries, which makes it difficult to distinguish clearly between the effects of standard and actual cost upon price.

However, despite the fact that this approach explicitly considers demand variables--expressed through the industry operating rate and the ratio of unfilled orders to sales--to be important in determining price changes, the authors seem to have overlooked the impact which demand has upon average hourly earnings and other factor prices. The fact that a firm bases its price decisions on cost elements does not exclude the possibility that excess demand exerts its pressure simultaneously upon factor and product prices. A single-equation model as this seems to run the risk of ignoring the fact that price changes and changes in hourly earnings mutually influence each other, and obscure the relation between them and other magnitudes. On the other hand, the model points to the importance which short-run changes in productivity may have in bringing about changes in velocity of circulation of money independently from changes in monetary aggregates.

Inventory Changes and Inflation. It is interesting to mention, among models of inflation centered upon the firm's pricing behavior, the approach taken by Courchene in explaining variations of prices
in individual industries. Cournene maintained that the process of inventory changes is of primary importance in explaining changes of industrial prices as a result of excess demand. He tested this hypothesis against quarterly data for the Canadian manufacturing experience between 1956 and 1962. The author found that the variable which best tracked price changes in individual industry groups was the instrument variable standing for the difference between desired and actual inventories. Contrary to Eckstein and Fromm, who calculated desired inventories from a twelve-quarter moving average of actual inventory levels, Cournene derived the level of desired inventories from a regression relating inventory levels to other variables.

The efficiency of the inventory adjustment instrument variable in explaining price changes was greater, as expected, in

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industries producing predominantly to stock, where inventory adjustments are the dynamic procedure of adjusting production to demand changes. However, it was also statistically significant in industries producing primarily to orders, where the change in the volume of unfilled orders would be expected to stand better for excess demand. Actually, the difference between desired and actual inventories was the only one of several alternative variables used to represent excess demand which was statistically significant at the one percent level in all individual industries and for manufacturing as a whole.

Afterwards, Courchene introduced variables standing for changes in money wage rates and material prices, but they did not show consistent explanatory power through different industries, or for manufacturing as a whole. Since changes in wage rates and material prices are proxies for changes in standard per unit cost, these findings appear to deny the relevance of the "administered prices" hypothesis, at least for the Canadian economy. On the other hand, at least part of the difference between the Courchene and the Eckstein and Fromm presentations may be attributed--apart from the fact of referring to two different countries and within different time spans--to the different manner in which the desired level of inventories is derived by each of them, and the use of different price variables.
Although Courchene's article does not deal directly with inflation, but with the problem of how important are different proxies used to measure excess demand in order to explain price variations in particular industries, the approach he uses to measure the extent of market demand pressure is generally used by those authors who support non-monetary views of inflation. However, it is difficult to know, under this approach, the extent to which the variables used to represent demand pressure are, in turn, a result of changes in monetary variables. Some economists have found variations in the level of these variables to be largely determined by current and previous changes in the money stock, without the reverse being true.12

**Inflation-Unemployment Trade-Off**

The model primarily discussed here stresses the importance of the wage-price spiral and its relation with unemployment in bringing about inflation. The present heading also includes a brief reference to two models which, although not directly referring to the American experience, present some interesting points about relation between inflation and the price-wage mechanism. Both of these models are based, as the first one, upon the inflation-unemployment trade-off.

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Gordon's Wage-Price System of Equations. Gordon developed a two-equation system trying to explain the simultaneous interaction of prices and wages. Although within the Phillips curve tradition, both equations incorporate a detailed analysis of the behavioral and technological relations assumed to underlie the quantitative investigation. Also, extensive effort was undertaken by the author to refine available figures on most of the variables, so as to make them more compatible with the conceptual magnitudes they are designed to represent. It is interesting to notice that in a previous article where Gordon presented the system of equations, the results obtained allowed him to conclude that the "accelerationist" hypothesis of inflation—which, as mentioned in the previous chapter, denies the existence of any stable trade-off between inflation and unemployment—could be clearly rejected, at least for the U. S. economy. However, the results emanating from his second article—where he revised both equations to take into account the 1970 U. S. experience—show a much weaker ground for rejecting such hypothesis. Gordon states that:


There appears to be good reason to believe that the main costs of a fully anticipated inflation are small, and that most of the political furor caused by the recent inflation has been due to its unanticipated character.  

In the wage equation, he assumed the change in the ratio between a fixed weight wage series—which Gordon constructed from average straight-time earnings by industry with fixed 1963 industry weights—and potential productivity, to depend primarily upon excess demand in the labor market and price expectations, and also upon the impact of changes in the effective rate of employers social security contributions and changes in the effective tax rate born by employees, and a dummy variable standing for the Wage-Price Guideposts.

Regarding excess demand in the labor market, Gordon experimented with several alternative measures of aggregate unemployment rates, with no clear support from the historical data in favor of any of them. Moreover, as none of them is statistically significant when introduced with other indicators of labor market conditions, they are deleted from the final specification of the equation. On the other hand, Perry's measure of the dispersion of unemployment


among different groups of workers, alongside Gordon's own measures of disguised unemployment and unemployment of hours, performed consistently better than the aggregate unemployment measures. Nevertheless, Gordon's measure of unemployment of hours drops substantially in terms of statistical significance when unemployment dispersion enters into the equation, possibly implying some multicollinearity between both variables. Although the author includes it in the final form of the equation together with unemployment dispersion, it carries a coefficient which is insignificant at the five percent level.

Gordon introduced two different variables representing the effects of price expectations on wages. One—constructed from a distributed lag on past rates of change of the personal consumption deflator with weights determined from interest rate equations—stands for the effect of the growth in the cost of living upon wages. Gordon uses the personal consumption deflator instead of the consumer price index, due to the very close relation between the rate of growth of the personal consumption deflator and that of the non-farm price deflator, which is the dependent variable used in the price equation. It is interesting to notice that Gordon tested several

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alternative price expectations variables, including not only those based on past values of actual price changes fitted against different nominal interest rate series, or directly against wages, but he also compared them with results obtained by using directly in the wage equation values of a set of actual price expectations derived from a survey taken among business economists about expected price changes for the following six and twelve months. However, this series was consistently observed to underestimate actual price changes and gave worse statistical fits than those instrumental variables constructed upon actual past rates of price change. The selected price expectations variable was that derived from a fourth-degree constrained lag structure of past rates of change on the personal consumption deflator, with the coefficient corresponding to the current price change being constrained to zero in order to avoid simultaneous equation bias with the price equation.

The second price expectation variable which Gordon introduces in the wage equation is one constructed from a distributed lag of the difference between the rate of growth of the non-farm private deflator and the personal consumption deflator. It stands, according to the author, for the effects which the increase in prices of products not directly affecting the consumer have on wages. He gives two

\footnote{For a discussion on the problems of construction of a price expectation proxy, see comments following Gordon's article.}
explanations for this effect: first, when prices rise, the firm's demand for labor increases because the value of the marginal product of labor has shifted up, and firms are willing to pay higher wages, and, second, regardless of whether or not firms increase their demand for labor when product prices go up, unions are likely to claim for higher wages because profits have increased. However, it seems that, if the unemployment measures included in the equation are reliable proxies for excess market demand for labor, the first effect has to be already taken into account by the variables assumed to stand for the effect of excess demand for labor upon wages. Therefore, as this price expectations variable appears with a significant coefficient in the wage equation, either this variable stands only for the second effect, or the three unemployment figures included in the equation do not properly fulfill their role as proxies for excess demand for labor.

Regarding the effect of changes in the social security tax rate paid by employers upon wages, Gordon found the employers absorb practically all of the increase in taxes in the current period. On the other hand, after imposing several restrictions upon the lag structure, he found that the best structure is one which implies that they are able to shift the tax back to employees within three subsequent quarters. Thus, the sum of lagged and current coefficients affecting the percentage wage change resulting from a given change
in the employers' social security tax rate adds up to zero. The change in the effective tax rate borne by employees, on the other side, does not appear to have noticeable lagged effects upon wages, but the coefficient affecting current changes is statistically significant, although its size implies that only one-seventh of the increased tax burden is offset by wage increases. Finally, the guidepost dummy failed to show any significance.

Assuming a constant relative share of the labor and non-labor components of national income, Gordon establishes a price equation which implies that, in the long run, the price level is a function of standard unit labor cost. In the short run, deviations from this trend are primarily due, according to the author, to four reasons. They are excess demand, short-run changes in productivity, changes in compensation other than wages, and the lag involved in the adjustment of prices to changes in standard unit labor cost. Following this outline, Gordon makes the rate of growth of the non-farm price deflator dependent upon the current ratio of unfilled orders to capacity, a distributed lag structure of the ratio of actual to potential productivity, the current ratio of total compensation per man-hour to the wage rate, and a distributed lag structure of the ratio between Gordon's measure of wages to potential productivity, that is, the variable which he used as the dependent one in wage equation.
The coefficient attached to each of the four variables turns out to be statistically significant at the one percent level, except that of the sum of the coefficients of the current and lagged ratios of actual to potential productivity. Not only the sum is insignificant in the case of this variable, but each of the coefficients of the lag structure is insignificant at the five percent level as well. At any rate, the lagged coefficients show that about two-thirds of the effect of wage changes and productivity changes on prices take place within the first year. The structure of coefficients suggests that, as a business expansion begins, excess demand carries prices up, although the price increase is moderated by above-average productivity growth. Then, as excess demand disappears, prices continue going up because slowdowns in productivity intensify the effect of wages upon prices.

The model presented by Gordon is derived after a thorough investigation of the different alternative manners in which the theory underlying both equations could be presented. However--besides the already-mentioned lack of clarity regarding the separate effects of the unemployment figures and the difference between the rate of growth of the non-farm price deflator and the personal consumption deflator in the wage equation--there still remains the problem of whether the problem of the price-wage spiral is central to the explanation of the inflationary process, as Gordon's model suggests,
or this phenomenon can be better explained in terms of magnitudes which simultaneously affect both prices and earnings, and which does not fall into the issue of the unemployment-inflation trade-off.

The Price-Wage Spiral and the European Experience. The two models discussed here, although not directly related to the American experience, point out alternative ways through which the Phillips curve may be included in models attempting to explain the rate of change of prices.

Sylos-Labini built a model of price changes which is very similar to the approach taken by others in viewing the inflationary process in any developed country. The model is primarily based upon the Italian experience and consists of three price equations—one for each sector: agriculture, industry and retail trade—and an equation explaining changes in wages for non-agricultural workers. The reason for disaggregating the price change equation is, according to Sylos-Labini, derived from the fact that each of the sectors mentioned above sets prices in a manner different from the other two. The rate of price change in agriculture is assumed to be purely determined by demand conditions. On the other hand, Sylos-Labini postulates, based upon his theoretical developments of the

price-setting mechanism in oligopolistic markets, that the rate of price change in industry and retail trade is a function of the rate of change in unit labor cost, unit material cost and productivity. He also draws a difference between prices set in the industrial sector from those set in retail trade.

The main reason for treating separately industrial from retail trade prices is that, while in the latter sector the mark-up over prime costs is constant, in industry the effect of a rise in wage rates or material prices on product prices is considered to be non-proportional, indicating a variable mark-up. This difference in behavior arises, according to Sylos, because of the more acute degree of competition, especially foreign in the case of Italy, facing industrial oligopolies. The fourth equation tracks the variation in non-agricultural wage rates as a function of the current unemployment rate and the current cost-of-living index, that is, in a rather simple Phillips curve fashion. So, except for the case of agricultural prices, Sylos-Labini allows demand to affect prices only insofar as excess demand can be reflected in the unemployment rate.

Although the price equations of this model are built upon a very sophisticated theory of oligopolistic pricing behavior, the almost complete reliance upon a mark-up process, which Sylos

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himself admits to be variable in the industrial sector due to competition, plus the absence of lagged adjustments, seems to make the whole system of equations devoid of much explanatory power.

Within a similar framework, Klein and Ball set a system of equations for the determination of prices and wages in the United Kingdom. This system consists of four equations and the parameters were estimated by the limited information-maximum likelihood method. The first equation explains the four-quarter change in money wage rates as a function of excess demand—as measured by the average quarterly rate of unemployment through the last four quarters—the average change in prices during the last four four-quarter price changes, and a dummy variable introduced to denote a political factor. The second equation relates the difference between a quarterly index of weekly earnings and the wage rate level in the same quarter as a function of the number of hours worked during the week (quarterly index of hours worked weekly) and of productivity. Klein and Ball emphasize the importance of the number of hours worked during the week as a proxy for short-run

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22 This variable stands for the possible effect of wages of the Conservative Government after 1952.
changes in demand. The third equation makes the number of hours worked quarterly index a function of the unemployment rate during the same quarter, and the level of economic activity (measured through a quarterly index of industrial production). Finally, the fourth and last equation specifies—through a full-cost pricing approach—that the level of prices is explained by the current index of weekly earnings, the two-quarter lagged index of import prices and an index of indirect taxes.

Other than the statistical problems arising from the actual estimation of the parameters of the system of equations, the model seems to present some conceptual obscurities. It appears that some variables, such as the quarterly index of total hours worked per week and the unemployment rate stand for the same effect, namely, excess demand, and no one of them can properly determine the other. What is more important is that the most significant variable explaining money wage rate changes is unemployment, and the primary determinant of prices appears to be the quarterly index of weekly earnings, which, according to what the authors themselves specify, reflect primarily the extent of excess demand in the market.

If demand pressure is thought to be of primary importance in affecting the rate of change of both prices and wages, it seems worthwhile to attempt to determine more explicitly what brings about this demand pressure. Most of the models reviewed in this section
point to the importance of variables such as changes in productivity and real economic activity in leading the way to changes in the price level. It is important to investigate to what extent these variables, in combination with changes in policy variables, may explain inflationary processes without having to rely upon a wage-price spiral.

**Inflation and Monetary Aggregates**

The two models discussed in this section include changes in monetary and fiscal aggregates as determinants of the rate of price change. The second of these quantitative works is an explicit attempt to offer an alternative explanation of inflation from that based upon a cost-price relation.

**The Relative Importance of Demand-Pull and Cost-Push Forces in Inflation**

The model discussed here is a very simple attempt to measure the extent to which changes in policy variables determine inflation compared to changes in cost conditions.\(^{23}\) Hunt and Rose postulated an equation of the following type:\(^{24}\)

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\(^{24}\)A similar type of equation, this referring to the Chilean inflation, may be found in Robert S. Kool, "A Test for Demand-Pull or Wage-Push Inflation," *Social and Economic Studies*, Vol. 17 (June, 1968), pp. 147-57.
\[ dp_t = f(dC, dM, dG, dE)_{t-i} \quad (i = 1, \ldots, n) \]

where \( dp, dC, dM \) and \( dG \) stand, respectively, for quarterly percentage changes at annual rates in the price level, per-unit labor cost in manufacturing, the monetary base and high-employment Federal expenditures, and \( dE \) represents the state of expectations about future prices, constructed from a four-quarter weighted average of past rates of price changes, with weights apparently arising from equations fitting the dependent variable against different lag structures of itself. The model was tested against data for the U. S. economy during 1952-68.

Different regressions were run, giving alternatively different values to "\( i, \)" and considering as the dependent variable first the Consumer Price Index and then the Implicit GNP Deflator. With the first specification of the dependent variable, \( dC \) and \( dG \) were the only variables which, for lags up to two quarters, were statistically significant at the five percent level, but the cost variable becomes insignificant for lags longer than three quarters. The fiscal variable, on the other hand, generally remains significant at the five percent level up to the eight-quarter lag. The price expectations variable becomes significant at the one percent level for lags of six, seven and eight quarters.

Considering the Implicit GNP Deflator as the dependent variable, results are still worse. Running different regressions with
the explanatory variables lagged from zero to eight quarters, as in the previous case, the only variables which are significant at the five percent level are again the fiscal and cost variables, and only for lags of up to two quarters. For longer lags no variable is significant even at the ten percent level, except in the equation with a three-quarter lag, where the price expectations proxy is barely significant at the ten percent level.

What is most surprising of all, however, is that the monetary variable is insignificant throughout the different equations under both specifications of the dependent variable—except in one case in which it is only significant at the ten percent level—and its coefficients take negative signs for lags longer than two quarters in the GNP Deflator specification. It has to be said that not only the coefficients of multiple determination are very low—only in four out of eighteen cases it is higher than 0.2—but the standard errors are unduly large also, which results in very low "F" ratios in most of the cases. Apart from the fact that the authors do not specify a given structure of lagged effects, but only regress current values of the dependent variable against values of the independent variables which are lagged differently in each equation, they seem to have overlooked some major conceptual problems related to their equation.
In deriving their equation, Rose and Hunt simply assume that changes in prices depend upon changes in costs, changes in demand and price expectations, but without indication of how these elements work their influence over prices. They further assume that, as changes in demand are affected by changes in monetary and fiscal policy, and by other elements which they consider linearly related to monetary and fiscal policy, changes in demand can be replaced by changes in monetary and fiscal policy, thus justifying the specification used in the empirical analysis. However, not only do the authors ignore the effects which changes in monetary and fiscal policy have upon cost conditions, but they also seem to have violated the justification which Andersen and Jordan—to whom Rose and Hunt referred in relating nominal demand to monetary and fiscal policy—postulated for making changes in nominal spending dependent upon changes in monetary and fiscal policy. Not only did Andersen and Jordan make current changes in nominal spending dependent upon current and lagged changes in monetary and fiscal aggregates, but they also never seemed to imply that all other elements which affect changes in nominal demand were linearly dependent upon monetary and fiscal policy.

The reason Rose and Hunt offer for assuming no relation among the independent variables of their equation—namely, that the simple correlation coefficients between them were not larger than 0.2—could, as well, be used against them in saying that their equations showed no relation at all between the dependent and the explanatory variables. Actually, it seems rather difficult to accept that, if prices are affected by monetary and fiscal policy, labor costs would not be similarly dependent upon them. Additionally, the construction of the price expectations variable seems to be devoid of an explanation of why and how such expectations are being formed; it is very difficult to attach any significance to weights which result from regressing a given variable against its own lagged values.

Summarily, the model built by Rose and Hunt seems to suffer from multiple conceptual obscurities, and the statistical results clearly reflect these weaknesses.

The Monetarist View of Inflation

Unlike the previous model, the present one does not attempt to test the relative importance of cost and demand forces in bringing about price changes, but postulates a simple structure where inflation is a function of the extent of pressure exerted by market demand on real output. It makes no explicit reference to the cost-price
relation, although the possible influence which cost conditions have upon real output is implicitly considered through the potential change in output.

The model, developed by Andersen and Carlson, consists of a simple set of aggregate relationships. According to it, changes in monetary aggregates are the primary vehicle for changes in nominal spending. In turn, the difference between changes in nominal demand and the potential change in physical output, which provides a measure of demand pressure, is assumed to be--together with the state of expectations about future prices--the force determining the current change in the aggregate price level. The current change in real output is determined through the difference between the change in nominal spending and the part of it which has been due to change in prices. The current rate of unemployment is

\[ (P_t - P_{t-1}) \cdot X_{t-1} \]

that is, this quarter's change in the Implicit GNP Deflator multiplied by last quarter's level of output.

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26 Leonall C. Andersen and Keith M. Carlson, op. cit.

27 Although formally fiscal activity is allowed to affect spending, the actual estimates show no significant fiscal effects on spending.

28 The dependent variable of the price equation is not the rate of price change, but the part of the change in nominal GNP which has been due to price changes, defined as:
assumed to be a function of the GNP gap. Finally, interest
rates--which are not allowed to enter in the mechanism running
from changes in the money stock to price and output--are determined
by current changes in the real money supply, current and lagged
changes in real income and price expectations.

As it can be observed, the Andersen-Carlson model runs in
terms of a monetarist approach. That is, the short-run effects of
changes in the money stock are directly reflected in price and real
output changes, and changes in the level of interest rates do not
play any direct role in the determination of aggregate spending.
The purpose of including an interest rate equation is to establish the
lag structure of past price changes with which to construct a proxy
for expected price changes.

As the Andersen-Carlson model bears some similarities
with the model to be developed in the next chapter, its statistical
results are presented in Statistical Appendix A. The model develop-
ed in this paper attempts to overcome certain shortcomings of the
Andersen-Carlson one. First, it appears that Andersen and Carlson
have not allowed, in the nominal spending equation, for the effect
which changes in velocity exert upon changes in aggregate demand.

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29 This equation is based on a relation suggested by Okun.
Their model assumes that changes in the real demand for money are reflected in the coefficients of money stock changes, but this overlooks the effect which changes in other variables may have upon velocity of circulation of money. This, obviously, hinges upon the difference existent between the monetarist and neo-Keynesian approaches to economic stabilization. The next chapter discusses further the relation between money, interest and income, in the light of recent empirical investigations.

Second, the hypothesis that expectations of future price changes affect the actual current rate of inflation independently from the influence which changes in nominal spending exert upon the same variable seems obscure. The generally accepted argument is that, if individuals expect prices to rise further in the future, such expectations will be reflected through a higher demand for commodities and services and a lower real demand for money and bonds. To include both variables in the price equation would suggest that the price expectations effect is considered twice. It seems that, as the authors did not include price expectations in their estimation of nominal spending changes, it might have been correct to include the price expectations variable in the price equation along with demand pressure. But, as this instrumental variable was constructed using actual changes in nominal demand, the effect of price expectations is, at least conceptually, included.
Finally, the fact that Andersen and Carlson utilize actual changes in nominal spending in constructing the demand pressure variable--instead of inserting the values of nominal spending changes estimated through the nominal spending equation--nullifies, to a large extent, the significance attached to the estimates of the parameters of the price equation. Since a large amount of the total variation of changes in nominal spending, namely, one-third, remains unexplained in the model, there can be no direct relation between the coefficients attached to demand pressure in the price equation and those affecting monetary and fiscal variables in the nominal spending equation.

Thus, although Andersen and Carlson built a model which offers an alternative explanation of inflation from that based upon a wage-price-unemployment trade-off, their equation of price changes seems to be largely lacking in a clear exposition of the mechanism of price changes. To say that prices change because of demand pressure is not denied by anybody, but it does not seem to say much either. The following chapter will present an attempt to give the nominal spending and price equations more substance than that implied in the Andersen-Carlson model.
CHAPTER III

AN INTERPRETATION OF THE
INFLATIONARY PROCESS

Introduction

The model to be developed in this chapter is based upon the assumption that changes in the price level come about primarily through demand pressure. It is the interrelation between demand and supply which brings about movements in prices. Demand-pull theorists focus on the importance of rising aggregate demand, but it is not merely the demand factors that matter; the reaction of real output to changes in demand are also important in the dynamics of inflation. The process of price changes depends upon the relation existent between demand changes and the capacity of the economy to produce. This seems to be rather elementary, but very often authors have paid almost exclusive attention to only one element in the relation. It has been observed that, during the initial moments of almost all inflationary processes, aggregate demand grows faster than production. However, as there is some amount of
unemployed resources to start with such an acceleration in the rate of growth of aggregate demand by itself produces a stimulating effect upon the rate of growth of real output, thus reducing the pressure which the growing level of demand exerts upon the price level.

But, as the process continues, the level of output begins to approach full-employment, making it more difficult for real production to keep the pace set by demand. Additional increases in demand would primarily affect prices at this stage because real output cannot continue to expand as readily as before. Furthermore, it is here postulated that the introduction of restrictive monetary and fiscal policy measures exerts their most immediate effects upon real production, because of the lag with which velocity of circulation of money, and, thus, aggregate spending, reacts to any change in the direction of policy variables. Along similar lines, Thompson has argued that the most immediate effects of restrictive monetary and fiscal policy measures in a period of inflation are to shift inwards, at least in the short run, the economy's production possibilities frontier, rather than primarily affect aggregate demand.¹

To the extent to which this is a correct approximation of the real economic world, such movements in production and demand increase

the pressure upon the price level, instead of ameliorating it. Only after the effects of a lower velocity of circulation and a continuing restrictive monetary and fiscal policy are absorbed by demand, the pressure upon the price level is lessened. Although changes in the money stock are an important determinant of velocity of circulation, it seems that the monetarist interpretation of demand-pull inflation often underestimates the role which other variables play in the determination of short-run changes in velocity of circulation.

Without attempting to discuss the subject of the long-run stability of the velocity of circulation of the money stock, it seems rather inaccurate to assume, as, for instance, Andersen and Carlson do, that short-run changes in this variable are only a function of changes in the money stock. Latane has correctly suggested that a spending function such as the "St. Louis equation"—used by Andersen and Carlson—does not take into account the effects which movements in interest rates have upon velocity, independently from those originating in changes in monetary aggregates.²

The timing of the dynamics of demand pressure greatly rests upon changes in variables other than the money stock and which are known to affect the real demand for money. Variables such as real activity—which is here used primarily as a proxy for

real wealth--interest rates, and the expected rate of future price changes, which, even under the simplest assumptions, are considered to affect the real demand for money, are likely to be important elements in determining the pace of nominal spending changes.

**The Role of Interest Rate on Spending**

Much of the debate between monetarists and neo-Keynesians centers upon the question of which variable, money or interest rate, affects aggregate spending, and, if both, what are their impact multipliers on nominal income. The monetarist position generally states that interest rates do not exert any noticeable influence upon the desire of individuals to change their spending patterns and, as such, cannot be relied upon as indicators of changes in the demand for real cash balances. The neo-Keynesians, on the other hand, stress the relevance of interest rates, based upon a liquidity-preference approach.

Gibson distinguished three types of effects over interest rates, namely, the "liquidity effect," the "income effect," and the "price effect."\(^3\) The "liquidity effect" refers to movements of the interest rate variable along a given liquidity-preference schedule in

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reaction to changes in the money stock. This is the effect whose importance is stressed by those who advocate the relevance of interest rates as a determinant of spending. This effect can be thought of also as the "impact effect" of a change in the money stock on interest rates. The "income effect" is brought about by movements in interest rates due to shifts in the liquidity-preference schedule caused by changes in nominal income. This effect is referred to by the monetarists as the "feedback effect" on interest rates of the previously mentioned change in the money supply. The third effect, also referred to as the "Fisher effect," points to movements in the nominal interest rate which are caused by changes in expectations about future price movements. That is, by defining the nominal interest rate as:

\[ r_t^n = r_t^r + \left( \frac{dp}{p dt} \right)^* \]

--where \( r_t^n \) represents the nominal rate, \( r_t^r \) is the real rate and \( (\frac{dp}{p dt})^* \) stands for the expected rate of price change--the difference between the nominal and the real market rate is known as the "Fisher effect" or, in Gibson's terms, the "price effect." While the "liquidity effect" is assumed to be negative--in the sense that an increase in the money stock lowers the interest rate and vice versa--the "income" and "price" effects are positive. This framework seems to be useful in discussing the basic differences between
the monetarist and neo-Keynesian positions regarding the effect of interest rates upon spending. The point which hinges upon the center of their discussion is the relative importance and timing of the three above-mentioned effects in determining interest rates.

Monetarists vs. Neo-Keynesians Debate

The monetarists maintain that, although there may be an initial "liquidity effect" upon interest rates when the money stock changes, this effect is likely to disappear rapidly. This is due to the effect which the change in nominal income, directly brought about by the above change in the money supply, has on interest rates. Moreover, if continuous changes in the money supply are assumed, expectations of future price changes begin to develop, forcing the nominal interest rate in a direction contrary from that assumed by the "liquidity effect." This argument forms the analytical basis of the monetarist position in its criticism of economic policies which rest upon movements in nominal interest rates as leading indicators of movements in the real demand for money. According to the monetarists, high or rising nominal interest rates do not necessarily indicate a "tight money" situation in the market. The post-1965 experience in the U. S. economy is presented by these
economists as a clear case of how "Keynesian" monetary policies may be biased toward inflation. 4

However, although acknowledging the effect which nominal income exerts upon the real demand for money schedule, neo-Keynesians point to the fact that in order for the monetarist position to be correct, nominal income has to change proportionally to the change in the money stock. Tobin, for instance, maintains that, except in the case of a perfectly inelastic demand for cash balances with respect to the rate of interest, part of a money stock increase will be directed into idle balances, lowering the interest rate. Although, assuming that investment or consumption is favorably affected by the lower interest rate, nominal income is likely to increase, this increase of nominal income cannot be proportional to the change in the money stock as long as part of the added money supply is channeled into idle balances. 5 Thus, the neo-Keynesians assert, velocity of circulation is not constant.


Empirical Investigations

Some empirical studies have shown that the demand for cash balances is responsive to interest rates, while others found no significant relation. Peltzman concluded from his statistical analysis that changes in velocity of circulation cannot be significantly attributed to changes in interest rates. His statistical results suggest that the rise in velocity during the post-war period in the U. S. may be primarily explained by other factors which, he maintains, may well be the growing recognition by money holders that the economic environment has become more stable. Jaffee, on the other hand, has cast some doubts on the statistical validity of Peltzman's findings because they introduce a downward bias upon the coefficient of the interest rate variable. Moreover, apart from statistical

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7 This idea was developed by Milton Friedman and Anna J. Schwartz, *A Monetary History of the United States: 1867-1960* (New Jersey: Princeton, 1963), Chapter 12.

considerations, Jaffee asserts that the statistical significance of the coefficient of the trend variable in Peltzman's equation when the narrow definition of money is used, can be derived from the post-war increase of time deposits at the expense of demand deposits brought about primarily because of increased interest paid on the former, which would suggest, according to him, that these indirect effects have to be also taken into account in order to calculate the interest elasticity of the demand for money function.

It seems that, in considering short-run fluctuations of aggregate economic magnitudes, the timing with which each of the above-mentioned effects of a change in the money stock works upon interest rates is extremely crucial. If the "liquidity effect" influences interest rates before the "income effect" and the "price effect," this might imply that there is room for money changes to affect aggregate demand through interest rates in the short run. Statistical attempts to measure the time span which elapses between the initial change in the money stock and the appearance of the income effect upon interest rates found that at least six months seem to be necessary before a lagged change in the money supply appears to have positive effects over interest rates.  

the effect of changes in interest rates on spending need not be confined to that upon investment expenditures, but it can be expanded to consumer expenditures, involving rather short lags, there is no absolute guarantee that interest rates do not exert any noticeable influence on demand in the short run.

**Nominal and Real Interest Rates**

The conventional wisdom proposes, at least in periods of rising prices, that nominal interest rates cannot be relied upon as indicators of monetary policy actions because the "Fisher effect" makes them the result and not the leading force of movements in aggregate demand. As previously mentioned, this point has been stressed by the monetarists in discussing the post-1965 inflationary experience of the U. S. economy. The expectation of future price increases becomes in these circumstances a primary reason for higher nominal interest rates. This being so, exponents of the monetarist position maintain, higher or rising nominal interest rates offer, during inflation, a distorted view of changes in the demand for commodities and services.

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Feldstein has shown that, assuming the "Fisher effect" is a component of nominal interest rate, the use of such a rate will result in statistically biased estimates of the parameters of the equation where the nominal interest rate is an independent variable.¹¹ He attributes to this bias the fact that very often attempts to find statistical relations between the interest rate and other variables have failed. Not only the estimate of the interest rate coefficient becomes insignificant but, as Feldstein shows, it is possible that the bias introduced by using the nominal rate instead of the real market rate makes the estimate appear contrary to a priori considerations. Such a finding would seem to support the monetarist position in the sense that nominal interest rates are not reliable indicators of movements in the demand for money during periods of rising prices. However, this statistical consideration does not answer the question of whether interest rates--not merely nominal, but real rates--are leading forces of economic conditions or not.

It has been pointed out that the difference between monetarists and neo-Keynesians is not limited to the "Fisher effect"--which affects only the nominal market rate, but not the real market rate--but it also involves the "liquidity" and "income" effects, which affect both the nominal and the real market rate.

The monetarist position maintains that the "income effect" operates in such a manner that the "liquidity effect" of a change in the money stock is substantially offset within a very short period of time, thus keeping the interest rate from exerting any influence upon the demand for money, and, thus, aggregate spending. However, this conceptual apparatus not only implies that the change in nominal income is proportional to the change in the money stock—that is, a constant velocity of circulation—but that the effect of money changes upon nominal income is exerted in a direct manner and is simultaneous to that exerted by the same money change upon interest rates. The liquidity-preference approach does not deny the presence of the "income effect," but it stresses the fact that it can neither be assumed that the change in nominal income is proportional to the change in the money stock nor that there is no lag between the "liquidity" and the "income" effects. This is specially relevant in discussing short-run changes in aggregate demand.

Even if interest rates would finally settle at the level previous to the initial change in the supply of money, it is very likely that the adjustment is not smooth. On the other hand, it may involve temporary overreactions from the side of spending to a given change in the interest rate. Also, regarding the "Fisher effect," up to the point in which future price changes are not fully anticipated, real equilibrium interest rates decrease when prices increase, leading
to an expansion in the level of real output, and vice versa when
prices fall.\textsuperscript{12} This is another possible source of short-run disturbances in spending being brought about by changes in the interest rate. The fact that the above-mentioned effects may actually have been at work during the 1950's and 1960's in the U. S. economy does not seem in any way contradictory with the apparent constancy of real interest rates during the post-war years. Short-run deviations from a constant real interest rate may be associated with short-run movements in aggregate demand. Finally, within a growing environment, the natural or equilibrium real interest rate does itself experience variations which reflect changes in technology and other factors related to the productivity of capital, as well as changes in the population's saving patterns.

**The Model**

The model which will be tested against quarterly data for the U. S. economy during the 1950's and 1960's is formally presented in Table I. An important assumption of the model is that current values or variables affecting the nominal demand for commodities and services are not, in turn, affected by changes in the demand equation occurring in the current period. Although this assumption

# TABLE I

**Formal Specification of the Model**

<table>
<thead>
<tr>
<th>Nominal Interest Rate Equation</th>
</tr>
</thead>
</table>
| \[
  r^n_t = f \left[ x_t' (\frac{1}{x} \frac{dx}{dt})_t \ldots \left(\frac{1}{x} \frac{dx}{dt}\right)_{t-i} \left(\frac{1}{(M/p)} \frac{d(M/p)}{dt}\right)_t \right] \left(\frac{1}{p} \frac{dp}{dt}\right) \right] \tag{3.1}
| |

<table>
<thead>
<tr>
<th>Real Interest Rate Definition</th>
</tr>
</thead>
</table>
| \[
  r^r_t = r^n_t - \int_1^n w_i \left(\frac{1}{p} \frac{dp}{dt}/(u/4)\right)_{t-i} \tag{3.2}
| |

<table>
<thead>
<tr>
<th>Expected Price Change Definition</th>
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</thead>
</table>
| \[
  \left(\frac{1}{p} \frac{dp}{dt}\right)^*_t = \int_1^n w_i \left(\frac{1}{p} \frac{dp}{dt}/(u/4)\right)_{t-i} \tag{3.3}
| |

<table>
<thead>
<tr>
<th>Nominal Spending Equation</th>
</tr>
</thead>
</table>
| \[
  \left(\frac{dy}{dt}\right)_t = f \left[ (\frac{dw}{dt})_t, (\frac{dx^r}{dt})^*_t, (\frac{1}{p} \frac{dp}{dt})^*_t, (\frac{dM}{dt})_t \ldots (\frac{dM}{dt})_{t-i}, \right] \left(\frac{dHE}{dt}\right)_t \ldots \left(\frac{dHE}{dt}\right)_{t-i}, \left(\frac{dHR}{dt}\right)_t \ldots \left(\frac{dHR}{dt}\right)_{t-i} \right] \tag{3.4}
| |

<table>
<thead>
<tr>
<th>Demand Pressure Definition</th>
</tr>
</thead>
</table>
| \[
  D_t = \left[ \frac{dy}{dt}\right]_t - (x^f_t - x_{t-1}) \tag{3.5}
| |

<table>
<thead>
<tr>
<th>Price Equation</th>
</tr>
</thead>
</table>
| \[
  \left(\frac{1}{p} \frac{dp}{dt}\right) = f (D_t, \ldots, D_{t-i}) \tag{3.6}
| |
Definition of Symbols:

\( r^n \) = Nominal Interest Rate

\( r^r \) = Real Interest Rate

\( x \) = Real Output

\( \frac{1}{x} \frac{d}{dt} x \) = Rate of Change of Real Output

\( \frac{1}{(M/p)} \frac{d}{dt} (M/p) \) = Rate of change of Real Money Stock

\( \frac{1}{p} \frac{d}{dt} p \) = Expected Rate of Price Change

\( \frac{1}{p} \frac{d}{dt} p \) = Actual Rate of Price Change

\( (u/4) \) = Index of Unemployment as a Percent of Labor Force (base = 40)

\( \frac{dy}{dt} \) = Change in nominal spending

\( \frac{dw}{dt} \) = Change in real wealth

\( \frac{dr}{dt} \) = Change in real interest rate

\( \frac{dM}{dt} \) = Change in Money Stock

\( \frac{dHR}{dt} \) = Change in High Employment Federal Spending

\( \frac{dHR}{dt} \) = Change in High Employment Federal Revenue

\( D \) = Demand Pressure

\( f \) = Potential Real Output
may somewhat distort the simultaneous character of the real economic world, it appears reasonable to expect that changes in real variables affect nominal magnitudes immediately, while it takes more time for real forces to adjust to changes in monetary magnitudes. This assumption allows the model to take a recursive form. As the unit of time chosen in the empirical testing of the model is one quarter, it appears that the above reasoning is not fundamentally violated. Naturally, although the formal model is presented in terms of continuous functions, the impossibility of observing infinitesimal adjustments in the variables of the model dictates the consideration of first differences whenever the model indicates a differential form and rates of change whenever a relative differential form is assumed.

The model is tested against quarterly data for the U. S. economy from 1952/III quarter through 1970/IV quarter. The period chosen begins in the third quarter of 1952 because of the Federal Reserve System policy to control nominal interest rates before 1952. It is assumed here that by the third quarter of 1952 the effects of such a policy had largely disappeared. It may be observed that this model is very similar to the Andersen-Carlson one.\(^\text{13}\) The rate of change in prices is a function of demand

\(^{13}\)Leonall C. Andersen and Keith M. Carlson, \textit{op. cit.}
pressure, where this variable is defined as the difference between the change in nominal spending and the potential change in output. However, this model attempts to take explicit account of the effect which variables other than the money stock have upon the real demand for money in the short run. Taking into account what has been pointed out above regarding interest rates, nominal spending is assumed to depend upon the real market interest rate instead of the nominal rate, besides current and lagged changes in monetary and fiscal aggregates, the current change in real activity—which is assumed to stand for real wealth effects upon nominal spending, and is approximated by changes in the Industrial Production Index—and price expectations. The price expectations variable is also considered to affect nominal demand, but as a force independent of the interest rate effect. Actually, if the nominal interest rate were used in the spending equation to represent the interest rate effect, there will not only be multicollinearity between the variables, but, also, from a conceptual point of view, the price expectations effect will be considered twice. Another difference between the models stems from the fact that, contrary to the Andersen-Carlson specification, the price expectations instrument variable is assumed to affect the current rate of price change through nominal spending and not as a force independent of demand pressure. Finally, although both models are formally recursive, an attempt is being made here
to preserve the recursive character of the model through an alternative method of estimation of the parameters of the price equation.

**Interest Rate Equation**

The first equation of the model states that the nominal interest rate is a function of several variables, i.e.,

\[ r^n_t = f\left[ x_t, \left( \frac{1}{x} \frac{dx}{dt} \right)_t \ldots \left( \frac{1}{x} \frac{dx}{dt} \right)_{t-i}, \left( \frac{1}{(M/p)} \frac{d(M/p)}{dt} \right)_t, \left( \frac{1}{p} \frac{dp}{dt} \right)^* \right] \quad (3.1) \]

where \( r^n_t \) is the nominal rate, \( x_t \) is real output, \( \left( \frac{1}{(M/p)} \frac{d(M/p)}{dt} \right)_t \) is the rate of growth of the real money stock, and \( \left( \frac{1}{x} \frac{dx}{dt} \right)_t \) and \( \left( \frac{1}{p} \frac{dp}{dt} \right)^* \) are, respectively, the rate of growth of real output and price expectations. The above specification of the nominal interest rate equation is based upon the conceptual framework developed by Sargent.\(^{14}\)

Through the following identity:

\[ r^n_t = r^e_t + (r^n_t - r^e_t) + (r_t - r^e_t) \quad (3.1.a) \]

--where \( r^e_t \) is the real equilibrium interest rate, \( r^n_t \) is the real market rate and \( r^n_t \) is, as in the previous equation, the nominal rate--it is possible to obtain estimates of the real equilibrium and market rates if the determinants of each of the right-hand side terms are correctly specified.

The basic assumption needed to relate (3.1) and (3.1.a) is that both real saving and investment depend upon real income and

the interest rate, and—according to the "acceleration" theory of investment—real investment depends upon the rate of change of real income. By definition, the rate of interest at which real saving and investment are equal is the real equilibrium rate. Then, by simultaneously solving for the real saving and investment schedules, the rate consistent with equilibrium would then be a function of real income and the rate of growth of real income. This determines the first term of the right-hand side of Sargent's identity.

The second term of the identity, that is, the divergence between the real market and the equilibrium rates, is brought about by changes in the real money stock. If part of real investment is financed through sources other than intended real saving, the real market rate will temporarily fall below the equilibrium rate. On the other hand, when a part of intended real saving is not channeled into investments, the real market rate will rise above the equilibrium rate. The effect of changes in the real money stock on interest rates is referred to as the "Wicksell effect." Finally, assuming away "money illusion" and assuming the same expectations about future price changes by savers and investors, the saving and investment schedules shift up by the expected rate of price increase. This explains the term $(r^n_t - r^n_t)$ on the right-hand side of Sargent's identity.
Although the equilibrium and the real market rates of interest are not observable, their values can be estimated from equation (3.1), which expresses the same magnitude as Sargent's identity, that is, the nominal interest rate, but not in terms of the determinants of each of the right-hand side terms of (3.1.a). Actually, the above conceptual framework can be readily assimilated to Gibson's approach. The "Wicksell effect" represents the "liquidity effect" or "impact effect" on interest rates of a change in the money stock, and the real income variables stand for the "income" or "feedback" effect on interest rates of movements in income associated with changes in the money supply. The only important difference between both approaches seems to be that, while in Gibson's apparatus money illusion is assumed except in the case of continuous changes in the money stock, Sargent's model assumes no money illusion. The consequence is that the current rate of inflation may affect the real interest rate in Gibson's model, but not in Sargent's.

Equation (3.1), then, makes the nominal interest rate a function of real income, the current rate of growth of real money, current and lagged change in real income, and price expectations. This last variable is unobservable and, thus, is approximated by a function of past price changes. The rate of growth of the real money stock is assumed to be negatively correlated to the level of interest rates. On the other hand, no sign can be attached a priori
to the level of real income, because it depends upon the relative shifts of the saving and investment schedules to changes in income.\textsuperscript{15} Under the present theoretical framework, the rate of change of real income is expected to affect the level of interest rates in a positive manner because it influences positively real investments while not affecting real savings. As noted above, the variable \(\left(\frac{1}{p} \frac{dp}{dt}\right)^*\), standing for the expected rate of price changes, is approximated by assuming that individuals extrapolate into the future past rates of price change. In order to avoid simultaneous equation-bias, the current rate of price changes is assumed to be ignored by individuals in forming expectations. For reasons explained below, expectations of future price changes are not assumed to be based merely upon past rates of price changes, but upon such rates adjusted by a measure of resource utilization.

Once the pattern of past price changes affecting the nominal interest rate is estimated from equation (3.1), an instrument variable standing for the real market interest rate is constructed, as stated in the following equation:

\textsuperscript{15}Sargent attached a negative "a priori" sign to the level of real income because, in his conceptual model, only real savings is dependent upon real income. Thus, changes in the level of real output cause only shifts in the real saving schedule.
This instrument variable is assumed to be the relevant interest rate variable affecting nominal spending. Assuming the proxy for price expectations approximates satisfactorily the true magnitude of the "Fisher effect," changes in the real market interest rate constructed through (3.2) reflect the "liquidity effect" on interest rates. Thus, its significance in determining changes in nominal demand may throw some light upon the monetarist-neo-Keynesian controversy regarding the role of interest rates as indicators of changes in the real demand for money.

Price Expectations

The third equation of the model defines the short-run expected rate of change of prices in the following manner:

$$\frac{1}{p} \frac{dp}{dt}^* = \int_{1}^{n} w_i \left( \frac{1}{p} \frac{dp}{dt} \right)_{t-i} dt$$  \hspace{1cm} (3.3)

where, as before, \(\left( \frac{1}{p} \frac{dp}{dt} \right)^*\) stands for expected price changes, \(\left( \frac{1}{p} \frac{dp}{dt} \right)_{t-i}\) represents the rate of price change in quarter \((t-i)\), \((u)_{t-i}\) is the present rate of unemployment in quarter \((t-i)\), and \(w_i\) is the weighted importance given by individuals to the relevant variable in quarter \((t-i)\).

It has become a standard procedure in economic literature to assume that individuals expect price movements in the near future.
to be functionally related to past price changes. Although this framework of analysis may somehow limit the different possible forms under which true expectations are being borne out by individuals, it is a practical procedure and provides a conceptually sound explanation for the quantification of a purely psychological phenomenon. Generally, past price changes are assumed to affect expectations in a positive manner; that is, individuals expect prices to rise more rapidly in the near future if prices in the near past have risen more rapidly, and vice versa. However, it is not conceptually incorrect to expect that, particularly in the case of price expectations involving interest rates on principals with short-term to maturity, prices in the more distant past may affect expectations in a negative manner. This "regressive effect" of some past price changes over expectations—opposite from the positive "extrapolative effect"—can be explained by assuming that, in periods of fluctuating prices but with no definite tendency to go up or down, individuals incorporate such cyclical behavior into their

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16 Robert G. Gordon, op. cit., 1971, experimented with a series on a published survey on actual price expectations held by economists and businessmen for the following six months, but, as said in Chapter II, dismissed it on conceptual, as well as statistical, grounds.

17 Thomas J. Sargent, op. cit., p. 138, found this effect in his short-term nominal interest rate equation.
expectations. Nevertheless, especially in periods of inflation, individuals are in almost all cases assumed to extrapolate into the future their past price experience.

In order to reduce the limitations imposed on the structure of expectations by attaching fixed coefficients to past rates of price change, it is here assumed that the relevant variable is the past rate of price change adjusted by a measure of resource utilization in the corresponding past period. It seems appropriate to consider, as by Andersen and Carlson, that individuals will form their expectations taking into account not only past rates of price change, but these rates in relation to some measure of the level of economic activity at the time such rates of price change took place. For a given past rate of price change, the equation implies that individuals will attach a higher importance to it if the level of resource utilization during the same period was high or rising than if it was low or falling.

The measure of resource utilization is represented in the equation by the quotient \( (u/4)_{t-i} \), where, as pointed out above, \( u_{t-i} \) is the actual percentage rate of labor unemployment during the period corresponding to the past price change, and the number 4 stands for what is here assumed to be the percentage rate of labor unemployment which is consistent with long-run full-employment equilibrium. The reason for considering "\( (u/4) \)" instead of "\( u \)" as
the correct measure of resource utilization is that, within the spirit of the "accelerationist" hypothesis of inflation, it is the relation between the actual and the long-run natural unemployment rate which in the short-run brings about a trade-off between inflation and unemployment, and not the actual unemployment rate. The above quotient indicates the amount by which individuals discount current inflation in forming their expectations about future price changes.

The weights assigned to the adjusted past rates of price change are those obtained from the nominal interest rate equation. The assumption underlying this procedure is that there is no substantial difference between the formation of price expectations in the financial and capital markets and those affecting the goods market. This does not seem to involve an exceedingly unrealistic assumption, although in the real world there is likely to be a substantial difference in the time required for expectations to appear in each of these markets. The present procedure provides a conceptual basis for the explanation of expectations which is independent from the nominal demand equation.

Changes in Nominal Demand

The fourth equation of the model presents the nominal spending equation in the following form:
\[
\left( \frac{dy}{dt} \right)_t = f \left[ \left( \frac{dw}{dt} \right)_t, \left( \frac{dr^r}{dt} \right)_t, \left( \frac{1}{dp} \right)^*, \left( \frac{dM}{dt} \right)_t \ldots \left( \frac{dM}{dt} \right)_{t-i}, \left( \frac{dHE}{dt} \right)_t \ldots \left( \frac{dHE}{dt} \right)_{t-i}, \left( \frac{dHR}{dt} \right)_t \ldots \left( \frac{dHR}{dt} \right)_{t-i} \right]
\]

where \( \left( \frac{dy}{dt} \right) \) represents the change in nominal spending, \( \left( \frac{dw}{dt} \right) \) and \( \left( \frac{dr^r}{dt} \right) \) stand for changes in real activity and real market interest rates, \( \left( \frac{dM}{dt} \right), \left( \frac{dHE}{dt} \right) \) and \( \left( \frac{dHR}{dt} \right) \) are, respectively, changes in monetary aggregates, high-employment Federal government expenditures and high-employment receipts, and, finally, \( \left( \frac{1}{dp} \right)^* \) represents the proxy for expectations of future price changes. As said before, through this specification of the nominal spending equation, it is possible to determine the influence which variables other than the money supply and government fiscal activity exert upon aggregate demand.

It is interesting to observe that Andersen and Carlson maintain that their spending equation takes into account changes in velocity of circulation of money. Their equation, referred to as the "St. Louis equation," has the following form:

\[
\left( \frac{dy}{dt} \right)_t = f \left[ \left( \frac{dM}{dt} \right)_t \ldots \left( \frac{dM}{dt} \right)_{t-i}, \left( \frac{dHE}{dt} \right)_t \ldots \left( \frac{dHE}{dt} \right)_{t-i} \right]
\]

\[\text{(3.4.a)}\]

\[\text{18} \text{ Leonall C. Andersen and Keith M. Carlson, op. cit., p. 12.}\]

\[\text{19} \text{ This equation was originally developed in Leonall C. Andersen and Jerry L. Jordan, op. cit.}\]
According to Andersen and Carlson, the coefficients of changes in the money stock include the effects which changes in velocity exert upon aggregate demand. This statement clearly implies that velocity of circulation is only a function of the money stock, and omits the effects which other variables have upon demand through changes in velocity. Andersen and Carlson claim that their treatment of velocity as embodied in the money stock multipliers is corroborated by Walters. However, Walters seems to have found that in the United Kingdom there is a relation close to unity between the nominal interest rate and velocity. This is closer to what has been shown by Latane than to what Andersen and Carlson attempt to establish. This finding does not necessarily reject the stability of velocity as a function of the money stock over the long run, but it is rather an attack on the assumption that short-run changes in velocity depend exclusively upon changes in monetary aggregates.

The Andersen-Carlson approach assumes that changes in nominal income are proportional to changes in the money supply, even within the short run, which is extremely restrictive. This


study, on the other hand, postulates that the Andersen-Carlson money multipliers are not constant, but are functionally related to magnitudes such as real activity, the real interest rate and price expectations. Inflationary pressures—at least those experienced by developed economies—seem to be essentially short-run phenomena. Then, it is short-run deviations of nominal demand from its long-run path that are relevant in an analysis of inflation, and, thus, short-run variations of velocity become a point of primary concern. Equation (3.4) states that short-run changes in nominal demand are affected by changes in real activity, changes in the real market interest rate, price expectations, and changes in monetary and fiscal aggregates. The presence of the first three variables in the equation implies that short-run changes in velocity of circulation do not depend only upon monetary aggregates.

Changes in real activity are approximated by changes in the Industrial Production Index. This variable is assumed to represent real wealth and related effects of a changing level of activity on the desire to spend. Although it is recognized that real wealth and the Index of Industrial Production do not express the same conceptual elements, the lack of quantitative information on the first variable forces the use of some other magnitude as a proxy. It can be expected that real income and real wealth, at least for the economy as a whole, vary in a closely related manner. The Industrial
Production Index, in turn, is a reliable indicator of changes in real output. Some authors have preferred to use series on net investment as a proxy for changes in real wealth.\(^{22}\) However, variations in the Industrial Production Index may offer a more satisfactory representation of changes in real wealth than investment, not only because this last magnitude experiences considerable fluctuations, but also because a substantial part of what may be regarded as real wealth is not included as investment. Even though changes in the Industrial Production Index, i.e., changes in real activity, are partly induced by current and lagged changes in monetary and fiscal aggregates, a substantial portion of the effect of changes in real activity on nominal demand cannot properly be attributed to changes in the above-mentioned policy variables.\(^{23}\)

For reasons explained throughout the present chapter, equation (3.4) implies that changes in interest rates may offer some explanation for short-run variations in nominal spending. However, it is recognized that the nominal interest rate is a poor indicator of


\(^{23}\)As it will be seen in the next chapter, the statistical significance of the policy variables is not substantially affected when the change in real activity is introduced into the equation, which seems to support the hypothesis of a substantial degree of independence between the policy variables and the change in real activity.
changes in the real demand for money. This is the reason for separation of the components of the nominal interest rate. Changes in the real market interest rate are assumed in this model to exert a significant influence upon nominal spending. Expectations about future price changes are included in order to allow for the influence which an increasing adaptation of individuals to the going rate of inflation may have upon changes in aggregate spending. It seems that the separation of the price expectations effect from the interest rate is important on at least two counts; first, the interest rate effect upon nominal demand is more properly represented than by including the nominal rate in the equation, and, second, the price expectations proxy variable will take into account the effect of expectations directly, and not only insofar as they are channeled through the nominal interest rate.

The inclusion of changes in the money stock and changes in government expenditures and receipts places the nominal spending equation in accordance with both Keynesian and Classical views of macroeconomic policy. High-employment expenditures and receipts are used instead of actual figures because the first group of variables are considered to express more clearly than the latter the direction of fiscal policy, although some leading economists, such as Tobin and Smith, disagree with the alleged superiority of
high-employment figures over actual ones. Those who advocate
the superiority of high-employment figures maintain that these
magnitudes express the truly exogenous level of government activity
upon the economy. It is interesting to point out that, although it
does not seem correct to omit—at least in the formal model—the
effects of government receipts upon changes in spending, Andersen
and Jordan have suggested that changes in receipts do not exert any
significant influence upon changes in spending, and that changes in
monetary aggregates have a more consistent, larger and faster ef-
fect upon nominal demand than fiscal variables. Their results,
which clearly support the monetarist approach to economic stabil-
ization, have brought about a number of issues regarding their valid-
ity. One of the criticisms raised regards the degree of exogeneity
which can be attributed to the monetary aggregates used by Andersen
and Jordan. Further empirical studies carried through by using

24 For a discussion of high-employment and actual levels of
the Federal Budget, see Edward M. Gramlich, "The Behavior and
Adequacy of the U. S. Federal Budget, 1952-64," Yale Economic
Essays, Vol. 6 (Spring, 1966), pp. 99-159.

19-22.

26 Andersen and Jordan used changes in the Money Stock nar-
rowly defined—that is, currency plus demand deposits—and changes
in the Adjusted Monetary Base. The results are very similar, al-
though the size of the monetary coefficients is increased when using
the second magnitude, which is to be expected. The main criticisms
raised against them is that not only the Money Stock is affected by
changes in GNP (the so-called Reverse Effect), but the (continued)
different specifications of the money supply variable have, in some cases, found the fiscal variables to be more important than Andersen and Jordan suggest, and, in others, reached results substantially similar to those of Andersen and Jordan.

**Demand Pressure**

Once the change in nominal spending is obtained, the model defines demand pressure in the following manner:

26(continued) Base is likewise affected because it contains Borrowed Reserves and Currency among its components.

27See, for instance, Frank DeLeeuw and John Kalchbrenner, "Monetary and Fiscal Actions: A Test of Their Relative Importance in Economic Stabilization: Comment," *Federal Reserve Bank of St. Louis Review*, Vol. 51 (April, 1969), pp. 6-16. They used Non-Borrowed Reserves as the relevant exogenous monetary policy variable, and, under this specification, the monetary multipliers become less significant than under the Andersen-Jordan specification. However, in a reply following the DeLeeuw-Kalchbrenner paper, Andersen and Jordan suggested that the properly exogenous monetary variable is the Adjusted Monetary Base.

\[ D_t = \left( \frac{dy}{dt} \right)_t - (x_t^f - x_{t-1}) \quad (3.5) \]

where \( D_t \) and \( \left( \frac{dy}{dt} \right)_t \) represent, respectively, current demand pressure and the current change in nominal spending, and \( (x_t^f - x_{t-1}) \) stands for the potential change in real production, with \( x_t^f \) being the estimated current level of full-employment output and \( x_{t-1} \) the level of actual production during the previous period. As it can be observed, demand pressure is assumed to increase in direct relation to the difference between the change in demand and the capacity of the economy to increase actual output. For a given increase in nominal spending, demand pressure increases more if the level of actual output is near the level of full-employment output than if there is substantial gap between full-employment and actual output. The idea behind the above definition is that of excess demand, but, instead of taking into account actual output the relevant component of the supply term is the relation between actual output and the ceiling imposed on it by the real forces of the economy.

This is the same measure used by Andersen and Carlson and by Fair, but with one important difference.\(^{29}\) While they used the actual change in nominal spending in the construction of the demand

pressure variable, the present equation contains the value obtained in the nominal spending equation.

The Price Equation

The last equation of the model states that the rate of price change is a function of current and past demand pressure, that is:

\[
\left( \frac{1}{p} \frac{dp}{dt} \right) = f(D_t \ldots D_{t-i})
\]

(3.6)

It can be observed that cost elements are not explicitly brought into the model. Microeconomic theory indicates that--except in the theoretical case of an unlimited supply of factors of production--it becomes increasingly difficult to expand the use of productive factors without affecting their prices when the gap between actual and full-employment is narrowed. It seems perfectly consistent with a demand-pull type of inflation to think that factors of production, as well as any other good, will experience price increases due to excess market demand. There does not seem to be a consistent reason for including cost elements as autonomous sources making for price increases as long as one explicitly allows for the relation between potential and actual employment to be a contributing force in raising prices.

The reason for including lagged demand pressure as affecting the current rate of price change is derived from at least two considerations. On the other hand, firms may likely revise their
price decisions only after the presence of excess demand for their commodities for a somewhat prolonged period of time; in other words, there may be a certain lag between the market demand pressure appearance and the corresponding movement in prices. On the other hand, and closely related to the previous consideration, the current rate of price change may reflect changes in factor prices in previous periods which, in turn, have been a consequence of excess demand. This is an additional reason for not explicitly considering cost elements. As long as demand pressure is an explicit cause of price changes, the interplay between factor prices and product prices is implicitly taken into account. 30

The improvement of this price equation over the Andersen-Carlson form is that this equation uses the information provided by the nominal spending equation. Thus, it is possible in the present model to relate the rate of price change to the variables affecting nominal spending. To say that inflation depends upon demand pressure seems to be devoid of much explanatory power if the elements bringing about demand pressure are not clearly specified.

30 Ibid., p. 19.
CHAPTER IV

EMPIRICAL TEST OF THE MODEL

Introduction

The parameters of the equations of the model presented in the preceding chapter have been estimated through the use of least squares regression analysis. The model is amenable to a single-equation method of estimation due to its recursive nature. In other words, changes in nominal demand are assumed to be affected by changes in policy variables, real activity, real interest rates and price expectations without, in turn, affecting them. Similarly, the relation between current changes in nominal demand and the potential change in output causes the rate of price change to vary. Hence, there are no simultaneous effects between the variables endogenous to the model.

Regarding the interaction between current changes in real activity and current changes in nominal demand, it seems plausible

\(^1\) In order to avoid simultaneous bias, the current rate of price change is excluded from the price expectations proxy.
to consider the former as significantly unaffected by the latter.

Actually, it is proposed that current changes in real activity are affected by lagged changes in spending, for it appears highly unrealistic to assume that real output will show any noticeable reaction to changes in spending within the same quarter. A certain amount of time is required before producers modify their going rate of output in reaction to changes in spending. The present model assumes that there is a lag of at least three months between a given change in demand and its effect upon production.

Lag structures throughout the model are estimated with the use of the Almon distributed lags technique. It is proposed that the Almon distributed lags technique offers a more flexible array of structures than geometrically distributed lags or lag structures based on the Pascal distribution. On the other hand, through the use of distributed lag techniques, the equations under analysis are

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2Shirley Almon, "The Distributed Lag Between Capital Appropriations and Expenditures," *Econometrica*, Vol. 33 (January, 1965), pp. 178-96. This technique constrains the distribution of lagged coefficients to fit a polynomial curve of degree q. Assuming the relevant lag structure of the independent variable is of size n, and the degree of the polynomial is q (where q < n), the n coefficients of the lag structure are linear combinations of the q roots of the polynomial function.

not so critically exposed to multicollinearity problems as in the case of unconstrained lag structures.  

Despite the limited reliability which can be placed upon the Durbin-Watson statistic when dealing with distributed lags, the nominal interest rate and the price equations were subjected to the Cochrane-Orcutt iterative technique to solve for autocorrelation.  

The main reason for using this technique was that, regardless of the actual specification of the equation, the Durbin-Watson coefficients were always extremely low, thus pointing to the presence of positive autocorrelation of the error term.  

As previously noted, the model was tested against quarterly data for the U. S. economy from 1952/III to 1970/IV. Except for the nominal interest rate series, all magnitudes used were taken from published seasonally adjusted figures. None of the nominal

4See John Johnston, *Econometric Methods* (New York: McGraw-Hill, 1963), pp. 201-07. However, it is known that, if the error term is randomly distributed in the original equation, it will be serially correlated in the transformed equation when the transformation includes a lagged value of the dependent variable on the right-hand side of the equation. Moreover, the Durbin-Watson statistic cannot be relied upon as an indicator of the degree of autocorrelation on this case. On this, see also Zvi Griliches, *op. cit.*, pp. 40-42.


interest rate series were adjusted for seasonal variation. An enumeration of data sources may be found in Statistical Appendices B and C.

The Interest Rate Equation

Regarding the nominal interest rate equation, it has been found that, contrary to Gibson, Sargent, and others, expectations about future price changes seem to be formed taking into account a substantially shorter time horizon of past price changes. The results of the present study show that, in equations explaining short-run interest rates, the sum of lagged coefficients of past rates of


8Thomas J. Sargent, op. cit., p. 137.


10Sargent suggests that "the weights trace out a long humped distributed lag which peaks at a lag of about eight years," op. cit., pp. 137-38. Gibson (p. 30), in turn, found that in the case of the fastest-adjusting rate, less than half of the total adjustment process occurs within ten years.
price change consistently exceeds .50 when a 16 quarters lag structure is assumed, and it is similar but slightly lower when long-term rates are explained. In a study undertaken by Yohe and Karnowsky which covers substantially the same period used in the present investigation, the authors found that the coefficients of past rates of price change become insignificant after four years.

Relating their results to those of previously mentioned studies, Yohe and Karnowsky pointed to several possible reasons for the significant divergence regarding the pattern of past price influence upon current interest rate levels. Some of the potential reasons are primarily related to the type of data used and the type of lag structure assumed. It has been observed that aggregation of data over time may result in overestimation of the average lag.

11 If the sum of lagged coefficients is equal to 0.5, this means that, assuming the adjusted rate of price change to grow at a rate of 1 percent per year, after 4 years the nominal rate increases by 50 basis points.

12 William P. Yohe and Denis S. Karnowsky, op. cit., pp. 18-38. They used both unconstrained lag structures and Almon lag structures, and most of the results were derived by directly regressing the nominal interest rate against past rates of price change. Their analysis covers the period from 1952 to 1969.


As to the type of lag structure assumed, the use of geometrically
declining lag structures may exert an upward bias in the estima-
tion of the lag distribution. On the other hand, unconstrained lag
structures may present multicollinearity problems which, in the
case of succeeding rates of price change, are likely to be too seri-
ous to be ignored. Another disadvantage attached to unconstrain-
ed lag structures is that the wide variations in the size of the
estimates of the coefficients of such lag distributions becomes very
difficult to explain in a reasonable behavioral pattern.

However, besides taking into account the different procedures
used for the estimation of the lag distribution, it seems that the
primary reason for the divergent results is one of economic as well
as purely statistical relevance. While those studies reporting very

\[\text{(continued)}\]

(continued) adjustment of interest rates to price level
changes is rapid enough to make this aggregation bias from quarter-
ly to annual data a substantial one.

15 See Zvi Griliches, op. cit., p. 41. Also, Arthur
Goldberger, Econometric Theory (New York: John Wiley and Sons,
1964), pp. 276-78.

16 This may explain, at least in part, the low "t" values at-
tached to many of the estimates of the lagged price change coeffi-
cients in the study carried out by Gibson. Statistical significance of
the estimates of the lagged price change coefficients suggested by
Yohe and Karnowsky were not presented.

17 See Gibson's work. The graphical representation of the
unconstrained lag structure resulting from Yohe and Karnowsky's
work does not appear very clear to explain either.
long adjustment processes--mean lags between seven and thirty
years--have embraced the experience of at least the present
century, the Yohe-Karnowsky and the present study are only
considered with the last two decades. As the last two decades cover
a period of relatively constant full-employment and generally rising
prices, it appears reasonable to expect substantially shorter lag
structures than if one were to linearly interpolate the experience of
the last eighty or ninety years. Since price expectations are
generally recognized to be a purely behavioral phenomenon, the
relevant time horizon taken into account by individuals in forming
such expectations should largely depend upon the sort of variations
being experienced by the price level. Hence, if it is recognized
that prices have generally experienced a more rapid upward varia-
tion during the 1950's and 1960's than during the present century
considered as a whole, regression studies covering the longer

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18Sargent analyzed the period 1902-1940, using annual data.
Gibson used annual observations for the period 1869-1963, and
quarterly data for the period 1948-63. Yohe and Karnowsky mention
(p. 21) an unpublished study carried out by Milton Friedman and Anna
Schwartz for the National Bureau of Economic Research entitled
"Trends in Money, Income and Prices, 1867-1966," where the au-
thors seemed to have reached results similar to those of Sargent and
Gibson regarding the length of the lag of price changes in affecting
the nominal interest rate. Friedman and Schwartz used the business
cycle phase as the unit time period and found mean lags of between
25 and 30 years for long-term rates.

19See Yohe and Karnowsky, op. cit., p. 31. This idea was
quoted from the unpublished report by Friedman and Schwartz cited
in the previous footnote.
period seem bound to overestimate the true structure of lagged
price changes relevant in forming expectations during the post-war
period.

The above reasoning points to the fact that results on the
dynamic structure of the influence of past price changes on current
nominal interest levels which embrace the experience of a long
period of time may seriously misrepresent the true underlying struc-
ture. Although expectations are not observable, it can be certainly
agreed that they do not conform to a linear combination of past
price changes regardless of the type of price variations being
experienced. Linear interpolations of past price changes covering
an approximately uniform type of price experience are more likely
to approximate the true underlying structure— at least for that
period— than similar mathematical manipulations embracing into
one period widely different historical price experiences.  

Results of the Present Study

Four different interest rate series were tested; the Treasury
Bill Rate and the Rate on the 4 to 6 months Commercial Paper were

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Yohe and Karnowsky point out that changes in the structure
of financial markets may have contributed to the more rapid absorp-
tion of past price changes by the nominal interest rate in the last
two decades than in previous periods. However, as will be seen
below in more detail, the hypothesis of institutional changes does
not seem to be valid in trying to explain differences between the
1950's and the 1960's.
used for short-term rates, and the Yield on Long-run Government Bonds and the Yield on Aaa Corporate Bonds were used for long-term rates. Polynomials of second and fourth degree were fitted to the data to observe their effect upon the lag structure of past price changes. However, regardless of the particular interest rate series used, or the actual specification of the equation, results were substantially the same under different degree polynomials. Second degree polynomials were preferred, however, because they consistently showed a higher $R^2$ than fourth degree ones. Lag structures of between eight and sixteen quarters were tried in order to capture the "Fisher Effect." In all four interest rate series it was observed that, as expected, the total effect of past price changes on the dependent variable increased with the size of the lag. Once it was observed that the overall fit of the equation

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21 However, although the sum of lagged coefficients were very similar, the standard error of equations using second degree Almon lags tended to be smaller than those using fourth degree lag structures.


23 For the Corporate Aaa Bond Yield, for instance, the total price change effect was .33, .22, and .14 when the lagged structure covered sixteen, fourteen, and twelve quarters, respectively, during the fifties. During the sixties, however, the difference between them was substantially smaller (the sums were .83, (continued)
improved with the length of the lag, subsequent investigations were limited to lag structures of fourteen and sixteen quarters. The fact that the total effect of past price changes on nominal interest rate increases with the length of the lag is consistent with the "extrapolative hypothesis," that is, the hypothesis which assumes that individuals expect prices to rise more rapidly in the near future if prices have risen more rapidly within the relevant past, and vice versa. Moreover, from experimentation with the four different interest rate series used, it was observed that short-term rates were influenced by a shorter structure of past price changes than long-term rates. This agrees with the generally accepted hypothesis that the relevant time horizon taken into account in forming price expectations increases as the term to maturity of the nominal magnitude under consideration increases.

The rate of change in real income was also subjected to an Almon lag structure to capture the influence which past changes in

(continued) .82 and .81), which can be explained by the fact that in the later decade the total effect was more heavily concentrated on the most recent past price changes than in the previous decade.

Sometimes the unadjusted specification resulted in larger total effects, and others the reverse was true, but there was no tendency for one to be consistently larger than the other. The standard error of the equation, however, was completely unaffected, as well as the coefficient of determination.

This was specially clear when a lag structure of only 8 quarters was used.
real income may exert upon interest rates through the acceleration

effect upon investment. Lag structures of four, six and eight quar-
ters were tried. It was observed that lags longer than four or six
quarters generally reduced the statistical significance of the lag
structure. It is very unlikely that this result, which seems to imply
that there is a very short lag between the rate of growth of income
and the nominal interest rate through the working of the investment
accelerator effect, expresses the true underlying lagged effects of
income changes on interest rates. The fact that the statistical
significance of current and lagged changes in real income is en-
hanced when the level of real income is excluded from the equation,
indicates a strong degree of multicollinearity between the current
level of real income and current and lagged changes in real income.
As the overall fit of the equation was clearly superior with the in-
clusion of the level of real income, the specification containing both
variables was preferred. However, it is important to keep in mind
that no definite significance can be attached to the size and sign of
the coefficients of real income changes due to the high interdepen-
dence between this variable and the level of real income.

The effect of a change in the money supply upon interest
rates was tested with the use of the rate of change in the deflated
money stock and the rate of change in the nominal money stock. The
size and statistical significance of the estimate of the money
variable coefficient was very similar under either specification of this variable. Also, the other variables did not show any noticeable vulnerability to the change in the specification of the money variable between the deflated and the nominal figure. Following Sargent's model, the deflated rate was used in the final equation. A lag structure of two quarters was tested in the money stock variable to see whether lagged changes in the money supply exert any significant effect upon current interest rate levels when variables other than money are included in the equation. It was observed that, without exception, lagged changes in either the real or the nominal money stock were statistically insignificant even at the 10 percent level, and often appeared with the wrong a priori sign.26 This supports the hypothesis that the "liquidity effect" of a change in the money stock on interest rates "washes out" rapidly when other variables are explicitly taken into account.

Both long-run series consistently provided better fits than short-run series, which is to be expected due to the greater amount of non-systematic variation to which short-term rates are exposed.27

26 When unconstrained lags were used for the money variable, neither the current nor the one-quarter lagged rate of change in the deflated or undeflated money stock were statistically significant.

27 Not only the coefficient of determination increased when long-term rates were used, but the standard error of the equation was two or three times larger when short-term rates were used.
Also, the rate on 4 to 6 months Commercial Paper and the Aaa Corporate Bond Yield seemed to offer slightly superior fits than the corresponding rates on government securities. This might be explained by the fact that the latter rates would be more closely exposed to random variations in the public securities market caused by governmental policy. However, the similarities seem to be too many between both groups in order to attach a large relevance to the differences between interest rates in markets for public and private securities, at least on a preliminary basis. At any rate, since the Aaa Corporate Bonds Yield series showed superior statistical results than the others, it was selected to represent the nominal interest rate variable in the model. Detailed results of the selected specification of the equation for the entire period under consideration as well as for the sub-periods 1952/III-1960/IV and 1961/I-1970/IV are shown in Statistical Appendix B.

The reason for breaking the entire period into two sub-periods is to test the hypothesis that in periods of high-employment and more or less continuously rising prices individuals incorporate into their expectations a larger fraction of their recent past experience than in periods with a lesser inflationary pressure. In

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28 The coefficient of determination remained fairly unaffected, but the standard error of the equation decreased slightly in size when the Commercial Paper Rate and the Corporate Aaa Bond Yield were used.
Statistical Appendix B results for both sub-periods are presented with a sixteen quarters lag structure and a fourteen quarters lag structure for the effect of past rates of price changes on nominal interest rate. In the case of the 1961-70 sub-period, the price expectations instrument variable which results from the sixteen quarters lag structure is larger than the total price expectations effect resulting from the fourteen quarters lag structure during the early 1960's, but becomes smaller after the middle sixties. This phenomenon indicates that, although the total effect of past price changes--as measured by the sum of the individual weights--is larger in the case of the longer lag structure, the distribution of individual coefficients is more heavily concentrated on the recent price experience in the case of the shorter lag structure. Hence, in a period of steadily increasing inflationary pressure such as the middle sixties, the shorter lag structure expresses a larger "Fisher effect" on interest rates than the longer one. This becomes even more clear if one observes that, in the later sixties, when the rate of inflation becomes more stable, both series converge.

Comparing the results, it seems clear that a larger total fraction of past rates of price change affected nominal interest rates in the sixties than in the fifties. However, the mean lag of the

\[ 29^\text{Regardless of interest rate series used, the sum of lagged coefficients increased, almost without exception, around 2 or 3 times between both decades for comparable lag structures.} \]
structure—that is, the time which elapses until half of the effect of a change in the independent variable is reflected in the dependent variable—is not very much shorter in the sixties than in the fifties. This would indicate that the relevant past time-horizon in forming expectations was substantially the same, although individuals do seem to have attached a noticeably higher overall importance to their recent past experience in the sixties than in the fifties. This agrees with the generally accepted position that, as inflation develops and continues for a certain time, individuals increasingly adapt their expectations to the going rate of inflation.

A more accurate testing of the above hypothesis would have been to divide the entire period between the pre-1965 and the post-1965 experience, but, given the number of variables, quarterly observations did not provide enough degrees of freedom for the last period to allow for meaningful statistical results. In fact, it seems that the number of observations composing the 1952/III-1960/IV and the 1961/I-1970/IV sub-periods do not offer large enough degrees of freedom to draw definite conclusions about the extent to which inflationary expectations changed between both periods. Contrary to

30 The difference of mean lags between the fifties and the sixties seemed to be slightly more pronounced in the case of twelve and fourteen quarters lag structures than in sixteen quarters ones, but the differences were small.
Yohe and Karnowsky\textsuperscript{31} and Andersen and Carlson, \textsuperscript{32} there seems to be insufficient evidence to consider the 1950's as substantially different from the 1960's regarding the structure of financial markets based only upon preliminary statistical results. \textsuperscript{33} The reasons offered by Yohe and Karnowsky for treating the 1950's separately from the 1960's do not appear to have much validity, at least without more conclusive proof. \textsuperscript{34} The only plausible source of difference between both decades regarding interest rate determination appears to be a higher inflationary structure of expectations during the 1960's than during the 1950's. \textsuperscript{35}

\begin{footnotesize}
\begin{enumerate}
\item William P. Yohe and Denis S. Karnowsky, \textit{op. cit.}, pp. 29-31.
\item Leonall C. Andersen and Keith M. Carlson, \textit{op. cit.}, p. 27.
\item Besides the problem of limited degrees of freedom, there seems to be a high level of multicollinearity between some variables, especially in the 1960's.
\item Yohe and Karnowsky point out as possible reasons for the change in expectational behavior a decrease in "money illusion" and a reduction of price change effects of real wealth. The first arises from the increased importance of large institutional investors. The second is due to the increasing importance of real assets. These, as well as other reasons, seem to be valid in comparing the post-war period to earlier ones, but Yohe and Karnowsky appear to put forward the same arguments to explain differences between the fifties and sixties. Andersen and Carlson include a dummy variable in the nominal interest rate equation which is equal to 0 in the fifties and equal to 1 in the sixties, and is supposed to stand for undefined "institutional changes" between both decades.
\item This hypothesis does not maintain that the behavior of savers and investors remained unaffected by the different intensity of inflationary pressures. It only precludes the possibility (continued)
\end{enumerate}
\end{footnotesize}
At any rate, real market interest rate and price expectations proxies have been constructed for both sub-periods in order to see how their effect upon nominal spending differs from that of the same variables when considering the whole period as a unit.

Summarized results of the equation are as follows:

1952/III-1970/IV

\[ r_t^n = 0.997 + 0.068T - 0.037S_1 - 0.049S_2 - 0.011X_t - \]
\[-0.83 \quad 2.71 \quad -1.32 \quad -1.72 \quad -0.59 \]
\[ 0.004(M/p)_t + 0.055\hat{X}_{t-i} + 0.523\left(\frac{\dot{p}}{U/4}\right) \]  
\[-1.33 \quad 2.39 \quad 5.71 \]  
(4.1a)

1952/III-1960/IV

\[ r_t^n = -6.88 + 0.005T - 0.0895S_1 - 0.077S_2 + 0.086X_t - \]
\[-4.51 \quad 0.412 \quad -3.11 \quad -2.74 \quad 4.97 \]
\[ 0.005(M/p)_t - 0.0107\hat{X}_{t-i} + 0.3353\left(\frac{\dot{p}}{U/4}\right) \]  
\[-2.22 \quad -1.003 \quad 7.75 \]  
(4.1b)

1961/I-1970/IV

\[ r_t^n = -6.195 + 0.008T - 0.09S_1 - 0.066S_2 + 0.0814X_t - \]
\[-3.56 \quad 0.56 \quad -2.85 \quad -2.13 \quad 4.07 \]
\[ 0.005(M/p)_t - 0.014\hat{X}_{t-i} + 0.225\left(\frac{\dot{p}}{U/4}\right) \]  
\[-1.735 \quad -1.1 \quad 5.63 \]  
(4.1c)

1961/I-1970/IV

\[ r_t^n = 4.07 + 0.105T - 0.053X_t - 0.022(M/p)_t + \]
\[ 3.61 \quad 2.06 \quad -1.77 \quad -1.76 \]
\[ 0.065\hat{X}_{t-i} + 0.829\left(\frac{\dot{p}}{U/4}\right) \]  
\[1.67 \quad 9.31 \]  
(4.1d)
\[ r_t^n = 4.61 + 0.122T - 0.065X_t - 0.023(M/p)_t + \]
\[ (4.59) (2.46) (-2.29) (-1.82) \]
\[ 0.074^*X_{t-i} + 0.8176^*\left(\frac{\dot{P}}{U/4}\right)_{t-i} \]
\[ (1.92) (9.31) \]

(4.1.e)

Notes:

Numbers in parentheses below coefficients are "t" values

*Sums of lagged coefficients

1 First equation contains a 16 quarters lag structure and second equation a 14 quarters lag structure, for \( \left(\frac{\dot{P}}{U/4}\right)_{t-i} \)

2 First equation contains a 16 quarters lag structure and second equation a 14 quarters lag structure, for \( \left(\frac{\dot{P}}{U/4}\right)_{t-i} \)

A time trend variable was included in the equations in order to allow explicitly for the influence which trend factors not included in the equation may have had upon nominal interest rates. As the nominal interest rate series were not seasonally adjusted while those of the other variables were, the effect of seasonal variations was included whenever it was considered statistically significant.

(continued) of substantial change in behavior due to causes independent from expectations.

First differences in the variables were also tried, but with negative results.

The seasonal for the third quarter was never significant, and all of them were completely insignificant in the sixties.
equations show that the time trend variable was statistically significant in the 1960's, but not so during the 1950's. On the other hand, only for the sub-period 1952-60 are the quarterly dummies standing for the first and second quarter significant at the 5 percent level of higher. It has to be pointed out that, although the inclusion of the time trend variable improves the overall fit of the equation, the statistical significance attached to the estimate of its coefficient for the whole period, and especially for the 1960's, may be distorting the true influence of real income upon interest rates. 38

The close relationship existing between the level of real income and current and lagged changes in real income makes it very difficult to try to discern their separate effects upon nominal interest rate levels. The sign of the coefficient of real income is negative for the whole period and the 1961-70 sub-period, and the estimate is not significantly different from zero at the one percent level. The coefficient estimates of current and lagged rates of change in real income are, on the other hand, all positive and their sum significantly different from zero at the one percent level in the

38 When the trend variable was deleted for the sub-period 1961-70, the level of real income was always positive but not highly significant. However, the degree of multicollinearity between this variable and the adjusted rate of price change in the previous quarter was very high in the 1961-70 sub-period. The simple coefficient of determination between them was .78. Thus, it appears rather difficult to discern their separate influences upon the nominal interest rate.
case of the whole period. The reverse is true for the 1952-60 sub-period; real income has a positive effect upon nominal interest rate which is statistically significant at the one percent level, and changes in it a negative effect which is insignificant even at the 10 percent level.

As both the real saving and the real investment schedules of the model from Chapter III are assumed to depend upon the level of real income, either sign is a priori correct regarding the coefficient of real income in the nominal interest rate equation. The sign of this coefficient depends upon the relative shifts of the real saving and investment schedules when real income changes. Regarding current and lagged changes in real income, as long as one expects the investment accelerator mechanism to be positive, changes in real income affect interest rates in a positive manner. That is, as an increase in the rate of change in real income shifts the real investment schedule to the right, the equilibrium level of interest rate will be higher than before, and vice versa. This model assumes that real savings are not responsive to changes in the rate of growth of real income, at least relative to real investment. As long as real investment's reaction to income changes is larger than that of real saving, the above argument is correct. Since the investment accelerator mechanism is widely accepted and it does not seem that
real income changes are an important determinant of real savings, the plausibility of the present conceptual mechanism is justified.

Unfortunately, the interdependence between the level and the rate of change in real income obscures the effects which each one of these variables may separately exert upon interest rates. It is important to notice, however, that the statistical significance of the coefficient estimates of changes in real income increased consistently whenever the level of real income was deleted from the equation. In cases in which these estimates appeared with negative sign when real income was included, they always changed sign when the level of real income was deleted.\(^{39}\)

Regarding the level of real income, this variable was rather insignificant and the sign of the coefficient was negative whenever the time trend variable appeared as statistically significant. This clearly seems to imply that the strong common trend existing between time and real income during the sixties obscures the true relation between real income and the interest rate, not only for the 1961-70 sub-period, but for the whole 1952-70 period as well. On the other hand, the results for the 1952-60 sub-period clearly

\(^{39}\) The interdependence between both variables becomes even more clear when observing that, whenever the level of real income was rather insignificant---namely, during the sixties---the rate of change in real income was highly significantly positive.
show--with the time trend having no importance at all--the significance of real income in interest rate determination.

The statistical results show that, regardless of the period considered and the choice of variables, past rates of price change exert a highly significant influence upon the current level of nominal interest rates. Each of the estimates of the individual lagged price change coefficients is statistically significant at the one percent level. The fact that the size of the coefficients and their statistical significance were substantially unaffected by different specifications of the equation lends support to the position which stresses the importance of price expectations as an independent force in interest rate determination. As mentioned before, a substantially larger fraction of past rates of price change affected nominal interest rates in the 1960's than in the 1950's. The size of the mean lag appears to have been reduced in the second period, but not very substantially. From the lag structures in Appendix B, it may be observed that the distribution of coefficients has shifted in favor of more recent rates of price change during the 1960's vis-a-vis the 1950's. These differences between decades, however, do not seem to support the hypothesis of substantial changes in the structure of financial markets, apart from changes which were

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40 The form of the lagged structure seemed to have changed from an inverted-V form into one closer to geometrically distributed lags.
themselves a result of the different expectational outlook in both decades. 41

These findings imply that individuals do not form their expectations based upon a linear interpolation of past price changes, but incorporate substantially different fractions of those price changes depending upon the intensity of their present inflationary experience. This argument is specially critical of linear regression studies covering the experience of at least the present century. If expectations of future price changes have any relation with the past price experience, individuals are likely to attach a greater weight to such experience when it is more inflationary than when it is less so.

The results of the nominal interest rate equation were utilized to construct a market real interest rate proxy and a price expectations proxy to test their effect upon changes in nominal spending.

**The Nominal Spending Equation**

The results of the nominal spending equation establish rather clearly that velocity of circulation is not exclusively a function of the money stock in the short run, as monetarists sometimes appear to maintain.

41 See footnote (34) above.
Before presenting the results of the equation, it is important to draw a clear distinction between the two different purposes for which a "St. Louis" type of equation has been used. If such an equation is used to compare the relative impact of monetary vs. fiscal policy upon economic activity, it might be correct to ignore changes in velocity caused by variables endogenous to the economic system itself. 42 On the other hand, if the "St. Louis" equation is utilized to explain the complete set of forces making for changes in nominal spending, the ignorance of changes in velocity of circulation becomes a crucial shortcoming in the analysis. 43 While in the first case, a low $R^2$ and a high standard error may not critically hamper the argument, in the second case it precisely reflects the inability of the equation to fulfill the purpose to which it is used, that is, to track actual changes in nominal spending through time. 44

If short-run variations in velocity of circulation are of primary importance in inflationary processes as those experienced by

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42 This is the case of Andersen and Jordan, op. cit.

43 This is the purpose of its use in Andersen and Carlson, op. cit.

44 The most dramatic change occurring in the equation when variables other than policy indicators are introduced are reflected in the reduction of the standard error. When the interest rate and the price expectations variables are introduced, the standard error drops from above 3.5 to around 0.9, and when the change in the Industrial Production Index is added, it falls to 0.55. The $R^2$ is primarily improved by the introduction of the last variable.
the U. S. economy during the 1950's and the 1960's, it becomes crucial to allow explicitly for variables which, besides policy-determined magnitudes, affect nominal spending. The only possible world in which an equation such as the "St. Louis" one would offer a satisfactory explanation of short-run changes in spending would be one in which velocity is only a function of the money stock. In this case, the "monetary multipliers" attached to current and lagged changes in the money stock would express the direct and the indirect effect which changes in the money stock exert upon nominal spending. Since, besides, changes in the money stock are the only possible source of variation of velocity of circulation, the explanatory power of the equation would not improve by the introduction of other explanatory variables. The only possible modification resulting from the inclusion of variables endogenous to the system would be the reduction in the size of the coefficients of monetary changes. These coefficients would now only represent the direct influence of money on spending. Moreover, since the dependence of variables endogenous to the system upon money changes would be very high, multicollinearity would be a certain problem. Hence, the statistical significance of the estimates of the parameters of the equation would likely be low. 45

45In a perfectly monetarist world, the degree of dependence of endogenous variables upon money would be almost (continued)
However, the present investigation shows that the introduction of variables representing changes in real activity, real interest rates and price expectations improves the explanation of changes in nominal demand over the "St. Louis" equation. By adding these variables, the coefficient of multiple determination increases from about 0.66 to almost 0.90, and the standard error of the equation decreases from above 3.50 to slightly above 0.50. This increases substantially the explanatory power of the equation, as reflected through a higher F ratio.

As expected, the size of the coefficients of changes in the money stock is reduced when changes in real activity, real interest rates and price expectations are introduced in the equation. This reduction reflects the fact that part of the effects which these variables exert upon nominal spending are originated from changes in policy variables. It is not the purpose of the present investigation to deny that changes in the money stock and government expenditures and revenues are an important source of movements in magnitudes endogenous to the economic system, and indeed a very important one. But the improvement of the overall fit of the equation when other variables are introduced indicates that forces independent from policy aggregates exert an important influence on nominal

\(^{45}\text{(continued) absolute. Changes in economic activity would keep a rigid proportionality to changes in the money stock.}\)
spending. The statistical significance of the coefficients attached to changes in real activity, changes in real interest rates and price expectations even in the presence of monetary and fiscal variables certainly implies that it does matter what values such variables take in determining short-run changes in nominal spending.

Results of the Equation

After extensive experimentation with alternative specifications of the nominal spending equation, the selected equation shows the following results:

\[
d y_t = 0.508 + 0.319 d I P_t + 1.272 d r^*_1,t + 1.421 d r^*_2,t +
\]

\[
  (2.25) \quad (8.6) \quad (1.54) \quad (2.04)
\]

\[
  0.125 p^A_{1,t} + 0.595 p^A_{2,t} + 0.263^* d C P_{t-1} +
\]

\[
  (.34) \quad (6.6) \quad (3.98)
\]

\[
  0.04^* d H E_{t-i}
\]

\[
  (.71)
\]

Notes:

Numbers in parentheses below coefficients are "t" values

*Sums of lagged coefficients

where dy stands for the change in nominal GNP, dIP for the change in the Industrial Production Index, \( dr^*_1 \) and \( dr^*_2 \) represent the change in the real interest rate proxy for the 1950's and the 1960's, \( p^A_1 \) and \( p^A_2 \) represent the instrument variables standing for expectations of future price increases during the fifties and the sixties, and dCP and dHE stand for the change in total commercial bank deposits—also
referred to as credit proxy—and the change in high-employment Federal expenditures. All changes are first differences in the variables between quarters. A more detailed presentation of the equation is shown in Statistical Appendix C.

The real interest rate and price expectations proxies utilized in the above equation are those derived from equations (4.1.c) and (4.1.e) in the previous section. The specification using the 14 quarters lag structure for past rates of price change adjusted are preferred because it consistently offered results superior to those utilizing the 16 quarters lag structure and the instrument variables constructed from the nominal interest rate equation which covers the two decades.46

Fourth degree Almon lag structures were used for the monetary and fiscal policy variables.47 The monetary policy indicator was selected to be the total amount of deposits in commercial banks, 

46This was not dependent upon the choice of the other variables in the equation. The specification using the results of equation (4.1.a) were consistently inferior to those of equations (4.1.b) and (4.1.d). The most striking differences between the specification using the results of equation (4.1.a) and the others were, as expected, in the price expectations variable.

47Lower degree polynomials did not affect the character of the results, but statistically they tended to be inferior to those using fourth degree polynomials.
or credit proxy. This variable was selected as the monetary policy indicator instead of the money stock narrowly defined because although results are otherwise very similar, the use of the money stock seemed to affect unfavorably the statistical significance of the price expectations proxy. Another reason for the use of the credit proxy is that this variable is less sensitive to the reverse-causation argument than the money stock as shown by the statistical insignificance of the coefficient of current changes in the credit proxy variable.

Considering the effect of policy variables upon changes in spending, the results are still very much the same as in the "St. Louis" equation. Changes in monetary aggregates exert a significantly positive effect over nominal spending changes at least up to four quarters after the change in the monetary indicator has taken place. Changes in high-employment Federal expenditures, on the

48 Other monetary indicators used included the Adjusted Monetary Base, Actual Bank Credit, Non-Borrowed Reserves and the Money Stock narrowly defined.

other hand, have a significantly positive influence on current and the following quarter's change in nominal spending, but a significantly negative effect after two quarters. Current and lagged changes in high-employment Federal revenues are consistently insignificant and the signs attached to their coefficients are positive as often as negative. This variable was thus taken out of the equation. Actual changes in the fiscal variables were also tried, but with no significantly different results from those using high-employment figures.

Although the statistical results imply that monetary aggregates have a substantially larger and more consistent influence upon nominal spending than fiscal variables, it is unlikely that the effect of changes in government expenditures would disappear so rapidly, and that changes in government taxes exert no consistent influence at all upon the desire to spend of economic units. Apart from problems dealing with the selection of the proper monetary aggregate—which were discussed in Chapter III—it appears that there are some points which need further clarification before the above statistical results can be generally accepted.

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50 These results seem to support a sort of "crowding-out" theory of effects of government spending advocated by the monetarist view.

51 The high-employment Federal surplus was also used but with no satisfactory results.
The point under discussion here is not whether monetary policy is important or not, but rather whether "money is the only thing that matters."\(^{52}\) The only possible case in which a single-equation model can be able to clearly distinguish between monetary and fiscal effects would be if no interactions exist between them. However, a change in fiscal expenditures generates an offsetting monetary effect brought about by an increased demand for money, which results in higher interest rates.\(^{53}\) The ultimate size of the fiscal expenditures multiplier will, in this case, depend upon the type of monetary policy being carried out at the same time. If it allows interest rates to rise, the simple Keynesian multiplier will be reduced, and conversely if it brings interest rates down. But the only case in which the monetary effect of a change in government expenditures would completely eliminate the fiscal multiplier is in the hypothetical case of zero interest elasticity of both the demand for and the supply of money.\(^{54}\)


\(^{54}\) This is the case of the extreme monetarist world. In this case, the nominal money supply is completely exogenous.
The interactions existent between fiscal and monetary magnitudes makes it very unlikely for a single-equation model to attribute the proper influence to each variable. This seems to be especially important considering the small size of variations in policy variables relative to their level in the U. S. experience, and the intimate relation kept between them within the policy-making mechanism. It seems that a quantitative study purporting a clear advantage of monetary over fiscal policy actions would require a clear conceptual apparatus specifying the channels through which different policy variables affect nominal income.

The effect of changes in real forces upon nominal spending is represented in equation (4.2) by the quarterly change in the Industrial Production Index. The statistical significance attached to the coefficient of this variable in the presence of monetary and fiscal policy variables supports the hypothesis of short-run velocity changes caused by forces other than monetary aggregates. The lagged level of the Industrial Production Index was also included in the equation in order to observe the influence which past movements in real variables may exert upon current changes in spending.

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55 The change in real GNP was also tried and showed results superior to those of the change in the Industrial Production Index. However, since the dependent variable is nominal GNP changes, the use of changes in real GNP on the right-hand side of the equation would greatly nullify the meaningfulness of the results.
Nevertheless, although this variable results statistically significant at the 5 percent level, the overall fit of the equation did not improve noticeably, and the statistical significance of other variables disappeared, especially that of the price expectations proxy for the 1960's. As expected, the sign of the coefficient attached to changes in real activity is positive. It reflects the fact that changes in real activity have exerted, through a wealth effect and related influences, a positive impact on the desire to spend of the community. It is possible that this variable is transmitting to nominal spending changes the fruits of the rather smooth increase in economic prosperity which the U. S. economy has experienced during the fifties and sixties. However, this effect does not seem to be very important because when a time variable is introduced, it is not statistically significant. Short-run changes in productivity, previous changes in demand and other factors affecting the real output may be more properly considered the forces affecting spending changes through changes in the Industrial Production Index.

56 The use of a lag structure for changes in the Industrial Production Index was also tried, but with no noticeable improvement in the overall fit of the equation.

57 The time variable is statistically insignificant either when the change in the Industrial Production Index is introduced into the equation or when it is deleted.

58 The importance of changes in real activity would seem to support theories of inflation which maintain that velocity of circulation follows the real business cycle.
The low statistical significance of real interest rate changes in the equation is due to the presence of changes in real activity in the equation.\(^{59}\) However, it was considered advantageous to introduce the real activity variable because the standard error of the equation is reduced to almost one-half of its previous size, and the \(R^2\) increases from less than .70 to almost .90. The high statistical significance of changes in real interest rate when the change in real activity is deleted from the equation expresses the importance of this variable as an indicator of changes in spending.

The unexpected result regarding changes in the real interest rate proxies is the positive sign attached to their coefficients. One possible explanation results from suggesting that current changes in interest rate are an effect rather than a cause of current changes in spending. However, when lagged interest rate changes are used instead of current ones the signs attached to this variable are still positive.\(^{60}\)

A more satisfactory explanation for the positive signs attached to real interest rate changes is that, although the relation between interest rates and spending is inverse, the shape of the

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\(^{59}\)When changes in real activity are deleted from the equation, both interest rate proxies are highly significant at the 1 percent level, and the coefficients are substantially larger in size.

\(^{60}\)This is absolutely independent from the choice of the real interest rate instrument variable.
relation is convex to the origin. This makes the slope of the relation between the first differences of both variables positive. Experimentation with the current real interest rate level proxy showed that this variable affects the change in nominal spending with a negative sign. So, it appears that, although lower interest rate levels stimulate the desire to spend and expand economic activity, this effect is less than proportional to the extent of the change in interest rates. Unfortunately, alternative hypotheses of the transmission mechanism may be more properly dealt with only when a fully specified model is built and the relations existing between interest rates, policy variables and nominal spending are introduced into it. A useful step in this direction may be taken by disaggregating the analysis into specific types of expenditures.

Equation (4.2) shows that the instrument variable representing price expectations during the 1960's has a substantially more significant effect upon nominal demand changes than that representing price expectations during the 1950's. These findings suggest that under a state of rather stable prices, as in the 1950's, 

61 When the lagged level of the Industrial Production Index is introduced in the equation, however, the significance of the price expectations proxy for the sixties falls considerably, and the size of its coefficient is also affected. This is due to the very close common trend existing in the sixties between price increases and the level of activity, already noticed in the nominal interest rate equation.
individuals largely disregard short-lived movements in prices when planning their expenditures. On the other hand, when the price level begins to move consistently in an upward direction, as in the middle and late sixties, the same individuals incorporate the expectation of further price increases into their spending patterns. The magnitude of the different effects exerted by price expectations on nominal spending changes in the 1960's from that of the 1950's has to be considered taking into account not only the larger size attached to the coefficient of the price expectations proxy for the sixties, but also the substantially higher level of the instrument variable for the second of the two decades under consideration. 62

The positive signs attached to the coefficients of both price expectations instrument variables seem to support the "accelerationist" hypothesis of inflation. A positive sign implies that a rising expectation of future price increases pushes up not only the level of nominal spending but the magnitude of its increase as well. In other words, the equation suggests that the relation between the expectation of future price changes and nominal demand is increasing with an increasing slope. Then, as individuals adjust their expectations

62 The level of price expectations for the sixties is about five times that of the fifties. That would imply that the weight given to price expectations during the second decade in determining expenditures is substantially larger than that of the fifties. If this is true, a price expectations variable constructed for both decades would very likely fail to determine it.
to the going rate of inflation, nominal spending is increasingly affected, thus providing the fuel for further inflationary pressures. So, price expectations would lead to a structure of unstable nominal economic magnitudes.

However, it is important to point out that the significantly positive relation between price expectations and nominal spending changes in the equation is highly dependent upon the monetary aggregate variable used. When the monetary aggregate is represented by the money stock narrowly defined, the statistical significance of the price expectations proxy for the sixties drops substantially and the signs attached to the coefficients of both price expectations variables are negative as frequently as they are positive. It is possible that the rather close relation existing between prices and money changes especially in the sixties obscures the true influence of price expectations upon nominal spending changes. However, if the true sign attached to price expectations in the equation is negative, then the "accelerationist" hypothesis of inflation would suffer a serious blow because it implies that the nominal magnitudes of the economy are inherently stable. In other words, a negative sign attached to price expectations in the equation indicates that this

63 The coefficient of the proxy for the fifties carried always a negative sign, and that of the sixties had both signs, depending upon the other variables used, when the money stock was the monetary indicator.
variable is related to nominal spending through a decreasingly increasing function. That is, as inflationary expectations become more and more acute, the magnitude of the increase in spending goes down. But the statistical insignificance of the expectational variable when the money stock is used makes it very difficult to infer a given relationship between the first variable and changes in spending in the presence of money stock changes. The less pronounced common trend existing between price changes and the credit proxy during the 1960's, on the other hand, makes equation (4.2) less vulnerable to multicollinearity problems than if the money stock would have been used as the monetary indicator.

As indicated above, the results of the equation presented in this section appear to establish the importance of real activity, interest rates and price expectations in determining short-run changes in velocity of circulation. Since inflationary processes like those of the U. S. economy during the period under analysis are limited to relatively small deviations from a stable long-run path, the interconnection between monetary and real variables becomes far more crucial than in the case of hyper-inflations, where the dislocation of nominal from real magnitudes can be almost completely traced to abnormal increases in the money stock.  

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64 In some cases, as in wars, the substantial decrease in real output has also been instrumental in bringing about hyper-inflations.
Monetary aggregates and fiscal activity are certainly very important in determining the boundaries within which short-run changes in economic activity occur, but the nature of "gradual" inflationary processes requires the presence of other determinants in addition to movements in the money stock. 65

The Price Equation

The results of the price equation show that price changes do not react as smoothly to movements in demand pressure as implied in previous studies. 66 As stated in Chapter III, price changes are assumed to be a function of the extent of pressure originated by excessive increases in aggregate demand relative to the potential change in output. In the absence of a frictional world, one would expect that prices react instantaneously to changes in demand pressure. However, the need for firms to adjust to changes in product as well as factor markets indicates that a lag is necessary before price changes can be substantially affected by given changes in demand pressure. 67

The results of the St. Louis equation seem precisely to express this fact.


67 Obviously, the extent of the lag has to be in direct relation with the extent of imperfection existing in the market.
demand pressure may have as much importance as, or even more than, current ones in determining the extent of current price changes.

In order to eliminate the problem of comparing relative against absolute magnitudes, the dependent variable in the price equation is the first difference of the Implicit GNP Deflator. Current and lagged changes in nominal spending are represented by the values of this variable obtained in the nominal spending equation. The potential change in output in quarter (t) is represented by the difference between the estimate of full-employment real GNP in that quarter and actual real GNP in the previous quarter. Estimated values of nominal demand changes, as opposed to the actual values, were used because they captured the sum of the effects of the exogenous variables considered important in determining nominal demand. It is recognized that the proper manner to fit a recursive model is through the use of actual values of the

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68 Using relative price changes as the dependent variable would introduce the problem of heteroscedasticity in the equation. A proper specification of the equation when relative price changes are used would be to construct a measure of relative demand pressure.

69 The estimates of full-employment real GNP used in the present analysis were kindly provided by the Federal Reserve Bank of St. Louis. For more on its construction, see "Estimates of the High-Employment Budget," Federal Reserve Bank of St. Louis Review, Vol. 53 (June, 1967).
variables. However, the instrument variable used here is neutralized from influences other than those specifically assumed in the model.

Although the demand pressure instrument variable was constructed and regressed against changes in the Implicit GNP Deflator, its results were inferior than those results obtained by specifying both components of demand pressure separately in the equation. The values of the variables were transformed through the Cochrane-Orcutt technique due to the presence of autocorrelation. The specification of the price equation finally selected is:

\[ dp_t = 0.2875 + 0.2714 \bar{\Delta}y_{t-1} - 0.04074 (X^f - X_{-1})_{t-1} \]  

\( (1.97) \quad (6.326) \quad (-3.213) \)  

Notes:

Values in parentheses below coefficients are "t" values

*Sum of lagged coefficients

where \( \bar{\Delta}y \) and \( (X - X_{-1}) \) represent, respectively, the change in nominal spending and the potential change in output, and \( dp \) represents

\[ dp_t = 0.2875 + 0.2714 \bar{\Delta}y_{t-1} - 0.04074 (X^f - X_{-1})_{t-1} \]  

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\( (1.97) \quad (6.326) \quad (-3.213) \)  

Notes:

Values in parentheses below coefficients are "t" values

*Sum of lagged coefficients

where \( \bar{\Delta}y \) and \( (X - X_{-1}) \) represent, respectively, the change in nominal spending and the potential change in output, and \( dp \) represents
the change in the Implicit Price Deflator. The lag structure is represented by a fourth degree polynomial and the length of the lag covers the current and the last four past values of both variables. 73 A more detailed presentation of the equation is shown in Statistical Appendix C.

The structure of coefficients of both variables in Appendix C shows that at least two quarters are necessary before a movement in either nominal spending changes or in the potential change in output may significantly affect price changes in the expected direction.

Considering changes in nominal spending, current movements in this variable seem to affect price changes in a negative manner, but the statistical significance attached to its coefficient is very low. 74 The negative sign attached to current changes in spending would suggest that current accelerations or retardations of nominal spending change are an effect rather than a cause of current price changes. However, although there may exist some mutual effects between both variables, the fact that the sign of current spending changes depends

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73 Second degree polynomials were also tried, but, as said below, the results were inferior to those assuming fourth degree polynomials. Longer lag structures were also tried, but it was observed that, after four lagged quarters, the net effect of the independent variables did not increase noticeably.

74 The statistical significance of current changes in nominal spending was always low regardless of the extent of the lag or the degree of the polynomial.
upon the use of second or fourth degree polynomials while always remaining statistically insignificant indicates that its effect upon price changes is not significantly different from zero. \(^7^5\) Last quarter's change in nominal spending is not significantly different from zero either, when using fourth degree polynomials. \(^7^6\)

Most of the effect of changes in nominal expenditures upon price changes seems to be concentrated in changes in nominal spending which occur two and three quarters before the change in prices. The coefficients of the equation indicate that, while the effect of current and last quarter's change in nominal spending broadly offset each other, more than 99 percent of the total effect of a given increase or fall in the rate of growth of nominal spending on price

\(^7^5\)When assuming second degree polynomials and constraining both ends to zero, the sign of current nominal spending changes is positive, although insignificant.

\(^7^6\)There are some disturbing results regarding the statistical significance of last quarter's change in nominal spending. While it is always insignificant when fourth degree polynomials are assumed, it is highly significant even at the one percent level when a second degree polynomial with both ends constrained to zero is used. Besides, in this case its size is very similar to those of the coefficients attached to changes in spending occurring two or three quarters before the price change. However, the crucial dependence of second degree polynomials upon the type of constraint assumed, seems to indicate that they are not the best ones to assume, at least in this equation.
changes occurs within six and twelve months of the change in spending. 77

The structure of effects of current and lagged potential changes in output on price changes is, as in the case of nominal spending changes, substantially limited to four quarters after the movements in actual relative to full-employment output takes place. 78 As in the case of changes in nominal spending, current values of this variable do not seem to affect significantly price changes. However, it is interesting to notice that last quarter's potential change in production affects current price changes in a positive manner, and its coefficient is statistically significant at the 5 percent level. Its size, moreover, is substantially larger in absolute value than that of any of the other lagged coefficients of the same variable. This relatively large immediate positive effect of potential change in production on price changes appears to be largely independent of the degree of polynomial assumed. 79 On

77 A six quarters lag structure seems to stress the effect slightly more into the past. However, as the total effects do not increase noticeably and the overall fit of the equation does not improve, it was considered that a four quarters lag captures most of the effect of nominal spending changes on prices.

78 What was said in the previous footnote regarding changes in nominal spending, applies to this variable as well.

79 This relatively large immediate positive effect of a change in the relation between potential and actual output on price changes seems to be largely independent of the degree of the polynomial assumed; when a second degree polynomial is assumed the (continued)
the other hand, after two quarters, the effect of potential changes in output on price changes becomes, as expected, negative. The total net effect of potential changes in output on the rate of inflation, however, does not seem to be high due to the similar offsetting effects taking place within a year of the change in the independent variable. 80

The use of the demand pressure instrument variable does not modify the nature of the effects observed when its components are included separately. Within the current and next quarters, the net effect of a change in demand pressure on price changes is not significantly different from zero at the 5 percent level. The positive effect appears after two quarters with high statistical significance, but it does not seem to continue after four or five quarters. 81 However, as previously said, the specification of the price equation using the components of the demand pressure variable as affecting the dependent variable is preferred because the overall fit of the

79 (continued) same effects are obtained, the only difference being that, in this case, the very significant positive effect is attributed to current changes in the independent variable. Assuming a six quarters lag structure, the positive effect is extended one more quarter.

80 The net effect of this variable is of the same magnitude when considering longer lag structures.

81 See footnote 76.
equation shows considerable improvement over the one using the demand pressure variable.

The structure of effects of a given movement in demand pressure on price changes taking place within a year of the aforementioned change in demand pressure shows that they are not as smoothly distributed through time as implied in the Andersen-Carlson model. It has to be emphasized that the difference between the results of both equations is not dependent upon the use of changes in nominal spending derived from the nominal spending equation instead of actual ones. Part of the difference may be attributed to the fact that the dependent variable used by Andersen and Carlson is not the change in the Implicit GNP Deflator, but the dollar value of changes in nominal GNP due to price changes. However, the primary reason for the structure of coefficients presented by Andersen and Carlson is likely to be the use of second degree polynomial. Experimentation with second degree polynomial.

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82 See Statistical Appendix A.

83 Experimentation with actual changes in nominal spending showed results very similar to those presented in the text.

84 Defined as \( (P_t - P_{t-1}) \cdot X_{t-1} \), that is, the change in the Implicit GNP Deflator multiplied by the level of real GNP in the previous quarter. This definition of the dependent variable seems to deprive the equation of much of its meaning.

85 As it may be observed in Statistical Appendix A, not only the coefficient attached to current changes in demand pressure is significantly positive at the 1 percent level, but a given change in demand pressure seems to exert the same effect on price (continued)
polynomials in the present equation—either using the demand pressure variable or its components separately—results in a similar type of smoothly distributed lag effects. 86 But when a fourth degree polynomial is assumed, the structure of coefficients changes substantially. Not only the relative importance of each coefficient is more unevenly distributed through the different lagged periods than in the case of a second degree polynomial, but the statistical significance of some of these coefficients drops below the 10 percent confidence level. The improvement in the overall fit of the equation when fourth degree polynomials are assumed for the lag structure instead of second degree ones, and the fact that in the former case the structure is not so crucially dependent upon the constraints used, seem to indicate the appropriateness of using fourth degree polynomials. 87

The fact that current changes in demand pressure affect price changes in a negative manner suggests the cyclical nature of

85(continued) changes for three quarters, and then exert a smaller, but also constant, effect for the following three quarters.

86 This is especially so when both ends of the polynomial are constrained to zero.

87 It may be observed that the standard error of this equation is substantially lower than in Andersen-Carlson's model which, together with a coefficient of determination not much smaller than theirs, results in a substantially higher "F" ratio.
gradual inflationary processes. This can be more clearly seen by analyzing the effects of the components of demand pressure on price changes. The rather sizeable positive effect which a given movement in the potential change in production exerts upon price changes occurring within the current and following quarter implies that, assuming constant nominal demand changes, a fall in actual relative to full-employment output increases the rate of inflation within the immediate future. But within the following quarters the direction of the influence seems to reverse itself, in such a manner that after a year of the movement in the gap between full-employment and actual output, its net effect on the rate of inflation is slightly negative. That is, when actual output falls relative to full-employment levels, it has a dampening effect upon the rate of inflation, although this cannot be felt until almost a year after the gap widens. Actually, the first or "impact" effect appears to accelerate the rate of inflation. On the other hand, an increase in actual output larger than that experienced by the full-employment ceiling will push upwards the rate of inflation within the year. However, as in the previous case, its immediate effect—that is, within the current and following quarters—will be deflationary.

This phenomenon can be explained by the need of a period of adjustment before individuals and firms adjust to changing conditions. An increase in the difference between full-employment and actual
production has to increase the pressure exerted by a constant increase of nominal spending on prices. Thus, the rate of inflation increases in the immediate future when actual falls relative to potential output. After a few months, the increased availability of productive factors will have to bring down their prices—or, at least their rate of increase—and, as a consequence, product prices as well. On the other hand, an increase in actual output which exceeds that allowed by the level consistent with long-run stable growth of the economy will, at first, introduce a larger amount of commodities into the market and reduce the pressure of demand on prices. But the pressure of this accelerated rate of production on the factor market makes itself present after a few months. The result is that after a year of the closing of the gap between full-employment and actual output the rate of inflation not only goes back to its initial levels, but continues to even higher ones. Nevertheless, it seems that the net effect of a change in the relation between potential and actual output upon inflation within a year is relatively minor. The negative and positive effects occurring within the year almost completely offset each other. 88

88 It seems important to emphasize that the almost complete offsetting effects of this variable upon price changes within a year are not at all dependent upon the use of fourth degree polynomials or the assumption of a fourth quarters lag structure.
On the other side, an acceleration in the rate of growth of nominal spending, assuming the potential increase in production remains constant, does not seem to exert any significant influence on the rate of inflation within the current and next quarters, but accelerates the rate of inflation during the following months. Similarly, a retardation in the rate of growth of spending, with actual output keeping the pace imposed by the growth of potential output, will certainly, after a few months, exert a downward pressure upon the rate of inflation. Contrary from the case of a movement in the difference between full-employment and actual output, which exerts nearly offsetting effects within a year, the total effect on prices of a change in the pace at which nominal spending grows appears to be relatively large.

Hence, while the relation between full-employment and actual output is important in determining the pact of inflation within a year, it does not have an important lasting effect upon it; changes in nominal spending is the key variable to determine the path followed by an inflationary process. This reasoning would support a pure "demand-pull" explanation of inflation. However, the fact that changes in nominal spending seem to be significantly influenced by changes in real activity introduces an important qualification to the above statement. The present price equation certainly rejects the hypothesis of a rate of inflation which adjusts rapidly and smoothly to any
change in the extent of market pressure. On the other hand, it suggests that, in the short run, perverse movements in the rate of inflation may be expected. Only when at least two quarters have elapsed between the change in demand pressure and price changes, the rate of inflation responds considerably to market pressure in the expected direction.

The structure of coefficients of the nominal demand and the price equations imply that more than 80 percent of the effect of a given change in the total amount of commercial bank deposits on prices takes place within seven quarters after the change in the monetary indicator. However, a very small fraction of this effect occurs within the first three quarters of the change in the credit proxy. On the other hand, the net effect of a change in high-employment Federal expenditures on prices is virtually zero. This is due to the offsetting coefficients affecting the different lagged values of changes in high-employment Federal expenditures in the nominal spending equation. Unfortunately, the coefficients of the nominal spending equation only capture the direct effect of monetary and fiscal policy changes on changes in nominal demand. In order to determine the total effect of policy variables on spending, it would be necessary to know how much of the current change in real activity is originated in current and lagged changes in monetary and fiscal aggregates.
CHAPTER V

SUMMARY AND CONCLUSIONS

Summary of Major Findings

The model formally presented in Chapter III suggests that the rate of inflation may be explained by the extent of market demand pressure, which is defined as the difference between changes in nominal demand and the potential change in real output. Furthermore, the nominal spending equation implies that short-run changes in velocity of circulation of money cannot be considered a function of only monetary aggregates. Changes in nominal spending are assumed to be a function of current changes in real activity, in real market interest rates and in monetary and fiscal aggregates, and price expectations. It may be observed that the relevant interest rate magnitude assumed to affect spending is not the nominal, but the real market rate, with the difference between both, i.e., price expectations, exerting a separate influence on expenditure changes. This is in accordance with the generally accepted fact that, especially during inflationary periods, the nominal interest rate is
substantially affected by the mounting state of expectations about future price changes.

Unfortunately, real interest rates and price expectations are magnitudes which cannot be directly observed. The model attempts to overcome this shortcoming by constructing two proxies for them. The real market interest variable is obtained by subtracting the price expectations component from the observed nominal interest rate. The price expectations variable is approximated by assuming that individuals base their expectations about future price changes on their past price experience adjusted for the level of resource utilization. The relative importance attached to past rates of price change adjusted for the level of resource utilization is estimated through an equation making the nominal interest rate level a function of the adjusted past rates of price change and other variables.

Nominal Interest Rate

The statistical results of the nominal interest rate equation appear to confirm the importance which many economists attribute to past rates of price change as an independent determinant of current levels of the nominal interest rate. Moreover, the results of the present study imply a substantially shorter period of adjustment of interest rates to past price changes than that suggested in several previous studies. Taking into account the 1950's and the 1960's, the sum of the coefficients of adjusted past price changes indicates that
current interest rate levels—short-term as well as long-term rates—absorbed more than half of the price changes occurring within the last four years. Considering only the 1960's, more than 80 percent of a given price change was translated into a corresponding change in the long-term interest rate within four years.

These results seem to point to the inaccuracy of attempts to estimate the effect of past price changes in interest rates through linear regressions covering a time-span which embodies within it very diverse types of economic experience. Expectations about future price changes are not likely to be significant but when the aggregate price level begins to develop a consistent tendency to move in a certain direction. Hence, a linear estimation of the effect of past rates of price change on nominal interest rates which covers a very long period of time is of very limited usefulness in offering a meaningful estimate of the true importance given by individuals to recent past price changes in forming their expectations about future price changes. The variability of the expectational structure may be clearly seen by looking at the higher importance attached to past rates of price change in the 1960's compared to the 1950's. Not only each coefficient of lagged price changes is larger in the 1960's than the corresponding one in the 1950's, but the whole structure of coefficients shifts in favor of more recent price changes in the second decade, although the mean lag is not substantially reduced.
Regarding the remaining variables assumed to affect nominal interest rates in the equation, it seems that the multicollinearity exists between the level of real income and the rate of change in real income, and that between real income and time during the 1960's, obscures the possible effect of real activity variables on interest rates. On the other side, changes in the money stock exert a significantly negative effect upon nominal interest rates, but this effect does not appear to last much beyond the current quarter. However, it has to be pointed out that the presence of the real income variables may partially offset the effect of past changes in the money stock on current interest rate levels.

Nominal Spending

The main results obtained from the nominal spending equation relate to the statistical significance of changes in real activity and expectations about future price increases in determining nominal spending changes. Current and lagged changes in monetary and fiscal aggregates behave in similar manner as they do in the "St. Louis equation." Monetary changes have a consistently positive effect on nominal spending until, at least, four quarters after the change in the monetary variable. On the other hand, changes in Federal expenditures exert a significantly positive influence on current and next quarter's demand changes, but it is nearly offset within the following three quarters, in such a manner that the net
effect of Federal expenditures on nominal spending disappears within a year.

Changes in real interest rates lose much of their significance when changes in real activity are included in the equation. This is to be expected since interest rates are likely to be closely related to changes to real activity. However, the real interest rate variable is highly significant when the real activity variable is deleted from the equation, and this is so regardless of the monetary aggregate included in the equation. The change in real activity, on the other hand, is statistically significant at the one percent level, and its introduction improves substantially the overall fit of the equation. This is important because it clearly suggests that a noticeable part of changes in demand have to be explained by elements other than changes in the money stock. Velocity of circulation, then, appears to be dependent upon changes in real economic forces, as well as changes in the money stock. Moreover, the fact that the presence of the real activity variable does not affect substantially the statistical significance of the lagged changes in monetary aggregates, suggests that at least part of changes in real activity are independent from previous changes in the money stock.

The price expectations proxy for the 1960's is highly significant, and the comparison of this variable with the coefficient and statistical significance of the price expectations proxy for the 1950's
seems to confirm the non-linear nature of expectations about future price changes. However, there is a disturbing fact which limits the significance which is attributed in the equation to the price expectations proxy variable. The statistical significance, and in some specifications of the equation even the sign, of the price expectations proxy for the 1960's is crucially dependent upon the particular monetary aggregate used to represent changes in the money stock. While the use of the credit proxy makes both price expectations proxies to have a positive sign attached to their coefficients and the one for the 1960's to be statistically significant even at the one percent level, the money supply specification seems to take all of the significance away from the price expectations variable.

Price Changes

The results of the price equation show that, although demand pressure explains more than three-fourths of the variation in price changes, the time pattern of this effect is not smoothly distributed. The current and last quarter's variation in nominal spending do not seem to exert any significant net effect on price changes. On the other hand, a reduction in the potential change in output reduces, instead of raising, the magnitude of price changes within the same period. Thus, the immediate effect of demand pressure on price changes seems to be especially due to movements in the relation
between full-employment and actual output, and not from demand forces. Within the subsequent three quarters, however, increases in nominal demand exert a significantly positive effect on price changes and this effect is strengthened by the negative influence on price changes of the potential change in output. The lagged effects of demand pressure on the rate of inflation are such that, within one year, the net influence of an increase in demand pressure accelerates the upward movement of prices. This appears to obey the fact that, while an acceleration of nominal demand changes has a net positive effect on inflation, the effect of changes in the gap between full-employment and actual output disappears within a year or so.

Conclusions

The statistical results of the model postulated in the present investigation seem to point to the cyclical character of gradual inflationary processes. Although, on the whole, changes in nominal spending seem to be the dominant force in determining the future path of the rate of inflation, the equation stresses the short-run importance of supply elements.

The structure of coefficients of the price equation implies that the immediate effects of a short-run increase in productivity over its long-run path are to slow down the going rate of price
increases, but, after about two quarters, it exerts a destabilizing influence on the inflation rate, probably due to the pressure which such a short-run productivity increase exerts on the existing supply of productive factors through an expansion of activity. It is possible that the lagged perverse effects of a productivity increase on prices is also related to the influence which the real expansionary movement exerts on spending, and, thus, on prices. However, this second effect would have to be attributed, in the equation, to changes in nominal demand. On the other hand, short-run productivity decreases, relative to its long-run path, immediately increase the pressure upon prices. But, after a few months, it brings the rate of inflation down, probably due to the falling pressure exerted in the factor market by the slowdown in real activity.

The significant positive influence exerted on price changes by a change in the difference between full-employment and actual output between the current and the next quarter, added to the rather insignificant net effect of movements in demand changes on the rate of inflation within the same period, clearly shows the cyclical pattern of a gradual inflationary process. Restrictive monetary and fiscal policy measures will, within the first semester or so, accelerate inflation because this variable is more immediately affected by a slowdown in actual output relative to full-employment ceilings than by demand. However, although supply elements seem to
be important within the short run, they do not appear to have an important lasting influence on the behavior of price changes because the equation shows that the total effect is the result of two largely offsetting forces. Changes in nominal demand, on the other hand, seem to be responsible for most of the lasting effects of a change in demand pressure on inflation. Although not having a significant importance on price changes immediately, a given change in nominal spending has a substantially larger net effect than changes in supply conditions on price changes occurring at least within the next four to six quarters.

However, the influence which real activity exerts upon nominal spending according to the results of the nominal spending equation seem to throw some doubts on any assertion denying any lasting importance to supply conditions on the rate of inflation. As said before in this section, it is likely that short-run changes in productivity can exert part of their effect upon the rate of inflation through changes in the level of real activity and, thus, through aggregate spending. Unfortunately, in order to clarify the relation between short-run changes in real activity and the rate of inflation, the model would have to include an equation explaining changes in real output.

The nominal spending equation, in turn, seems to have clearly established the inaccuracy of the position which attributes
short-run changes in velocity of circulation of money only to changes in monetary aggregates. But, on the other hand, despite some positive findings, the nominal spending equation also shows some disturbing results regarding, mainly, the behavior of real interest rate changes and the dependence of the price expectations proxy upon the monetary aggregate used. The structure of effects of policy variables on nominal spending is, also, a source of somehow unconvincing results. It seems that some different specification of the equation and/or a different treatment of changes in the fiscal variables may clarify the true dynamic relation between changes in the Federal Budget and aggregate spending.

Research efforts seem to be badly needed on a more meaningful formulation of the true structure of expectations about future price changes to take account, without necessarily breaking the continuity of the sampled period, the non-linear character of the expectational variable. Finally, the interrelations existing between interest rates, real activity, nominal magnitudes and policy variables, together with the necessity to specify clearly the transmission mechanism going from policy variables to economic activity and prices, appear to point to the convenience of designing a more fully-specified model, in order to reject or confirm statements which, in the present investigation, could only be suggested on a preliminary basis.
ANDERSEN-CARLSON MODEL

1. Nominal Spending Equation

\[ dY_t = 2.67 + 5.57 \times dM_{t-i} + 0.05 \times dHE_{t-i} \]

\[ R^2 = 0.66 \]

\[ (3.46) (8.06) \]

\[ (0.17) \]

\[ \text{S. E.} = 3.84 \]

\[ \text{D. W.} = 1.75 \]

Lagged Coefficients of \( dM_{t-i} \)

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( m_0 )</td>
<td>1.22 (2.73)</td>
<td></td>
</tr>
<tr>
<td>( m_1 )</td>
<td>1.80 (7.34)</td>
<td></td>
</tr>
<tr>
<td>( m_2 )</td>
<td>1.62 (4.25)</td>
<td></td>
</tr>
<tr>
<td>( m_3 )</td>
<td>0.87 (3.65)</td>
<td></td>
</tr>
<tr>
<td>( m_4 )</td>
<td>0.06 (0.12)</td>
<td></td>
</tr>
</tbody>
</table>

Lagged Coefficients of \( dHE_{t-i} \)

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( e_0 )</td>
<td>0.56 (2.57)</td>
<td></td>
</tr>
<tr>
<td>( e_1 )</td>
<td>0.45 (3.43)</td>
<td></td>
</tr>
<tr>
<td>( e_2 )</td>
<td>0.01 (0.08)</td>
<td></td>
</tr>
<tr>
<td>( e_3 )</td>
<td>-0.43 (-3.18)</td>
<td></td>
</tr>
<tr>
<td>( e_4 )</td>
<td>-0.54 (-2.47)</td>
<td></td>
</tr>
</tbody>
</table>

2. Anticipated Price Definition

\[ dP^A_t = Y_{t-2} \left\{ \left[ \sum_{t-i} p_i \frac{P_{t-i}}{U_{t-i}^{1/4}} \right] .01 + 1 \right\}^{k_t} \]

3. Demand Pressure Definition

\[ D_t = dY_t = (X_t^F - X_{t-1}) \]

4. Total Spending Identify

\[ dY_t = dP_t + dX_t \]

5. Price Equation

\[ dP_t = 2.70 + 0.09 \times D_{t-i} + 0.86 \times dP^A_t \]

\[ R^2 = 0.87 \]

\[ (7.07) (9.18) \]

\[ (8.55) \]

\[ \text{S. E.} = 1.07 \]

\[ \text{D. W.} = 1.41 \]
Andersen-Carlson Model (continued)

Lagged Coefficients of Demand Pressure

\[
\begin{align*}
  d_0 &= 0.02 (2.63) \\
  d_1 &= 0.02 (6.33) \\
  d_2 &= 0.02 (6.63) \\
  d_3 &= 0.01 (2.93) \\
  d_4 &= 0.01 (1.86) \\
  d_5 &= 0.01^a (1.38)
\end{align*}
\]

^aLess than 0.01

6. Unemployment Rate Equation

\[
R^2 = 0.92 \\
U_t = 3.9 + 0.04 G_t + 0.28 G_{t-1} \\
R^2 = 0.92 \\
S. E. = 0.30 \\
D. W. = 0.60
\]

7. Long-Term Interest Rate Equation

\[
R^L_t = 1.28 - 0.06 \dot{M}_t + 1.42 Z_t + 0.20 \dot{X}_{t-i} + 0.96 \left( \frac{\dot{P}_{t-i}/U_{t-1/4}}{\dot{P}_{t-i}/U_{t-1/4}} \right) \\
R^2 = 0.92 \\
S. E. = 0.28 \\
D. W. = 0.60
\]

Definition of Symbols

\[
\begin{align*}
  dY_t &= \text{Change in nominal GNP in quarter "t"} \\
  dM_{t-i} &= \text{Change in the Money Stock narrowly defined, in quarter "t-i"} \\
  dHE_{t-i} &= \text{Change in high-employment Federal Expenditures in quarter "t-i"} \\
  dPA_t &= \text{Anticipated price change (scaled in dollar units) in quarter "t"} \\
  \dot{P}_{t-i} &= \text{Annual rate of change in GNP Deflator in quarter "t-i"}
\end{align*}
\]
Andersen-Carlson Model (continued)

\[ \frac{U_{t-i}}{4} = \text{Index of unemployment as a percent of labor force (base = 4.0) in quarter "t-i"} \]

\[ Y_{t-2} = \text{Nominal GNP in quarter "t-2"} \]

\[ D_t = \text{Demand Pressure in quarter "t"} \]

\[ X_t^F = \text{Potential Output in quarter "t"} \]

\[ X_{t-1} = \text{Actual Real Output (GNP in 1958 prices) in quarter "t-1"} \]

\[ dP_t = \text{Dollar change in nominal GNP due to price change in quarter "t"} \]

\[ U_t = \text{Unemployment as a percent of labor force in quarter "t"} \]

\[ X_t = \text{Real Output (GNP in 1958 prices) in quarter "t"} \]

\[ G_t = \frac{X_t^F - X_t}{X_t^F} \cdot 100 \]

\[ R_t^L = \text{Moody's seasoned Corporate Aaa Bond rate in quarter "t"} \]

\[ M_t = \text{Annual rate of change in money stock in quarter "t"} \]

\[ Z_t = \text{Dummy variable in quarter "t" (0 for 1/1955-IV/1960 and 1 for IV/1961-IV/1969)} \]

\[ X_{t-i} = \text{Annual rate of change in real output (GNP in 1958 prices) in quarter "t-i"} \]

- **NOTES:** Numbers in parentheses are "t" values attached to coefficients.

- Sum of lagged coefficients

- "p_t's are from Long-term Interest Rate Equation"
Andersen-Carlson Model (continued)

Notes:

2 The cross-product term \((dP_t)(dX_t)\) was observed to be near zero between 1953 and 1960.

LONG-TERM NOMINAL INTEREST RATE EQUATIONS

Period 1952/III - 1970/IV

\[ r_t^* = 0.997 + 0.068T - 0.037S_1 - 0.049S_2 - 0.011X_t - 0.04(M/p)_t + \
(0.83) (2.71) (-1.32) (-1.72) (-0.59) (-1.33) \]

\[ \cdot055^*X_{t-i} + 0.523^*(\frac{p}{u/4})_{t-i} \]

(2.39) (5.71)

\[ R^2 = 0.9903 \quad S.E. = 0.139 \quad D.W. = 1.299 \]

\[ \text{Sum of lagged coefficients} \]

Structure of Lagged Coefficients of \(X_{t-i}\)

\[ x_0 = .0144 (2.41) \quad x_2 = .0107 (2.3) \quad x_4 = .0059 (1.8) \]
\[ x_1 = .0127 (2.47) \quad x_3 = .008 (2.04) \quad x_5 = .0031 (1.6) \]

Mean Lag: 1.8

Structure of Lagged Coefficients of \(\frac{p}{u/4}\)

\[ p_1 = .045 (3.34) \quad p_6 = .0423 (5.71) \quad p_{11} = .0293 (4.62) \]
\[ p_2 = .0453 (3.95) \quad p_7 = .0405 (5.67) \quad p_{12} = .0254 (4.37) \]
\[ p_3 = .0452 (4.57) \quad p_8 = .0383 (5.47) \quad p_{13} = .0211 (4.14) \]
\[ p_4 = .0446 (5.14) \quad p_9 = .0357 (5.19) \quad p_{14} = .0165 (3.94) \]
\[ p_5 = .0437 (5.54) \quad p_{10} = .0327 (4.90) \quad p_{15} = .0114 (3.76) \]
\[ p_{16} = .0059 (3.60) \]

Mean Lag: 5.8

Period 1952/III - 1960/IV

16 quarter lag structure in variable \(\frac{p}{u/4}\)

\[ r_t^* = -6.88 + .005T - .09S_1 - .077S_2 + .086X_t - .0055(M/p)_t + \
(-4.51) (.412)(-3.11) (-2.74) (4.97) (2.21) \]

\[ .01074^*X_{t-i} + .335^*(\frac{p}{u/4})_{t-i} \]

(-1.093) (7.75)
171

\[ R^2 = 0.9866 \quad S.E. = 0.078 \quad D.W. = 1.742 \]

\( * \) Sum of lagged coefficients

Structure of Lagged Coefficients of \( X_{t-i} \)

\[ x_0 = -.004 (-1.15) \quad x_2 = -.002 (-.73) \]
\[ x_1 = -.003 (-1.003) \quad x_3 = -.001 (-.56) \]

Mean Lag: -.01074

Structure of Lagged Coefficients of \( \left( \frac{\dot{p}}{u/4} \right)_{t-i} \)

\[
\begin{align*}
p_1 &= .0195 (3.5) \quad p_6 = .0271 (7.97) \quad p_{11} = .0397 (2.66) \\
p_2 &= .022 (4.6) \quad p_7 = .0271 (8.10) \quad p_{12} = .0198 (7.21) \\
p_3 &= .0241 (5.75) \quad p_8 = .0267 (8.04) \quad p_{13} = .0168 (7.004) \\
p_4 &= .0256 (6.78) \quad p_9 = .0257 (7.87) \quad p_{14} = .0134 (6.82) \\
p_5 &= .0266 (7.54) \quad p_{10} = .0242 (7.65) \quad p_{15} = .0094 (6.65) \\
\end{align*}
\]

Mean Lag: 6.5

14 quarter lag structure in variable \( \left( \frac{\dot{p}}{u/4} \right) \)

\[ r_t^n = -6.195 + .008T - 0.09S_1 - 0.066S_2 + .0814X_t - .005(M/p)_t - (.3.56) (.56) (-2.85) (-2.13) (4.07) (-1.735) \]

\[ .014*\dot{X}_{t-i} + 0.225* \left( \frac{\dot{p}}{u/4} \right)_{t-i} \]

\[ (-1.1) (5.63) \]

\[ \begin{align*}
R^2 &= 0.9829 \quad S.E. = 0.08816 \quad D.W. = 1.3489 \\
\end{align*} \]

\( * \) Sum of lagged coefficients

Structure of Lagged Coefficients of \( \dot{X}_{t-i} \)

\[ x_0 = -.00441 (-1.074) \quad x_2 = -.00336 (-.917) \]
\[ x_1 = -.00417 (-1.098) \quad x_3 = -.00197 (-.784) \]

Mean Lag: 1.207
Structure of Lagged Coefficients of $\left(\frac{p}{u/4}\right)_{t-i}$

<table>
<thead>
<tr>
<th>$p_1$</th>
<th>$p_2$</th>
<th>$p_3$</th>
<th>$p_4$</th>
<th>$p_5$</th>
<th>$p_6$</th>
<th>$p_7$</th>
<th>$p_8$</th>
<th>$p_9$</th>
<th>$p_{10}$</th>
<th>$p_{11}$</th>
<th>$p_{12}$</th>
<th>$p_{13}$</th>
<th>$p_{14}$</th>
<th>$p_{15}$</th>
<th>$p_{16}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0064 (.8527)</td>
<td>0.0110 (1.807)</td>
<td>0.0148 (2.976)</td>
<td>0.0179 (4.242)</td>
<td>0.0201 (5.344)</td>
<td>0.0216 (6.04)</td>
<td>0.0223 (6.31)</td>
<td>0.0222 (6.31)</td>
<td>0.0214 (6.176)</td>
<td>0.0198 (6.004)</td>
<td>0.0174 (5.83)</td>
<td>0.0142 (5.66)</td>
<td>0.0103 (5.52)</td>
<td>0.0055 (5.39)</td>
<td>0.0198 (6.004)</td>
<td>0.0198 (6.004)</td>
</tr>
</tbody>
</table>

Mean Lag: 6.4

Period 1961/I - 1970/IV

16 quarter lag structure in variable $\left(\frac{p}{u/4}\right)$

$$r^n_t = 4.07 + 1.05 T - 0.053 X_t - 0.022 (M/p)_t + 0.0647 \hat{X}_{t-i} + (3.61) (2.06) (1.77) (-1.756) (1.67)$$

$$0.8.9^6 \left(\frac{p}{u/4}\right)_{t-i}$$

$R^2 = 0.9907$  \hspace{1cm} S. E. = 0.137  \hspace{1cm} D. W. = 1.46

*Sum of lagged coefficients

Structure of Lagged Coefficients of $X_{t-i}$

$X_t = 0.0298 (1.988) \hspace{1cm} X^2 = 0.011 (1.106)$

Mean Lag: .85

Structure of Lagged Coefficients of $\left(\frac{p}{u/4}\right)_{t-i}$

<table>
<thead>
<tr>
<th>$p_1$</th>
<th>$p_2$</th>
<th>$p_3$</th>
<th>$p_4$</th>
<th>$p_5$</th>
<th>$p_6$</th>
<th>$p_7$</th>
<th>$p_8$</th>
<th>$p_9$</th>
<th>$p_{10}$</th>
<th>$p_{11}$</th>
<th>$p_{12}$</th>
<th>$p_{13}$</th>
<th>$p_{14}$</th>
<th>$p_{15}$</th>
<th>$p_{16}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.089 (2.3)</td>
<td>0.085 (2.89)</td>
<td>0.081 (3.78)</td>
<td>0.0765 (5.26)</td>
<td>0.0719 (7.64)</td>
<td>0.067 (9.4)</td>
<td>0.062 (7.55)</td>
<td>0.0567 (5.38)</td>
<td>0.0512 (4.03)</td>
<td>0.0456 (3.21)</td>
<td>0.0397 (2.66)</td>
<td>0.0336 (2.28)</td>
<td>0.0273 (2.004)</td>
<td>0.0208 (1.79)</td>
<td>0.0141 (1.62)</td>
<td>0.0071 (1.48)</td>
</tr>
</tbody>
</table>
14 quarter lag structure in variable $\left(\frac{p}{u/4}\right)$

$$r^n_t = 4.61 + 0.122T - 0.065X_t - 0.023(M/p)_t + 0.074X_{t-i} +$$

$$(4.59) (2.46) (-2.29) (-1.82) (1.92)$$

$$0.8176^{*} \left(\frac{p}{u/4}\right)_{t-i}$$

$$R^2 = 0.9904 \quad S.E. = 0.1393 \quad D.W. = 1.472$$

$^{*}$Sum of lagged coefficients

Structure of Lagged Coefficients of $X_{t-i}$

$$x_0 = .0336 (2.252) \quad x_2 = .0127 (1.28) \quad \text{Mean Lag:} \quad .862$$

$$x_1 = .0221 (1.917) \quad x_3 = .0053 (.809)$$

Structure of Lagged Coefficients of $\left(\frac{p}{u/4}\right)_{t-i}$

$$p_1 = .1039 (2.773) \quad p_6 = .0706 (8.44) \quad p_{11} = .0330 (2.39)$$

$$p_2 = .0976 (3.535) \quad p_7 = .0634 (6.09) \quad p_{12} = .0250 (2.07)$$

$$p_3 = .0911 (4.75) \quad p_8 = .0561 (4.46) \quad p_{13} = .0169 (1.83)$$

$$p_4 = .0844 (6.75) \quad p_9 = .0486 (3.47) \quad p_{14} = .0085 (1.64)$$

$$p_5 = .0776 (9.08) \quad p_{10} = .0409 (2.83)$$

Mean Lag: 4.46

Numbers in parentheses are "t" values attached to coefficients.

**Definition of Symbols:**

$r^n_t$ = Aaa Corporate Bond rate in quarter "t"

$X_t$ = Real GNP (1958 prices) in quarter "t," seasonally adjusted

$(M/p)_t$ = Annual rate of change in real money stock (currency plus demand deposits, divided by the GNP Deflator) in quarter "t," seasonally adjusted

$X_{t-i}$ = Annual rate of change in real GNP in quarter "t-i," seasonally adjusted
\[ p_t = \text{Annual rate of change in GNP Deflator in quarter "t," seasonally adjusted} \]

\[ (u/4)_t = \text{Index of unemployment as a percent of the labor force (base = 4.0) in quarter "t"} \]

\[ S_1 = \text{Seasonal dummy for first quarter} \]

\[ S_2 = \text{Seasonal dummy for second quarter} \]

\[ T = \text{Time trend} \]

**SOURCES:** Aaa Corporate Bond rate, Federal Reserve Bulletin; Money Stock, Federal Reserve Bulletin; GNP, Survey of Current Business; GNP Deflator, Survey of Current Business; Unemployment Rate, Survey of Current Business.
STATISTICAL APPENDIX C
NOMINAL SPENDING EQUATION

\[
dy_t = 0.508 + 0.319 dIP_t + 1.272 d\text{IP}_t^1 + 1.421 d\text{IP}_t^2 + 0.125 p^A_1 + 0.595 p^A_2 + 0.263 d\text{CP}_{t-1} + 0.04 d\text{HE}_{t-1}
\]

\[(2.25) \quad (8.6) \quad (1.54) \quad (2.04) \quad (0.34) \]

\[
R^2 = 0.8880 \quad S.E. = 0.5889 \quad D.W. = 2.177
\]

*Sum of lagged coefficients

Lagged Coefficients of \(d\text{CP}_{t-i}\) \quad Lagged Coefficients of \(d\text{HE}_{t-i}\)

\[
c_0 = 0.00977 \quad .394)
\]

\[
c_1 = 0.04895 \quad (3.30) \quad \text{Mean}
\]

\[
c_2 = 0.0787 \quad (3.575) \quad \text{Lag: 2.4}
\]

\[
c_3 = 0.0787 \quad (4.32)
\]

\[
c_4 = 0.047 \quad (1.613)
\]

Lagged Coefficients of \(d\text{HE}_{t-i}\)

\[
e_0 = 0.1001 \quad (3.422)
\]

\[
e_1 = 0.0722 \quad (3.432) \quad \text{Mean}
\]

\[
e_2 = -0.0022 \quad (-.081) \quad \text{Lag:}
\]

\[
e_3 = -0.0623 \quad (-2.69) \quad -9.8
\]

\[
e_4 = -0.068 \quad (-2.055)
\]

Numbers in parentheses are "t" values attached to coefficients.

Definition of Symbols:

\[d\text{y}_t\] = Change in nominal GNP in quarter "t," seasonally adjusted

\[d\text{IP}_t\] = Change in the Industrial Production Index in quarter "t," seasonally adjusted

\[d\text{IP}_t^1\] and \[d\text{IP}_t^2\] = Change in the real interest rate instrument variables obtained from nominal interest rate equations (4.1.c) and (4.1.e).

\[p^A_1\] and \[p^A_2\] = Price Expectation instrument variables obtained from nominal interest rate equations (4.1.c) and (4.1.e).

\[d\text{CP}\] = Change in total Commercial Bank Deposits in quarter "t," seasonally adjusted

\[d\text{HE}\] = Change in High-Employment Federal Expenditures in quarter "t," seasonally adjusted
PRICE EQUATION

\[ dp_t = 0.2875 + 0.2714* \overline{dy}_{t-i} - 0.04074* (X^f_t - X_{-1})_{t-i} \]

\[ (1.97) \quad (6.326) \quad (-3.213) \]

\[ R^2 = 0.7756 \quad S.E. = 0.2436 \quad D.W. = 1.6373 \]

*Sum of lagged coefficients

Lagged Coefficients of \( \overline{dy}_{t-i} \)  \hspace{1cm} Lagged Coefficients of \( (X^f_t - X_{-1})_{t-i} \)

\[ d_0 = -0.04789 \quad (-1.618) \quad e_0 = -0.01555 \quad (-.3177) \]
\[ d_1 = 0.0238 \quad (0.4454) \quad e_1 = 0.1226 \quad (1.958) \]
\[ d_2 = 0.1476 \quad (3.993) \quad e_2 = -0.0061 \quad (-.1402) \]
\[ d_3 = 0.1366 \quad (3.619) \quad e_3 = 0.09322 \quad (-2.326) \]
\[ d_4 = 0.0113 \quad (0.2234) \quad e_4 = -0.0485 \quad (-1.196) \]

Numbers in parentheses are "t" values attached to coefficients.

Definition of Symbols:

\( dp_t \)  = Change in the Implicit GNP Deflator in quarter "t," seasonally adjusted

\( \overline{dy}_t \)  = Value of change in nominal spending in quarter "t" obtained from the nominal spending equation

\( (X^f_t - X_{-1})_{t-i} \)  = Potential change in real output in quarter "t"

\( X^f_t \)  = Potential output in quarter "t"

\( X_t \)  = Actual real GNP in quarter "t," seasonally adjusted

SOURCES: Implicit GNP Deflator, Survey of Current Business; Potential GNP, Federal Reserve Bank of St. Louis; Real GNP, Survey of Current Business.
VITA

Jorge Osvaldo Bonvicini was born in Nueve de Julio, Province of Buenos Aires, Argentina, on May 4, 1943. He completed his elementary and secondary education in Nueve de Julio.

In 1961, he entered the University of La Pampa, where he received the degree of Contador Publico Nacional in July, 1966. After graduation, he obtained a teaching position at the same university. In October, 1966, he came to the United States holding a Fulbright travel grant and a fellowship from the Latin American Studies Institute of Louisiana State University. In February, 1967, he began working toward the degree of Master of Science in Economics, which he obtained in August, 1968. In February, 1969, he returned to L. S. U. He is now a candidate for the degree of Doctor of Philosophy in Economics.

From February to May, 1968, and from February to May, 1969, he held a research assistantship in the Department of Economics. From September, 1969, to May, 1971, he held a teaching assistantship in the same department. In September, 1971, he was awarded a Dissertation-Year Fellowship from
Louisiana State University. He is a member of Phi Kappa Phi Honor Society and Omicron Delta Epsilon Honor Society in Economics.

In 1967, he married Nora A. Lopez Noguera. They have two children, Ricardo and Monica.
EXAMINATION AND THESIS REPORT

Candidate: Jorge Osvaldo Bonvicini

Major Field: Economics

Title of Thesis: Cycles in Demand-Pull Inflation: An Econometric Approach

Approved:

[Signature]

Major Professor and Chairman

[Signature]

Dean of the Graduate School

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James A. Buchanan

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Karl H.immernag

Roger L. Berkhoef

Date of Examination:

July 12, 1972