A SIMULATION ANALYSIS OF MONETARY POLICY AND MACROECONOMIC ADJUSTMENT

by

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ABSTRACT

This dissertation will consist of a theoretical and simulation analysis of several issues raised by the monetarist debates in macroeconomic policy making. Alternative monetary policies will be evaluated with respect to their long run effects and associated macroeconomic adjustment processes. The Gibson Paradox and the usefulness of interest rate behavior as an indicator of the success of monetary policy will be examined. Finally, we will consider the problem of monetary and non-monetary factors as sources of economic fluctuations: to what extent do oscillations caused by monetary policy--whatever its type--differ from oscillations caused by disturbances outside the scope of monetary policy, such as a shift in private sector investment demand?

PREFACE

I would like to dedicate this dissertation to the memory of my father, whose work for the United Mine Workers developed my interest in Economics.

Jürg Niehans and Louis Maccini of the Department of Political Economy served as my advisors. Solis James and Wilson Outen of the University Computing Center helped me with computer programming. Ilma Rosskopf typed the final draft of this dissertation. I am grateful to all of these people.

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CHAPTER I

INTRODUCTION

Section 1: The Monetarist Debate

In this dissertation we shall investigate several issues raised by the recent debates on "monetarism" in macroeconomic policy making.

Monetarism and Monetary History

Monetarism has been a topic of debate in theoretical as well as empirical literature, and monetarist propositions deal with the long run as well as the dynamic adjustment of the economy to monetary change. The central postulate of monetarism--that changes in the level of money income were due essentially to prior money stock changes--was propounded by Friedman and Schwartz [1963, 1965] after a study of business cycles and monetary change in U.S. economic history. The theoretical foundation for this postulate was traced by Friedman to the quantity theory of money, which Friedman calls a "theoretical approach that insisted that money does matter--that any interpretation of short-term movements in economic activity is likely to be at fault if it neglects monetary changes and repercussions and if it leaves unexplained why people are willing to hold the particular quantity of money in existence." [Friedman (1956): p. 3] However, Friedman and Schwartz did more than simply insist that "money does matter;" they claimed that their evidence made an "extraordinarily strong case" for two propositions:

> (1) appreciable changes in the rate of growth of the stock of money are a <u>necessary and sufficient condition</u> for appreciable changes in the rate of growth of money

> income; and that (2) this is true for long secular changes and also for changes over periods roughly the length of business cycles. [Friedman and Schwartz (1963): p. 53]

Finally, Friedman and Schwartz conjectured from their historical survey that a longer-period change in money income produced by a change in the rate of monetary growth is "reflected mainly in different price behavior rather than in a different rate of growth of output," whereas "a shorter-period change in the rate of growth of the money stock is capable of exerting a sizable influence on the rate of output as well." [Friedman and Schwartz (1963): p. 53]

The Policy Implications of Monetarism

James Tobin accepts the fact that money does matter. He praised the work of Friedman and Schwartz for "putting to rout the neo-Keynesian, if he exists, who regards monetary events as mere epiphenomena, postscripts added as afterthoughts to the non-monetary factors that completely determine income, employment, and even prices." [Tobin (1971): p. 490] However, Tobin criticizes Friedman and Schwartz for going beyond their own logic to the other extreme, where the stock of money becomes the "necessary and sufficient determinant of money income." [Tobin (1971): p. 491] According to Tobin, the difference between the propositions "Money matters" and "Money is all that matters" is also the difference between the propositions "Fiscal policy matters" and "Fiscal policy doesn't matter:"

> If there is a tight linkage, at any moment of time, between money income and the stock of money, then pure fiscal policy--e.g., bond-financed government spending--cannot raise money income. [Tobin (1971): p. 491]

In Tobin's view, the genesis of new money becomes an important question when we admit the importance of government debt. If government debt is of no significance and "money is all that matters" then an increase in the quantity of money has the same effect whether it is issued to purchase goods or to purchase bonds. Tobin writes:

> If all kinds of debt matter, then the genesis of new money makes a difference. To borrow an overworked metaphor, is a "rain" of Treasury bills--promises to pay currency in three months or less--of no consequence for the price level, while a "rain" of currency inflates prices proportionately? [Tobin (1972): p. 862]

We believe that the central problem of the monetarist debate focuses on the genesis of new money. Does it make a difference if money is supplied to the economy in the form of transfer payments, in payment for goods and services, or to purchase bonds? In this dissertation we shall compare the relative macroeconomic effects of equiproportionate money supply changes through transfer payments, open market purchases, and currency-financed expenditures to see if the genesis of new money does indeed make a difference. We shall simulate both the dynamic and long run effects of these three money supply mechanisms on the price level, interest rates, and employment.

The Quantity Theory and the Demand for Money

Of crucial importance to the monetarist interpretation of history is the specification of the private sector demand for money. According to Friedman, the "key insight of the quantity theory approach is that a discrepancy between the demand for and supply of money will be manifested primarily in attempted spending, thence in the rate of change of nominal income." [Friedman (1970): p. 225] Consequently, if an increase in the supply of money, by lowering interest rates, would greatly increase the amount of money the public desires to hold, then the linkage of money and business activity would be weakened if not broken.[1] Friedman thus puts stress on the stability and the relatively low interest elasticity of the demand for money. Friedman has written that:

> The quantity theorist accepts the empirical hypothesis that the demand for money is highly stable--more stable than functions such as the consumption function that are offered as alternative key relations....The stability he expects is in the functional relation between the quantity of money demanded and the variables that determine it...[and] he must sharply limit, and be prepared to specify explicitly, the variables that it is empirically important to include in the function. [Friedman (1956): p. 16]

Friedman takes the interest elasticity of money to be low relative to the other arguments in the demand for money function.[2] In Friedman's view an interest elasticity of $-\infty$ would imply an unstable velocity relation between changes in money and changes in money income.[3] David Fand writes that "although marginal and average velocity differ, the velocity function is sufficiently stable to provide a relation between changes in money and changes in money income." [Fand (1969): p. 563] To Fand, the essential difference between the monetarist and non-monetarist positions is summed up in the demand for money--velocity nexus:

> The quantity theory relates money M, prices P, and income through the quantity of real balances given by the money demand function, while the Keynesian theory relates M or M/P and interest rates via the liquidity preference theory. [Fand (1969): p. 564]

In this dissertation we shall examine the sensivity of monetarist or non-monetarist conclusions to variations in the interest elasticity of money. While the interest elasticity of money may prove to be an important parameter, we shall also vary other asset demand interest elasticities to see if they too play an important role in vindicating monetarist conclusions.

The Importance of the Interest Rate

In emphasizing the importance of money as the "driving force of economic activity,"[4] monetarists have taken exception to Keynesian analysis, which focuses on the interest rate as the operational policy variable.[5] David Fand writes:

> ....the quantity theory focuses on discrepancies between actual and desired real balances to explain movements in income and in the price level, and highlights M as the operational policy variable; the Keynesians assume a given price level, focus on discrepancies between actual and full employment output, and highlight interest rates i; and since i may not always respond to changes in M, other policy variables are sometimes needed.

The non-monetarist emphasis on interest rates is due to their acceptance of a particular theory of the monetary transmission mechanism known as the Income-Expenditure approach. Fand describes this approach in the following way:

> The [Income-Expenditure] theory of the Fiscalists assumes that money changes will affect output or prices only through its effect on a set of conventional yields--on the market interest rate of a small group of financial assets, such as government or corporate bonds. A given change in the money stock will have a calculable effect on these interest rates...given by the liquidity preference analysis, and the interest rate changes are then used to derive the change in investment spending, the induced

> effects on income and consumption, etc. [Fand (1970): p. 280]

Fand lists three reasons why monetarists do not accept the Income-Expenditure theory of the monetary transmission mechanism:

> First, Monetarists suggest that an increase in money may directly affect expenditures, prices, and a wide variety of implicit yields on physical assets, and need not be restricted to a small set of conventional yields on financial assets. Second, they view the demand for money as determining the desired quantity of real balances, and not the level of interest rates. Third, and most fundamentally, they reject the notion that authorities can change the stock of real balances--an endogeneous variable--and thereby bring about a permanent change in interest rates.

In this dissertation we shall examine the importance of the interest rate as an "operational policy variable" by relating its behavior with employment and prices. Must lower interest rates accompany higher prices and/or employment, as the Income Expenditure theory suggests, or might lower interest rates conceivably accompany lower prices and/or employment? In short, must expansionary monetary policy lower interest rates if it is to succeed in stimulating employment and prices?

The Dynamic Adjustment of Interest and Prices

The historical behavior of interest rates and prices has been a frequent topic of research in monetary empirical literature. Over long periods of time in the United States, England, and other major countries interest rates have been highly correlated with the aggregate level of commodity prices. This empirical regularity Keynes named the "Gibson Paradox" since it seemed to contradict the prediction of classical monetary theorists that the interest rate is independent of the price level. According to classical doctrines the price level is determined primarily by the quantity of money, and the quantity-theory relation between money and prices should have no long run effects on interest rates. Irving Fisher writes:

> It certainly stands to reason that in the long run a high level of prices due to previous monetary and credit inflation ought not to be associated with any higher rate of interest than the low level before the inflation took place. It is inconceivable that, for instance, the rate of interest in France and Italy should tend to be higher just because of the depreciation of the franc or lira,... the price level as such can evidently have no permanent influence on the rate of interest except as a matter of transition from one level to another. [Fisher(1930): p. 441]

Fisher went on to explain the Gibson Paradox by positing a unidirectional influence from inflation to interest through an adaptive price expectations scheme when the economy is in transition from one price level to another. Fisher writes:

> The transition from one price level to another may and does work havoc as we have seen, and havoc follows with a lag which is widely distributed. The result is that during a period of inflation the interest rate is raised cumulatively, so that at the end of this period when the price level is high, the interest rate is also high.... Thus, at the peak of prices, interest is high, not because the price level is high, but because it has been rising.... [Fisher (1930): p. 441]

In recent empirical work William Gibson has distinguished three components in the observed movement of interest rates following a monetary increase: (1) a "liquidity" effect, which is the immediate response before income has changed, and thus is expected to be in the opposite direction of the monetary shift, (2) an "income" effect, which is the induced reaction of interest rates to a change in income brought about by a monetary impulse, and is expected to be in the same direction following a monetary change, and (3) a "price expectations" effect, which comes about because monetary changes cause lenders and borrowers to anticipate a changing price level and lead lenders to protect themselves against the expected depreciation in the value of their funds by charging higher rates. This last effect would cause market interest rates to change in the same direction as the monetary change. [See Gibson (1970): pp. 431-55]. Recently, however, Thomas Sargent [1973] has challenged the adequacy of positing a unidirectional influence from inflation to interest rates. Simulating a model in which inflation and interest rates were mutually determined, Sargent generated a positive correlation between prices and interest rates without reference to anticipated inflation.

In this dissertation we shall examine the dynamic adjustment of prices and interest rates following a monetary change. Supressing inflationary expectations, we shall draw attention to macroeconomic forces which produce a positive price-interest rate correlation during the adjustment process. We shall relate the interest rate reactions in our monetary policy experiments to the empirical findings of Gibson [1970] and Sargent [1973].

Monetary Control and Macroeconomic Stability

While stressing the significance of money as the driving force of economic activity, Friedman has cautioned against the use of monetary policy for stabilization of the price level. Friedman writes:

> ...monetary action takes a longer time to affect the price level than to affect the monetary totals, and both the time lag and the magnitude of effect vary with circumstances. As a result, we cannot predict at all accurately just what effect a particular monetary action will have on the price level and, equally important, just when it will have that effect. Attempting to control the price level is therefore likely to make monetary policy itself a source of economic disturbance because of false stops and starts. [Friedman (1968): p. 16]

Friedman believes that monetary authorities have time and again overreacted to changes in economic activity, changing the money supply "too much and too late" in general practice.[6] The reason is clear: the "failure of monetary authorities to allow for the delay between their actions and the subsequent effects on the economy." [Friedman (1968): p. 16] Friedman believes that the best policy that the monetary authorities could adopt would be one of a "steady rate of growth of a specified monetary total." Friedman writes:

> ...it would be better to have a fixed rate that would on the average produce moderate inflation or moderate deflation, provided it was steady, than to suffer the wide and erratic perturbations we have experienced. It is a matter of record that periods of relative stability in the rate of monetary growth have also been periods of relative stability in economic activity. [Friedman (1968): p. 17]

A. W. Phillips takes a much less pessimistic view of monetary policy as a stabilization tool. Having simulated monetary control rules for a simple multiplier-accelerator macroeconomic model, Phillips concluded that "it is quite likely that a monetary policy based on the principles of automatic regulating systems would be adequate to deal with all but the most severe disturbances to the economic system." [Phillips (1954): p. 315] More recently, Holt found that the incorporation of linear decision results will automatically convert an inherently unstable system into an inherently stable one. [Holt (1962): p. 43] Finally, Cooper and Fisher [1973a, 1973b] have found from simulation experiments with the FRB-MIT-Penn and St. Louis Econometric Models that specific monetary control rules outperform constant monetary growth in reducing fluctuations in inflation and unemployment.

In this dissertation we shall simulate the alternative dynamic adjustment processes generated by constant monetary growth and alternative monetary control rules. We shall appraise the relative stability of constant monetary growth and each control mechanism, and relate our results to the timing of observed business cycles.

The Monetary Interpretation of History

Finally, as our last theme we shall scrutinize Friedman's "monetary" interpretation of economic history. We shall do this by simulating the dynamic adjustment of inflation and unemployment set off by monetary and non-monetary change and comparing our results with the historical evolution of inflation and unemployment pictured by Phillips [1958] and Lipsey [1960] for the British economy and by Christ [1973a] for the United States economy. From our simulation experiments we shall see if it is possible to distinguish fluctuations caused by monetary factors from those caused by non-monetary factors, and from pictures of historical cycles we shall see if we can infer the proposition that "money is all that matters."

Section 2: The Niehans Model

A. The Results of Niehans' Analysis

The theoretical framework we have adopted for our simulation study is a dynamic extension of a three-asset static macroeconomic model developed by Niehans in 1971 and published in 1974. [See Niehans (1974)]

In Niehans' model employment, prices, interest rates, and the capital stock are determined by monetary policies. Niehans compared the long run effects of a once-over money stock change through three alternative monetary policies, namely transfer payments, open market purchases, and currency-financed government expenditures. Money supplied through transfer payments he labeled "pure transfer money," money supplied against bonds, "pure debt money," and money issued to pay for expenditures, "pure expenditure money." [Niehans (1974): p. 18] In comparative static experiments for two versions of his model--a "classical" version with full employment and flexible wages and a "Keynesian" version with unemployment and fixed wages--Niehans found that in general the genesis of new money did matter. Pure debt money proved to be less inflationary (with full employment) and less expansionary (with fixed wages) than pure transfer money, while the effects of pure expenditure money turned out to be ambiguous, depending on the way government expenditures affect asset demand. In fact, Niehans could not even rule out the possibility of expansionary open market operations lowering the equilibrium level of prices and employment. [Niehans (1974): p. 30, p. 38]

Niehans found that the monetarist position was upheld in his model when he introduced time preference into his model. Under the time preference version of his model the cross effects of interest rates on asset demands become zero. (Hence a change in the bond rate of return would have no effect on the demand for capital or money, and a change in the capital rate of return would have no effect on the demand for bonds or money). [See Niehans (1974): p. 23] With these zero cross effects of interest rates Niehans found that debt money had the same price and employment effects of transfer money, while the effects of expenditure money remained ambiguous. However, if government expenditures had no effects on private sector asset demand, then transfer and expenditure money would have indentical effects. Niehans thus concluded that time preference coupled with no government expenditure effects on private sector asset demand would vindicate the proposition "money is all that matters."

B. The Merits of Niehans Analysis

We have chosen Niehans' model as our starting point for our dynamic model because of Niehans' focus on the monetarist debate, his incorporation of capital stock adjustment, and his treatment of government expenditures. We also felt the Niehans' model left unanswered many questions which were important for the monetarist debate and which were ripe for further development by dynamic analysis and simulation techniques.

Capital Accumulation and Wage Adjustment

Niehans' analysis of long run macroeconomic adjustment in which monetary policy affects capital accumulation as well as the price level fills a gap left by Patinkin's approach to macroeconomic theory. The equilibrium generated by Patinkin's model--which does not include capital stock changes--thus appears as a snap-shot showing the economy somewhere in the course of adjustment to full stock equilibrium.[7] However, Niehans does acknowledge that the fixed-wage version of his static model is a "Keynesian way-station to dynamic analysis." [Niehans (1974): p. 33] We shall therefore extend Niehans' model to include unemployment with semi-flexible "Phillips Curve" wage dynamics, and we shall consider the long-run and dynamic effects of monetary policies in our "Phillips Curve" version as well as in the full employment and unemployment versions developed by Niehans.

Treatment of Government Expenditures

Niehans' treatment of government expenditure effects on the private demand for assets is new. His result--that expenditure money may be more expansionary or less expansionary than transfer money--has also been found by Henderson and Sargent [1973] and Blinder and Solow [1973]. The reason for his result--that government expenditures have ambiguous effects on asset demand, depending on the way asset holders view government expenditures vis-a-vis their human and non-human wealth--strikes us as more appealing than the reasons put forward in the Henderson-Sargent and Blinder-Solow models.

The Henderson-Sargent model has two sectors but neglects capital accumulation. In their two-sector model government purchases may either increase or decrease output and employment "depending on the relative capital intensities of the two production sectors and some other conditions involving the interest elasticity of the demand for money." [Henderson and Sargent (1973): p. 363] Blinder and Solow, on the other hand, found it logically possible for the economy to be stable and fiscal policy "ineffective" when they introduced capital accumulation into their model. Nevertheless, they concluded that their model still supports the fiscalist position for a range of parameter values characteristic of the United States economy.

The Henderson-Sargent and Blinder-Solow models suffer from the same drawback: both do not consider the nature of specific government expenditures. In Niehans' treatment specific types of government expenditures--such as military spending--may be considered by asset holders as offsets to their human and private wealth, and may have very different macroeconomic effects than government expenditures which asset holders regard as supplements to their human and private wealth --such as investment in education and research.

Unanswered Questions

Niehans' study left open many questions. Niehans could not exclude by analytical means the possibility of deflationary or contractionary open market purchases, and he could not say how much government expenditure effects on asset demand make a difference if his model took on parameter values characteristic of the United States economy.

Finally he did not consider dynamic aspects of the monetarist debate such as the short run effects of alternative monetary policies and the adjustment of interest and prices during the transition process. We shall consider these questions in our simulation study of our dynamic model of monetary policy and macroeconomic adjustment.

Section 3: Method of Analysis

In this dissertation we have employed computer simultation techniques to analyze the dynamic response of employment, prices, and interested rates generated by monetary policies in our model. In this dissertation we have simulated our model after we numerically specified the parameters with personally and sometimes arbitrarily selected values. Two problems may arise with respect to our analysis: (1) why simulate, and (2) if simulation, why not an econometric model of the U.S. economy.

Why Simulate?

Our interest in simulation developed after a study of Monetary and Fiscal Policy in a Growing Economy by Duncan Foley and Miguel Sidrauski. We believe that Foley and Sidrauski severely limited their policy discussions by restricting themselves to "two dimensional" analysis. To sidestep third order dynamic systems, Foley and Sidrauski assumed that one policy instrument always maintained one of the three endogenous variables (capital stock, price level, or interest rate) constant during the adjustment process. From this assumption they proceeded to study the dynamic effects of another policy instrument on the two remaining endogenous variables.

In our dynamic analysis of monetary policy we did not want to make the same restrictive assumptions on capital, price, or interest rate adjustment as Foley and Sidrauski made to sidestep third-order dynamic analysis. We believed that the realism of our policy results would be severely handicapped if we had to assume that prices or interest rates remained perfectly stable during the adjustment process. Instead of trying to reduce our third-order model to a lower-order model for analytical solution, we decided to turn to simulation in order to study the dynamic properties of our model. Indeed, Naylor believes that the analytical difficulties of solving higher-order dynamic models has provided most of the impetus for using computer simulation as a tool of analysis in economics:

> Since the 1930's, economists have relied on solutions to differential and difference equations as the standard analytical techniques for investigating the behavior of business cycles and competitive markets. But as non-linearities, higher-order equations, and stochastic variates are introduced into these models, solutions by straightforward analytical techniques become increasingly difficult, if not impossible....Under these circumstances economists have almost been forced to turn to numerical analysis or to computer simulation as an alternative mode of analysis. [Naylor (1971): p. 8]

With simulation we became convinced we could easily trace out the dynamic consequences of our model without distorting or reducing relationships in our model for purposes of analytical solution.

Small-Scale Model Simulation

For purposes of tracing the dynamic effects of specific monetary policies on the economy one might wonder why we did not simply simulate any one or several of a number of large scale macroeconometric models. We have chosen to numerically specify and simulate our own small scale model rather than a particular econometric model to determine the general properties of our model, to examine the influence of new behavioral relationships specified in our model, and to isolate more easily specific dynamic processes in the monetary adjustment process.

First, we do not want to restrict ourselves to model predictions specific for the United States economy. In our simulation experiments we wanted to be able to vary initial conditions and parameter values over a wide range of magnitudes, and to analyze the properties of our model with respect to the effects of monetary policy. While we did select many of our initial parameters and starting conditions from empirical studies of the U.S. economy, we did not want to feel bound to confidence intervals and parameter selections estimated for the U.S. economy. If monetary policies generate specific results for a wide range of parameter variations and changes in initial conditions, we believe our findings would have greater appeal than results generated by a model estimated for one particular economy.

Secondly, specific relationships in our model, such as the effects of government expenditures on private sector asset demand, are new, and consequently do not appear in present large scale econometric models. In this dissertation we wanted to determine the influence of these previously unspecified relationships on the monetary adjustment process by simulating our own model for a variety of parameter selections.

Third, our model is small and aggregative, and simplifies many structural relationships studied in current, large-scale disaggregated econometric models. In this dissertation we wanted to test the influence of variations in key parameter magnitudes on the monetary adjustment process, and to isolate specific links in the monetary transmission mechanism. In large-scale econometric model simulations, where the causal and feedback relationships are quite complex, this task would be much more difficult.[8]

Section 4: Chapter-By-Chapter Survey

We shall now briefly survey the contents of each chapter of this dissertation.

In Chapter II we present our dynamic version of Niehans' theoretical static macro model. [See Niehans (1974)]. We shall develop a full employment model and a rigid wage model with unemployment for studying the dynamic effects of once and for all money supply changes through transfer payments, open market purchases, and currency-financed government expenditures. We shall then introduce a semi-flexible wage adjustment model incorporating inflationary expectations and a Phillips Curve wage mechanism for studying the dynamic effects of monetary growth rate changes, control rules, and non-monetary disturbances. In this chapter we shall differentiate our model from the models put forward by Rose [1966, 1967, 1969], Stein [1971], and Brainard and Tobin [1971].

Chapter III contains our numerical specification of parameters and initial conditions. As often as possible we have drawn upon published empirical estimates for specifying our parameters. In this chapter we shall also discuss the stability of our model by the Newton-Raphson root finding algorithm, and we shall discribe the Runge-Kutta method we employed for numerically integrating our system of differential equations.

In Chapter IV we shall discuss our simulation results. Here we shall consider the dynamic effects of a once-over 10% money supply increase through transfer payments and open market purchases under conditions of full employment with perfect wage flexibility and unemployment with perfect wage rigidity. Finally, we shall consider the effects of both policies when inflationary expectations and semi-flexible wage rates enter into our model. In the full employment model we shall discuss the validity of the quantity theory of price adjustment and the long run neutrality of money under relatively high and relatively low asset demand interest rate elasticities, and under a 50% reduction of the stock of government bonds. In the unemployment wage model we shall scrutinize the positive price-interest rate correlation generated during the adjustment process, and relate this phenomenon to relative speeds of adjustment for capital accumulation and employment. Finally, we shall examine the interaction of unemployment and inflationary cycles in our model of expectations and imperfect wage flexibility. In this chapter we shall conclude that money is practically all that matters, since the dynamic and long-run effects of money supplied through open market purchases always fall quite close to the corresponding effects of money supplied through transfer payments.

Chapter V deals with the dynamic and long run effects of a once over 10% money stock increase serving as payment for government expenditures. We shall again study the adjustment process under conditions of perfectly flexible and perfectly rigid wages, as well as for inflationary expectations and semi-flexible wage rates, and we shall compare our results with the corresponding effects of transfer money. In our model "fiscal policy matters" only when government expenditures affect private sector asset accumulation. In particular, if asset holders consider public expenditures as complimentary to private wealth, expenditure money turns out to be less expansionary than transfer money, and if they consider public expenditures as substitutes for private wealth, expenditure money turns out to be more expansionary than transfer money.

While comparing the relative macroeconomic effects of expenditure and transfer money in Chapter V, we shall draw attention to the importance of the interest rate in the monetary adjustment process. In our policy experiments presented in this chapter similar interest rate effects accompanied considerably different employment and price effects of expenditure and transfer money. Low interest rates thus do not appear as a sine qua non for new money to stimulate employment and economic expansion.

Finally, in Chapter VI we shall discuss the effects of continuing and intermittent monetary expansion in the context of semi-flexible wage rates, unemployment, and inflationary expectations. In the first set of policy experiments monetary control rules will be considered, and in the last section of this chapter we shall compare the dynamic effects of monetary expansion and an exogenous shift in private sector investment. We shall compare our artificially generated "Phillips Curve whirlwinds" with inflation-unemployment configurations observed over the last two decades.

Chapter VII is our concluding chapter. It is both a summary of our principal results and an assessment of the limitations of our research.

FOOTNOTES TO CHAPTER I

(1) This point was made by Tobin in his review of Friedman and Schwartz's Monetary History of the United States 1867-1960. [See Tobin (1971): p. 490]

(2) Friedman contends that with only one exception, "every study for the United States finds that variations in real income or wealth are a more important source of variations in the real quantity of money demanded than are variations in interest rates" [Friedman (1969): p. 143] The one exception a study of post-World War II U.S. quarterly data for households by M. J. Hamburger [(1966): p. 600]

(3) In Friedman's opinion, no "fundamental issues in either monetary theory or monetary policy hinge on whether the estimated elasticity can for most purposes be approximated by -.1 or -.5 or -2.0, provided it is seldom capable of being approximated by $-\infty$. [Friedman (1969): p. 155]

(4) Brunner [1970] cites this as the third of four propositions he calls the "defining characteristics of the monetarist position." [See Brunner (1970): p. 7]

(5) Brunner lists the differences between monetarists and non-monetarists on the importance of the interest rate in the monetary transmission mechanisms as the first of four propositions which he calls "defining characteristics of monetarism." [See Brunner (1970): p. 3]

(6) Brunner also believes that most of the destabilizing shocks experienced by the economy arise from decisions of the government with respect to tax, expenditure, and monetary policy, rather than from the instability of private investment or of some other aspect of private-sector behavior. Brunner lists this as the second of the four defining characteristics of monetarism. [See Brunner (1970): p. 5].

(7) Niehans [(1973): p. 1-8] has shown how his full stock equilibrium model may be reduced to the IS-LM model utilized by Patinkin.

(8) For example, a change in the money supply in a large-scale model would entail reactions of the commercial banking system and a wide range of interest rates on various financial assets. In our model there is no comercial banking system, and there are only three assets, namely money, capital, and government bonds. An examina-

tion of the monetary transmission mechanism in our model would therefore not have to consider the reactions of the banking system and the links between many different financial assets.

CHAPTER II

A THEORETICAL MODEL OF MACROECONOMIC ADJUSTMENT

Section 1: Introduction

In this chapter we shall develop our dynamic model of macroeconomic adjustment. In later chapters of this dissertation we shall study the dynamic effects of monetary policy for three versions of this model. The "classical" version of our model is a full-employment system with perfect wage rigidity, while the "Keynesian" version is an unemployment system with perfectly rigid wages. Finally, the "Phillips Curve" version of our model includes unemployment, semi-flexible wage adjustment, and adaptive price expectations.

In the following section of this chapter we shall discuss our stock adjustment framework for private sector asset accumulation. In this framework we shall present our dynamic equations for capital, cash balance, and government bond accumulation, as well as our price and interest rate adjustment mechanisms. In the third section we shall present our labor market equations for the classical and Keynesian versions of our model as well as our dynamic model of inflationary expectations and semi-flexible wage adjustment for the Phillips Curve version of our model. The fourth section is a summary of our model.

Section 2: A Stock Adjustment Model of Asset Accumulation

In our dynamic model we shall abstract from long run growth and assume that the economy is dynamically stable and converges to a stationary equilibrium. Hence, saving and wealth accumulation appear in our model as disequilibrium phenomena, and occur only during periods of transition.

There are two sectors in our model: a government sector and a private sector. Households, firms, the commercial banking system, and financial intermediaries do not appear explicitly in our model, but are subsumed by our definition of the private sector.

The government sector purchases goods and services from the private sector, collects taxes, and issues currency and bonds to the public. These activities of the government sector are related by the government budget constraint, which states that the excess of government expenditures (g) over tax inflows (t) must equal the sum of government currency and bond issues to the public:

$$(1) \quad g - t = \frac{\Delta M}{p} + \frac{\Delta B}{ip}$$

where M represents the money stock, B the stock of outstanding government bonds consisting of consols paying \$1 per year forever, p the price level, i the bond rate of return, and Δ the operator denoting the change in a stock per time period. We shall interpret g, t, M, and B as per capita variables with population measured by the number of people in the labor force.

The three money supply mechanisms which we shall examine in this dissertation are transfer payments, open market purchases, and currency-financed government expenditures. For simplicity, we shall refer to new money supplied through currency-financed government expenditures as "expenditure money."[1] The three money supply mechanisms are expressed by the following equalities in the government budget constraint:[2]

$$\text{transfer payments:}\quad \frac{i}{p}\Delta M = -t; \quad g = \Delta B = 0$$

$$\text{open market purchases:}\quad \frac{1}{p} = -\frac{1}{ip}\Delta B; \quad t = g = 0$$

$$\text{expenditure money:}\quad \frac{1}{p}\Delta M = g; \quad t = \Delta B = 0.$$

The private sector engages in two activities: the production of goods and services and the accumulation of wealth.

Output (q) is related to the two factors of production, real capital (K) and labor (E) by the following Cobb-Douglas macroeconomic production function:

$$(2) \quad q = q(K,E) = AK^{\alpha}E^{1-\alpha}$$

Each factor of production is paid its marginal product. Hence we express the real wage rate (w/p) and the rate of return on capital (r) as follows:

$$(3) \quad \frac{w}{p} = q_E(K,E) = (1 - \alpha)AK^{\alpha}E^{-\alpha}$$

$$(4) \quad r = q_K(K,E) = \alpha AK^{\alpha-1}E^{1-\alpha}$$

Unemployment is the difference between the labor force (whose per capita value is 1) and employment:

$$(5) \quad U = 1 - E.$$

In our model asset holders may hold their wealth in three forms: real capital (K), money (M/p), and government bonds (B/ip). Real capital (K) is simply the homogenous stock of productive capital in the economy, and its rate of return, r, is the marginal product of capital in the productive sector.[3] We define the stock of money (M/p) as the outstanding stock of government currency issued to the private sector. Finally, the stock of government bonds (B/ip) consists only of private holdings of government debt. The Central Bank's holdings of government debt cancel out in the balance sheet of the consolidated government sector, and private securities net out in the private sector balance sheet. We assume that private securities are perfect substitutes for government bonds, so that the same interest rate rules for both.

Wealth accumulation occurs in our model as a result of stock disequilibrium in real capital, cash balances, or bonds. Whenever there is a discrepancy between the desired and actual holdings of a particular asset, asset holders alter their holdings of the respective asset. However, we shall assume that asset holders cannot fully offset discrepancies between desired and actual asset holdings within one time period. This sluggish behavior of asset holders may be due to adjustment costs and other constraints which shall not be specified in our model. We shall express the accumulation of capital, cash balances, and bonds by the following stock adjustment model of asset accumulation:

(6) $\Delta K = \kappa[K^{*} - K]; \quad 0 < \kappa < 1$

(7) $\Delta(M/p) = \lambda[L^{*} - (M/p)]; \quad 0 < \lambda < 1$

$$(8) \quad \Delta(B/ip) = \beta[B^* - (B/ip)]; \quad 0 < \beta < 1$$

The stock demands for real capital, cash balances, and bonds, are represented by K^*, L^*, and B^*. Aggregate demand for each asset depends on the same set of variables:[4]

$$(9) \quad K^* = K(K, M/p, B/ip, h, g, r, i, \pi)$$

$$K_K > 0 \quad K_{M/p} > 0 \quad K_{B/ip} > 0$$

$$K_h > 0 \quad K_g \gtrless 0$$

$$K_r > 0 \quad K_i \leq 0 \quad K_\pi \geq 0$$

$$(10) \quad L^* = L(K, M/p, B/ip, h, g, r, i, \pi)$$

$$L_K > 0 \quad L_{M/p} > 0 \quad L_{B/ip} > 0$$

$$L_h > 0 \quad L_g \gtrless 0$$

$$L_r \leq 0 \quad L_i \leq 0 \quad L_\pi \leq 0$$

$$(11) \quad B^* = B(K, M/p, B/ip, h, g, r, i, \pi)$$

$$B_K > 0 \quad B_{M/p} > 0 \quad B_{B/ip} > 0$$

$$B_h > 0 \quad B_g \gtrless 0$$

$$B_r \leq 0 \quad B_i > 0 \quad B_\pi \leq 0$$

The expected signs of the partial derivatives appear below each equation. Eight arguments enter the asset demand functions. The wealth variables $K, M/p$, and B/ip are the first three arguments. The fourth argument, h, represents labor income $\frac{Ew}{p}$.[5] All of these first four arguments have positive effects on the demand for capital, cash balances, and bonds. The sixth argument r represents the rate of return on capital, and corresponds to the marginal productivity of capital, while the seventh argument i is the market-determined interest rate on government bonds.

The variable π is the expected rate of inflation.[6] In the classical and Keynesian versions of our model we shall not consider the effects of expectations. Hence π will be set at zero throughout the adjustment process. In the Phillips Curve version of our model, however, the evolution of π over time is adaptive:

$$(12) \quad \Delta\pi = \rho[\frac{\Delta p}{p} - \pi]$$

The partial derivatives K_g, L_g, and B_g express the effect of a balanced-budget increase in government expenditures on the private demand for assets. In our model a balanced-budget increase in government spending may be viewed as an increase in public wealth. Such public wealth changes, however, do not have clear-cut effects on asset demands. On the one hand asset holders may consider a balanced-budget increase in public wealth as a supplement to their labor income or their private wealth holdings. Then the partial derivatives K_g, L_g, and B_g will be positive. This is a plausible assumption according to Niehans if, for example, "the government supplies services to the private sector which otherwise would have absorbed labor." [Niehans (1974): p. 22] On the other hand, asset holders may regard a balanced-budget expenditure wave as an offset to their labor income or wealth holdings (like wasted resources). Then Niehans believes the partial derivatives will be negative. [Niehans (1974): p. 22] We shall further examine the probable effects of government expenditures on asset demand in Chapter V when we discuss the macroeconomic effects of expenditures coupled with money supply increases.

There is no need for tax flows t to appear in our asset demand equations (9) - (11). Let us consider, for example, the effect of a one-period increase in tax revenue on the demand for capital. If the government does not use any of increased tax revenue to pay for new expenditures or to retire bonds, then the tax increase will be reflected in a reduction in the money stock. The effect of this money stock change on the demand for capital is expressed by the partial derivative $K_{M/p}$. On the other hand, if the entire revenue from the tax increase is used to retire bonds, there will be a reduction in the outstanding stock of bonds. The effect of the change in the stock of bonds on the demand for capital is expressed by the partial derivative $K_{B/ip}$. Finally, if all of the increased tax revenue is used to pay for new government expenditures, there will be no change in the stock of currency or bonds in the economy. The effect of this tax-financed expenditure increase on the demand for capital is expressed by the partial derivative K_g, considered above. Of course, any given tax increase may be used to finance expenditures, retire bonds, and "destroy" money. Then the effect of this tax on the demand for capital is expressed by the three partial derivatives $K_g, K_{B/ip}$, and $K_{M/p}$. Thus the effect of a tax change on the private demand for assets may be expressed in our model by the corresponding effects of cash balances, bonds, or government expenditures on the demand for assets.

In asset demand equations (9) - (11) we have assumed that changes in the capital yield r and the interest rate on bonds i have positive own asset effects while their cross effects are negative or zero. Hence $K_r > 0$ and $B_i > 0$ while $B_r \leq 0$ and $K_i \leq 0$. We also expect increases in r or i to lower the demand for money. Hence $L_r \leq 0$ and $L_i \leq 0$. Finally, we shall assume that an increase in the expected rate of inflation may lower the demand for money and bonds and increase the demand for capital.

In all of our simulation experiments we have assumed linear asset demand functions. Hence the partial derivatives appearing below asset demand equations (9) - (11) represent the coefficients in each asset demand function.

For convenience, we have summarized our symbols in alphabetical order in Table II-1, below.

TABLE II-1

DEFINITION OF VARIABLES AND PARAMETERS

B: the nominal stock of government bonds, consisting of consols or perpetuities paying one dollar per year forever.

B^*: the stock demand for bonds.

$B_K, B_{M/p}, B_{B/ip}$: coefficients in the bond demand function for capital, cash balances, and bonds.

B_h, B_g: coefficients in the bond demand function for labor income and government expenditures.

B_r, B_i, B_π: coefficients in the bond demand function for the capital rate of return, interest rate on bonds, and the expected rate of inflation.

β: adjustment coefficient relating actual bond accumulation to asset holders' excess demand for bonds.

Δ: derivative operator denoting the change in a variable with respect to a change in time.

E: the employment rate.

g: government expenditures.

h: labor income, in per capita terms, defined as the real wage multiplied by the employment rate. Hence $h = Ew/p$.

i: the rate of return on government bonds, in real terms. In succeeding chapters we shall refer to this variable simply as the interest rate.

K: the stock of productive capital.

K^*: the stock demand for real capital.

$K_K, K_{M/p}, K_{B/ip}$: coefficients in the capital demand function for capital, cash balances, and bonds.

K_h, K_g: coefficients in the capital demand function for labor income and government expenditures.

K_r, K_i, K_π: coefficients in the capital demand function for the capital rate of return, the interest rate on bonds, and the expected rate of inflation.

κ: adjustment coefficient relating actual capital accumulation to asset holders' excess demand for capital.

L^*: the stock demand for money.

$L_K, L_{M/p}, L_{B/ip}$: coefficients in the money demand function for capital, cash balance, and bonds.

L_h, L_g: coefficients in the money demand function for labor income and government expenditures.

L_r, L_i, L_π: coefficients in the money demand function for the capital rate of return, the interest rate on bonds, and the expected rate of inflation.

λ: adjustment coefficient relating actual cash balance accumulation to asset holders' excess demand for money.

M: the nominal stock of money.

p: the price level.

π: the expected rate of inflation.

q: real output of the economy.

r: the rate of return on capital, defined as the marginal product of capital. In succeeding chapters we shall refer to this variable simply as the yield.

ρ: adjustment coefficient relating the evolution of anticipated inflation to the difference between actual and expected inflation.

t: tax revenue.

w: the nominal wage rate.

Inflation, Interest Rate Adjustment, and Market Equilibrium

In our stock adjustment model of asset accumulation both price level and interest rate movements reflect discrepancies between investment and desired saving.

In our model actual and desired investment are identical. Investment is simply the change in the capital stock generated by discrepancies between the desired and actual capital stock:

$$(13) \quad \Delta K = I = \kappa[K^* - K]$$

Our model of capital accumulation may be considered as a special case of capital accumulation models put forward by Rose [1969] and Stein [1971]. Rose and Stein assume that the actual rate of capital formation in periods of disequilibrium will be less than firms desire (I) but more than consumers desire to save (S). In the Rose-Stein models neither investment plans nor consumption plans are fully realized in periods of excess aggregate demand. Everyone is partially frustrated. Both Rose and Stein assume that the actual rate of capital accumulation is a linear combination of planned savings and investment:

$$(14)\quad \frac{\Delta K}{K} = a\frac{I}{K} + (1-a)\frac{S}{K}$$

However, Rose and Stein also acknowledge that their model of capital accumulation was made in default of a "theory of frustrations" for investment and consumption demand. Both acknowledge that the question of "which demands are frustrated and which demands are satisfied" is determined by an unspecified institutional structure. [See Rose (1969): p. 141 and Stein (1971): p. 63] In terms of the Rose-Stein capital accumulation model described in equation (14), we are simply assuming that the institutionally determined coefficient a is unity. In the absence of any theory of frustrations for investment and consumption demand, we are thus assuming that investors' plans are fully satisfied during periods of disequilibrium.

In our model desired saving is the change in non-human wealth:

$$(15)\quad S = \Delta K + \Delta(M/p) + \Delta(B/ip)$$

The difference between investment and saving thus corresponds to discrepancies between desired and actual cash balances as well as desired and actual bond stocks held by the private sector. Subtracting equation (15) from (13), and substituting stock adjustment equations (7) and (8) for cash balance and bond accumulation, we obtain the following equalities:

$$(16) \quad I - S = - \Delta(M/p) - \Delta(B/ip), \text{ and}$$

$$(16') \quad I - S = - \lambda[L^* - (M/p)] - \beta[B^* - (B/ip)]$$

Our expressions for inflation and interest rate adjustment come from equations (7) and (8), our stock adjustment expressions for cash balance and bond accumulation equations. Differentiating the left hand side of equation (7), we obtain the following formula for price adjustment:

$$(17) \quad \frac{\Delta p}{p} = \frac{-\lambda[L^* - (M/p)]}{(M/p)} + \frac{\Delta M}{M}$$

Our expression for interest rate adjustment comes from a differentiation of the left hand side of equation (8):

$$(18) \quad \frac{\Delta i}{i} = \frac{-\beta[B^* - (B/ip)]}{(B/ip)} + \frac{\Delta B}{B} - \frac{\Delta p}{p}$$

Equations (17) and (18) show that inflation and interest rate adjustment are directly related to stock disequilibrium in cash balances and bonds. Since the excess of investment over planned saving is manifested by cash balance and bond disequilibrium, we may conclude that changes in both the price level and the interest rate directly reflect inequality between saving and investment. By eventually restoring stock equilibrium in cash balances and bonds, the adjustment of both the price level and the interest rate simultaneously restore equality between planned saving and investment.

Equation (18), our expression for interest rate adjustment, shows that there is no interest rate "assignment problem." In Patinkin's model, interest rate adjustment is specified as a function of excess demand in the bond market, while Keynesian theory--in Patinkin's view--links interest rate adjustment to excess demand for money. [Patinkin (1965): p. 261)] Substituting equation (17) into (18), we may write our interest rate adjustment equation in the following way:

$$(18') \quad \frac{\Delta i}{i} = \frac{-\beta[B^{*} - (B/ip)]}{(B/ip)} + \frac{\lambda[L^{*} - (M/p)]}{(M/p)} + \frac{\Delta B}{B} - \frac{\Delta M}{M}$$

From (18') it is clear that the interest rate falls when there is an excess demand for bonds and rises when there is an excess demand for money. Hence we do not need to choose between the Patinkin or Keynesian theory of interest rate adjustment. In our model the problem of assigning interest rate adjustment to excess demand for bonds or excess demand for money simply does not arise. By derivation we find that our stock adjustment model links interest rate adjustment to disequilibrium in both bonds and money.

The Brainard-Tobin Model

Let us now return to the asset accumulation expressions represented by equations (6) - (8) and the asset demand expressions represented by equations (9) - (11).

Our stock adjustment model of asset accumulation is similar in form to the one put forward by William Brainard and James Tobin [1968]. However, there are important differences.

In the Brainard-Tobin model asset holders consider the stock of wealth to be exogenous. Furthermore, the demand for total wealth must always correspond to actual wealth (W):

$$K^* + L^* + B^* = K + (M/p) + (B/ip) = W$$

In the Brainard-Tobin model, therefore, income levels and interest may play no role in affecting the desired level of total wealth. Because of their wealth constraint Brainard and Tobin impose a unitary adding-up property on asset demand wealth coefficients and a zero adding-up property on asset demand income and interest rate slopes.

$$\frac{\partial K^*}{\partial W} + \frac{\partial L^*}{\partial W} + \frac{\partial B^*}{\partial W} = 1$$

$$\frac{\partial K^*}{\partial y} + \frac{\partial L^*}{\partial y} + \frac{\partial B^*}{\partial y} = 0$$

and $$\frac{\partial K^*}{\partial i} + \frac{\partial L^*}{\partial i} + \frac{\partial B^*}{\partial i} = 0$$

Income levels and interest rates thus play no role in determining the desired level of total wealth. There is never any excess demand for wealth or actual wealth accumulation as a direct result of stock disequilibrium. Capital, price, and interest rate movements generated by monetary policies simply reflect changes in the composition of total wealth as the economy adjusts from initial to long run equilibrium.

In our model, on the other hand, asset holders are free to alter the level as well as the composition of wealth. During the adjustment process desired wealth does not necessarily correspond to actual wealth. Hence we do not impose a unitary adding-up property on asset demand wealth coefficients and a zero adding-up property on interest rate slopes. Capital, price, and interest rate movements consequently reflect asset holders' adjustment to desired changes in the level as well as the composition of total wealth.

Section 3: Labor Market Adjustment

In this dissertation we shall consider the effects of monetary policy for three models of labor market adjustment. We shall first study the effects of monetary policy for our classical model of full employment and perfect wage flexibility and then we shall study the corresponding effects of monetary policy in our Keynesian model of unemployment and perfect wage rigidity. Finally, adaptive price expectations and semi-flexible wage rates will characterize our Phillips Curve model.

In our classical model the employment rate E is fixed at E^* and the price level is determined in the monetary sector. The nominal wage rate w therefore equates the real wage rate W/p with the marginal product of labor:

$$(19) \quad w = q_E(K, E^*)$$

The Cobb-Douglas constant returns to scale production function allows us to express the real wage rate as a function of total output. Hence we may specify equation (19) in the following way:

$$(19') \quad w = p \cdot (1-\alpha) \cdot \frac{q(K,E^*)}{E^*}$$

In the Keynesian version of our model, on the other hand, the nominal wage rate w remains fixed at w^* while the employment rate E adjusts to equate the marginal product of labor with the real wage rate (w/p). Differentiating equation (19) with $\Delta w = 0$, we obtain the following adjustment equation for employment:

$$(20) \quad \Delta E = -\frac{(w^*/p)}{q_{EE}(K,E)} \frac{\Delta p}{p} - \frac{q_{EK}(K,E)}{q_{EE}(K,E)} \Delta K$$

Our Cobb-Douglas production function allows us to specify equation (20) as follows:

$$(20') \quad \frac{\Delta E}{E} = \left(\frac{1}{\alpha}\right) \frac{\Delta p}{p} + \frac{\Delta K}{K}$$

Finally, in our Phillips Curve model of semi-flexible wage rates the nominal wage reacts to the expected rate of inflation and to differences between the actual and the exogenous "normal" level of employment:

$$(21) \quad \frac{\Delta w}{w} = \pi + \omega[E - E_0]; \qquad \omega > 0$$

Normal employment E_0 is simply the level of employment at which nominal wages keep pace with anticipated inflation π. For simplicity we call E_0 normal employment, but it conforms to a norm only in the sense that wage inflation does not accelerate.[7]

In our Phillips Curve model the adjustment of employment must now respond to changes in the nominal wage rate w as well as changes in the price level p and the capital stock K. Expanding equation (20), we now obtain the following adjustment equation for employment:

$$(22) \quad \Delta E = \frac{w/p}{q_{EE}(K,E)} \left[\frac{\Delta w}{w} - \frac{\Delta p}{p}\right] - \frac{q_{EK}(K,E)}{q_{EE}(K,E)} \Delta K$$

Given our Cobb-Doublas production function, we may express equation (22) as follows:

$$(22') \quad \frac{\Delta E}{E} = \frac{1}{\alpha}\left[\frac{\Delta p}{p} - \frac{\Delta w}{w}\right] + \frac{\Delta K}{K}$$

We admit that all three of our labor market models have been formulated in a simple and conventional way. However, the purpose of this dissertation is not to explore sophisticated theories of employment and wage behavior, but rather to determine the feedback effects of three alternative but simple labor market mechanisms on the monetary adjustment process.

Section 4: The General Framework

Let us now summarize our complete stock adjustment model of monetary policy and macroeconomic adjustment. In Table II.2 we present our framework embodying the three models of labor market adjustment.

TABLE II-2

A DYNAMIC MODEL OF MACROECONOMIC ADJUSTMENT

The Production Function:

$$q = AK^{\alpha}E^{(1-\alpha)}$$

Capital Accumulation:

$$\Delta K = \kappa[K^{*} - K]$$

Cash Balance Accumulation:

$$\Delta(M/p) = \lambda[L^{*} - (M/p)]$$

Bond Accumulation:

$$\Delta(B/ip) = \beta[B^{*} - (B/ip)]$$

The Demand for Capital:

$$K^{*} = K_0 + K_K \cdot K + K_{M/p}(M/p) + K_{B/ip}(B/ip) + K_h \cdot h + K_g \cdot g + K_r \cdot r + K_i \cdot i + K_\pi \cdot \pi$$

$$K_K > 0 \quad K_{M/p} > 0 \quad K_{B/ip} > 0 \quad K_h > 0$$

$$K_g \gtrless 0 \quad K_r > 0 \quad K_i \leq 0 \quad K_\pi \geq 0$$

The Demand for Money:

$$L^{*} = L_0 + L_K \cdot K + L_{M/p}(M/p) + L_{B/ip}(B/ip) + L_h \cdot h + L_g \cdot g + L_r \cdot r + L_i \cdot i + L_\pi \cdot \pi$$

$$L_K > 0 \quad L_{M/p} > 0 \quad L_{B/ip} > 0 \quad L_h > 0$$

$$L_g \gtrless 0 \quad L_r \leq 0 \quad L_i \leq 0 \quad L_\pi \leq 0$$

The Demand for Bonds:

$$B^* = B_0 + B_K \cdot K + B_{M/p}(B/p) + B_{B/ip}(B/ip) + B_h \cdot h + B_g \cdot g + B_r \cdot r + B_i \cdot i + B_\pi \cdot \pi$$

$$B_K > 0 \quad B_{M/p} > 0 \quad B_{B/ip} > 0 \quad B_h > 0$$

$$B_g \gtrless 0 \quad B_r \leq 0 \quad B_i > 0 \quad B_\pi \leq 0$$

The Capital Rate of Return:

$$r = \alpha A K^{\alpha-1} E^{1-\alpha}$$

The Government Budget Constraint:

$$g - t = \frac{\Delta M}{p} + \frac{\Delta B}{ip}$$

Labor Market Adjustment:

A. Classical Model:

Wage Adjustment: $w = p \cdot (1-\alpha)\frac{q(K, E^*)}{E^*}$

Employment: $\Delta E = 0; \quad E = E^*$

B. Keynesian Model:

Wage Adjustment: $\Delta w = 0; \quad w = w^*$

Employment: $\frac{\Delta E}{E} = (\frac{1}{\alpha})\frac{\Delta P}{p} + \frac{\Delta K}{K}$

C. Phillips Curve Model:

Expectations: $\Delta\pi = \rho[\Delta p/p - \pi]$

Wage Adjustment: $\frac{\Delta w}{w} = \pi + \omega[E - E_0]$

Employment: $\frac{\Delta E}{E} = \frac{1}{\alpha}[\frac{\Delta p}{p} - \frac{\Delta w}{w}] + \frac{\Delta K}{K}$

Price Adjustment:[8]

$$\frac{\Delta p}{p} = \frac{-\lambda[L^* - (M/p)]}{(M/p)} + \frac{\Delta M}{M}$$

Interest Rate Adjustment:[9]

$$\frac{\Delta i}{i} = \frac{-\beta\,[B^* - (B/ip)]}{(B/ip)} + \frac{\Delta B}{B} - \frac{\Delta p}{p}$$

Labor Income:

$$h = \frac{Ew}{p}$$

Section 5: Conclusion

In this chapter we have presented our stock adjustment/flow equilibrium model of macroeconomic adjustment. However, we have refrained from delving extensively into issues connected with monetarism and monetary policy, our overriding concern in this dissertation. Once we numerically specify this model, we shall analyze propositions about monetary policy as we discuss the results of our simulation experiments. Hopefully, the numerical specification and simulation of this abstract theoretical model will bring monetary analysis one step closer to more realistic policy conclusions.

FOOTNOTES TO CHAPTER II

(1) This term for new money supplied through currency-financed government expenditures comes from Niehans [(1974): p. 18].

(2) These eqalities also come from Niehans [(1974): p. 18].

(3) The fact that the rate of return on capital is always equal to the marginal product of capital does not mean that we assume the absence of adjustment costs. Our model is different from those of the Rose-Stein variety in which investment depends on differences between the market determined rate of interest and the natural rate of interest corresponding to the marginal product of capital. In these models differences between the market and natural rate of interest arise from adjustment costs. Differences between our model and those of Rose [1966, 1967, 1969] and Stein [1971] will become clear as we move on in this chapter

(4) The specification of these asset demand functions is taken from Niehans model. However, no wealth arguments appear in his asset demand equations. His model is a full stock equilibrium, and since desired and actual stocks are always equal, the three wealth arguments can be dropped or "solved out" of his asset demand equations.

(5) Niehans has capitalized labor income in his model by the balanced growth rate into a "human wealth" argument H. In our model, however, we are not studying the behavior of the macroeconomic system under balanced growth, so we have chosen not to capitalize labor income h into a human wealth argument H. [See Niehans (1974): p.22]

(6) In our model we are assuming that there is no interest paid on cash balances. Given our fixed zero rate of interest on cash balances, a positive expected rate of inflation may be viewed as a decrease in the rate of return on cash balances; thus lowering the demand for money.

(7) For an elaboration of the normal or natural rate of employment hypothesis, see Friedman [(1970): p. 103].

(8) This price adjustment equation is not specified by our model, but is derived from our stock adjustment specification of cash balance accumulation.

(9) Similarly, this interest rate adjustment mechanism is not specified by our model, but is derived from our stock adjustment specification of bond accumulation.

CHAPTER III

NUMERICAL SPECIFICATION, STABILITY ANALYSIS, AND EXPERIMENTAL DESIGN

Section 1: Introduction

In this chapter we shall assign values to the production parameters, asset demand coefficients, adjustment speeds, and initial conditions. We shall also discuss the stability of the specified model by obtaining and evaluating the roots of the characteristic equation of the dynamic system. Finally, we shall describe the numerical method for solving our simultaneous differential-equation model of macroeconomic adjustment.

Since we wish our simulation results to be as realistic as possible, we have tried to select parameter values on the basis of available econometric evidence, and we have relied on current United States data in setting the initial conditions. However, our theoretical framework presented a twofold handicap. First, our model is new in several respects, and defines economic variables not studied in existing empirical literature. Secondly, our model is small and aggregative, and simplifies many structural relationships studied in current econometric models. Hence, we could not turn to existing empirical studies for all of our parameter selections. Guided by *a priori* theoretical and stability restrictions, we had to rely on intuition for specifying subsections of our model.

We do not regard this lack of empirical certitude as a severe drawback to our study. We shall indeed employ the parameters specified in this chapter to obtain policy results, but we shall also test the sensitivity of our policy results by systematic variation of parameters in subsequent simulations. Hence, the parameters presented in this chapter should be viewed as initial benchmark figures set up for systematic variation rather than as universally accepted estimates.

Section 2: The Production Function, Interest Rates, and Stock/Flow Variables

Let us first consider the production function. We have deflated all stock and flow variables by the size of the total labor force in the United States, 85 million. Per capita output and capital stock have the following initial values:

$q = \$9,411.76$

$K = \$28,235.29$[1]

In most aggregate production functions describing annual output the capital stock is associated with an index of capacity utilization, and the labor stock is associated with an index of total man hours. For simplicity we shall assume full utilization of both capital and labor in our model, and set both indices at one. When we consider the adjustment of the economy in quarterly or monthly intervals, we shall simply divide the production function by the appropriate scale variable.

We have assumed a Cobb-Douglas form for the macroeconomic production function. According to U.S. Business Statistics for the last 10 years, labor income amounted to a 2/3 to 3/4 share of total income. This would imply a labor coefficient between 2/3 and 3/4 for our Cobb-

Douglas production function and a capital coefficient between 1/3 and 1/4. We have set the capital coefficient at .25 and the labor coefficient at .75 for our simulation experiments.[2]

The constant term in the production function serves as a residual variable. Given the production function, coefficients and the initial values of output, capital, and labor, we calculated the constant term to equate the initial value of output with full capacity output. For simplicity, we have also omitted the time trend variable which usually appears in estimated production functions. Hence, we write our production function in the following way:

$$q = 726.06\, K^{.25} E^{.75}$$

In our model we have defined the rate of return to capital as the marginal product of capital and the real wage as the marginal product of labor. Our numerically specified production function yields the following initial values for the rate of return to capital and the per capita real wage level:

$$r = q_K(K,E) = 8.33\%$$

$$w/p = q_E(K,E) = \$6,942.15$$

We have restricted the flow of government expenditures to include only federal government purchases of goods and service. State and local governments are subsumed by the private sector, since they cannot finance their deficits by printing money, as the federal government can. The flow of government expenditures, \$100 billion in current data, has the following initial per capital value:[3]

$g = \$1{,}176.47$

We define the stock of money as the outstanding stock of government currency issued to the private sector. The stock of currency, \$60 billion in current data, has the following initial per capita value:[4]

$M/p = \$705.88$

We have restricted the stock of bonds to consist only of private holding of government debt. The Central Bank's holdings of Treasury debt cancel out in the balance sheet of the consolidated government sector. Likewise, private securities net out in the private sector balance sheet. Finally, we assume that private securities are perfect substitutes for government bonds, so that the same interest rate rules for both.

In our model all government bonds are homogeneous consols or perpetuities paying \$1.00 per year forever in nominal terms. Thus we represent the nominal stock of bonds as the ratio (B/i), where B is the annual interest on government bonds and i is the bond rate of return. Given an annual interest of \$12 billion on government bonds,[5] and having set the rate of return at 5%, we obtained the following initial values for the per capita stock of government bonds:[6]

$B/i = \$2{,}823.52$

Finally, we have set the initial price level index at unity:

$p = 1.00$

Section 3: Asset Demand Coefficients and Adjustment Speeds

We shall not consider our asset demand specifications for the three wealth components, labor income, government expenditures, and the expected rate of inflation.

Wealth Coefficients

The three wealth variables K, (M/p), and (B/ip) enter the asset demand equations in both Niehans' long run model and our dynamic model. However, Niehans pointed out that the three wealth arguments may be dropped from the three asset demand equations if the conditions of the implicit function theorem hold. Niehans thereby proceeded with comparative static analysis without wealth arguments appearing in the asset demand aquations. [See Niehans (1974): p. 22, footnote]

However, in our dynamic model it is not possible to drop the wealth variables as asset demand arguments. While each wealth component is endogenous in the long run model, they are exogenous in the dynamic model. Asset holders are free to alter their stock of each wealth component move from one stationary state to another, but during the adjustment process the stock of each asset is fixed in any period by accumulation in past periods.

We are primarily interested in specifying our model for dynamic analysis. At the same time we wish our model to be reducible to Niehans' long run version in periods of full stock equilibrium. Specifically the conditions of the implicit function theorem must hold: it should be possible to drop the three asset demand equations when desired and actual stocks are equal. To do this, it is sufficient that the three asset demand equations have private wealth elasticities less than unity.[7]

We have assigned each asset demand equation a total wealth elasticity of .2, where total wealth W is the sum of all three asset values. Preliminary simulation experiments revealed that the dynamic and long run effects of monetary policy were insensitive to the choice of wealth elasticities between .2 and .9. We have therefore chosen to specify our model with relatively low wealth elasticities. With this elasticity we may thus calculate values for the nine asset demand total wealth coefficients:

$$\epsilon_{K,W} = K_W \cdot \frac{W}{K} = .2$$

$$K_W = \epsilon_{K,W} \cdot \frac{K}{W} = 0.1777$$

$$K_K = K_{M/p} = K_{B/ip} = 0.1777$$

$$\epsilon_{L,W} = L_W \frac{W}{(M/p)} = .2$$

$$L_W = \epsilon_{L,W} \cdot \frac{(M/p)}{W} = 0.0044$$

$$L_K = L_{M/p} = L_{B/ip} = 0.0044$$

$$\epsilon_{B,W} = B_W \frac{W}{(B/ip)} = .2$$

$$B_W = \epsilon_{B,W} \frac{(B/ip)}{W} = 0.0177$$

$$B_K = B_{M/p} = B_{B/ip} = 0.0177$$

Labor Income Coefficients

We have chosen to set our asset demand labor income elasticities at unity. Labor income thus serves as a "scale variable" in our model for all three asset demands. While there is no general reason for all three asset demands to have unitary labor income elasticities, there is no general reason why deviations should be in one direction rather than the other. In the case of money, for example, Friedman found that the simple correlation between the logarithm of the real money stock and the logarithm of real income per capita was 0.99. His data covered the period 1870 to 1954, and included 20 cycles. [Friedman (1969): p. 113] From our assumption of unitary labor income elasticities for asset demand, we calculated the following asset demand coefficients for labor income:

$$\epsilon_{K,h} = K_h \cdot \frac{h}{K} = 1$$

$$K_h = \epsilon_{K,h} \frac{K}{h} = 0.16$$

$$\epsilon_{L,h} = L_h \cdot \frac{h}{(M/p)} = 1$$

$$L_h = \epsilon_{L,h} \frac{(M/p)}{h} = 0.0039$$

$$\epsilon_{B,h} = B_h \cdot \frac{h}{(B/ip)} = 1$$

$$B_h = \epsilon_{B,h} \cdot \frac{(B/ip)}{h} = 0.011$$

Government Expenditure Coefficients

In the previous chapter the effect of a balanced-budget expenditure increase on asset demands was shown to be ambiguous. If asset holders regard balanced-budget expenditures as supplements to their labor income or private wealth, then the coefficients K_g, L_g, B_g would be positive. On the other hand, if asset holders view such expenditures as offsets to their labor income or private wealth, then K_g, L_g, and B_g would be negative.

We wish to determine the implications of both of these assumptions for the dynamic and long run adjustment of prices, interest rates, and employment.

In the first case, therefore, we shall simply assume that asset holders look upon balanced-budget expenditures as perfect supplements to their labor income. Hence we shall assign unitary government expenditure elasticities to all three asset demands, as we have assigned unitary elasticities to labor income. We may thus calculate the following government expenditure coefficients for each asset demand equation:

$$\epsilon_{K,g} = K_g \cdot \frac{g}{K} = 1$$

$$K_g = \epsilon_{K,g} \cdot \frac{K}{g} = 0.9600$$

$$\epsilon_{K,g} = L_g \cdot \frac{g}{(M/p)} = 1$$

$$L_g = \epsilon_{L,g} \frac{(M/p)}{g} = 0.0233$$

$$\epsilon_{B,g} = B_g \cdot \frac{g}{(B/ip)} = 1$$

$$B_g = \epsilon_{B,g} \cdot \frac{(B/ip)}{g} = 0.0666$$

In the second case, we shall simply assume that balanced-budget expenditures are perfect offsets to labor income. Hence the government expenditure elasticities for each asset demand equation are equal in magnitude but opposite in sign to the elasticities for labor income. We thus have the following asset demand coefficients when government expenditures are perfect offsets to human capital productivity:

$$\epsilon_{K,g} = -1; \quad K_g = -0.9600$$

$$\epsilon_{L,g} = -1; \quad L_g = -0.0233$$

$$\epsilon_{B,g} = -1; \quad B_g = -0.0666$$

Rate of Return Coefficients

We shall now specify the elasticities and slopes for the interest rates in the three asset demand equations. Let us first consider the demand for money, for which empirical research is most extensive.

Christ [1969], Friedman [1959], Laidler [1966], Latané [1954, 1960] and Meltzer [1963] expect the money demand elasticity for long term interest rates to lie between -0.5 and -1.00. Teigen [1964], on the other hand, found a much lower money demand elasticity for short term interest rates. His structural estimates lie between -0.01 and -0.05.

In our model we have assumed that all bonds are homogeneous consols or perpetuities paying $1.00 per year forever. Hence, the interest rate i represents a rate of return on long term assets. Similarly, we have identified the capital yield with the marginal product of capital, and thus is a return on long term productive assets. Consequently, we believe that the long term interest rate elasticities estimated by Christ, Friedman, Laidler, Latané, and Meltzer are more appropriate for our money demand equation than the short term interest elasticities estimated by Teigen. We have therefore set our money demand interest rate elasticities at -0.75, representing the mean between the highest and lowest values estimated by Christ, Friedman, Laidler, Latané, and Meltzer.

$$\epsilon_{L,r} = L_r \cdot \frac{r}{(M/p)} = -0.75$$

$$L_r = \epsilon_{L,r} \cdot \frac{(M/p)}{r} = -6352.91$$

$$\epsilon_{L,i} = L_i \cdot \frac{i}{(M/p)} = -0.75$$

$$L_i = \epsilon_{L,i} \cdot \frac{(M/p)}{i} = 10588.2$$

Now let us turn to the capital demand equation. Griliches and Wallace [1965] estimated a stock adjustment model of capital accumulation for total United States investment in manufacturing, and found an elasticity of -0.38 for the demand for capital with respect to the industrial bond rate of return. Since we have assumed perfect substitutability between government and industrial bonds in our model, we shall use the Griliches-Wallace estimate of -0.38 for the interest elasticity of capital. With this estimate we have calculated the following interest rate coefficient for our capital demand equation:

$$\epsilon_{K,i} = K_i \cdot \frac{i}{K} = -0.38$$

$$K_i = \epsilon_{K,i} \cdot \frac{K}{i} = -214588.2$$

Griliches and Wallace did not present any elasticity estimates for capital with respect to its own rate of return. For lack of better information, therefore, we have decided to set the yield elasticity of capital at .6. We have chosen this value on the assumption that the yield elasticity for capital is larger in absolute magnitude than its interest elasticity of -0.38. We calculated the following capital demand coefficient for its own rate of return:

$$\epsilon_{K,r} = K_r \cdot \frac{r}{K} = .60$$

$$K_r = \epsilon_{K,r} \cdot \frac{K}{r} = 203294.0$$

Finally, let us consider the yield and interest rate coefficients for the bond demand equation. Unfortunately, current large scale econometric models have ignored the demand for bonds in the specification of their financial subsectors.[8] For lack of better information, then, we shall assume that the yield elasticity of bonds is identical to the interest elasticity of capital, -0.38. We thus obtain the following yield coefficient for the bond demand equation:

$$\epsilon_{B,r} \doteq B_r \cdot \frac{r}{(B/ip)} = -0.38$$

$$B_r = -12875.2$$

We have initially set the interest elasticity of bonds at 3.98. We obtained this value by setting the interest slope for bonds equal to the sum of the interest slopes for money and capital in absolute value:

$$B_i = -(L_i + K_i) = 225176.4$$

$$\epsilon_{B,i} = 3.98$$

The calculated value 3.98 for $\epsilon_{B,i}$ thus represents an assumption on our part that an increase in the bond yield will have neutral effects on the demand for total wealth. We have made this assumption simply to obtain an initial value for $\epsilon_{B,i}$, and we shall consider the effects of upward and downward variations in this parameter when we discuss our simulation results in succeeding chapters.

Expected Inflation Coefficients

Now let us consider the coefficients for the expected rate of inflation, represented by the variable π in our three asset demand equations.

We have obtained our expected inflation elasticity for money from A. A. Shapiro [1973]. While Shapiro found that the reaction of money demand to expected inflation was smaller than the money demand reaction to interest rate changes, he nevertheless considered his estimate a "meaningful magnitude." [Shapiro (1973): p. 94] Shapiro's elasticity estimate, and the corresponding coefficient for our money demand equation, have the following values:

$$\epsilon_{L,\pi} = -0.01$$

$$L_{\pi} = -.141.176$$

Since empirical work has little to say on bond demand, we have decided to set our bond demand expected inflation elasticity equal to the money demand expected inflation elasticity. For want of better information, we reason that expected inflation would reduce the desirability of our consol bonds paying a fixed dollar value per year by the same amount as it would reduce the desirability of money holdings. Our bond demand expected inflation elasticity and coefficient thus have the following values:

$$\epsilon_{B,\pi} = -0.01$$

$$B_{\pi} = -564.704$$

Finally, we obtained our expected inflation coefficient for capital by adding-up the expected inflation slopes for money and bonds and setting the capital coefficient equal to the absolute value of this sum:

$$K_{\pi} = -(L_{\pi} + B_{\pi}) = 705.88$$

The elasticity for expected inflation has the following value:

$$\epsilon_{K,\pi} = .00096$$

Our value for $\epsilon_{K,\pi}$ thus represents an assumption on our part that an increase in expected inflation will have neutral effects on the demand for total wealth. We made this assumption simply to obtain an initial value for $\epsilon_{K,\pi}$. In the next chapter we shall examine the effects of alterations in our expected inflation elasticities to see if upward or downward changes in these parameters significantly affect our results.

Dynamic Adjustment Coefficients

For complete specification we must now set the dynamic coefficients for the asset accumulation equations, expectations, and the Phillips' wage adjustment mechanism.

Let us first consider the adjustment speed for money. DeLeeuw [1965], Teigen [1964] and Shapiro [1973] estimated monetary adjustment coefficients. DeLeeuw found the quarterly adjustment coefficient to be 0.1, which implies a lag of 3 years or more before monetary adjustment is 75% complete, and a lag of 5 years or more before monetary adjustment is 90% complete. Teigen, on the other hand, found a much faster speed of adjustment: his results show monetary adjustment 31.4% complete after one quarter. Finally, Shapiro found monetary adjustment 100% complete after 11 quarters, and over 50% complete within one year. Since Shapiro's study was based on more recent data, we shall select our quarterly monetary adjustment coefficient in rough conformity with his estimates, and set λ equal to .25.

Jorgenson [1963] and Griliches and Wallace [1965] have estimated stock adjustment models of investment behavior. Jorgenson found a much faster speed of adjustment than Griliches and Wallace: adjustment is 90% complete in two years in the Jorgenson model, and 90% complete in five years in the Griliches-Wallace model. We shall side with Griliches and Wallace, and set our capital adjustment speed at .10.[9]

For lack of empirical evidence, we shall set our bond accumulation coefficient equal to the monetary adjustment coefficient for our initial simulations. Hence, $\beta = .25$.

Finally, let us specify the adjustment speeds for our wage adjustment mechanism and expectations scheme.

Empirical studies of the Phillips' curve for the United States economy have been abundant, and many competing theories of wage and price adjustment have been tested in these studies. [See Eckstein (1971)] In his simulation study with the OBE Econometric Model, Hirsch [1970] adopted a normal employment rate hypothesis in his wage adjustment equation, and expected a 1% increase in the employment rate above its normal rate to cause a .447% increase in wage inflation after one quarter. [See Hirsch (1971): p. 273] De Menil and Enzler, on the other hand, found that a 1% employment rate change would change wage inflation by .34% in simulation runs with the FRB-MIT-Penn Econometric Model. [See de Menil and Enzler (1971): p. 308] We have chosen to set our wage adjustment at .4, representing a mean value for the alternative estimates of Hirsch and de Menil and Enzler.

We have set our adaptive expectations coefficient, ρ, at a quarterly value of .4. Preliminary simulation results showed that very fast expectation coefficients ($\rho > .7$) led to unstable adjustment processes in our model. Our quarterly adoptive price expectations coefficient of .4 comes from the empirical work of Steven Turnovsky, who found an annual rate of adaption of .75 but a much slower quarterly rate of adaption. [Turnovsky (1970): p. 451] Since a quarterly adjustment speed of .4 roughly implies a 75% annual rate of adaption, our adjustment speed selection ensures stability and is consistent with Turnovsky's results.[10]

Summary of Numerical Selections

We have summarized in Table III-1 our numerical selections for the initial conditions, production function, asset demand equations, and dynamic adjustment speeds. All stock and flow variables appear in per-capita terms, and have been divided by the size of the current total U.S. labor force, 85 million.

TABLE III-1

NUMERICAL SPECIFICATION OF INITIAL CONDITIONS AND PARAMETERS

Initial Conditions:

Real Bond Stock (B/ip): \$2,823.52
Government Expenditures (g): \$1,176.47
Rate of Return on Bonds (i): 5.0%
Capital Stock (K): \$28,235.29
Real Money Stock (M/p): \$705.88
Price Level Index (p): 1.00
Rate of Return on Capital (r): 8.33%
Real Wage Rate (w/p): \$6,942.15
Expected Rate of Inflation (π): 0.0%

Production Function Parameters:

Capital coefficient (α) = .25
Labor coefficient ($1-\alpha$) = .75
Constant term (A) = 726.06

Asset Demand Parameters:

Argument:	Capital (K^*)	Bonds (B^*)	Money (L^*)
Capital (K)	$\epsilon_{K,K} = .177$ $K_K = .177$	$\epsilon_{B,K} = .12$ $B_K = .012$	$\epsilon_{L,K} = .16$ $L_K = .004$
Bonds (B/ip)	$\epsilon_{K,B/ip} = .017$ $K_{B/ip} = .177$	$\epsilon_{B,B/ip} = .012$ $B_{B/ip} = .012$	$\epsilon_{L,B/ip} = .016$ $L_{M/p} = .004$
Money (M/p)	$\epsilon_{K,M/p} = .004$ $K_{M/p} = .177$	$\epsilon_{B,M/p} = .003$ $B_{M/p} = .012$	$\epsilon_{L,M/p} = .004$ $L_{M/p} = .004$
Labor Income (h)	$\epsilon_{K,h} = 1$ $L_h = .16$	$\epsilon_{B,h} = 1$ $B_h = 0.01$	$\epsilon_{L,h} = 1$ $L_h = .003$
Expenditures (g)	$\epsilon_{K,g} = \pm 1$ $K_g = \pm 0.96$	$\epsilon_{B,g} = \pm 1$ $B_g = \pm 0.06$	$\epsilon_{L,g} = \pm 1$ $L_g = \pm 0.0233$
Capital Yield (r)	$\epsilon_{K,r} = .60$ $K_r = 203294$	$\epsilon_{B,r} = -0.38$ $B_r = -12875.2$	$\epsilon_{L,r} = -0.75$ $L_r = -6352.91$
Interest Rate (i)	$\epsilon_{K,i} = -0.38$ $K_i = -214588$	$\epsilon_{B,r} = 3.98$ $B_i = 225176.4$	$\epsilon_{L,i} = -0.75$ $L_i = -10588.2$
Expected Inflation (π)	$\epsilon_{K,\pi} = .0096$ $K_\pi = 705.88$	$\epsilon_{B,\pi} = -0.01$ $B_\pi = -564.704$	$\epsilon_{L,\pi} = -0.01$ $L_\pi = -141.76$

Dynamic Adjustment Speeds:

Capital accumulation (κ): 0.10
Cash balance accumulation (λ): 0.25
Bond accumulation (β): 0.25
Wage inflation (ω): 0.40
Expectations (ρ): 0.40

Section 4: The Stability of the Adjustment Process

We shall now evaluate the stability of the adjustment process. To do this, we first linearize the three asset accumulation equations and then displace each equation from the long run equilibrium variables K^e, $(M/p)^e$, and $(B/ip)^e$. Our asset accumulation and demand equations appear in Table II-2.

Let us begin with our equation for capital accumulation:

$$\Delta K = \kappa[K^* - K]$$

Displacing this equation from the long run equilibrium variable K^e, we obtain the following expression:

$$\frac{\partial(\Delta K)}{\partial K^e} = \kappa[\frac{\partial K^*}{\partial K^e} - 1]$$

Taking the partial derivative of K^* with respect to K^e, the effect of a change in K^e on ΔK may be expressed as follows

$$\frac{\partial(\Delta K)}{\partial K^e} = \kappa[K_K + K_h q_{KE}(K,E) + K_r q_{KK}(K,E) - 1]$$

In the same manner, we may obtain the effect of a change in the equilibrium money stock $(M/p)^e$ and equilibrium bond stock $(B/ip)^e$ on capital accumulation:

$$\frac{\partial(\Delta K)}{\partial(M/p)^e} = \kappa[\frac{\partial K^*}{\partial(M/p)^e}] = \kappa K_{M/p}$$

$$\frac{\partial(\Delta K)}{\partial(B/ip)^e} = \kappa[\frac{\partial K^*}{\partial(B/ip)^e}] = \kappa K_{B/ip}$$

Turning to our cash balance accumulation equation, we obtain the following equations to express the effect of changes in K^e, $(M/p)^e$, and $(B/ip)^e$ on money stock adjustment:

$$\frac{\partial[\Delta(M/p)]}{\partial K^e} = \lambda[\frac{\partial L^*}{\partial K^e}] = \lambda[L_K + L_h q_{KE}(K,E) + L_r q_{KK}(K,E)]$$

$$\frac{\partial[\Delta(M/p)]}{\partial(M/p)^e} = \lambda[\frac{\partial L^*}{\partial(M/p)^e} - 1] = \lambda[L_{M/p} - 1]$$

$$\frac{\partial[\Delta(M/p)]}{\partial(B/ip)^e} = \lambda[\frac{\partial L^*}{\partial(B/ip)^e}] = \lambda L_{B/ip}$$

Finally, the following three equations express the effects of changes in K^e, $(M/p)^e$, and $(B/ip)^e$ on bond accumulation:

$$\frac{\partial[\Delta(B/ip)]}{\partial K^e} = \beta[\frac{\partial B^*}{\partial K^e}] = \beta[B_K + B_h q_{KE}(K,E) + B_r q_{KK}(K,E)]$$

$$\frac{\partial[\Delta(B/ip)]}{\partial(M/p)^e} = \beta[\frac{\partial B^*}{\partial(M/p)^e} = \beta B_{M/p}$$

$$\frac{\partial[\Delta(B/ip)]}{\partial(B/ip)^e} = \beta[\frac{\partial B^*}{\partial(B/ip)^e} - 1] = \beta[B_{B/ip} - 1]$$

The nine equations expressing the effects of changes in K^e, $(M/p)^e$, and $(B/ip)^e$ on capital, cash balance, and bond accumulation may be arranged in the following matrix form:

$$\begin{bmatrix} \frac{\partial(\Delta K)}{\partial K^e} & \frac{\partial(\Delta K)}{\partial(M/p)^e} & \frac{\partial(\Delta K)}{\partial(B/ip)^e} \\ \frac{\partial[\Delta(M/p)]}{\partial K^e} & \frac{\partial[\Delta(M/p)]}{\partial(M/p)^e} & \frac{\partial[\Delta(M/p)]}{\partial(B/ip)^e} \\ \frac{\partial[\Delta(B/ip)]}{\partial K^e} & \frac{\partial[\Delta(B/ip)]}{\partial(M/p)^e} & \frac{\partial[\Delta(B/ip)]}{\partial(B/ip)^e} \end{bmatrix}$$

A necessary and sufficient condition for dynamic stability of our model requires the roots of the characteristic equation associated with the above matrix be less than one in absolute value. [See Goldberg (1958): p. 171].

The characteristic equation for our dynamic system is a third order polynomial. We have employed the Newton-Raphson algorithm for calculating the numerical roots of this equation. The Newton-Raphson algorithm is described by Kelly [(1967): p. 90] and Carnahan, Luther, and Wilkes [(1969): p. 156] as an accurate iterative method for factoring polynomials and finding roots.

Using the parameter specifications from Table III-1, we found the largest root for our numerical model to be 0.8971. We are thus guaranteed stable dynamic adjustment when we use our initial parameter selections.

Our root calculations reveal that very high asset demand rate of return elasticities do not affect the stability of the system. However, when we allow the adjustment speeds for cash balances or bonds to become more rapid, the possibility of instability arises. In Table III-2 we list the largest root of our model for specific parameter variations from Table III-1.

TABLE III-2

CALCULATED ROOTS FOR ASSET DEMAND ELASTICITIES AND ADJUSTMENT SPEEDS

Parameter Change from Table III-1	Largest Root Value
None	0.8971
$\epsilon_{L,r} = \epsilon_{L,i} = \epsilon_{B,r} = -2.00$	0.8972
$\lambda = \beta = .40$	1.141
$\lambda = .90$	1.232
$\beta = .90$	1.679
$\lambda = \beta = .75$	1.731

We find that even when the interest and yield elasticities for money and bonds take on the very high value of -2.00, the dominant root of our model does not change. Furthermore, changes in initial conditions also revealed little change in dominant root values. On the other hand, when we changed the money and bond adjustment speeds from the initial value of .25 to .40, the dominant root increased from .89 to 1.14, and we moved into an unstable region. Furthermore, an increase in the money adjustment speed from .25 to .90 causes the dominant root to increase from .89 to 1.23, while an identical increase in the bond adjustment speed causes the dominant root to increase from .89 to 1.67. We can conclude from these root calculations that the stability of our model is much more sensitive to changes in adjustment speeds--particularly the bond adjustment speed--than to changes in initial conditions and asset demand interest and yield elasticities.[11]

Section 5: Experimental Design and the Method of Numerical Solution

For finding the numerical solution of our simultaneous differential equation model, we have employed the Runge-Kutta algorithm. Kelly [1967] and Carnahan, Luther, and Wilkes [1969] consider this algorithm one of the most stable and accurate numerical integration methods.

Initially, we have set all stock/flow variables at their long run equilibrium values, and then introduced our policy disturbances at time 0. We have thus confined our simulation analysis to a study of transition processes moving the economy from one position of equilibrium to another.

Section 6: Conclusion

In this chapter we have tried to be as realistic as possible in setting our parameter values, and we have selected our numerical integration method for its accuracy and stability. With these parameters and our simulation method we shall now tackle propositions about dynamic adjustment. We shall evaluate the realism of our parameter selections and our simulation method by comparing our results with empirical findings about monetary adjustment in the course of this study.

FOOTNOTES TO CHAPTER III

(1) We have taken an initial equilibrium value of $800 million for total output in the U.S. economy. Assuming a capital stock-output ratio of 3:1, we then set the capital stock at $2,400 million. Our total output value of $800 million corresponds to U.S. output in 1970. See Dec. 1973 Federal Reserve Bulletin Financial and Business Statistics, p. A68 for data.

(2) Recent data show that the share of "compensation of employees" in national income is growing progressively larger. In 1970, the share was approximately .75, while in 1973 the share was about .79. We have chosen 1970 as our base year for selecting initial conditions, so we have set out Cobb-Douglas labor coefficients at .75, reflecting the labor share in national income for that year. See Dec. 1973 Federal Reserve Bulletin Financial and Business Statistics p. A68 for data on national income and compensation of employees.

(3) Again, this figure corresponds to 1970 data in Federal Reserve statistics. See Dec. 1973 Federal Reserve Bulletin p. A68.

(4) This definition of currency includes bank reserves. See Dec. 1973 Federal Reserve Bulletin p. A15 for data on total U.S. currency. (Total U.S. currency outstanding is slightly greater than total currency in circulation, which does not include bank reserves.) In our model we are thus treating bankers as any other asset holders demanding money. The money they hold in reserve is considered part of the total stock of money demanded by the aggregate private sector.

(5) Source: Budget Outlays, Federal Fiscal Operations, Dec. 1973 Federal Reserve Bulletin, p. A41.

(6) Interest rates on government securities of different maturity have varied between 7 and 6 per cent. We have set 5% as our interest rate because it represents a mean value of interest rates.

(7) When the asset demand wealth elasticities are unitary, it is impossible to invert the matrix of total wealth coefficients and express each wealth variable as a function of non-wealth variables. When the wealth elasticities are unitary, the determinant of the matrix of wealth coefficients is zero.

(8) See Christ [1971] for an elaboration of this point in his critique of current econometric models of the financial sector.

(9) In Jorgenson's model the desired stock of capital depends on output deflated by a user-cost-of-capital measure. Interest rates indirectly affect desired capital through their effects on the used-cost-of-capital measure. In the Griliches-Wallace model, however, interests rates, as in our own model, are direct arguments in the demand for capital. Since the Griliches-Wallace concept of desired capital is closer to our model than Jorgenson's concept, we have taken the Griliches-Wallace estimate for for our simulation experiments.

(10) Turnovsky's study was a "direct" study based on survey evidence of popular price expectations. Other studies of price expectations measure the effect of past price change on interest rates, and from this infer the rate of adaption of expected inflation to past price change and current inflation. [See Anderson and Carlson (1971) and Yohbe and Karnosky (1969)].

(11) It is not surprising that our linearized model generates unstable roots for realistic parameter selections. E. Philip Howrey [1971] calculated unstable roots for a linearized version of the Wharton Econometric Model.

However, we must not infer from this stability analysis that our model will never converge to long run equilibrium when we use relatively high money and bond adjustment speeds. The roots have been calculated for a linearized version of our non-linear dynamic model. In his discussion of non-linear dynamic systems, Charles Holt pointed out the difficulty of judging the response of dynamic systems from their roots:

> Knowing the characteristic roots of the system tells a great deal, particularly if any of them are unstable, but how much each of these roots will be excited, and how they interact, can only be determined for particular sets of initial conditions and disturbances. [See Howrey (1972): p. 665]

Therefore, while our model may be unstable for specific parameter values, it may still converge to long run equilibrium in response to purely monetary disturbances.

CHAPTER IV

THE DYNAMIC EFFECTS OF MONETARY EXPANSION THROUGH TRANSFER PAYMENTS AND OPEN MARKET PURCHASES

Section 1: Introduction

In this chapter we shall study the progressive and long run adjustment of the economy to a once-and-for-all 10% change in the nominal money stock by transfer payments and open market purchases. We shall compare the alternative response of the price level, employment rate, and capital and bond rates of return to money supplied as a "free gift" to the economy and to money supplied as payment for government bonds. These two money supply mechanisms are described in Section 2 of Chapter II.

Our dynamic model is summarized in Table II-2. In Section 2 of this chapter we shall analyze the dynamic effects of transfer money and open market purchases for our classical model of full employment and flexible wages, and in Section 3 we shall analyze the corresponding effects of both policies for our Keynesian model of unemployment and rigid wages. In Section 4 we shall consider the effects of both policies on our Phillips Curve model of adaptive price expectations and semi-flexible wage rates.

The parameters for our initial policy simulations for each section are listed in Table III-1. We tested the sensitivity of our initial results by further simulations with alternative parameter selections. In each section of this chapter we shall consider the policy results both for our initial parameter selections as well as for alternative parameter values for adjustment speeds, asset demand elasticities, and initial conditions.

Prior to our policy change the economy was in full stock/flow equilibrium. At time 0 we then engineered our monetary distrubance and jolted the economy from equilibrium. Our simulation analysis is thus the study of the movement of the economy from one position of full equilibrium to another. The adjustment of each variable is pictured in quarterly intervals, but smaller intervals were necessary for purposes of numerical integration.[1]

Section 2: Macroeconomic Adjustment with Flexible Wages and Full Employment

In Figure IV-1 we have pictured the adjustment process for two cases of our classical model of full employment and flexible wages. The results for the case of gradual adjustment of money and bonds are pictured in the upper half of the graph. In this simulation experiment we have made no changes from the initial parameters specified in Table III-1. The adjustment speeds for both financial assets were set at the quarterly rate of 0.25. In the lower half of the graph, on the other hand, we have pictured the adjustment process for the case of instantaneous adjustment of money and bonds. Here we have discarded the finite money and bond adjustment speeds specified in Table III-1 and have set both financial assets in continuous stock equilibrium.

In Figure IV-2 we have pictured the classical adjustment process for three sets of parameter variations from Table III-1. In Simulation (a) we have set the interest and yield elasticities of

FIGURE IV-1

CLASSICAL MODEL

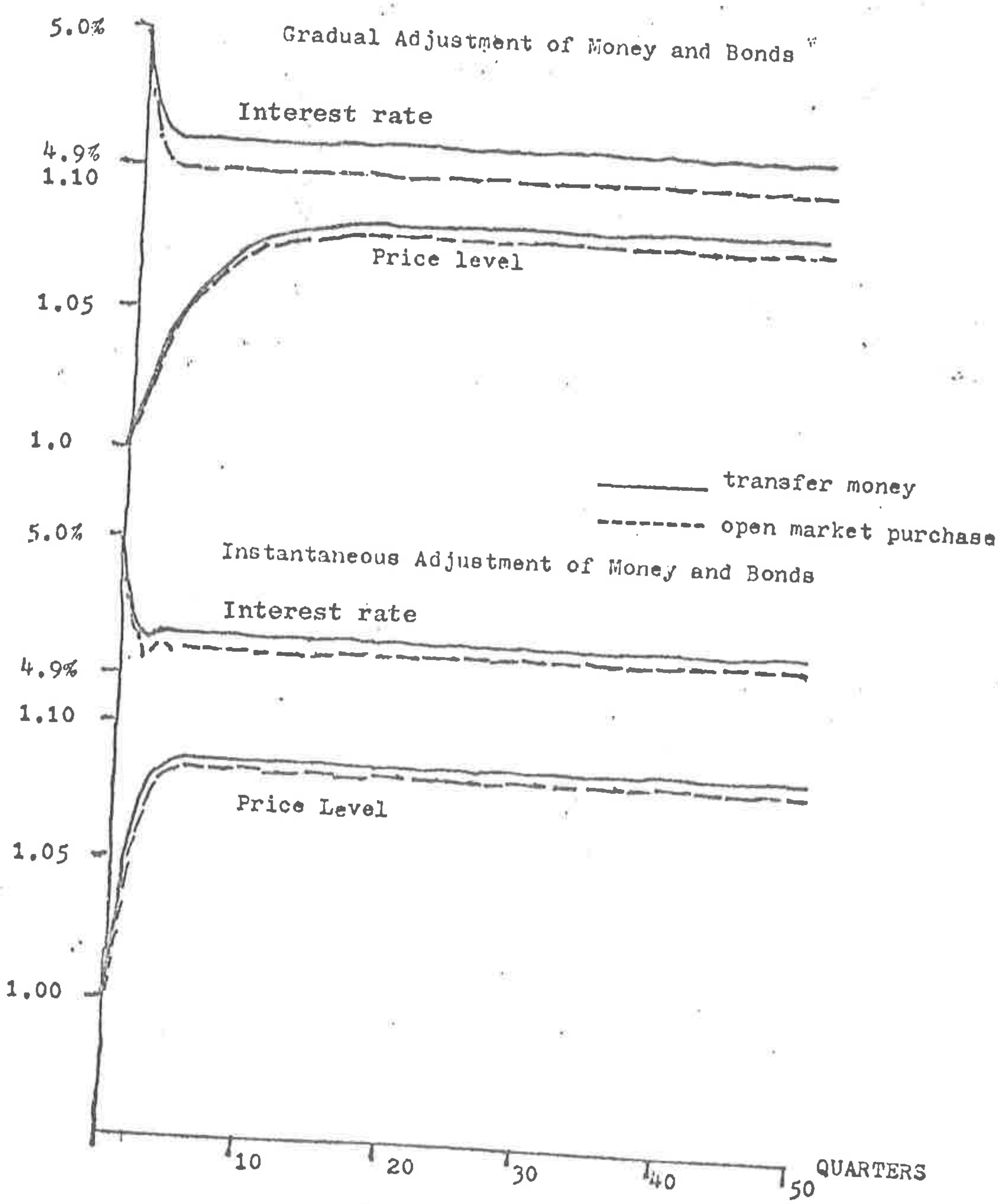
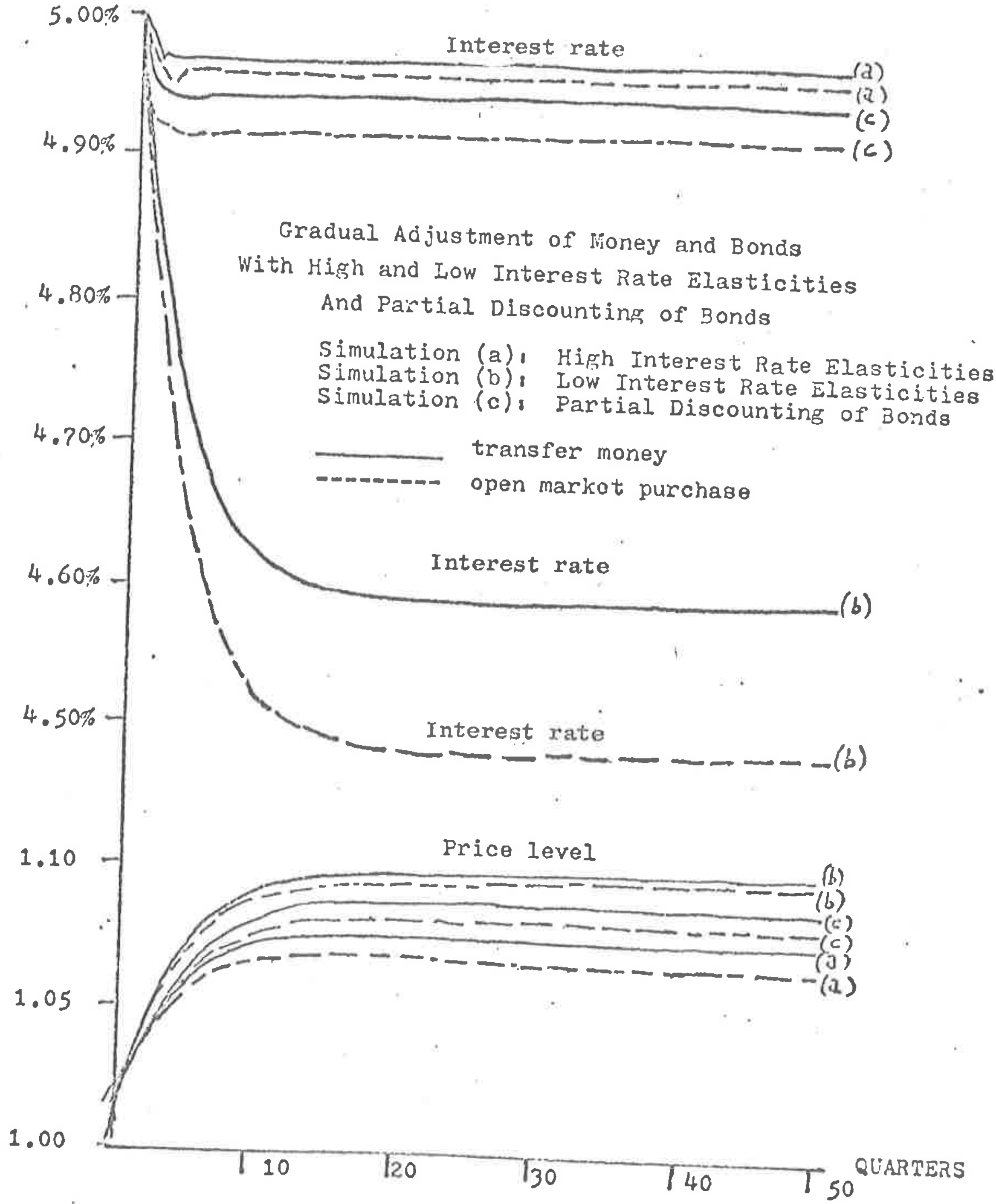


FIGURE IV-2

CLASSICAL MODEL



money ($\epsilon_{L,i}$ and $\epsilon_{L,r}$) and the yield elasticity of bonds ($\epsilon_{B,r}$) at the relatively high absolute value of 2.[2] We have also increased the interest elasticity of bonds ($\epsilon_{B,i}$) from its initial value of 3.9 to 7.1. In Simulation (b), on the other hand, we have set the interest and yield elasticities of money and the yield elasticity of bonds at the relatively low absolute value of 0.1. We have also decreased the interest elasticity of bonds to a value of 1.1. Finally, in Simulation (c) in Figure IV.2 we returned to our initial parameter selections, but we changed one initial value. In this case we reduced the stock of bonds by 50%. In Figure IV-2 both financial assets adjust with finite speeds.

In Figure IV-3 we have again varied our asset demand elasticities, but this time we restricted our variations to the money and bond "cross" rate of return elasticities. In Simulation (2) we have set the cross elasticities $\epsilon_{L,i}$, $\epsilon_{L,r}$ and $\epsilon_{B,r}$ at the relatively low absolute value of 0.1, and in Simulation (b) we have set $\epsilon_{L,i}$, $\epsilon_{L,r}$ and $\epsilon_{B,r}$ at the high absolute value of 2.

In Figure IV-4 we present our last two simulation pictures for our classical model. In both simulations in Figure IV-4 we have changed the initial values of both bonds and money. We raised the initial value of money from $700 to $1500 and we halved the value of bonds from $3000 to $1500. In Simulation (a) we have coupled these new initial values with low money and bond cross elasticities. Here $\epsilon_{L,i} = \epsilon_{L,r} = \epsilon_{B,r} = -0.1$. In Simulation (b), on the other hand, we coupled these new initial conditions with high cross elasticities for

FIGURE IV-3

CLASSICAL MODEL

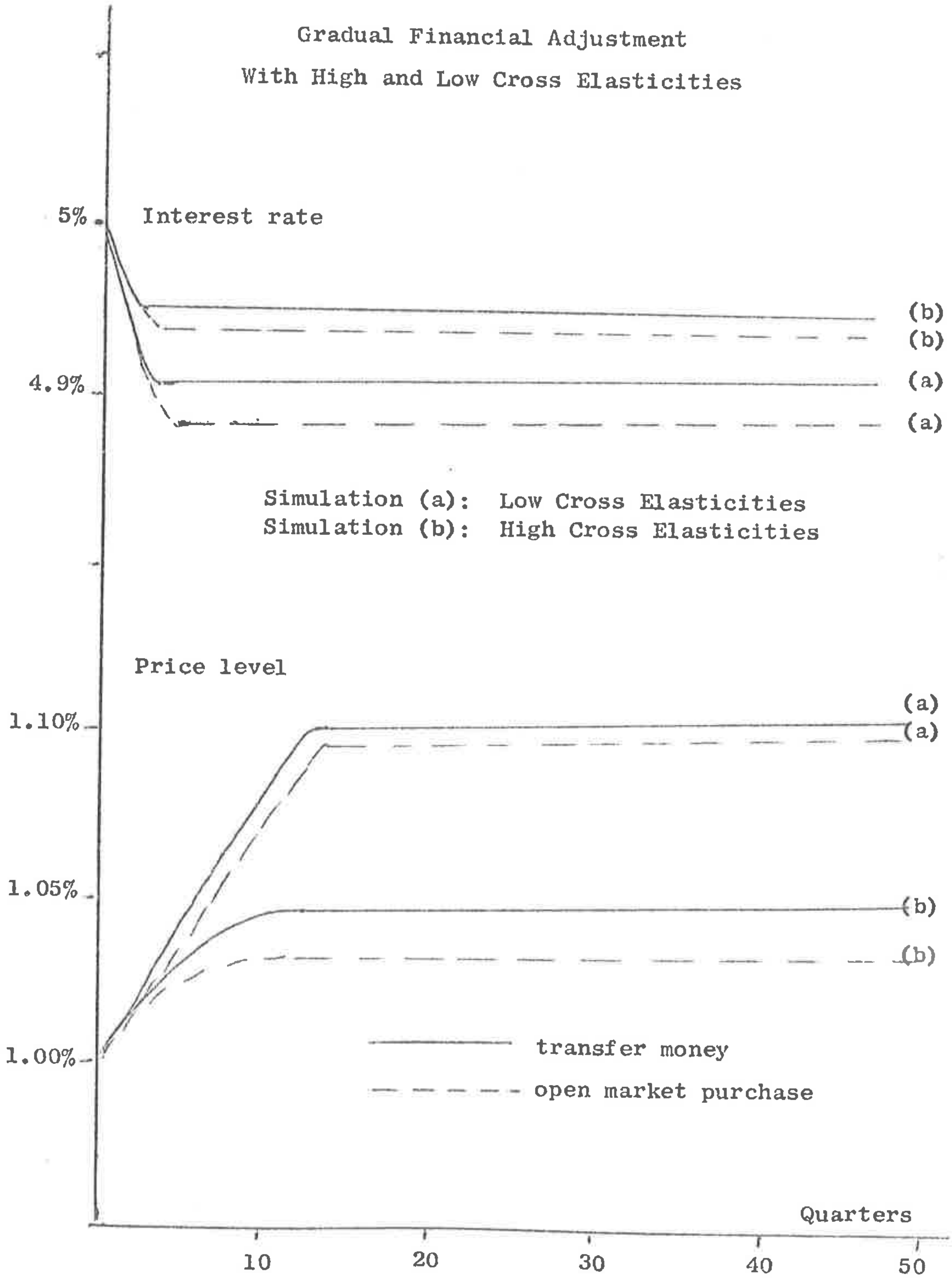


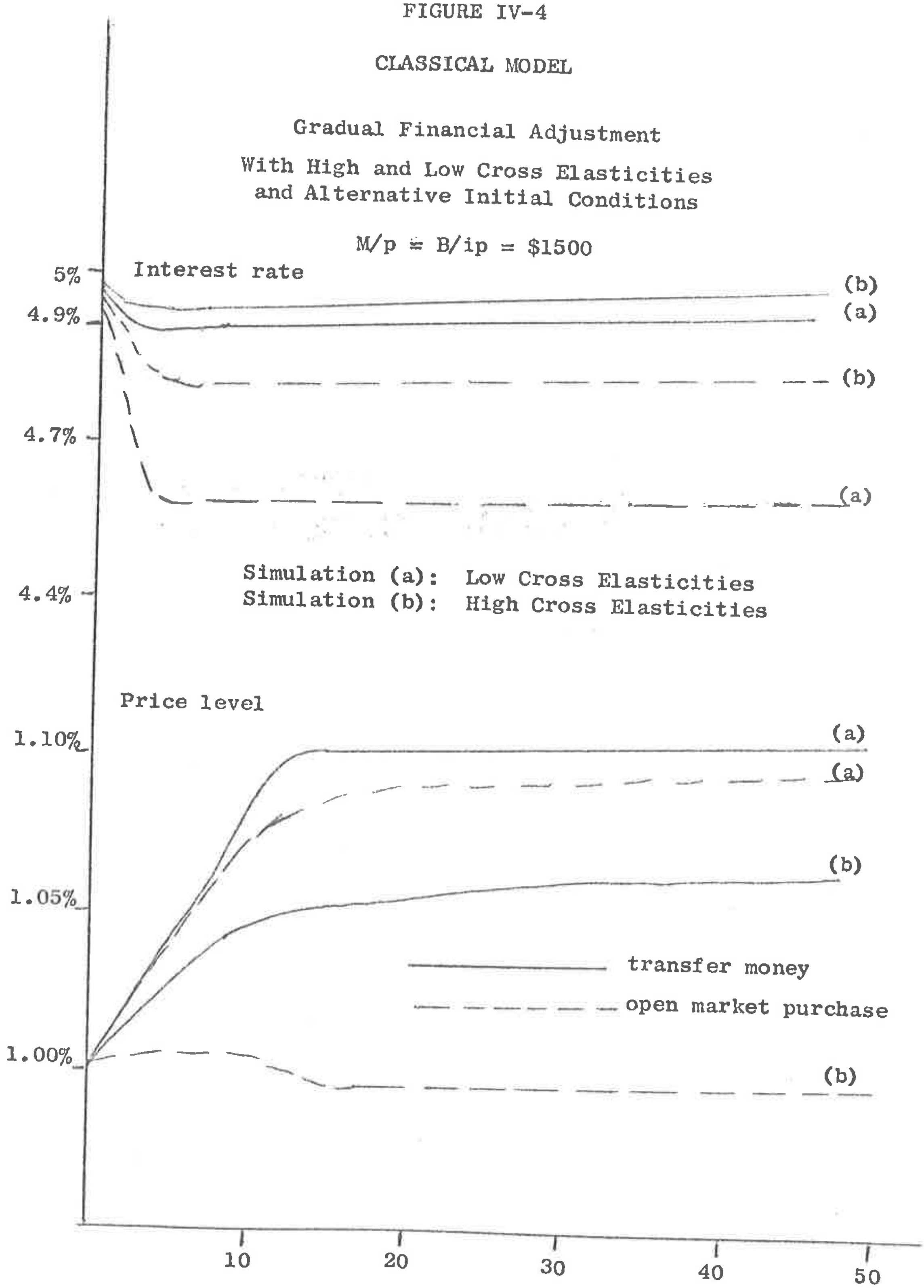
FIGURE IV-4

CLASSICAL MODEL

Gradual Financial Adjustment

With High and Low Cross Elasticities
and Alternative Initial Conditions

$M/p \doteq B/ip = \$1500$



money and bonds. Here we increased the elasticities $\epsilon_{L,i}$, $\epsilon_{L,r}$, $\epsilon_{B,i}$ to an absolute value of 2.

In Table IV-1 we have summarized our specific parameter variations for each of our simulation results pictured in Figures IV-1 through IV-4.

TABLE IV-1

SIMULATION EXPERIMENTS WITH PERFECT WAGE FLEXIBILITY

Simulation Picture	Parameter Change from Table III-1
Figure IV-1 - upper half	None
Figure IV-1 - lower half	$\lambda = \beta = \infty$
Figure IV-2 - Simulation (a)	$\epsilon_{L,r} = \epsilon_{L,i} = \epsilon_{B,r} = -2.00$; $\epsilon_{B,i} = 7.1$
Figure IV-2 - Simulation (b)	$\epsilon_{L,r} = \epsilon_{L,i} = \epsilon_{B,r} = -0.1$; $\epsilon_{B,i} = 1.1$
Figure IV-2 - Simulation (c)	B/ip = \$1411.76
Figure IV-3 - Simulation (a)	$\epsilon_{L,r} = \epsilon_{L,i} = \epsilon_{B,r} = -0.1$
Figure IV-3 - Simulation (b)	$\epsilon_{L,r} = \epsilon_{L,i} = \epsilon_{B,r} = -2.0$
Figure IV-4 - Simulation (a)	$\epsilon_{L,r} = \epsilon_{L,i} = \epsilon_{B,r} = -0.1$; M/p = B/ip = \$1500
Figure IV-4 - Simulation (b)	$\epsilon_{L,r} = \epsilon_{L,i} = \epsilon_{B,r} = -2.0$; M/p = B/ip = \$1500

A. <u>The Dynamic Effects of Transfer Money</u>

We shall first consider the adjustment paths generated by transfer money, represented by the solid curves in our simulation pictures.

Starting with the case of gradual money and bond adjustment in the upper half of Figure IV-1, we find that the interest rate behaves in a smooth downward manner. The adjustment is mostly concentrated in the first 3 months after the policy change, and is practically over within 2 quarters. Similar results on the timing of interest rate adjustment to monetary change were found by William Gibson [(1970): p. 453]. Once adjustment is complete, we find that the interest rate has declined by about six basis points. Thus the long run neutrality of money is not valid in our model, since our once-over money supply change causes a permanent reduction in the interest rate.

For the price level, the adjustment is upward, smooth and monotonic, with gradually declining speed. The duration of adjustment is much longer than that of the interest rate, for it takes the price level about 16 quarters or 4 years to reach long run equilibrium. This result is consistent with the empirical work of Cagan and Gondolfi [1969], who expect the monetary transition period to last between 3 and 5 years. Once adjustment is complete, we also find that the 10% transfer money injection has caused the price level to rise by 7.5%, implying that the quantity theory of long run price adjustment is not valid for a policy which increases the money supply but leaves the stock of bonds unchanged.[3]

Let us now turn to the case of instantaneous adjustment of money and bonds, pictured in the lower half of Figure IV-1.

The long run response of the interest rate and price level is the same as in the upper half of Figure IV-1. It is the adjustment paths which prove to be different. For the interest rate, the transition period is about as rapid as in the case of gradual financial asset adjustment. However, the path is not as smooth as in the previous case: the interest rate slightly undershoots its long run value by about one basis point before reaching equilbirum. For the price level, on the other hand, the adjustment is still smooth and monotonic, but the speed of adjustment is much more rapid than in the previous case: the price level is quite close to long run equilibrium within 4 quarters after the monetary change. This relatively quick effect of transfer money on the over-all price level is not consistent with most empirical descriptions of sluggish price behavior, and suggests that instantaneous financial asset adjustment is not a realistic lag structure for our model.[4]

Turning to Figure IV-2, let us first consider the results for Simulation (a), the case of relatively high direct and cross elasticities for money and bonds.

The adjustment path for the interest rate is not as smooth as in the initial case. We also find that the long run decline of the interest rate is not as great as in the previous simulations. Here, transfer money reduces the interest rate by about 3 basis points, whereas the previous reduction was about 8 basis points. The price level, on the other hand, still adjusts in a smooth monotonic manner. However, we find that the long run increase of the price level is not as great as before. The 10% transfer money injection raises the price level by 7%, about .5% less than in the initial case. Thus with high interest and yield elasticities transfer money seems to be less effective in its power to lower the interest rate and to raise the price level.

Our result is two-fold. With high interest and yield elasticities money becomes practically neutral in its long run effect on the interest rate. At the same time the quantity theory of long run price adjustment becomes less plausible. This two-fold result has a very straightforward explanation. The relatively small decline in the interest rate may be traced to the relatively high interest elasticity of bonds: with a highly interest-elastic bond demand only a very small interest rate change is required to restore bond equilibrium after the monetary change. Similarly, the relatively small price level increase may be traced to the relatively high interest elasticity of money: with a highly interest-elastic demand for money the decline of the interest rate becomes a strong equilibrating force in the monetary sector as well as in the bond market. Hence a smaller price level increase is required to remove the monetary disequilibrium.

Now let us consider the results for Simulation (b) in Figure IV-2, the case of relatively low interest and yield elasticities for money and bonds.

We find that the interest rate declines monotonically. However the interest rate does not reach long run equilibrium until the twentieth quarter, and the drop is almost 40 basis points. The movement of the price level is still upward and smooth, and reaches a long run value of 1.10. Thus with low interest and yield elasticities transfer money seems to be more effective in its power to lower the interest rate and to raise the price level.

The same two-fold result occurs as in the previous case, but with an opposite twist. Here the quantity theory of long run price adjustment is upheld in our model, but the interest rate effect of transfer money is far from neutral. At the same time, the interest rate completes adjustment much later than in previous cases which had identical asset adjustment speeds. Again, this result has a straightforward explanation. The large drop in the interest rate may be traced to the relatively low interest elasticity of bonds: with an interest-inelastic bond demand a very large long run interest rate change is required to restore bond equilibrium. Similarly the relatively large price level increase may be traced to the relatively low interest elasticity of money: with an interest-inelastic demand for money the decline of the interest rate becomes a weak equilibrating force in the monetary sector. Hence a larger long run price increase is required to remove the monetary disequilibrium. Finally, the slow contemporaneous adjustment of the interest rate and the price level to long run equilibrium indicates that the upward movement of the price level exerts a strong influence in the bond sector as well. In this case bond market equilibrium does not occur until price movements have ceased.

This relatively slow adjustment of the bond yield to monetary policy in Simulation (b) is not consistent with the empirical research of Cagan and Gondolfi [1969] and Gibson [1970]. Cagan and Gondolfi expect the total period of interest rate adjustment to take no more than 6 or 7 quarters, and Gibson expects an even shorter period of adjustment. We may thus rule out Simulation (b), the case of low direct and cross elasticities for money and bonds, as an unrealistic description of the timing of the monetary adjustment process.

Let us now consider the results for Simulation (c), in Figure IV-2. Here we have reduced the stock of bond by 50%. All other parameters are the same as in our first simulation appearing in the upper-half of Figure IV-1. The new set of initial conditions represents an economy with less debt, and our purpose is to examine the sensitivity of our initial results to a shift in the starting conditions of our dynamic model.

We find that the interest rate declines in much the same way as in the initial case. However the long run decline is much smaller: here transfer money reduces the interest rate by only 2 basis points, whereas the reduction is about 8 basis points in the initial case. The movement of the price level, on the other hand, is still monotonic but we find the long run increase to be slightly larger. Here transfer money raises the price level from 1.00 to 1.85, whereas the increase is from 1.00 to 1.75 in the initial case. Thus our partial reduction in real bond valuation renders transfer money practically neutral in its effect on the interest rate and brings us close to a quantity theory description of long run price adjustment.[5]

Let us now turn to Figure IV-3. Here we have reverted to our original value for bonds for both simulations. In Simulation (a) we specified relatively low cross elasticities for money and bonds ($\epsilon_{L,r} = \epsilon_{L,i} = \epsilon_{B,r} = -0.1$), and in Simulation (b) we specified relatively high absolute values for the same parameters. Here $\epsilon_{L,r} = \epsilon_{L,i} = \epsilon_{B,r} = -2$. In both experiments we retained our initial value for the direct elasticity of bonds $\epsilon_{B,i}$.

With low cross elasticities we again find that we are close to a quantity theory of long run price adjustment. Once adjustment is complete we see that the price level has risen by about 9.5% following the 10% money supply increase. The long run response of the interest rate is still downward, but the decline is not as large as the interest rate drop under low direct and cross elasticities. In Simulation (b) in Figure IV-2, the interest rate dropped by about 40 basis points when we lowered the direct elasticity of bonds as well as the cross elasticities of bonds and money. Here in Figure IV-3 we find that transfer money lowers the bond yield by 10 basis points for the same set of low cross elasticities in Figure IV-2 coupled with a higher direct elasticity for bonds. We can conclude from this comparison that low cross elasticities coupled with a progressively higher direct elasticity for bonds will bring us closer to complete interest-rate neutrality of money. However, as long as the interest elasticity of bonds $\epsilon_{B,i}$ is less than infinity, we must still expect transfer money to lower the interest rate even if the quantity theory of price adjustment is upheld. Since the increase in the price level will decrease the real value of government bonds, the interest rate will have to decrease to equalize the demand for bonds with their reduced supply.[6]

Let us now consider Simulation (b) in Figure IV-3. With high cross elasticities we see we are far away from a quantity-theory description of long run price adjustment. Here the 10% money stock increase induces a price change of 4%. Higher cross elasticities coupled with a positive stock of government bonds thus lead to progressively lower price effects of transfer money.

Finally, let us consider the results pictured in Figure IV-4. Here we have increased the money stock by more than 200% and reduced the stock of bonds by more than 50%. We again find that low cross elasticities lead to a quantity-theory description of long run price adjustment, and high cross elasticities lead to low price effects of transfer money. In fact, the new initial conditions do not significantly change the effects of transfer money pictured in Figure IV-3. In both figures there is practically a 10% price increase and a drop in the interest rate by 10 basis points for Simulation (a), the case of low cross elasticities, and in Simulation (b), the case of high elasticities, the price level rises by about 4.5% and the interest rate drops by about 5 basis points. Both Figures IV-3 and IV-4 thus show that variations in the interest elasticities of money and the yield elasticity of bonds substantially alter our initial results for transfer money, and highlight the importance of these cross elasticities for obtaining quantity-theory results.[7]

B. The Dynamic Effects of Open Market Purchases

We can now compare our transfer money results with the corresponding adjustment paths set off by an open market purchase. These paths are represented by the broken curves in Figures IV-1 through IV-4.

With respect to sign the differences agree with theoretical results obtained by Niehans: the reduction in the interest rate is now larger and the increase in the price level is smaller than for new transfer money of the same amount. [Niehans (1974): pp. 30-31]

In Figure IV-1 the quantitative differences between the two monetary policies appear to be quite small, and it is fair to say that for our initial parameters the dynamic and long run effects of both policies are about the same, whether we have gradual or instantaneous financial asset adjustment. Our initial policy simulations are thus consistent with Cagan's proposition that "monetary effects on interest rates and the economy at large depend primarily upon the quantity of money created and not upon the particular credit channels taken by the injection of the new money." [Cagan (1971): p. 122].

Let us now turn to Simulation (a) in Figure IV-2, the case of relatively high direct and cross rate of return elasticities for money and bonds. Here the interest rate effects of the two policies are still about the same. However, the differences in the price effects of the two policies are slightly larger than in the initial case. In this simulation experiment the price effect of the open market purchase is about one point lower than the transfer money effect. However, even with these relatively high direct and cross elasticities for money and bonds we are still very far away from the possibility of deflationary open market purchases. In qualitative comparative static analysis Niehans found that the price effects of bond retirement could be stronger than those of using money, and therefore it is logically possible for open market purchases to lower the price level. [Niehans (1974): p. 30]

Now let us consider Simulation (b) in Figure IV-2, the case of relative low direct and cross elasticities for money and bonds. Here the difference in the interest rate effect of the two policies is quite large: the drop in the interest rate following the open market purchase is 10 basis points greater than the transfer money effect. The price effects, on the other hand, are still about the same for the two policies. However, we have already dismissed the results for Simulation (b) as an unrealistic description of the timing of the monetary adjustment process. We thus believe that the different interest rate effects of the two policies generated by Simulation (b) does not merit much credibility.

Let us not turn to Simulation (c) in Figure IV-2, the case of a 50% reduction in our initial value of government bonds.

Finally let us compare the two policy effects under Simulation (c) in Figure IV-2, the case of a 50% reduction in real bond valuation. We find that the differences in the interest and price effects are only slightly larger than in the initial simulation. The open market purchase depresses the interest rate by 5 basis points more than transfer money, compared with a 3 point difference in the initial case. At the same time the open market purchase raises the price level about one point less than transfer money, compared with a .5 point difference in the initial case. Hence our 50% reduction in the value of the real bond stock still does not create the condition for significantly different effects between the two monetary policies.

Let us now turn to Figure IV-3. In Simulation (a), the case of low cross elasticities, we again find little difference between the price effects of an open market purchase and new transfer money. The price effect of an open market purchase is barely .5 point less than the price effect of transfer money. However, when we switch to the case of relatively high cross elasticities in Simulation (b), we find that the difference between the price effects of the two policies grows larger. In this case we see that transfer money raises the price level by 4 points, while the open market purchase raises the price level by 2.5 points. By comparison the price increase generated by the open market purchase is less than 75% of the full price effect of transfer money. We can conclude from this case that money is not simply all that matters when asset demand cross elasticities grow very large.

Finally, let us turn to Figure IV-4. In Simulation (a), the case of low cross elasticities of money and bonds, we find that the new initial values for money and bonds still do not create the conditions for significant differences between transfer money and open market purchases. Here the price effect of an open market purchase is about 1.5 points short of the transfer money effect. However, in relative terms this difference is small, for the price increase generated by the open market purchase is about 90% of the full price effect of transfer money. On the other hand, the interest rate effects of the two policies are quite different. We find that transfer money decreases the bond rate by 10 basis points whereas the open market purchase decreases the interest rate by 40 basis points. The reason, of course, is due to the relative proportions of money and bonds in the economy. In this case, the stocks of money and bonds are equal, so that a 10% increase in the money supply through an open market purchase decreases the stock of bonds by 10%. In our previous experiments bonds outnumbered money by a ratio of 3 to 1, so that a 10% money stock increase through an open market purchase decreased the stock of bonds by only 3%. In this case, we therefore find that a relatively large interest rate drop is required to equate bond demand with the relatively large reduction in supply.

Let us now consider Simulation (b) in Figure IV-4. Here we coupled relatively high cross elasticities with our new initial conditions. We find that the price effects of the open market purchase are significant in two respects: (1) the price effect of the open market purchase is about 5 points less than transfer money; (2) in the long run the open market purchase actually lowers the price level by about 1/2 point. In this case, we can surely say that money is not all that matters, for the way money is supplied to the economy makes all the difference, money being inflationary when supplied through the transfer mechanism, and money being deflationary when supplied through an open market purchase.

Our simulations thus show the importance of the cross rate of return elasticities in our asset demand equations. Significant differences between transfer money and open market purchases appear when these elasticities take on a relatively high value of 2, and we can even expect deflationary open market purchases when these high cross elasticities are coupled with a larger quantity of money and a lower quantity of debt than found in the U.S. economy. However, when the asset demand cross elasticities are in a lower range (between 0 and 1), our simulation results show for various sets of initial conditions that money is almost all that matters. Since most empirical studies show that the cross rate of return elasticities are indeed in this lower range,[8] we can conclude from our simulation experiments that the macroeconomic effects of transfer payments and open market purchases are practically the same.[9]

Section 3: Macroeconomic Adjustment with Unemployment and Fixed Wages

The adjustment paths for our Keynesian model of unemployment and fixed wages are presented in Figures IV-5 and IV-6. Our parameters have been varied in much the same way as in our classical simulations. Our initial simulation appears on the left hand side of Figure IV-5. No parameter changes have been made from Table III-2. On the right hand side of the same figure we have pictured the adjustment paths for the case of instantaneous adjustment of money and bonds. All other parameters are the same as in Table III-2.

In Figure IV-6 we have pictured the adjustment paths for two further sets of parameter variations. On the left hand side we have again set the direct and cross rate of return elasticities for money and bonds at relatively low absolute values. Here $\epsilon_{L,r} = \epsilon_{L,i}$

FIGURE IV-5

KEYNESIAN MODEL

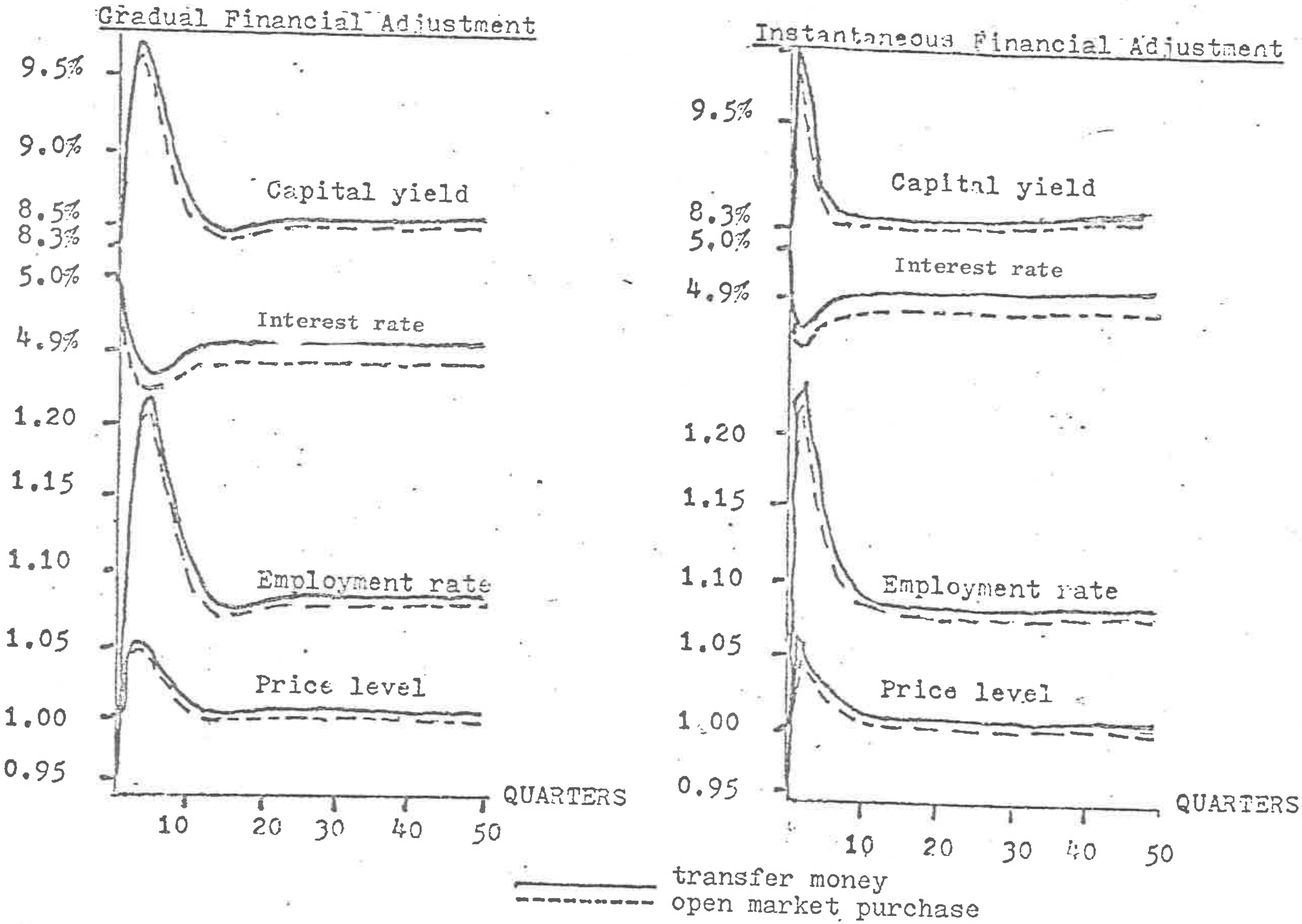
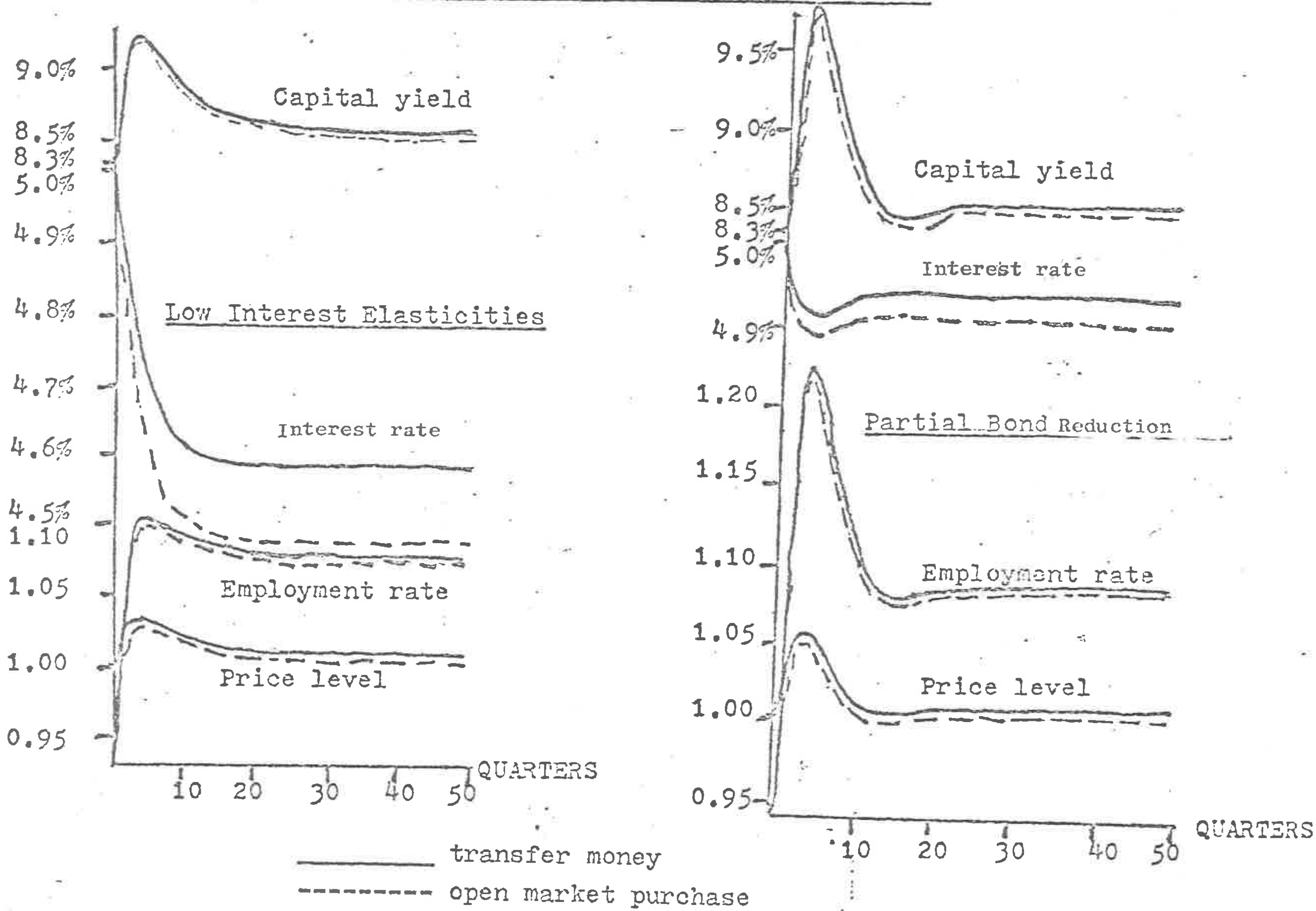


FIGURE IV-6
KEYNESIAN MODEL
Gradual Adjustment of Money and Bonds



$= \epsilon_{B,r} = -.01$.and $\epsilon_{B,i} = 1.1$. Finally, on the right hand side of Figure IV-4 we returned to our initial parameter selections, but we have reduced the value of the real bond stock by 50%.

We did not picture our simulation results for the case of relatively high asset demand rate of return elasticities and for the case of alternative initial conditions for both money and bonds.

With high asset demand elasticities the adjustment process turned out to be unstable in our Keynesian model. The unstable adjustment process occurred both for the case of high direct and cross elasticities, and for the case of high cross elasticities coupled with unchanged direct elasticities. For these same elasticity values the adjustment process was stable and smooth in our classical model. Furthermore, a casual inspection of Figures IV-5 and IV-6 reveals that for the simulations which do converge to equilibrium, overshooting characterizes our rigid wage model whereas monotonic adjustment prevailed in our classical model. In our model wage rigidity thus bears a heavy responsibility for the destabilizing effects of monetary policy.[10]

In the case of alternative initial conditions for both money and bonds we found that these changes made little difference in our results. Unstable adjustment occurred when we coupled high asset demand cross elasticities with a higher value of money ($1500) and a lower value of bonds ($1500). When we coupled low asset demand cross elasticities with these initial conditions, we obtained practically the same results we pictured on the left side of Figure IV-6, where we coupled low asset demand elasticities with our original values for money and bonds.

In Table IV-2 we have summarized our specific parameter variations for each of the simulation results presented in Figures IV-5 and IV-6

TABLE IV-2

SIMULATION EXPERIMENTS WITH PERFECTLY RIGID WAGES

Simulation Picture	Parameter Changes from Table III-1
Figure IV-5 - left side	None
Figure IV-5 - right side	$\lambda = \beta = \infty$
Figure IV-6 - left side	$\epsilon_{L,r} = \epsilon_{L,i} = \epsilon_{B,r} = -0.1$; $\epsilon_{B,i} = 1.1$
Figure IV-6 - right side	B/ip = \$1411.76

A. The Dynamic Effects of Transfer Money

Again let us begin with the adjustment paths generated by transfer money, represented by the solid curves in our simulation pictures.

Beginning with the case of gradual money and bond adjustment on the left side of Figure IV-5, we find that transfer money initially increases the capital yield. In our classical model transfer money had very little effect on the capital rate of return. For this reason we did not plot the time path of this variable in previous simulation pictures.

In our Keynesian model the story is quite different. The capital yield reaches a peak of more than 120 basis points above its initial value of 8.33% about 3 quarters after the policy change. Over the next 10 quarters the yield then declines by about 100 basis points and levels out at a value slightly above its initial rate of return.[11]

The interest rate, on the other hand, moves in the opposite direction following the transfer policy. The interest rate first declines and hits a trough 13 basis points below its initial value about 3 quarters after the policy change. The interest rate then reverses direction and during the next 3 quarters reaches a long run value of 4.90%.

The behavior of the interest rate is consistent with the recent empirical work of Cagan and Gondolfi [1969]. Cagan and Gondolfi also expect the interest rate to decline for the first 3 quarters after the policy change, then reverse direction and reach long run equilibrium during the next 3 or 4 quarters. In their model, however, Cagan and Gondolfi have made no assumption about employment or wage flexibility; they believe interest rates will first decrease and then increase under conditions of full employment as well as "when the expansion starts from less than full employment." [Cagan and Gondolfi (1969): p. 277]

The opposite movement of the capital yield from the interest rate, however, has further implications. In our model this phenomenon may be explained by the relatively faster speed of adjustment of employment over capital accumulation.

The expansionary transfer money stimulates both employment and capital accumulation by simultaneously lowering the level of real wages and the bond rate of return. The increasing rates of employment and capital accumulation then push the capital yield in opposite directions. The increasing employment rate raises the marginal productivity of capital and thereby increases the capital rate of return, while the increasing rate of capital accumulation lowers the marginal productivity of capital and thereby decreases the capital rate of return. Since we have assumed that capital accumulation occurs only with a finite adjustment speed and that the factor market for labor adjusts instantaneously, it is not surprising to find transfer money first increasing the capital rate of return through its expansionary effects of employment.

While the transfer policy is increasing the rate of return on capital, we also observe in Figure IV-5 that it is simultaneously raising the price level. With rigid wages our model thus generates a positive price-capital rate of return correlation as the economy adjusts to new transfer money.

Irving Fisher [1930] envisioned a positive price-interest rate correlation in periods of transition. Fisher decomposed observed interest rates into real interest rates and nominal or money rates of interest. According to Fisher, the money rate and the real rate are normally identical when the "purchasing power of the dollar is constant or stable." [Fisher (1930): p. 43] However, when the cost of living is not stable, the (money) rate of interest takes the appreciation and depreciation into account to some extent, but only slightly and, in general, indirectly. Fisher writes:

> ...when prices are rising, the money rate of interest tends to be high but not so high as it should be to compensate for the rise, and when prices are falling, the

> rate of interest tends to be low, but not so low as it should be to compensate for the fall. [Fisher (1930): p. 43]

In the long run, Fisher believed that a high level of prices due to previous monetary and credit inflation ought not to be associated with any higher money rate of interest than the low level before the inflation took place. According to Fisher, the high money rate of interest would "doubtless in time revert to normal if the normal high (price) level were maintained." [Fisher (1930): p. 441] Fisher therefore concluded that "at the peak of prices, interest is high, not because the price level is high, but because it has been rising" and similarly, when prices are low, "interest is low, not because the price level is low, but because it has been falling." [Fisher (1930): p. 441]

Fisher's study of interest and price adjustment was therefore based on the discrepancy between real and money rates of interest caused by rising prices. Fisher made no mention of the effects of increasing employment on interest rates during the adjustment process.

Unlike Fisher, we have made no distinction between real and nominal rates of return because we have supressed any direct influence of inflation on interest rates during the adjustment process. In our model, the capital yield and the bond rate include no component which takes appreciation or depreciation of money into account. The capital yield is simply the marginal productivity of capital, and the interest rate is the market-determined rate of return on government bonds. In our model we have found a positive correlation between the price level and the rate of return for only one asset, productive capital. There is no positive correlation between the price level and the rate of return on government bonds.

In a recent empirical and simulation study, Thomas Sargent [1973] found a positive price-interest rate correlation in real as well as in nominal rates. Holding the expected rate of inflation at zero, Sargent then simulated a Keynesian macromodel with an added Phillips Curve and generated time series showing a positive price-interest rate correlation. Sargent thus found a case of rising prices and interest rates where there is no direct unidirectional influence of inflation on interest rates. In Sargent's model, as in our own, interest rates and prices are mutually determined along with employment, capital accumulation and wage rates. To generate a positive price-interest rate correlation Sargent thus showed that there is no need to distinguish between real and nominal rates of interest. [Sargent (1973): p. 441]

In contrast to Sargent, we found a positive correlation between the price level and the marginal productivity of capital. In his simulation study Sargent did not consider the behavior of the marginal productivity of capital during the adjustment process. However, in Sargent's model and in our own model unemployment is the key variable. According to Sargent, the key reason for the positive price-interest rate correlation is "the failure of wages and prices to adjust sufficiently quickly to keep output always at its full-employment level." [Sargent (1973): p. 442] When Sargent simulated a classical version of his model, in which output is fixed at its full employment level and wages and prices become perfectly flexible, he found that a money supply increase left the interest rate unaltered and caused the price level and nominal wage rate to increase [Sargent (1973): p. 442] In our classical model, on the other hand, we found that the money supply increase left the rate of return unaltered, but caused the price level and the interest rate to adjust in opposite directions to their long run values. Only with unemployment did we find a positive correlation between the price level and the capital yield.

The adjustment of the price level in Figure IV-5 warrants special attention. With fixed wages the increase in the money supply ultimately leads to a new equilibrium with the price level about equal to its initial level.[12] In the meantime, however, there is overshooting: the price level reaches a peak 5 points above its initial value about 5 quarters after the policy change, and then gradually declines to equilibrium during the next 7 quarters.

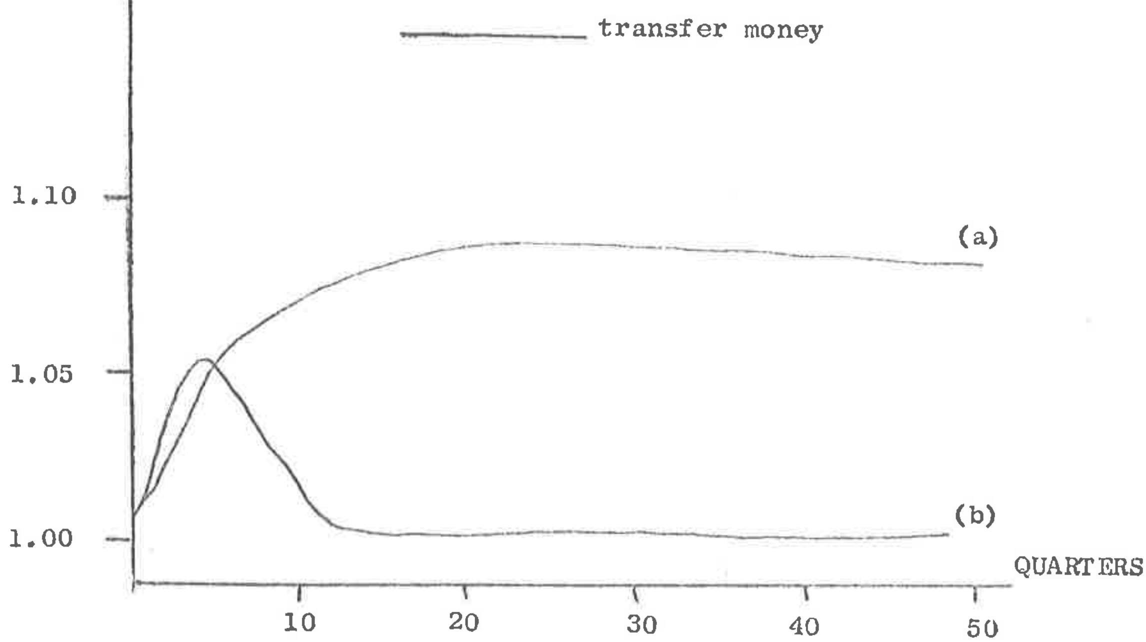
In econometric model simulations Anderson and Carlson [1971] and Hirsch [1971] have also found overshooting. Anderson and Carlson simulated monetarist control rules in the St. Louis model. Their results have a broadly similar structure: inflation overshoots and always approaches its steady state from above. Hirsch also reported overshooting in simulation experiments with the O.B.E. Econometric Model, but he did not find the overshooting to be terribly excessive.

We can thus conclude from our dynamic simulation results that fixed wages are no guarantee in our model for unchanged prices. In fact, the short run effect of transfer money with rigid wages is even slightly stronger than with flexible wages. In Figure IV-7 we compare the price adjustment paths under flexible and rigid wages generated by our initial parameter selections. For the first 5 quarters after the policy change the rigid wage adjustment path is always above the corresponding flexible wage adjustment path.

FIGURE IV-7

PRICE ADJUSTMENT WITH FLEXIBLE AND RIGID WAGES

Simulation (a): flexible wage model
Simulation (b): rigid wage model



This short run price behavior may be explained by the influence of the rate of return on capital on the demand for money. With rigid wages transfer money raises the capital yield. In turn the capital yield lowers the demand for money and thereby contributes to the inflationary effects of the excess supply of money. When wages are perfectly flexible, on the other hand, the capital yield remains practically unchanged. In this regime the initial inflationary effects of the new transfer money are not fed by the effects of an increasing capital yield on the demand for money.

In terms of one year policy goals, then, inflation appears to be strictly a monetary phenomenon. During this time it does not seem to matter whether wages are perfectly flexible or perfectly rigid. What is important in our model is the monetary disequilibrium created by the new transfer money, the initial reaction of interest rates, and the effectiveness of the interest rates in restoring monetary equilibrium by increasing asset holders' demand for money.

Let us now consider the behavior of the employment rate in Figure IV-5. Here we find pronounced overshooting: starting from an initial value of 94% the employment rate reaches a level of 122% about 3 quarters after the policy change. It then declines over the next 8 quarters to a long run value of 108%.

The reason for this pronounced overshooting is, of course, the rigidity of wages. Once wages begin to give way, as they can hardly fail to do sooner or later when the employment rate reaches high employment levels, we shall approach the full employment case, considered above, with rising wages and prices. This intereaction will be considered in Section IV. At the present stage it is important to realize that as long as wages are indeed perfectly rigid, there is good reason to expect very high employment gains from a 10%

increase in the money supply.

Turning to the other simulation results pictured in Figures IV-5 and IV-6, we find the same pattern of overshooting by interest rates, employment, and the price level. With instantaneous adjustment of money and bonds the turning points occur more rapidly, as expected. The only exception is for the case of low interest and yield elasticities for money and bonds, pictured on the left side of Figure IV-6. Here undershooting in the interest rate disappears. Since this behavior is inconsistent with the empirical evidence put forward by Cagan and Gondolfi [1969] and Gibson [1970] on the interest rate effects of monetary expansion, we can regard the results for this simulation as unrealistic. Finally, our initial results reappear on the left side of Figure IV-4, the case of a 50% reduction in real bond valuation.

B. The Dynamic Effects of an Open Market Purchase

Let us now consider the dynamic effects of an open market purchase with perfectly rigid wages, represented by the broken curves in Figures IV-5 and IV-6.

The results are quite similar to the adjustment paths generated by transfer money. The only noticeable differences appear in the adjustment of the interest rate. As expected, money supplied by an open purchase always lowers the interest rate a few basis points more than money supplied by transfer payments.

Once again our simulation results give us little reason to doubt the contention that money is nearly all that matters. For all of our parameter selection which generated stable adjustment in our

Keynesian model, it therefore seems to make little difference which way money is supplied to the economy.[13]

Section 4: Macroeconomic Adjustment with Adaptive Price Expectations and Semi-Flexible Wage Rates

We shall now consider the dynamic effects of transfer payments and open market purchases for our Phillips Curve model. In this model we embedded adaptive price expectations and semi-flexible wage rates. The adjustment equations for the expected rate of inflation and the nominal wage rate appear in Table II-2.

In Figure IV-8 we have pictured the adjustment process generated by our initial set of parameter values. The asset demand equations for money and bonds have a very low elasticity of -.01 for the expected rate of inflation, while the adjustment speeds for the nominal wage rate and the expected rate of inflation were set at .4.

In Figure IV-9 we picture our results for only one parameter variation from our initial specification in Table III.1. Here we have slightly increased the magnitude of the money and bond asset demand elasticities for the expected inflation from -.01 to -.05. Preliminary simulation experiments revealed that stability of adjustment was most sensitive to this parameter--higher asset demand elasticities for the expected rate of inflation led to unstable results. We shall therefore concentrate on the alternative adjustment pictures generated by small variations in this parameter and relate our results to problems of monetary policy in recent experience.

Preliminary simulation experiments revealed that relatively

FIGURE IV-8

PHILLIPS CURVE MODEL

$\epsilon_{L,\pi} = \epsilon_{B,\pi} = -.01$

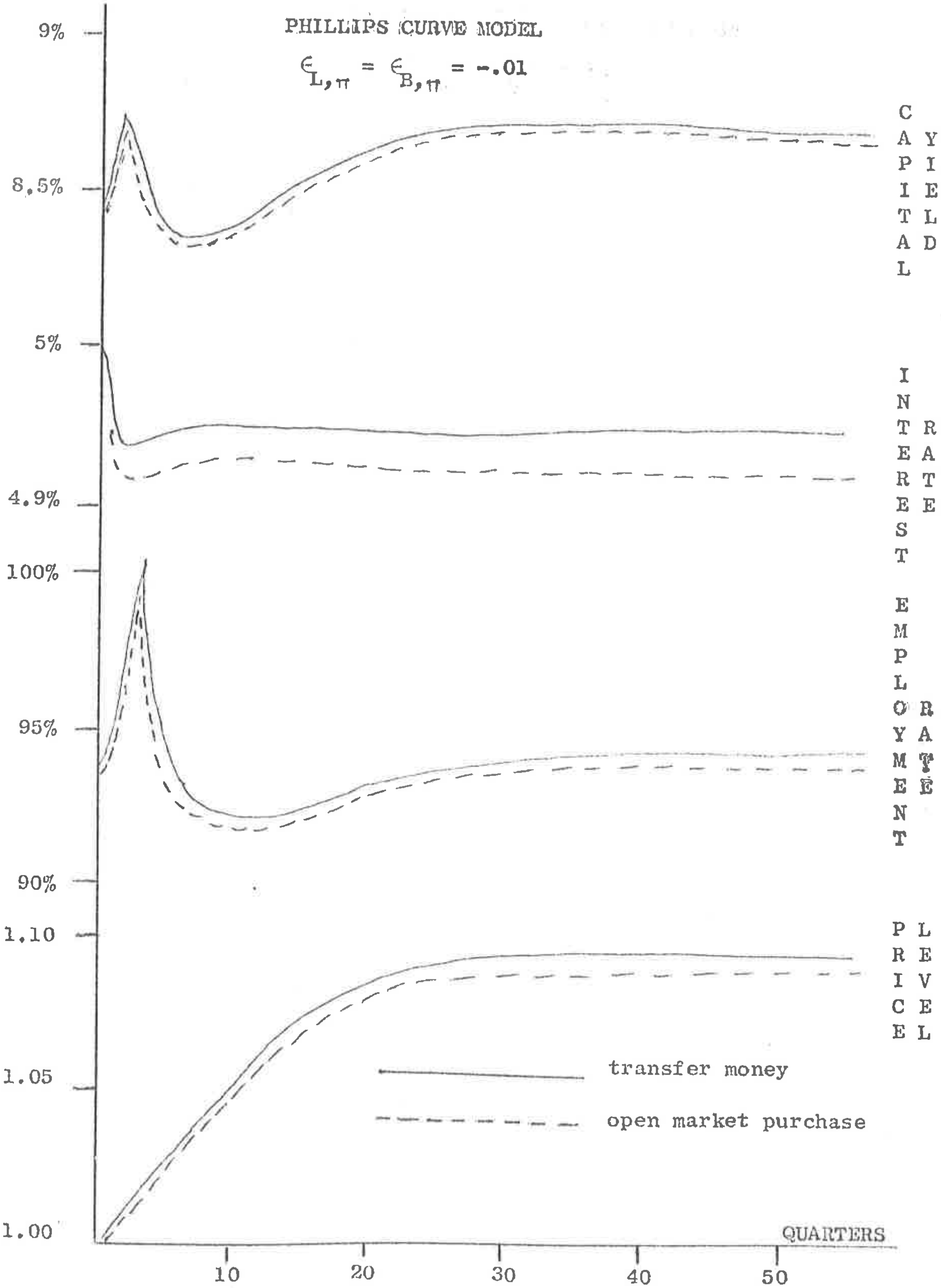
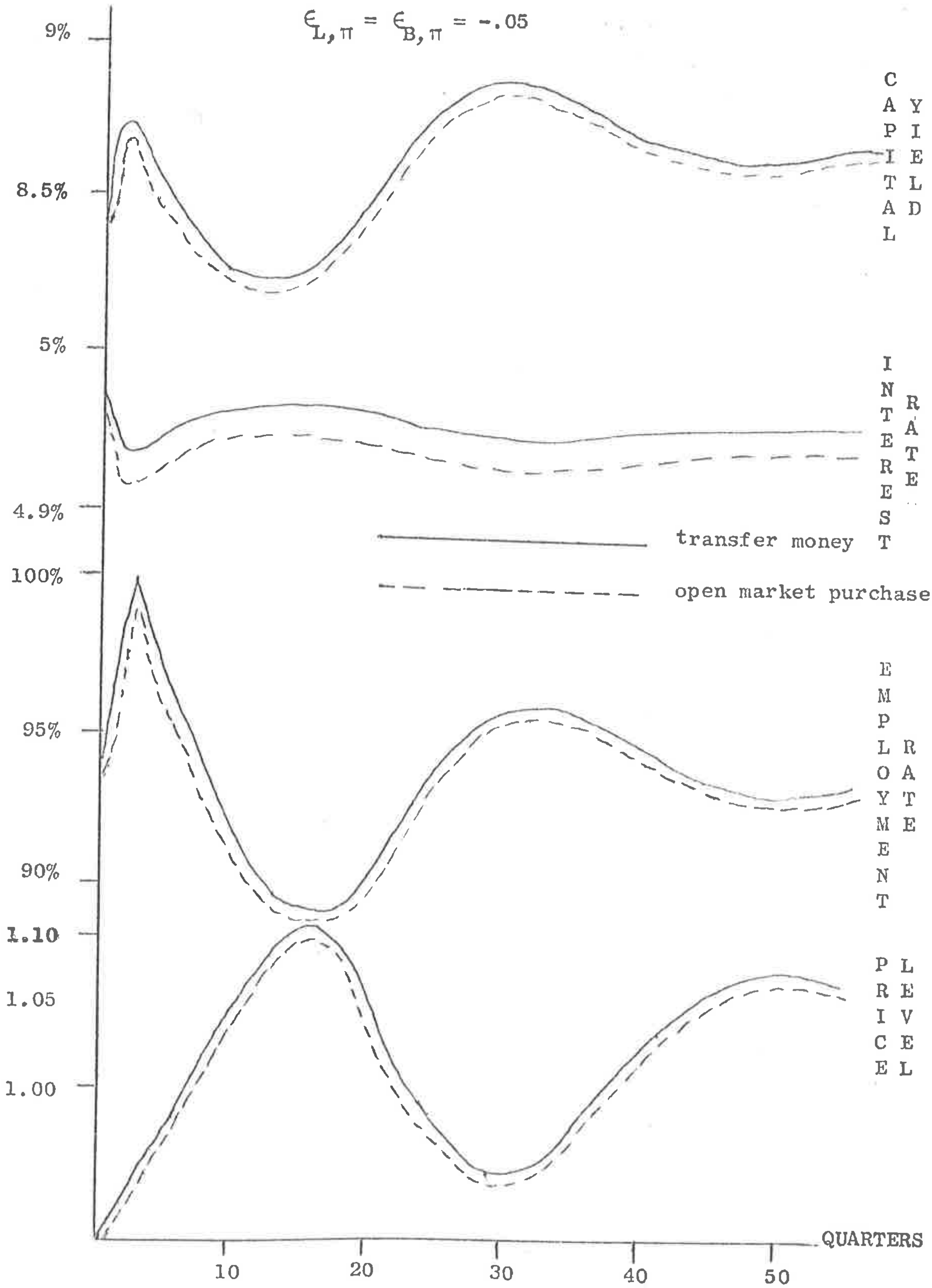


FIGURE IV-9

PHILLIPS CURVE MODEL

$\epsilon_{L,\pi} = \epsilon_{B,\pi} = -.05$



high cross rate of return elasticites led to unstable adjustment and relatively low cross elasticities adds nothing new to our results. Variations in the initial values for bonds and money also made little difference. Unstable adjustment was also caused by very fast adjustment speeds (.8 and upwards) for the expected rate of inflation and the nominal wage rate. Furthermore, we found that stable but very high adjustment speeds (between .7 and .8) brought about very fast and unrealistic price adjustment. However, variations in adjustment speeds between .6 and .2 for expectations and nominal wages did not significantly affect our results pictured in Figures IV-8 and IV-9.

In Table IV-3 we summarize our two sets of parameter specifications for our Phillips Curve model.

TABLE IV-3

SIMULATION EXPERIMENTS WITH ADAPTIVE PRICE EXPECTATIONS AND SEMI-FLEXIBLE WAGE RATES

Simulation Picture	Parameter Change from Table III-1
Figure IV-8	None
Figure IV-9	$\epsilon_{L,\pi} = \epsilon_{B,\pi} = -0.05$

A. The Dynamic Effects of Transfer Money

We shall start with transfer money, represented by the solid curve in Figures IV-8 and IV-9. In Figure IV-8 we observe once more that the capital and bond rates of return move in opposite directions immediately following the monetary injection. The capital yield first increases--reaching a peak of 8.75% by the fourth quarter--and then declines over the next 6 quarters to a trough of 8.3%. At the tenth quarter the capital yield reverses direction once again and increases over the next 10 quarters to a long run value of 8.6%. The interest rate, on the other hand, quickly declines to a value of 4.96% three quarters after the policy change, and then increases slightly over the next 4 quarters to a long run value of 4.95%.

Comparing Figure IV.8 with Figure IV.5, we observe that the introduction of adaptive expectations and semi-flexible wage rates to our unemployment model modifies the reactions of both rates of return to monetary expansion. When wages were perfectly rigid and expectations did not come into play, the capital yield rose to a peak of 9.6% three quarters after the policy execution, while the interest rate dropped by 10 basis points in the same period of time. The introduction of adaptive expectations and semi-flexible wage rates thus considerably shortens the initial surge of the capital yield and reduces by 50% the initial drop in the interest rate.[14]

Now let us turn to employment and price adjustment in Figure IV.8. Starting from an initial value of 96%, the employment rate reaches a peak of 100% five quarters after the policy change, and then declines rapidly to a trough of 93% over the next 6 quarters. By the tenth quarter employment then begins a 5 quarter reascent to its long run "normal" rate of 94%. In contrast to employment rate adjustment in Figure IV-5 when wages were perfectly rigid, we now find that its initial overshooting has been considerably reduced. With rigid wages the employment rate reached a peak of 122% five quarters after the policy execution. Hence the introduction of semi-flexible wage rates into our model leads to a more realistic picture of employment rate gains following a 10% monetary expansion, and acts as an effective "boundary constraint" by preventing the employment rate from surging past the full employment mark.

The adjustment of the price level in Figure IV.8 is slow and monotonic. After the 10% monetary increase it takes the price level 20 quarters to reach a long run value of 1.08.

The interaction of employment and price adjustment in Figure IV.8 poses special problems for monetary policy. For the first five periods employment and the price level increase together. Then we move into a period of "stagflation" for the next 5 quarters: prices continue to increase while employment recedes. Finally, we come into a period of "classical" adjustment in periods 10 through 20: employment shows very little gain while the price level increases steadily. As a net result of monetary policy we thus experience a slow upward inflationary trend and an employment record which shows only very short term gains and includes an intermittent period of rising prices and economic stagnation. In the long run we come close to a "quantity theory" description of macroeconomic adjustment: prices rise in direct proportion to the monetary increase while the employment rate appears unchanged.

The very slow price adjustment pictured in Figure IV.8 illustrates the problems posed by a policy of monetary contraction. According to Figure IV.8 a 10% decrease in the money supply aimed at "winding down" spiraling prices will have very quick employment effects--causing a 6% drop during the first 5 quarters--but will be very unsucessful in deflating the price level. While employment drops to a recessionary level, the price level will fall by a mere 3 points. Then the economy will move into a happy period of rising employment and falling prices: from period 5 through 15 employment will increase by 6% as it returns to its normal level while the price level will fall by 7 points. While the first year effects of monetary contraction appear unsuccessful and recessionary, the three-year effects appear successful; the price level is permanently lower and employment is back at its normal level.

Now let us turn to Figure IV.9. Here the money and bond asset demands take on slightly larger elasticities for the expected rate of inflation.

We find that the capital and bond rates of return still move in opposite directions following the 10% monetary expansion and their initial reactions appear to be the same as in Figure IV.8. Now, however, we find considerably more variation after the initial period of adjustment. The capital yield moves from its initial peak of 8.7% to a trough of 8.25% over a period of 10 quarters, and then climbs to a peak of 8.75% during the next 10 quarters. The interest rate, however, shows much less variation than the capital yield, and barely reflects any of the cyclical patterns appearing in the rest of the economy.

The initial first year reactions of the employment rate and price level in Figure IV.7 are identical to those appearing in Figure IV.8. Then the employment rate drops from its initial peak of 100% to a trough slightly less than 90% over the next 10 quarters, while the price level rises to a peak of 1.10 during the same period of time. After this period of severe "stagflation" we then begin a period of rising employment and falling prices. From period 15 through 25 employment ascends to 96% while the price level falls back to 1.02. Here we are practically back where the story began: employment is at its "normal" level and the price level is close to its initial value. Finally, for the next 15 periods we come into a less severe period of "stagflation:" prices begin a reascent while employment slightly declines. At period 40 we wind up with a price level increase closely proportionate to the initial money supply change and employment slightly below its "normal" rate.

The net result of introducing adaptive price expectations and semi-flexible wage rates is a pessimistic picture of monetary expansion. In our model monetary expansion can only buy a temporary gain in employment. A period of "stagflation" then raises its ugly head, and, as seen in Figure IV.9, employment rate may fall well below its initial "normal" rate during this period of transition. Finally, the lasting consequences of monetary policy manifest themselves in a price level increase closely proportionate to the monetary change and no perduring change in employment.

We thus conclude that adaptive price expectation and semi-flexible wage rates tie together the results obtained when wages were held perfectly flexible and perfectly fixed. We found that monetary policy first affects employment and, as in the case of fixed wages, generates very slow price changes. Then, after the economy goes through the wringer of stagflation, we find that monetary policy ultimately affects the price level and leaves the employment rate unchanged, as in the case of flexible wages. Perfectly rigid and perfectly flexible wages are extreme cases, and actual monetary policy has to manoeuvre somewhere in the foggy territory where expectations and semi-flexible wage rates interact with prices and employment. Unfortunately, expansionary monetary policy does not come off very well in this "foggy territory" in our model.[15]

B. The Dynamic Effects of an Open Market Purchase

Let us now examine the effects of an open market purchase in our Phillips Curve model. The adjustment of interest rates, employment, and the price level are represented by broken lines in Figure IV.8 and IV.9.

The results are quite close to those generated by transfer money. The only noticeable differences appear in the interest rate. Under both sets of money and bond asset demand elascities for expected inflation we find that money supplied by an open market purchase always lowers the interest rate a few basis points more than money supplied by transfer payments.

As in the case of perfectly flexible and perfectly rigid wages, our simulation results give us little reason to doubt the proposition that money is almost all that matters. As far as transfer money and open market operations are concerned, it seems to make little difference which way money is supplied to the economy. With adaptive expectations and semi-flexible wage rates monetary expansion through transfer payments and open market operations have very similar and unfortunate macroeconomic consequences.

Section 5: Conclusion

In this chapter we have found that transfer money and open market purchases have pretty much the same effects on the dynamic adjustment of prices, interest rates, and employment. Monotonic adjustment was set off by both policies under flexible wages, but overshooting characterized the adjustment paths with rigid wages. Finally, cyclical adjustment appeared when we introduced adaptive price expectations and semi-flexible wage rates.

In the next chapter we shall consider the effects of a one-shot monetary increase through government expenditures. Money supplied in this matter will prove to be quite different from money supplied through transfers and open market purchases, and it will indeed matter which way the government decides to supply money to the economy.

FOOTNOTES TO CHAPTER IV

(1) We have found that smaller step sizes resulted in more accurate numerical integration and convergence to equilibrium. After experimenting with several different step sizes, we set the integration interval at one-half. We pictured our simulation results at "print-out" intervals of one, however, to generate quarterly snap-shots of the adjustment process.

(2) The yield elasticity of money is simply the elasticity of the demand for money with respect to the rate of return on capital, and the interest elasticity of money is the elasticity of the demand for money with respect to the rate of return on government bonds. The yield elasticity of bonds is simply the elasticity of the demand for bonds with respect to the rate of return on capital, and the interest elasticity of bonds is the elasticity of the demand for bonds with respect to the rate of return on government bonds. When we use the term "yield" we thus refer to the capital rate of return, and when we use the term "interest" we thus refer to the bond rate of return.

(3) The quantity theory of long run price adjustment thus does not apply. The 10% money supply change has not brought about a 10% price level increase simply because there is a non-zero constant stock of bonds. Had we increased both bonds and money by 10%, we would have generated a 10% price level increase. Alternatively, had we set the value of the stock of bonds at zero, we would have generated a 10% price level increase. We shall find that we come closer to a quantity theory description of long run price adjustment when we decrease the stock of bonds by 50%.

(4) Griliches, in particular, has stressed that the over-all price level responds very sluggishly to changes in the money supply. [See Griliches (1971): p. 213]

(5) Niehans has shown that the quantity theory will be upheld in his model when there are no government bonds, even if the cross-elasticities are non-zero. Niehans expresses the quantity theory in the following way:

> If money is the only exogenously given financial asset of the private sector, then, starting from an equilibrium situation, an increase in the money supply by a given percentage will result in a new equilibrium in which prices are higher by the

same percentage. In this sense, the quantity theory enjoys very wide acceptance among economists holding the most diverse views on economic policy, including both "monetarists" and their opponents. [Niehans (1974): p. 28]

(6) In the time preference version of Niehans' model, the cross interest rate elasticities are zero. He found that in this version the elasticity of the interest rate with respect to the nominal money stock is inversely related to the interest elasticity of bonds $\epsilon_{B,i}$:

$$\epsilon_{i,M} = - \frac{1}{\epsilon_{B,i} + 1}$$

Hence as $\epsilon_{B,i} \rightarrow \infty$, $\epsilon_{i,M} \rightarrow 0$. In our simulation experiments we have approached this time preference version with low (but, not zero) cross interest rate elasticities for money and bonds. Hence it is not surprising that we find that low values for $\epsilon_{B,i}$ cause a relatively large interest rate drop in response to transfer money, and high values for $\epsilon_{B,i}$ cause a relatively low interest rate drop. (See Niehans (1974): p. 29]

(7) In preliminary simulation results we found that variations in the cross elasticity $\epsilon_{K,i}$ did not make much difference. We found that quantity theory results could be obtained by setting $\epsilon_{L,r} = \epsilon_{L,i} = \epsilon_{B,r} = 0$ while leaving $\epsilon_{K,i}$ at its initial value. Variations in this parameter had little effects on the price effects of transfer money.

(8) See Section 3 of Chapter III for our survey of empirical estimates for the interest elasticity of money and the interest elasticity of capital.

(9) In Chapter V, however, we shall find that it does indeed make a difference which way the government supplies money to the economy when we consider the dynamic effects of government expenditures financed by an increase in the total money supply. Differences between money supplied through transfer payments and government expenditures will be shown to depend crucially on the effects of government expenditures on the demand for assets by the private sector, symbolized by the coefficients K_g, B_g and L_g in our asset demand equations in Table II.2.

(10) Our model is therefore consistent with Haberler's contention that wage rigidity is "an essential prerequisite of any monetary ex-

planation of business cycles." [See Haberler (1965): p. 139].

(11) Our comparative static numerical simulation showed that transfer money should decrease the capital yield by a few basis points. There is thus a "convergence error" of about 20 basis points in the dynamic numerical simulation, for the capital yield levels out at a value slightly above the numerical comparative static solution. In view of the very large variation in the magnitude of this variable during the adjustment process, we consider this "convergence error" to be relatively small.

(12) In our comparative static experiments the price level fell slightly below its initial value to 0.98. The fact that the price level did not fall below its initial value here is due to a convergence error of about .02.

(13) When we come to Chapter V, however, we shall find that it will make a difference if the government supplies money to the conomy for the financing of expenditures.

(14) In our model the introduction of semi-flexible wages plays the leading role in checking the initial surge of the capital yield, while the influence of expectations on asset holders demand for bonds is the dominant factor checking the fall in the interest rate..

When wages were perfectly rigid the employment rate initially surged to very high levels. The very high employment levels in turn increased the marginal productivity of capital, and thus caused the capital yield to surge to a high level following the monetary increase. With semi-flexible wages, however, employment gains are checked when full employment levels are reached, and labor market pressures are translated into wage increases. Since the employment rate no longer surges to high levels, the marginal productivity of capital does not initially increase as much as it did when wages were rigid. Consequently we now find that the capital yield does not rise as much as it did in the previous case.

In our model we have specified a negative value of -.01 for the bond demand elasticity for the expected inflation. An increase in the expected rate of inflation following an expansionary monetary policy will thus lower the demand for bonds, push the interest rate in an upward direction, and thus partially offset the depressive effect of monetary expansion on the bond yield.

The fact that employment plays a key role in modifying the behavior of the capital yield in our model is suggestive of recent attempts by Feldstein and Chamberlain [1973] to use unemployment as an auxiliary variable with expected inflation in their study of multimarket expectations and the rate of interest. Our result is consistent with Feldstein and Chamberlain's preliminary finding that lower rates of employment may be expected to reduce interest rates by reducing expected inflation. They regard this result, however, with extreme caution. As an alternative explanation, they conjecture that lower employment rates "may lead investors and firms to anticipate that monetary authorities take actions to lower interest rates in an attempt to stimulate economic activity." [See Feldstein and Chamberlain (1973): p. p. 896]

Finally, the offsetting effect of expected inflation on the reaction of the real interest rate to monetary expansion is consistent with the empirical work of Yohe and Karnosky [1969], who found that expected inflation causes prompt upward movements in real as well as in nominal interest rates. [Yohe and Karnosky (1969): p. 35]

(15) However, in the dissertation we are considering the dynamic effects of monetary policy when the economy is initially in full stock/slow equilibrium. The initial effects of monetary policy when the economy is not in the neighborhood of full equilibrium may modify our pessimistic conclusions.

CHAPTER V

THE DYNAMIC EFFECTS OF MONETARY EXPANSION THROUGH GOVERNMENT EXPENDITURES

Section 1: Introduction

In this chapter we shall study the dynamic and long run effects of a one-shot 10% increase in the money supply issued in payment for government purchases of goods and services from the private sector. We would like to know what differences there are, if any, between the effects of money supplied to the economy in this way from the effects of money supplied through transfer payments and open market operations. In the next three sections of this chapter we shall consider the effects of expenditure money in our classical, Keynesian, and Phillips Curve models. We shall compare our results with those obtained in the previous chapter.

According to Anderson and Carlson, the general monetarist view is that the rate of monetary expansion is "the main determinant of total spending." [Anderson and Carlson (1970): p. 8] Monetarists therefore hold that fiscal actions, in the absence of accommodative monetary actions, exert little net influence on total spending and therefore have little effect on output and the price level. Anderson and Carlson write:

> Government spending unaccompanied by accommodative monetary expansion, that is, financed by taxes or borrowing from the public, results in a crowding-out of private expenditures with little, if any, net increase in total spending. A change in the money stock, on the other hand, exerts a strong independent influence on total spending. [Anderson and Carlson (1970): p. 8]

Using the St. Louis Econometric Model, Anderson and Jordan [1968] simulated the effects of a $1 billion increase in tax-financed or bond-financed government expenditures, a $1 money stock increase, and a $1 billion currency-financed increase in government expenditures. Anderson and Jordan reported that a $1 billion increase in tax-financed or bond-financed spending would, after 4 quarters, result in a permanent increase of $170 million in GNP. By comparison, an increase of the same magnitude in money would result in GNP being $5.8 billion permanently higher. [Anderson and Jordan (1968): p. 20] Finally, for a $1 billion increase in currency-financed expenditures, they found that practically all of the increase in GNP resulted from monetary expansion. [Anderson and Jordan (1968): p. 20] However, Anderson and Carlson [1970] have labeled the behavioral relationships embodied in the St. Louis Econometric Model as a "monetarist" model of economic stabilization. In contrast to Anderson and Jordan, de Menil and Enzler [1971] found much stronger effects of government expenditures on GNP in a simulation study of the Federal Reserve-MIT-Penn Econometric Model.[1] de Menil and Enzler report:

> In the full model the effect of the step change in government purchases is to augment real GNP by increasing amounts until by the ninth quarter of the simulations the increase is nearly four times the autonomous spending increase. Thereafter the effect begins to decline. [de Menil and Enzler (1971): p. 300]

In their simulation study de Menil and Enzler do not report whether their government expenditure increase was financed by taxes or by bonds. However, their results prove to be quite different from the government expenditure effects simulated by Anderson and Jordon, and illustrate the relative importance of fiscal policy in alternative econometric model simulations.

In recent literature Henderson and Sargent [1973] and Blinder and Solow [1973] considered the effects of fiscal policy in small-scale theoretical models. In the Henderson-Sargent model government expenditures financed by taxes or bonds have no effect on output or employment when the capital intensities of the investment and consumption sectors of their model are the same. In this case government spending simply "crowds out" private demand, and the monetarist position is upheld. When the capital intensities of the two sectors differed, on the other hand, Henderson and Sargent found that the effects of tax-financed and bond-financed government spending were ambiguous, "depending on the relative capital intensities of the two production sectors and some other conditions involving the interest elasticity of the demand for money." [Henderson and Sargent (1973): p. 363] In their comparative static analysis, however, Henderson and Sargent assume that government purchases consist only of consumption goods from the private sector. [Henderson and Sargent (1973): p. 358] They therefore did not consider the possible effects of government purchases which complement or substitute private sector investment.

Blinder and Solow [1973] considered the "crowding out" issue by examining the effects of bond-financed government expenditures in an extended IS-LM model incorporating the government budget restraint, rigid prices, and wealth effects. They found that "crowding out" does not occur if their model is stable, since bond-financed government expenditures must increase output when the necessary conditions for stability are satisfied [Blinder and Solow (1973): p. 330] When they introduced capital accumulation, however, Blinder and Solow found it logically possible to ensure stability and to obtain neutral or negative effects of bond-financed government expenditures on output. The qualitative effects of bond-financed government expenditures therefore depended on the parameter values of their model. Nevertheless they concluded that bond-financed expenditures can be expected to increase output for a range of parameter values characteristic of the United States economy. [Blinder and Solow (1973): p. 336]

Fiscal Policy and Private Sector Asset Demand

In this chapter we shall compare the effects of a 10% money supply increase as payment for government purchases with a 10% money supply increase through transfer payments. Since tax-financed government expenditures are equivalent to expenditures financed by new money combined with a reduction in the money supply through the tax/transfer mechanism, the macroeconomic effects of tax-financed expenditures may be obtained by examing the differences between new expenditure money and new transfer money. Similarly, we could determine the macroeconomic effects of bond-financed expenditures by examining the differences between expenditure money and open market purchases, since bond-financed expenditures are equivalent to money-financed expenditures combined with a contraction in the money supply through sales of bonds. However, our results in Chapter IV showed that the macroeconomic effects of transfer payments and open market purchases were practically the same. Hence the effects of bond-financed expenditures may be approximated by examining the differences between expenditure money and transfer money.

In our model differences between expenditure money and transfer money crucially depend on the effects of government expenditures on the private demand for assets. If the asset demand coefficients K_g, L_g, and B_g are zero, then tax-financed government expenditures have no effect on prices, employment, or interest rates. In this case, "money is practically all that matters," for the macroeconomic effects of expenditure money and transfer money would be the same. At the same time we would find practically no difference between new expenditure money and open market purchases, indicating that bond-financed expenditures would have little effect on prices, employment or interest rates. Our model is therefore consistent with the monetarist position when the asset demand coefficients K_g, L_g, and B_g are zero, since tax-financed and bond-financed government expenditures simply "crowd out" private spending and exert little, if any, influence on prices and employment. In this case, the genesis of new money would not matter very much, since the macroeconomic effects of transfer payments, open market purchases, and expenditure money would be practically the same.

Alternative Expenditure Effects on Asset Demand

In this chapter we would like to determine the effects of expenditure money when the asset demand expenditure coefficients K_g, L_g, and B_g are different from zero. In this case we cannot be sure that money is practically all that matters, since government expenditures may have significant effects on the accumulation and composition of wealth. The macroeconomic effects of money supplied to finance expenditures may therefore prove quite different from the effects of money supplied through transfer payments.

In our first pair of simulation experiments [Simulations (a) and (a') we shall consider the effects of expenditure money when asset holders consider government expenditures first as a supplement to their labor income and private wealth [Simulation (a)], and then as an offset to their labor income and private wealth [Simulation (a')].

Since labor income and private wealth have positive effects on all three asset demands, we would expect government expenditures viewed as a supplement to labor income and private wealth to increase the demand for all three assets. In Simulation (a), we have therefore set all three asset demand government expenditure elasticities $\epsilon_{K,g}$, $\epsilon_{L,g}$, and $\epsilon_{B,g}$ at unity. In Simulation (a'), when government expenditures are viewed as offsets to labor income and private wealth, we would expect government expenditures to decrease the demand for all three assets, since a decrease in private wealth andlabor income would decrease the demand for all three assets. Hence we have set $\epsilon_{K,g}$, $\epsilon_{L,g}$, and $\epsilon_{B,g}$ at -1.[2]

We consider government investment in education and manpower development as an example of government expenditures supplementing private wealth and labor income. The research facilities provided by such investment might not exist in the absence of government activity, and the services provided from these facilities would increase the productivity and more efficient use of labor. Government expenditures may be considered offsets to labor income or private wealth, however, if the government activities were causing inefficient use of labor or wasting resources. We believe that government military spending in Viet Nam was an absorption of labor from more efficient pursuits and wasted productive resources.

In our second set of simulation experiments we shall assume that government expenditures affect only the demand for capital. In Simulation (b) we shall assume that government expenditures increase capital demand. Hence $\epsilon_{K,g} = 1$, while $\epsilon_{L,g} = \epsilon_{B,g} = 0$. In Simulation (b'), on the other hand, government expenditures decrease the demand for capital. Here $\epsilon_{K,g} = -1$, while $\epsilon_{L,g} = \epsilon_{B,g} = 0$.

In this second pair of simulation experiments we are making no assumption about the nature of government expenditures vis-a-vis labor income. We are simply assuming that government expenditures may make capital either more attractive or less desirable to asset holders. Government expenditures for irrigation, for example, might stimulate demand for agricultural capital, whereas government investment in solar energy might decrease the demand for capital in private sector energy-producing industries. Particular types of government expenditures may therefore act as complements or substitutes for private sector investment.

By setting the elasticites $\epsilon_{B,g}$ and $\epsilon_{L,g}$ at zero, furthermore, we are assuming that government expenditures initially do not shift wealth away from money and bonds and into capital when $\epsilon_{K,g}$ is positive, or away from capital and into money and bonds when $\epsilon_{K,g}$ is negative. When $\epsilon_{K,g}$ is positive government expenditures initially shift spending away from consumption and into capital, and when $\epsilon_{K,g}$ is negative government expenditures initially shift spending away from capital and into increased consumption.

Simulation results from a very differently theoretically developed model--the Brookings Quarterly Econometric Model--show that tax-financed government expenditures are more likely to increase investment and divert spending away from consumption.

In a recent study of the Brookings Model, Gary Fromm [1969] presented simulations showing the alternative effects of a $3.2 billion increase in government purchases and a reduction in federal tax revenues by the same amount. Using Fromm's simulation results, we determined the effect of a balanced budget expenditure policy in the Brookings Model by subtracting the effects of the tax revenue decrease from the effects of the expenditure increases. Our results appear in Table V.1. The values represent differences in exogenous variables resulting from a comparison of the initial "historical" simulation with the policy simulation. Ten quarters after the $3.2 billion expenditure wave in 1960:2, the Brookings Model shows a $5.6 billion higher level of GNP, a $1.0 billion lower level of consumption, and a $1.0 billion higher level of total investment. [3]

While evidence from the Brookings Model indicates that govern-

TABLE V-1

POLICY EFFECTS OF A $3.2 BILLION BALANCED BUDGET GOVERNMENT EXPENDITURE INCREASE GENERATED BY THE BROOKINGS MODEL

(billions of dollars at annual rates)

Quarter	GNP	Total Consumption	Total Investment	Business Plant & Equipment Investment
1960:3	2.3	-.9	0	0
1960:4	3.0	-.7	.2	.2
1961:1	3.7	-.5	.4	.4
1961:2	2.9	-.9	.5	.4
1961:3	3.2	-1.0	.4	.3
1961:4	3.1	-1.3	.8	.6
1962:1	5.0	-.3	.9	.7
1962:2	5.7	-.9	1.1	.9
1962:3	6.1	-.8	1.1	.9
1962:4	5.6	-1.0	1.1	.9

Source: Gary Fromm, "An Evaluation of Monetary Policy Instruments", in Deusenberry, Fromm, Klein, and Kuh, editors, The Brookings Model: Some Further Results. Chicago, Rand McNally. 1969.

ment expenditures are likely to increase the demand for capital and decrease consumption spending, we would still like to know what happens when government expenditures affect only the demand for money or the demand for bonds.

In Simulation (c) and (c') we shall therefore assume government expenditures affect only the demand for bonds. In Simulation (c) we have $\epsilon_{B,g} = 1$ while $\epsilon_{L,g} = \epsilon_{K,g} = 0$. In this case we are assuming that government expenditures shift demand away from consumption goods and into bonds. In Simulation (c'), on the other hand, we have $\epsilon_{B,g} = -1$, while $\epsilon_{L,g} = \epsilon_{K,g} = 0$. In this case government expenditures initially increase consumption demand at the expense of bonds.

Finally, in Simulation (d) and (d') we shall assume only the demand for money responds to government expenditures. In Simulation (d) we have $\epsilon_{L,g} = 1$ while $\epsilon_{B,g} = \epsilon_{K,g} = 0$. Here government expenditures initially decrease consumption demand by increasing desired money holdings. In Simulation (d'), on the other hand, we have $\epsilon_{L,g} = -1$, with $\epsilon_{B,g} = \epsilon_{K,g} = 0$. In this case government expenditures initially stimulate consumption demand at the expense of money holdings.

In Table V.2 we have summarized our four pairs of simulation experiments with expenditure money. Of course, it is possible that government expenditures may affect all three asset demands in different ways. Government expenditures could very well increase investment ($\epsilon_{K,g} > 0$) at the expense of money holdings ($\epsilon_{L,g} < 0$) with no effect on bond holdings ($\epsilon_{B,g} = 0$). In this chapter we are thus considering only 8 out of 27 possible ways government expenditures may affect private sector asset demand. However, the relative importance of each of the three government expenditure elasticities will become clear as we move on in this chapter. From this one could approximate the outcome when the government elasticities are set at equal values but opposite signs.

In all four simulation pairs we have retained our initial parameter selections presented in Table III.1. Capital, money, and bonds adjust with finite speeds, and the asset demand interest rate elasticities are the same as in our initial transfer and open market monetary policy simulations.

TABLE V-2
SIMULATION EXPERIMENTS WITH EXPENDITURE MONEY

Simulation	Representation	Government Expenditure Elasticities
(a)	————————	$\epsilon_{K,g} = \epsilon_{B,g} = \epsilon_{L,g} = 1$
(a')	————————	$\epsilon_{K,g} = \epsilon_{B,g} = \epsilon_{L,g} = -1$
(b)	—— —— ——	$\epsilon_{K,g} = 1;\ \epsilon_{B,g} = \epsilon_{L,g} = 0$
(b')	—— —— ——	$\epsilon_{K,g} = -1;\ \epsilon_{B,g} = \epsilon_{L,g} = 0$
(c)	....	$\epsilon_{B,g} = 1;\ \epsilon_{K,g} = \epsilon_{L,g} = 0$
(c')	....	$\epsilon_{B,g} = -1;\ \epsilon_{K,g} = \epsilon_{L,g} = 0$
(d)	— .. — .. —	$\epsilon_{L,g} = 1;\ \epsilon_{K,g} = \epsilon_{B,g} = 0$
(d')	— .. — .. —	$\epsilon_{L,g} = -1;\ \epsilon_{K,g} = \epsilon_{B,g} = 0$

Section 2: Macroeconomic Adjustment with Flexible Wages and Full Employment

Let us first consider the effects of expenditure money in our classical model. Our simulation results are pictured in Figures V.1 through V.5.

We picture our first pair of results in Figure V.1. When government expenditures enter all three asset demand equations the price effects of expenditure money turn out to be considerably different from transfer money. While transfer money increases the price level by 7.5 points, expenditure money may either decrease the price level by 3 points [Simulation (a)] or raise the price level by more than 20 points [Simulation (a')]. The interest rate effects of expenditure money, on the other hand, turn out to be almost identical to transfer money. In Figure V.1 we observe that transfer and expenditure money decrease the interest rate by about 8 basis points, and it does not seem to matter whether government expenditures appear as supplements [Simulation (a)] or as offsets [Simulation (a')] to labor income and wealth in all three asset demand equations.

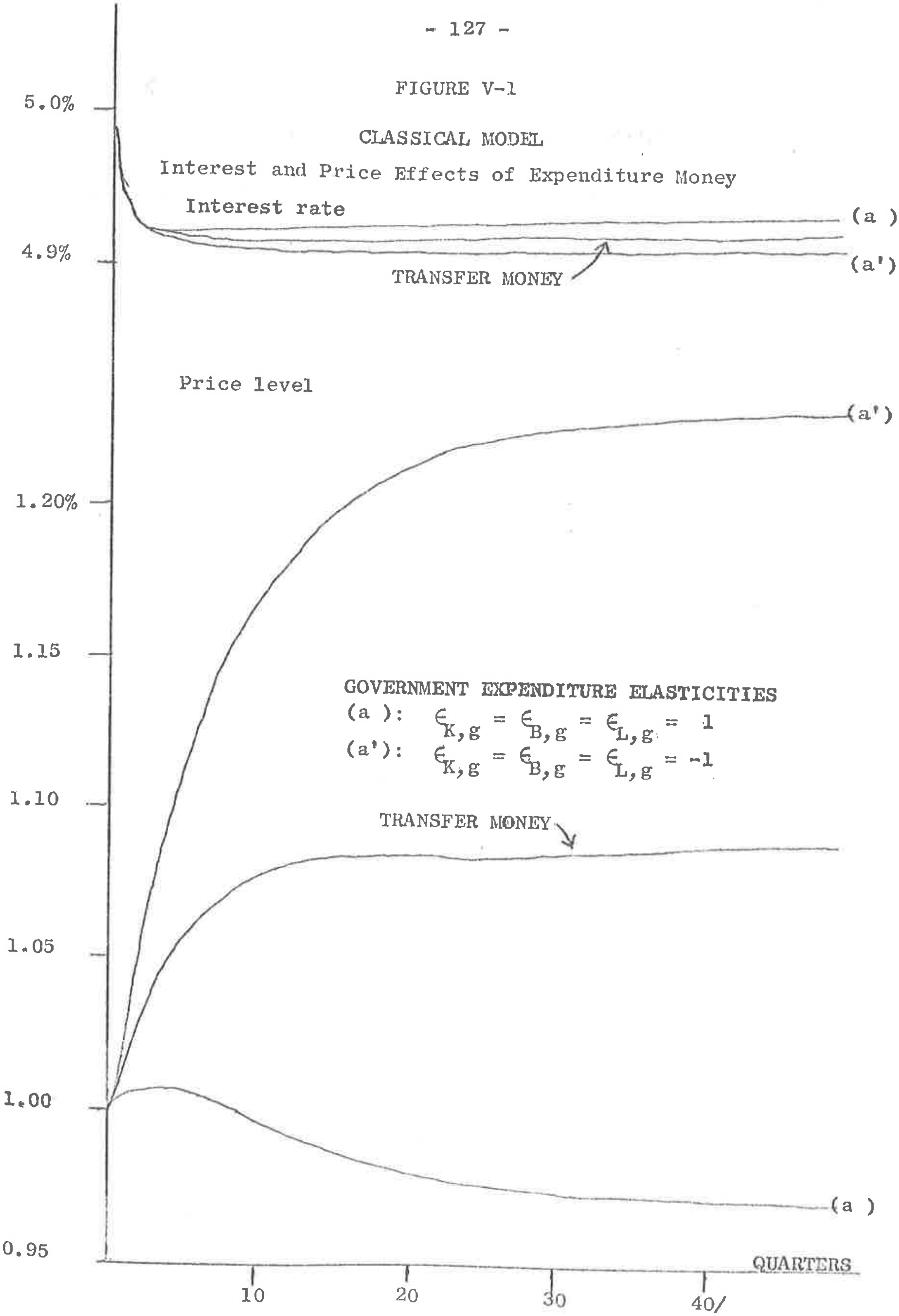
This result has several implications. The fact that transfer money and expenditure money are capable of generating identical interest rate and considerably different price effects in our model means that the comparative interest rate effects of two policies do not serve as reliable gauges of comparative macroeconomic consequences.[4]

Furthermore, when all three asset demand equations respond to expenditure money, identical interest rate effects accompany two

FIGURE V-1

CLASSICAL MODEL

Interest and Price Effects of Expenditure Money



widely different price effects of expenditure money. In one case, Simulation (a), expenditure money is deflationary; in the other case, Simulation (a'), highly inflationary. Consequently, we have no guarantee that a policy which always lowers interest rates will always raise prices. In our model lower interest rates may be accompanied by lower prices.

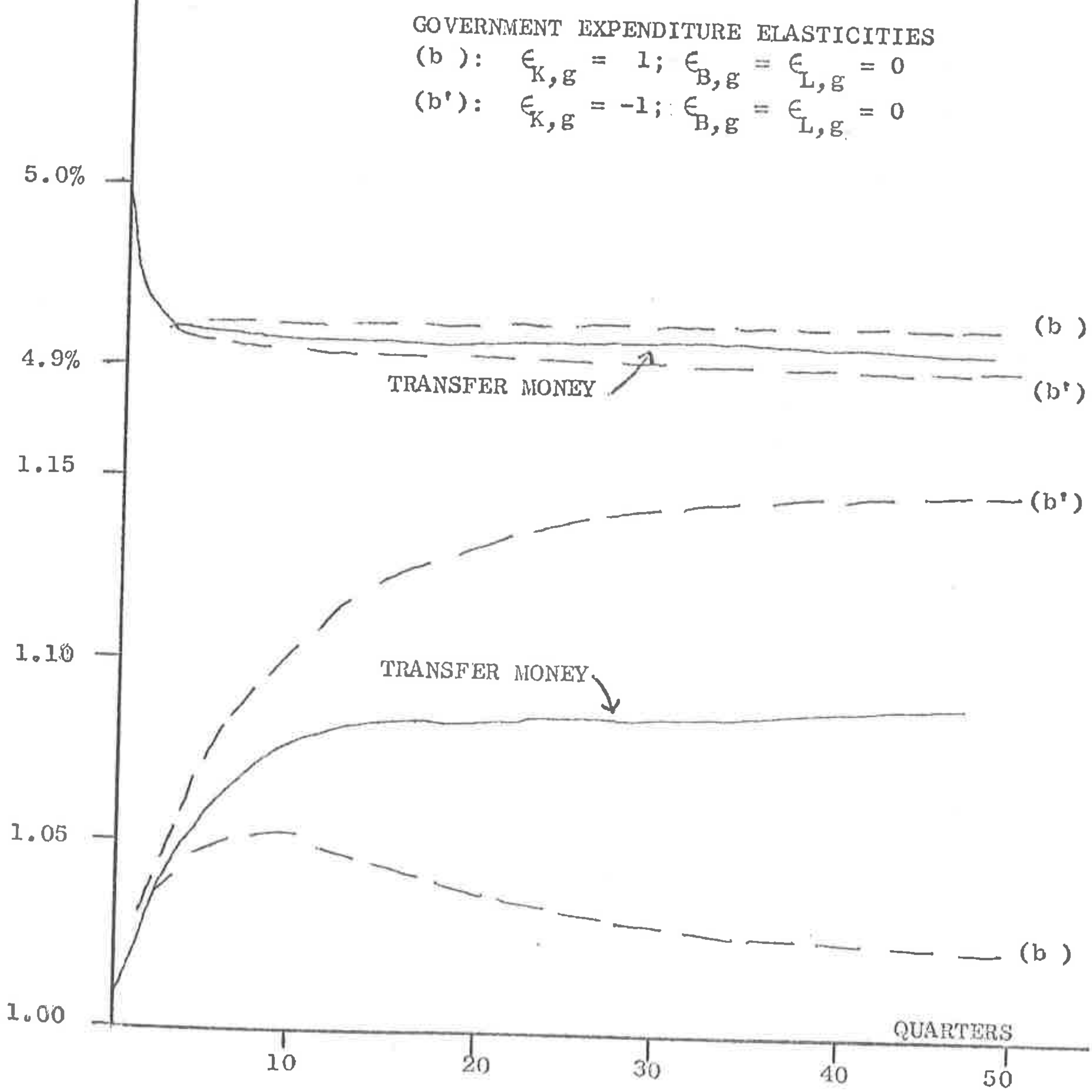
Let us now turn to Figure V.2. In this pair of expenditure money experiments only the demand for capital responds to government expenditures.

Again we find quite different price effects from that of transfer money. The broken curves in Figure V.2 indicate that expenditure money may either increase by price level by 2 points [Simulation (b)] or by almost 15 points [Simulation (b')] if government expenditures alternatively increase or decrease the demand for capital. These expenditure money effects stand in sharp contrast to the 7.5 point price increase associated with transfer money.

These alternative price effects of expenditure money have clear-cut explanations. The increase in capital demand by expenditure money in Simulation (a) leads to lower prices because the increased capital accumulation raises the productivity of labor and labor income. The increased labor income in turn raises the demand for money and bonds. A lower price level is necessary to equate the real supply of money and bonds with the increased demand. Expenditure money which decreases the demand for capital leads to lower prices for the opposite reason: the lower level of capital accumulation decreases labor productivity and

FIGURE V-2

CLASSICAL MODEL
Interest and Price Effects of Expenditure Money



labor income. Since the lower labor income decreases demand for money and bonds, a higher price level is necessary to equate the real supply of money and bonds with their decreased demand.

The interest rate effects of expenditure money in Figure V.2 are still pretty much the same as transfer money. We see that transfer money and expenditure money lower the interest rate by about 8 basis points, and it does not seem to matter whether government expenditures increase or decrease the demand for capital.

Once again, our model associates almost identical interest rate effects of transfer and expenditure money with widely different price effects. Similarly, our model shows that the interest rate may respond in much the same way to expenditure money which is only slightly inflationary and to expenditure money which is highly inflationary.

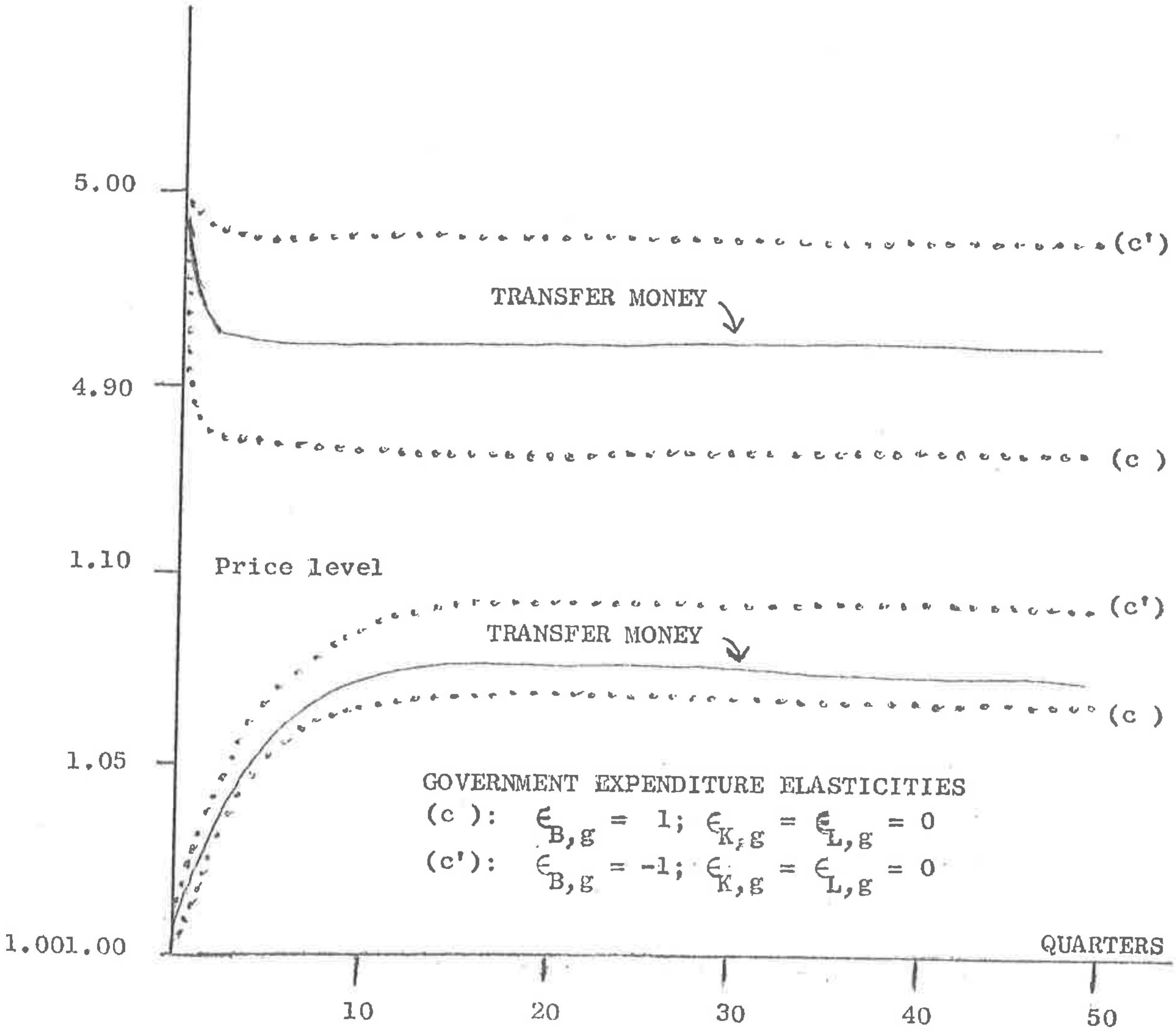
Let us now study the dotted curves representing simulations (c) and (c') in Figure V.3. In this pair of simulation experiments government expenditures are assumed to affect only the demand for bonds.

We now find that the price effects of expenditure money lie fairly close to the price effects of transfer money. When government expenditures increase bond demand [Simulation (c)], expenditure money is only slightly less inflationary than transfer money, and when government expenditures decrease bond demand [Simulation (c')], expenditure money is only slightly more inflationary than transfer money. Here the price effects of expenditure money which increases bond demand are slightly lower simply because the lower prices are needed to increase

FIGURE V-3

CLASSICAL MODEL

Interest and Price Effects of Expenditure Money



the real value of bonds with the increased demand. The price effects of expenditure money which decreases bond demand are slightly higher for the opposite reason: higher prices are needed to reduce the real value of bonds with the decreased demand.

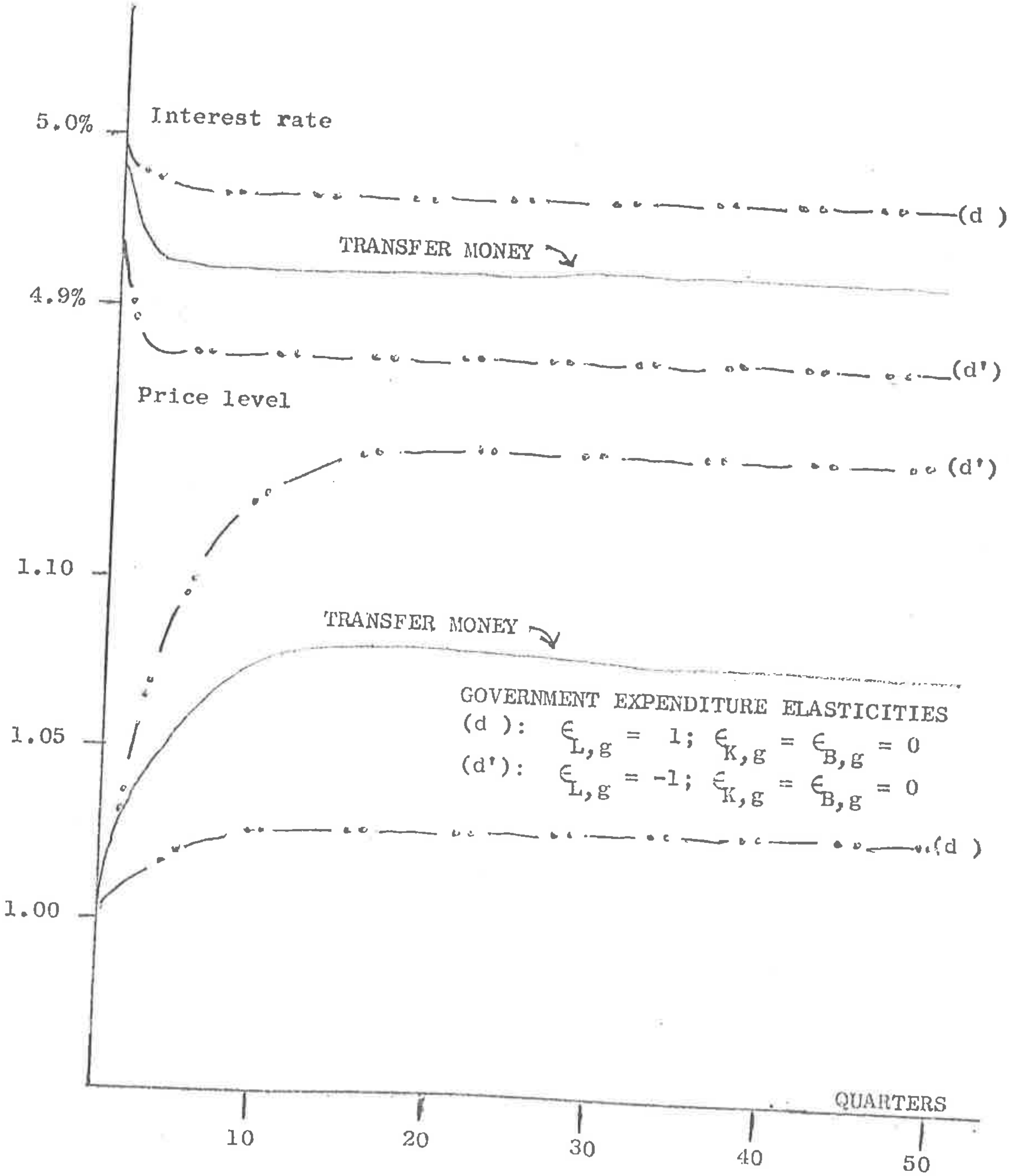
Since the price effects of new expenditure and new transfer money are practically the same in Simulations (c) and (c'), the proposition that money is almost all that matters would be vindicated if $\epsilon_{B,g}$ proved to be the only empirically significant government expenditure elasticity. It would make little difference whether money is supplied to the economy through transfer payments or through government expenditures. The only exception, of course, is for the interest rate. When government expenditures increase bond demand, the interest rate effect of expenditure money is 4 basis points below that of transfer money, and when government expenditures decrease bond demand, the expenditure money effect is about 6 basis points short of the transfer money effect. However, the different interest rate effects of expenditure money simply reflect the presence of government expenditure effects in the bond market and have no further macroeconomic implications.

Finally, in Figure V.4 we picture our last two expenditure money simulations. In this pair of policy experiments government expenditures affect only the demand for money. Here we find both the interest and price effects of expenditure money to be quite different from those of expenditure money. When government expenditures increase the demand for money [Simulation (d)], expenditure money is 5 basis

FIGURE V-4

CLASSICAL MODEL

Interest and Price Effects of Expenditure Money



points less effective in depressing the interest rate and 5 points less inflationary than transfer money. On the other hand, when government expenditures decrease the demand for money [Simulation (d')], expenditure money is about 5 basis points more effective in depressing the interest rate and about 8 points more inflationary than transfer money. Furthermore, our model now associates mildly depressive interest rate effects with mildly inflationary expenditure money [Simulation (d)] and highly depressive interest rate effects with highly inflationary expenditure money [Simulation (d')]. This is the only case in our model where interest rate behavior serves as a reliable gauge of the relative price effects of expenditure money.

Expenditure money which increases the demand for money leads to lower prices and higher interest rates than new transfer money of the same amount for the following reason: lower prices in this case are needed to equate the real supply of money with the increased demand. At the same time the lower prices increase the real value of bonds, so higher interest rates are needed to equate the demand for bonds with the increased supply. Expenditure money which decreases the demand for money leads to higher prices and lower interest rates for the opposite reason: higher prices are needed to equate the real money stock with reduced demand, and lower interest rates are needed to decrease the demand for bonds with the reduced supply.

In Figure V.5 we have summarized our 4 pairs of expenditure money experiments. Except for two cases, interest and price adjustment is always monotonic. The lower solid curve [Simulation (a)] and the lower broken curve [Simulation (b)] show slight overshooting in price behavior whenever government expenditures have positive effects on the demand for capital. Hence rigid wages are no longer the _sine qua non_ in our model for overshooting in price adjustment.

In conclusion, an examination of Figure V.5 reveals that expenditure money may generate a wide variety of price and interest rate effects, depending on the way government expenditures affect the private demand for assets. However, in only one pair of simulation experiments [Simulations (c) and (c')] do the price effects of expenditure money fall close to transfer money. In this instance only the demand for bonds responds to government expenditures. On the other hand, if government purchases significantly affect either the demand for capital or money, we can safely say that the macroeconomic consequences of expenditure money in our model will be very different from those of transfer money.[5]

Section 3: Macroeconomic Adjustment with Fixed Wages and Flexible Employment

In this section we shall consider the effects of expenditure money in our Keynesian model. We shall first compare the effects of expenditure and transfer money when their relative expansionary effects are most divergent [Simulations (a) and (a')] and then when their relative effects are most alike [Simulations (c) and (c')]. We shall then illustrate the spectrum of employment effects of expenditure money generated by our four pairs of simulation experiments listed in

FIGURE V-5

CLASSICAL MODEL

Interest and Price Effects of Expenditure Money

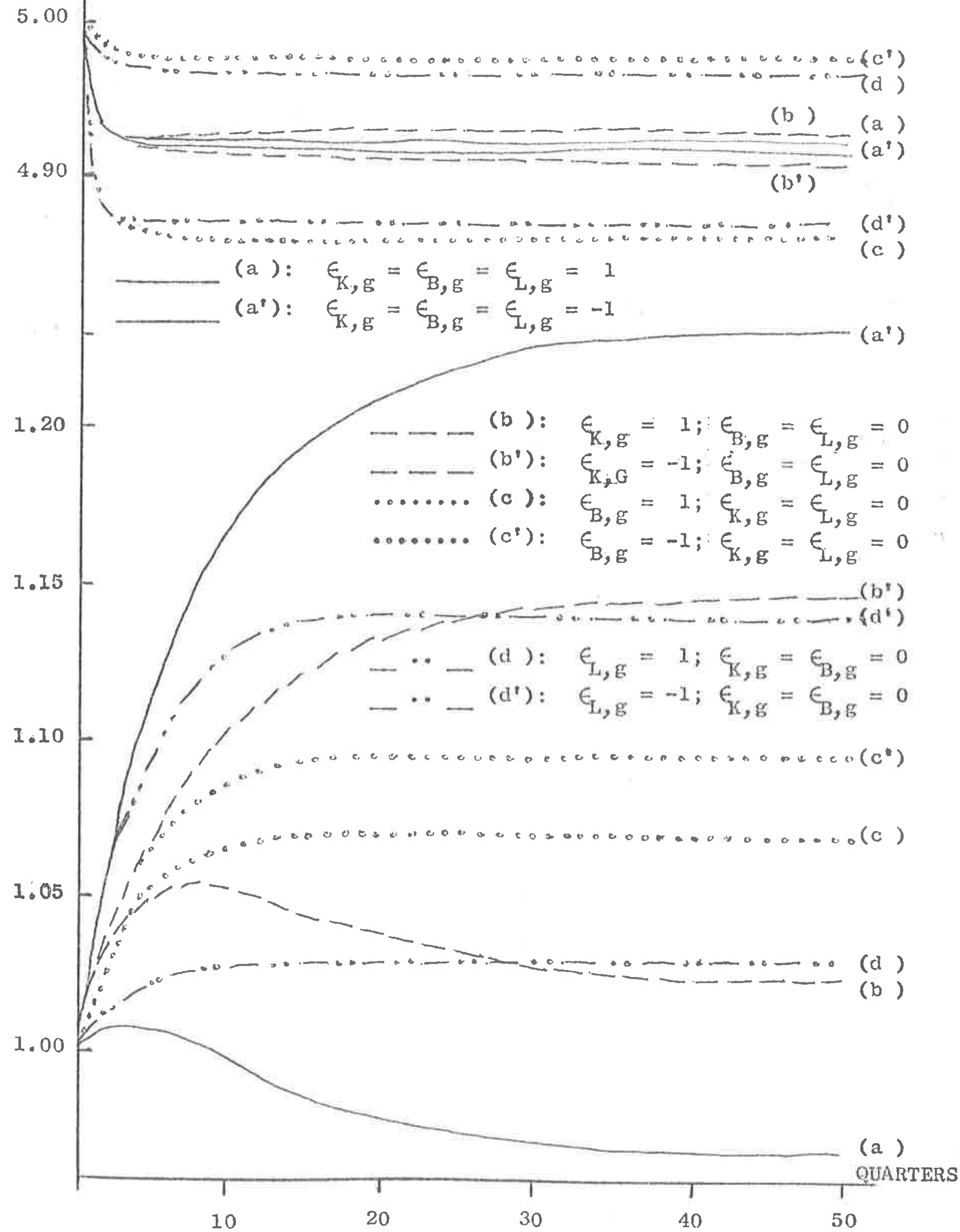


Table V.1.

In Figure V.6 we picture the dynamic effects of expenditure money when government expenditures increase the demand for all three assets [Simulation (a)] and when government expenditures decrease the demand for all three assets [Simulation (a')].[6]

The employment effects of expenditure money turn out to be considerably different from the employment effects of transfer money. The adjustment path for Simulation (a) shows that expenditure money will be about 4 percentage points less expansionary than transfer money when government expenditures increase the demand for all three assets. In the short run, however, the differences are even greater. One year after the policy change the employment rate reaches a cyclical peak 10 points below the cyclical peak generated by transfer money.

In Figure V.7 we compare the price effects of expenditure money under flexible wages with the corresponding employment effects under rigid wages for Simulation (a). With full employment and perfectly flexible wages expenditure money lowers the price level by about 3 points. With unemployment and rigid wages, however, expenditure money raises the employment rate by about 10 points. In our model, therefore, it is not necessarily true that a policy which deflates the price level under conditions of full employment and perfect wage flexibility will contract employment when wages become perfectly rigid.

These policy effects may be explained by the direct influence of expenditure money on capital accumulation. With perfectly flexible wages expenditure money stimulates the demand for capital through posi-

FIGURE V-6

KEYNESIAN MODEL

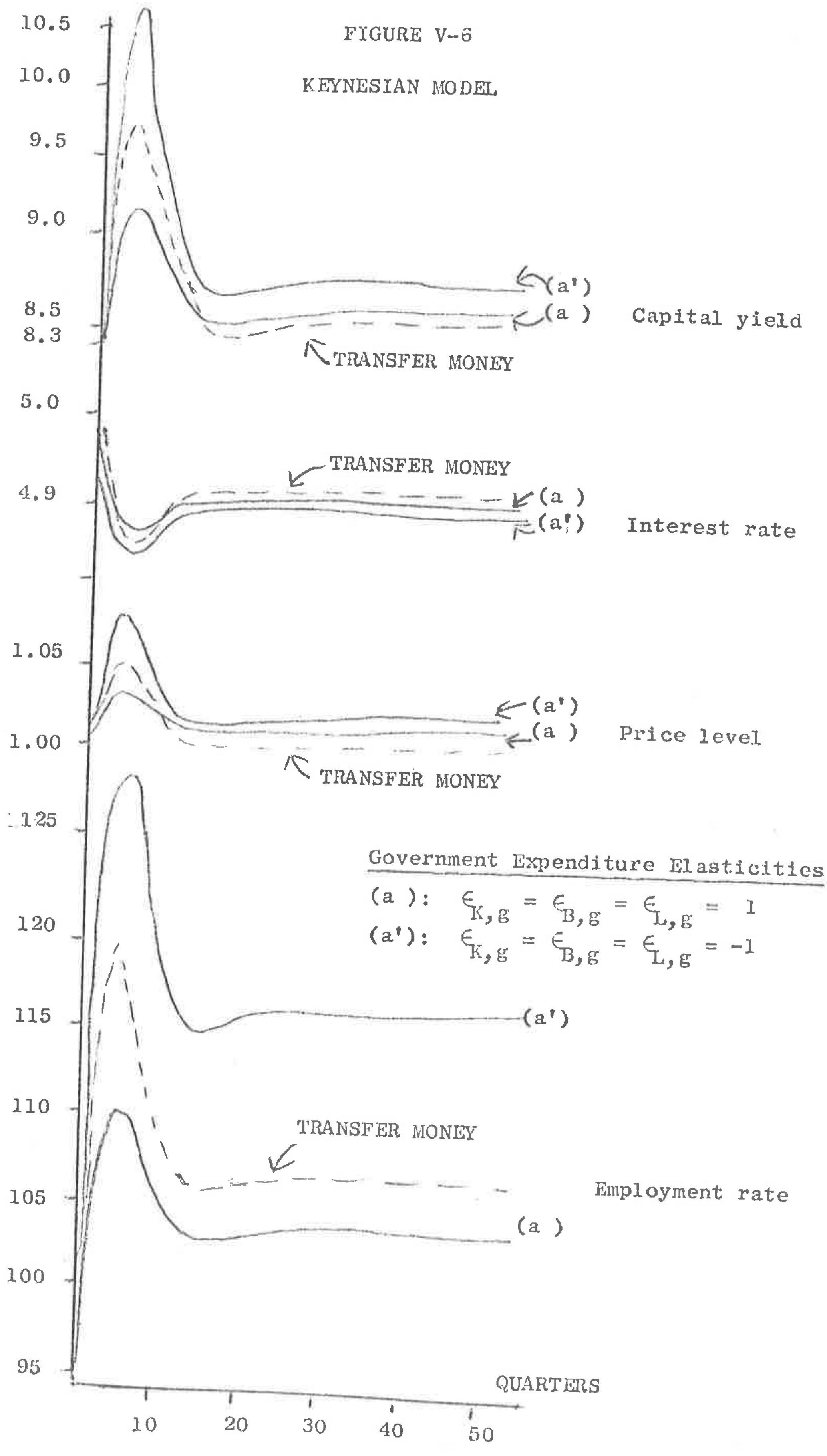
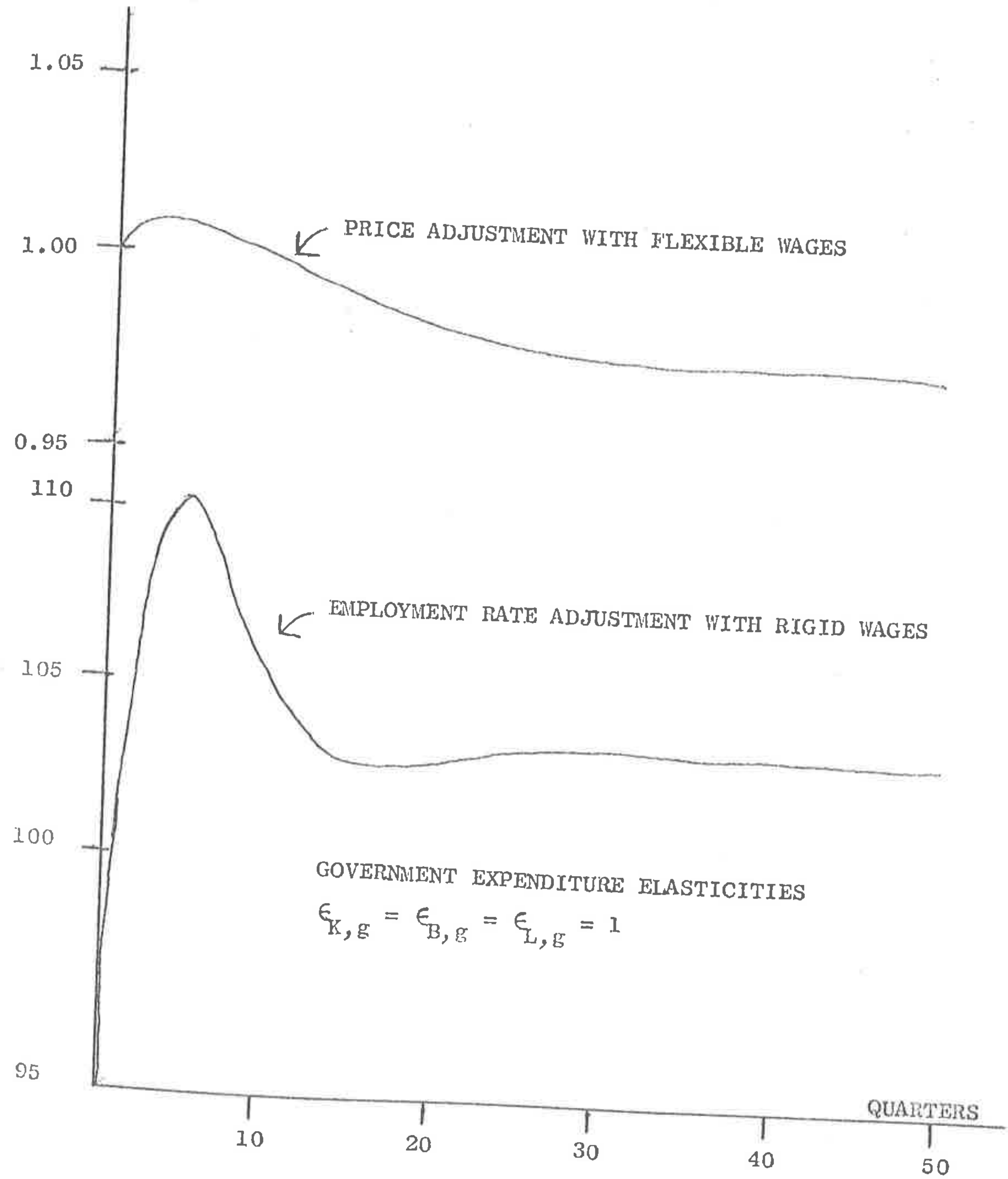


FIGURE V-7

REVERSAL OF POLICY EFFECTS OF EXPENDITURE MONEY



tive government expenditure effects. As capital accumulation progresses, asset holders increase their demand for money. In the long run, the feedback effects of capital accumulation in the money market actually outweigh the excess supply created by the new currency issues. We thus find a lower price level, a higher level of output, and a larger stock of capital.

With perfectly rigid wages, however, the increased capital accumulation directly increases employment by raising the marginal productivity of labor. This "marginal productivity effect" of capital accumulation on employment accounts for the reversal of policy effects as we shift from a model with perfectly flexible wages to one with perfectly rigid wages.

Perfectly flexible and perfectly rigid wages are, of course, two extreme cases of our model. As rigidities give way during the expansionary upswing, the employment gains pictured in Figures V.6 and V.7 will be translated into wage increases. This interaction will be considered in Section 4, when we introduce inflationary expectations and semi-flexible wage rates into our model. Nevertheless, our picture of price and employment adjustment in Figure V.7 serves as a forerunner of the chain of events set off by expenditure money in these circumstances.

When wages are fairly rigid during the early stages of adjustment, we can expect expenditure money to raise employment, and as wages become progressively flexible during the later stages of adjustment expenditure money will result in a lower long run price level.

In our model, therefore, short run expansion in employment is not incompatible with long run price deflation.

Let us now return to Figure V.6, and consider the results for Simulation (a'). We find that expenditure money proves to be considerably more expansionary than transfer money when government expenditures decrease the demand for all three assets. Once adjustment is complete the employment rate path for Simulation (a') lies 10 points above the corresponding path for transfer money. At the same time, however, the long run price and interest rate effects of expenditure money lie quite close to the effects of transfer money. In the long run expenditure money is only 3 points more inflationary than transfer money, and the interest rate effect of expenditure money is identical to the corresponding transfer money effect.

The relatively high expansionary effects of expenditure money in Simulation (a') have a straightforward explanation. Expenditure money in this case decreases the demand for all three assets. A higher level of labor income is therefore needed to restore stock equilibrium by increasing asset demand. With rigid wages labor income can increase only by an increase in employment. The slightly higher price effects of expenditure money have a similar explanation. Since expenditure money reduces the demand for all three assets, the higher price level helps to equate the real supply of money and bonds with the reduced demand.

Figure V.6 strengthens our case against the interest rate as a gauge of monetary policy. Once again we have found indentical interest rate effects of transfer and expenditure money associated with very different employment effects. Figure V.6 also shows that transfer and expenditure money generate the same pattern of overshooting when wages are rigid. Both policies cause the interest rate to undershoot and the price level and employment rate to overshoot. Furthermore, a positive price-capital yield correlation is generated by both policies during the transition process.[7]

Let us now consider the adjustment paths appearing in Figure V.8 for Simulation (c) and (c'). In this pair of simulation experiments government expenditures affect only the demand for bonds. The results for Simulations (b) and (b'), when government expenditures affect only the demand for capital, are included in our summary of employment effects in Figure V.9.

When government expenditures affect only the demand for bonds, we find in Figure V.8 that the employment, price, and capital yield affects of expenditure money fall quite close to the corresponding effects of transfer money. At most, the employment effect of expenditure money is 3 points more expansionary than transfer money.[8] The only exception, as expected, is for the interest rate. When government expenditures have positive effects on bond demand, expenditure money is more effective than transfer money in lowering the interest rate on bonds, and when government expenditures have negative effects on bond demand, expenditure money is less effective than transfer money.

Accordingly, if $\epsilon_{B,g}$ is the only empirically relevant govern-

FIGURE V-8

KEYNESIAN MODEL

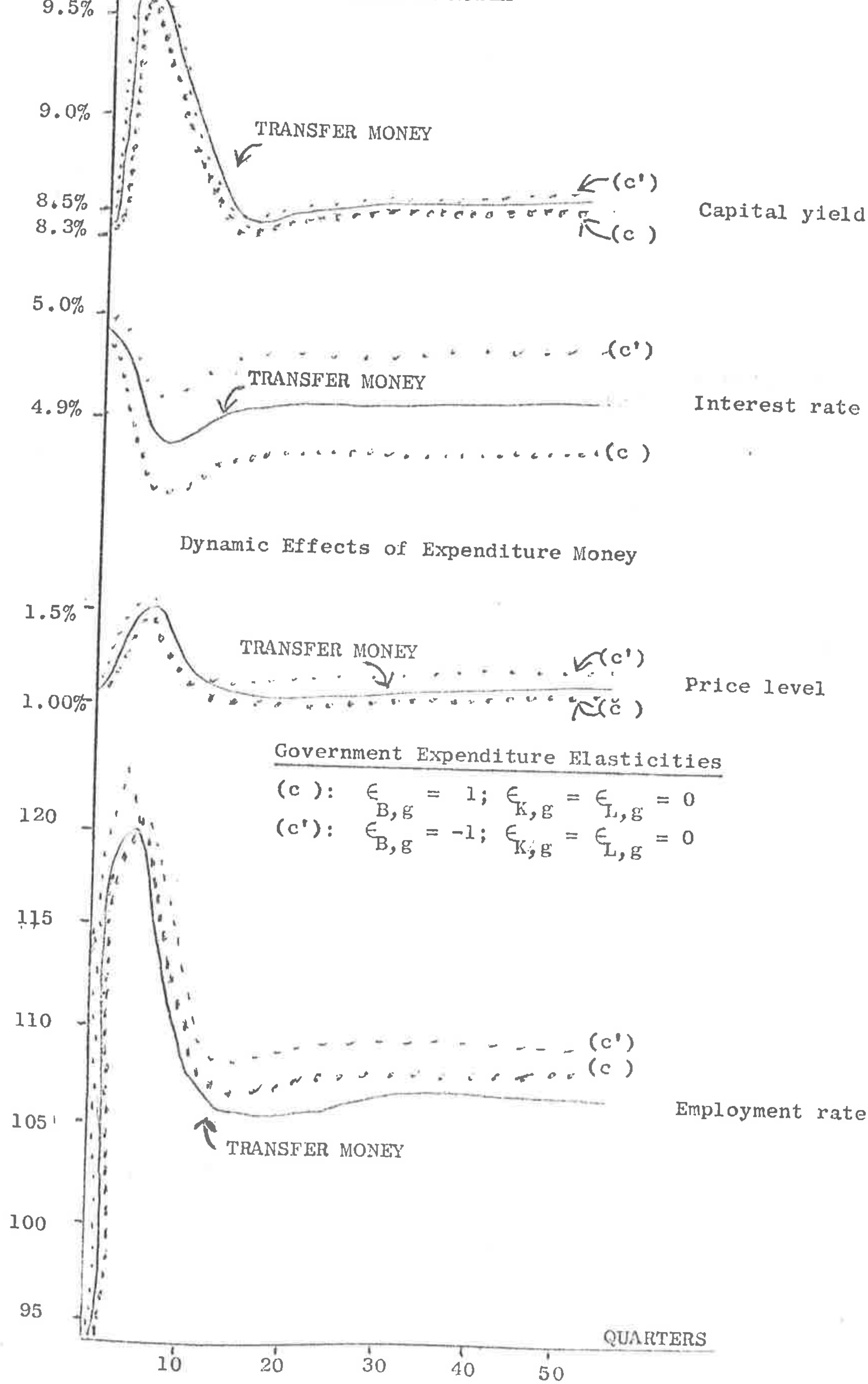
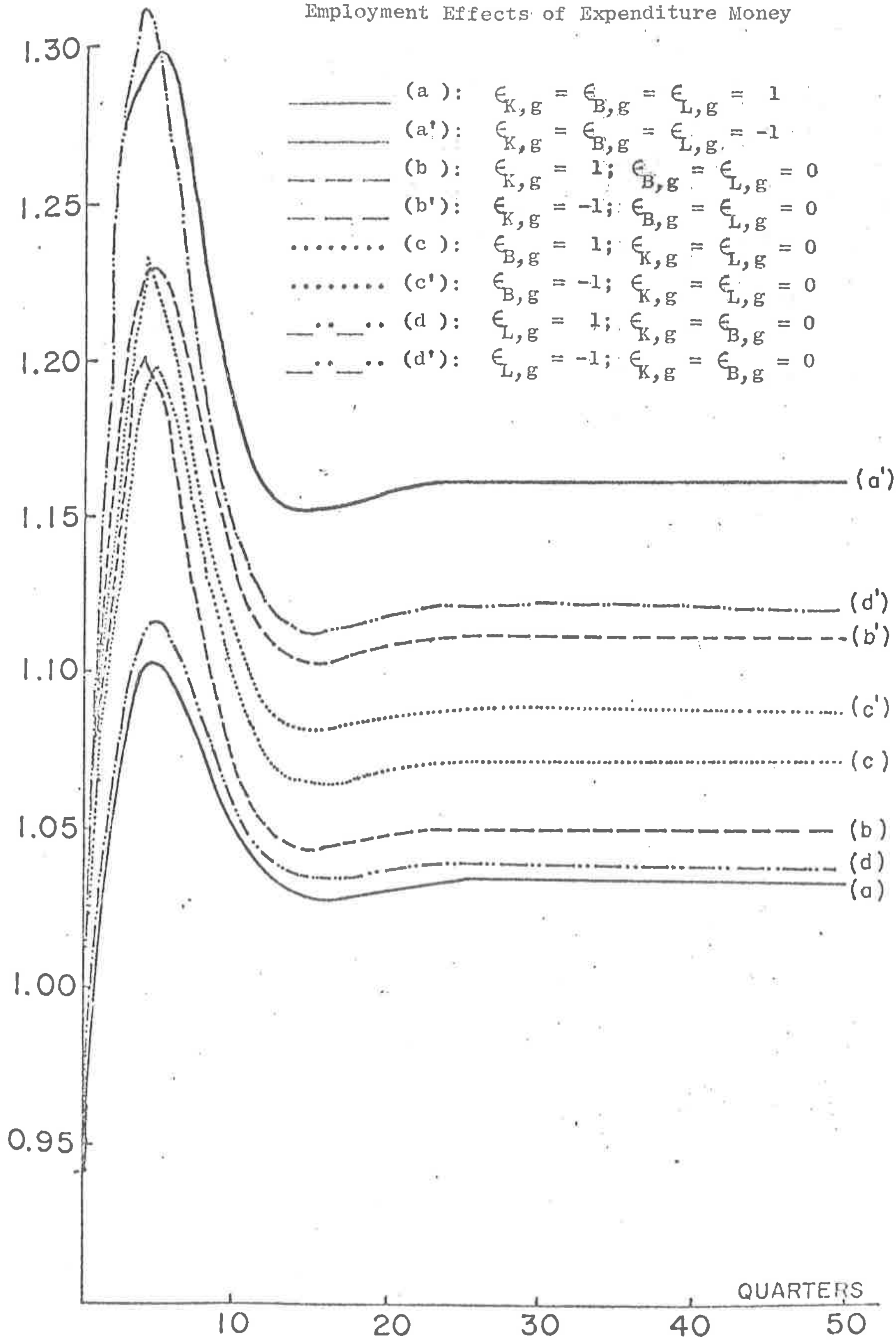


FIGURE V-9

KEYNESIAN MODEL

Employment Effects of Expenditure Money



ment expenditure elasticity, we can once again say that it makes little difference which way the government supplies money to the economy. In this case, money is all that matters in our model, for the macroeconomic consequences of new transfer and new expenditure money are the same.

In Figure V.9 we summarize the employment rate effects of expenditure money generated by our four pairs of expenditure money experiments. We see that expenditure money generates a wide spectrum of expansionary employment effects, depending on the way government expenditures affect saving and asset accumulation. However, in only one case [Simulations (c) and (c')] do the employment effects fall close to transfer money. Otherwise, the employment effects of expenditure money are much different from transfer money.[9]

Section 4: Macroeconomic Adjustment with Adaptive Expectations and Semi-Flexible Wage Rates

We shall now consider the effects of expenditure money in our Phillips Curve model. We shall examine the results for two pairs of simulation experiments, first when government expenditures affect the demand for all three assets, and then when government expenditures affect only the demand for capital.

In Figure V.10 we picture the adjustment of interest rates, employment, and the price level when there are positive government expenditure effects on all three asset demands [Simulation (a)] and when there are negative government expenditure effects on all three asset demands [Simulation (a')].

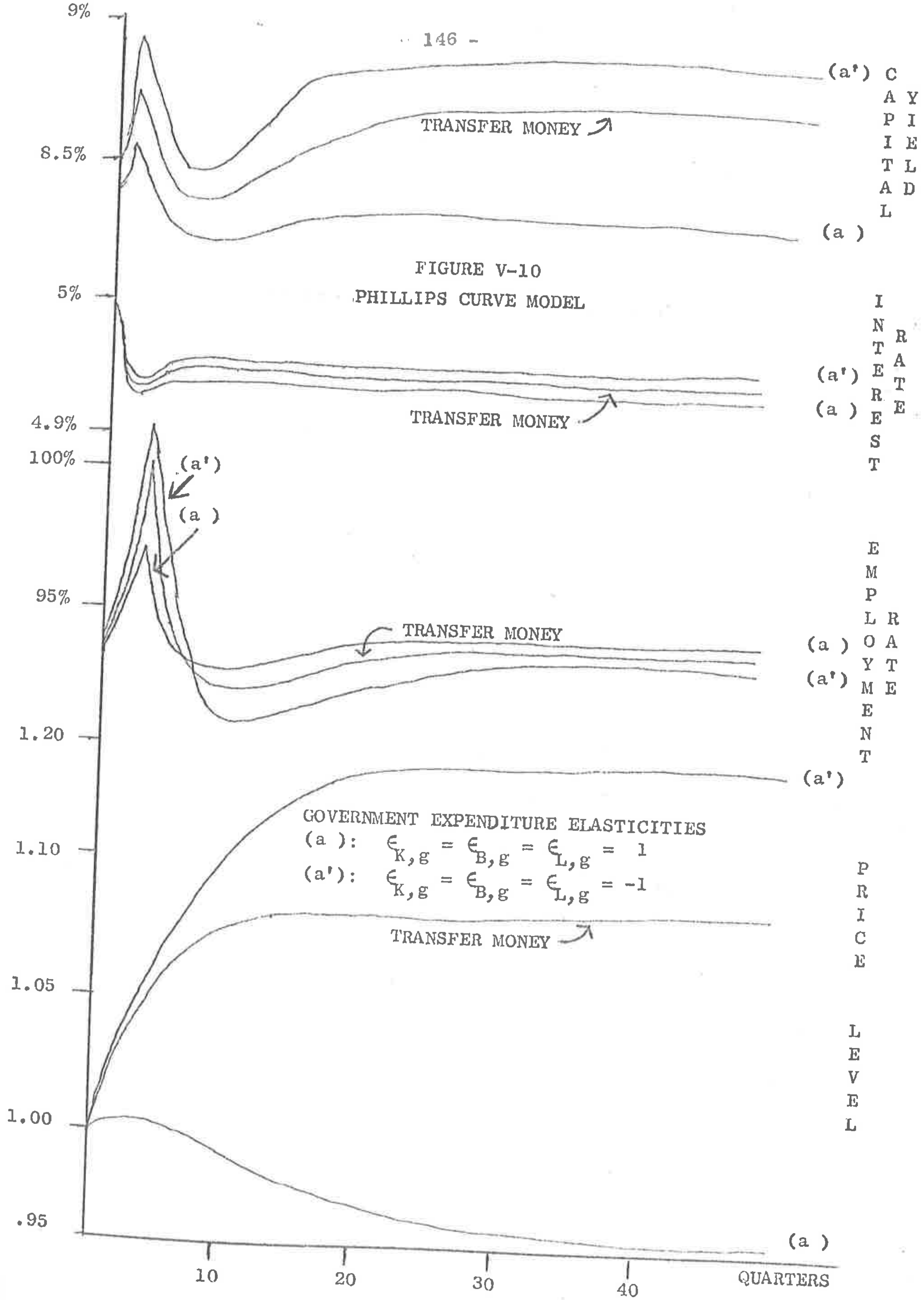


FIGURE V-10
PHILLIPS CURVE MODEL

We again find that the introduction of adaptive price expectations and semi-flexible wage rates considerably modifies the pronounced overshooting in the employment rate and capital yield under perfect wage rigidity. The highest peak reached by the capital yield is slightly less than 9% and employment surges to an initial peak slightly over 100% five quarters after the new expenditure money is supplied to the economy. When wages were perfectly rigid, on the other hand, the capital yield reached an initial peak of 10.5% and employment soared to 125% for the same set of government expenditure asset demand elasticities. Adaptive price expectations and semi-flexible wage rates thus lead to more realistic pictures of productivity and employment patterns during the adjustment period, and thereby act as effective labor and capital productivity "boundary constraints" in our model.

When government expenditures increase the demand for all three assets [Simulation (a)] we find that expenditure money increases the employment rate in the short run and deflates the price level in the long run.[10] Adaptive price expectations and semi-flexible wage adjustment thus tie together our previous results pictured in Figure V.7. For the same set of government expenditure elasticities new expenditure money increased employment when wages were perfectly rigid and decreased the price level when wages were perfectly flexible. Perfect wage rigidity thus serves as a short run approximation of macroeconomic adjustment in our model, and, by the same token, perfect wage flexibility serves as an approximation of the lasting consequences of monetary expansion.

During the intermediate stages of adjustment we find that employment and prices fall together. Hence there is no unhappy period of "stagflation" when government expenditures increase the demand for all three assets. However, the initial employment effects of expenditure money turn out to be much less than the corresponding effects of transfer money: employment rises to a peak of 97% five quarters after the new supply of expenditure money whereas new transfer money pushes employment to a peak of 100% in the same period of time.

When government expenditures decrease the demand for all three assets, on the other hand, we find that new expenditure money is slightly more effective than transfer money in stimulating employment in the short run and considerably more inflationary than transfer money in the long run.[11] Simulation (a') shows short run employment reaching a peak about 1 point above the transfer money summit, and the price level leveling off 10 points above the long run transfer money effect. Moreover, we again experience an unhappy period of rising prices and falling employment. From period 5 through 12 employment falls from a peak of 102% to a trough of 90% while the price level steadily rises by 8 points during the same period of time. Employment then gradually rises towards its "normal" level while prices continue to increase.

The adjustment of the interest rate in Figure V.10 once more proves to be a misleading gauge of the short run and lasting consequences of new expenditure money relative to transfer money. The initial drop in the interest rate is quite close to the transfer money effect, even though the short run employment effect of expenditure money proves to be quite different, and in the long run the interest rate approaches the transfer money effect, even though the lasting price effect of expenditure money is considerably different.

Let us now turn to Figure V.11, where we picture our last pair of expenditure money experiments. Here we assume that government expenditures first increase [Simulation (b)] and then decrease [Simulation (b')] the demand for capital.

In both experiments the employment effects of expenditure money fall quite close to the corresponding effects of transfer money. Like transfer money, expenditure money causes employment to rise to a peak of 100% five quarters after the policy execution. Employment then falls to a trough of 93% over the next seven quarters and finally reverses direction and levels off at a long run value of 94%.

The price effects of expenditure money, on the other hand, turn out to be considerably different from the corresponding effects of transfer money. When government expenditures increase capital accumulation [Simulation (b)] the long run price effect of expenditure money is six points less inflationary than transfer money, and when government expenditures decrease capital accumulation [Simulation (b')] expenditure money is six points more inflationary than transfer money. We thus find considerably different long run price effects following identical short run employment effects when we introduce new expenditure and new transfer money into our model.

This result leads to a clear-cut comparison between expenditure money and transfer money as anti-inflationary policies. When

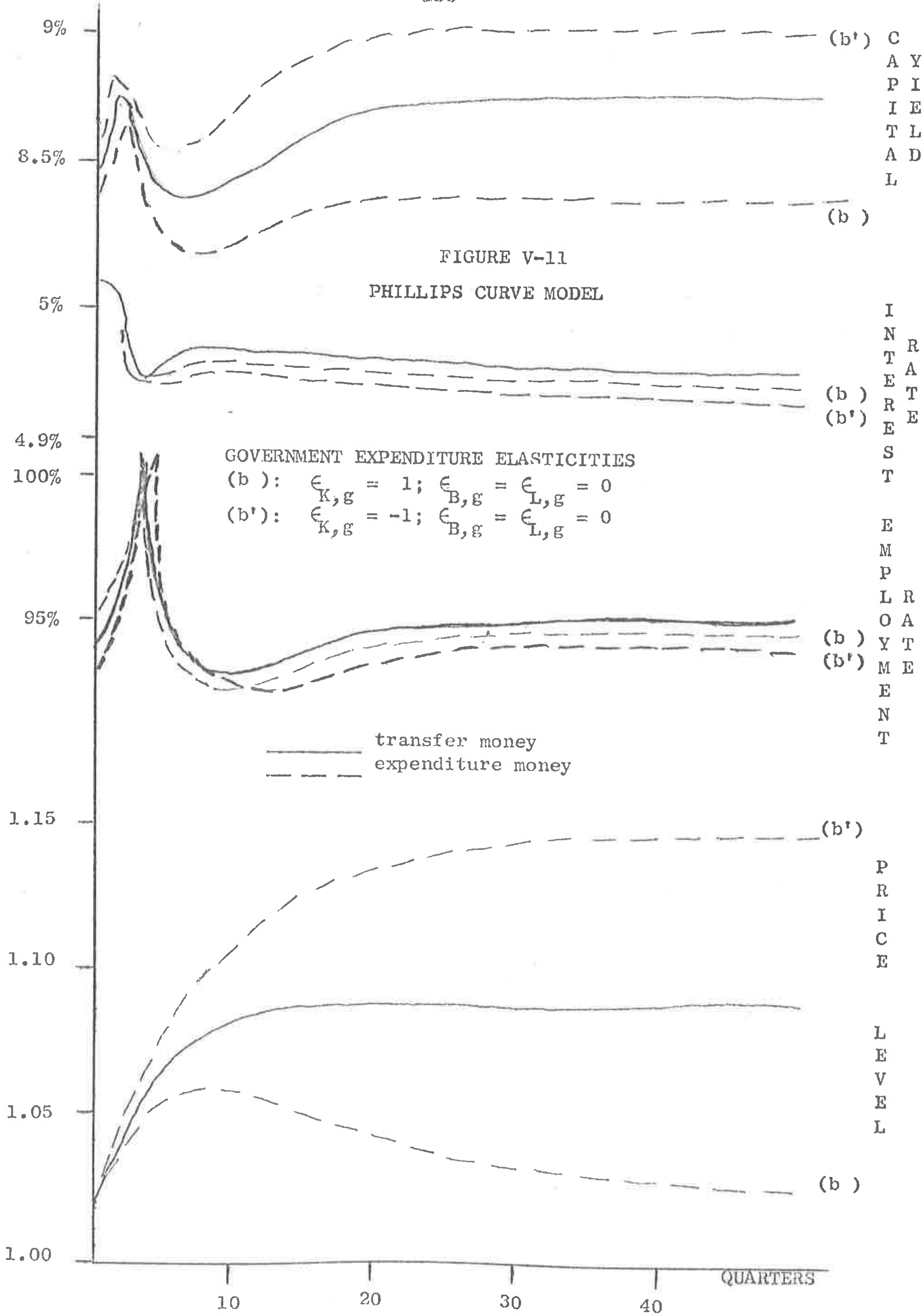


FIGURE V-11

PHILLIPS CURVE MODEL

government expenditures increase capital accumulation, as in Simulation (b), transfer money outperforms expenditure money. With equal short run unemployment effects, a simple contraction in the money supply proves to be more deflationary in the long run than an equivalent monetary contraction accompanied by a cutback in government expenditures. However, when government expenditures decrease capital accumulation, as in Simulation (b'), the opposite is true. With equal short run unemployment effects, a monetary contraction combined with a government expenditure cutback proves to be more deflationary than an equivalent monetary contraction with no expenditure cutbacks.

Consequently, if capital accumulation does indeed react positively to government expenditure flows, our model favors a pure monetary contraction over a combined policy of monetary tightness and fiscal severity for purposes of "cooling down" the economy. Simulation evidence from the Brookings Model in Table V-1 indicates that government expenditures are likely to increase capital accumulation.

Relying on simulation results from the Brookings Model, we thus come to a Keynesian policy conclusion for un-Keynesian reasons. Our model shows that expenditure money proves to be the better policy for stimulating employment, and transfer money is the more effective policy of winding down inflation--but only because the familiar balanced-budget government expenditure effect on consumption turns out to be negative.

Finally, our simulation picutres in Figure V-11 again damage the reputation of the interest rate as a gauge of monetary policy.

Despite the very different long run price effects of new transfer and expenditure money, the bond yield effects turn out to be virtually the same, and it does not seem to matter whether government expenditures increase or decrease the demand for capital.

We did not picture our simulation results when government expenditures affect only the demand for bonds, as in Simulations (c) and (c') in Sections 2 and 3 of this chapter, or when expenditures affect only the demand for money, as in Simulations (d) and (d') in the same two sections. In these two sets of simulation experiments the employment effects of expenditure money closely track the corresponding effects of transfer money. Moreover, long run price effects of expenditure money replicate the results obtained from our flexible wage model in Section 2: when government expenditures affect only the demand for bonds, the long run price effects of new expenditure match those of new transfer money, and the interest rate serves as an accurate gauge of long run inflationary pressures when government expenditures only affect the demand for money.

In conclusion, introduction of adaptive price expectation and semi-flexible wage rates into our model uphold the results obtained from previous simulations with perfectly flexible and perfectly rigid wages. At the same time, our Phillips Curve model generates more realistic--and less optimistic--pictures of dynamic adjustment: the employment gains from monetary policy--whatever its kind--vanish within 3 years while the price effects adjust slowly and prove to be long lasting.[12]

Section 5: Conclusion

All three versions of our model show that the relative macroeconomic effects of new expenditure and new transfer money crucially depend on the way government expenditures affect the demand for capital and the demand for money. The effect of government expenditures on the demand for bonds proves to be the only irrelevant parameter in our model: as far as employment and price adjustment are concerned, it makes little difference which way government expenditures affect bond demand.

Our results thus favor the fiscalist position when government expenditures affect the demand for capital or money. The different employment and price effects of new expenditure and new transfer money in these cases indicate that fiscal policy does indeed matter. The different effects of new expenditure and new transfer money indicate that tax-financed or bond-financed government expenditures will not simply "crowd out" private demand with little, if any, effect on employment or prices. Both tax-financed and bond-financed government expenditures will change employment and prices depending on the way government expenditures affect the demand for capital or money.

Practially all of our simulation results in this chapter indicated that the interest rate does not serve as a reliable gauge of the comparative macroeconomic effects of new expenditure and new transfer money. In all three versions of our model the interest rate effects of expenditure money closely matched those of transfer money despite very different price and employment effects. Consequently, in the absence of data on employment or price, we believe that time series showing the interest-rate effects of alternative monetary policies should not be the basis of ranking these policies for their anti-inflationary or expansionary effectiveness.

Finally, we found that "stagflation" occurred in our model as a straightforward intermediate event in the sequence of macroeconomic adjustment. As in the case of transfer money, a "stagflation" phase appears in our Phillips Curve model whenever expenditure money generates short run employment gains and long run price increases.

FOOTNOTES TO CHAPTER V

(1) De Menil and Enzler do acknowledge that their results are conditioned by their suppression of endogeneous money stock equations during this experiment. During their government spending simulation experiment the money stock was taken as exogenous. (See de Menil and Enzler (1971): p. 299, fn. 12]

(2) The government expenditure coefficients K_g, L_g, and B_g implied by the unitary government expenditure elasticities take on larger absolute values than the corresponding coefficients K_h, L_h, and B_h, which represent the effects of labor income on private sector asset demand. When government expenditures are perfect supplements to labor income, the expenditure coefficients K_g, L_g, and B_g should be equal to their corresponding labor income coefficients in the asset demand equations, and as perfect offsets to labor income, the coefficients K_g, L_g, and B_g should be in value but opposite in sign to the labor income coefficients K_h, L_h, and B_h. However, we are assuming that government expenditures may be supplements or offsets to labor income and private wealth, both of which appear as positive arguments in the assets demand equations. For this reason we have let the government expenditure coefficients K_g, L_g, and B_g take on higher absolute values than their corresponding labor income coefficients.

(3) While we consider these results indicative of government expenditrue effects on saving and investment, we also recognize one major drawback to our calculations. The Brookings model, like other econometric models, does not contain a government budget restraint. Consequently, we could not tell what was happening to the stock of government bonds during Fromm's expenditure and tax cut policy simulations.

In the Brookings Model government expenditures are defined as government purchases of investment goods or consumer durables. In our model, government expenditures directly affect the productivity of labor or human capital, and thus increase or decrease asset holders' demand for wealth. The Brookings conceptualization of government expenditures thus comes closest to our own definition, and for this reason we have chosen this econometric model for simulation evidence on the influence of government expenditure flows on saving and capital accumulation.

Other econometric modles do not classify government purchases as investment goods or durable expenditures. Evans and Klein [1968], for example, distinguish between two types of government purchases in the Wharton Econometric Forecasting Model. The two federal expenditure components are defined as government purchases of goods and services and government purchases for national defense. Similarly, de Leeuw and Gramlich [1968] simply classify government expenditures as a component of autonomous spending in the Federal Reserve--MIT Econometric Model.

(4) The fact that the interest rate is not reliable does not mean that the total money stock is the only unambiguous gauge of expansionary or restrictive monetary policy. In our model there is no commercial banking system. Consequently, money supply changes consist only of changes in the monetary base. If we did include a commercial banking sector, the identical interest rate effects of two policies--one being more inflationary than the other--may conceivably generate identical effects on the total money stock.

(5) In Chapter IV we found that identical money supply changes through open market operations and through transfer payments generated similar price and employment effects. Thus, we could amend this statement to read "...the macroeconomic consequences of expenditure money in our model will be very different from those of transfer money or open market purchases."

(6) In Figure V-6 the long run price, interest, and capital yield effects of transfer money are not between Simulation (a) and (a'), the alternative effects of expenditure money as comparative static simulation results indicated. This is due to convergence errors in our simulation program. However the different long run price, interest, and capital yield effects of new transfer and new expenditures were quite close when we simulated the comparative static version of our model, so this convergence error in our dynamic simulation is relatively slight.

(7) In Section 3 of Chapter IV we related our interest and price adjustment pictures to the empirical work of Cagan and Gondolfi [1969], Gibson [1970], and Sargent [1973]. Cagan and Gondolfi as well as Gibson stressed undershooting in the interest rate during the monetary transaction process, and Sargent considered the positive correlation between interest rates and prices during adjustment periods.

(8) In comparative static simulations the long run effect of expenditure money for Simulation (c) should fall .5% below the long run transfer money effect in Figure V-8. There is thus a convergence error of about 1% in our dynamic simulation experiment, since the long run employment effect of expenditure money is .5% above the transfer money effect in Simulation (c).

(9) Again, this statement could just as easily read: "Otherwise, the employment effects of expenditure money are much different from transfer money and open market purchases," since the employment effects of transfer payments and open market purchases were virtually the same in Chapter IV.

(10) The reason why expenditure money in this case results in a lower long run price level is easily explained. Since expenditure money increases the demand for all three assets, prices must fall to equate the real supply of money and bonds with the increased demand.

(11) In this case, expenditure money results in a higher long run price level for the opposite reason given in footnote (10). Here expenditures decrease the demand for all three assets. Hence lower prices are necessary to equate the real supply of money and bonds with their reduced demand.

(12) In this dissertation we did not consider the dynamic effects of expenditure money when the initial position of the economy is not in the neighborhood of full stock/flow equilibrium. In such a case we may be forced to modify some of our pessimistic conclusions about monetary policy when adaptive expectations and semi-flexible wage adjustment come into play.

CHAPTER VI

ADAPTIVE EXPECTATIONS, SEMI-FLEXIBLE WAGE RATES, AND THE DYNAMIC EFFECTS OF MONETARY EXPANSION AND EXOGENOUS INVESTMENT

Section 1: Introduction

In the previous chapters we studied the dynamic adjustment of employment, prices, and interest rates in our Phillips Curve model when monetary policies consisted of once-over 10% money stock changes through transfer payments, open market purchases, and government expenditures. In this chapter we shall now consider the effects of a once-over change in the rate of monetary growth, intermittent monetary expansion, and monetary control rules. Finally, we shall consider the effects of a once-over change in the rate of monetary growth, intermittent monetary expansion, and monetary control rules. Finally, we shall consider the effects of a once-over shift in the private sector rate of quarterly investment, and compare these results with the "monetary adjustment" set off by the once-over shift in the rate of monetary growth. We shall then evaluate the "monetary" interpretation of history. The adjustment speeds, asset demand elasticities, and initial conditions for these simulations appear in Table III-1.

In the next section of this chapter we shall study the dynamics of adjustment when the monetary authorities expand the money supply at a constant two per cent quarterly rate. Starting from a 6% normal rate of unemployment and a zero equilibrium rate of inflation, we shall see what happens in our model when policy makers simply follow a quarterly two per cent rule for expanding the money supply. They make no attempt at "fine tuning" the economy to target rates of inflation or unemployment.

In the third section of this chapter we shall turn to the effects of intermittent monetary expansion. Here we shall assume that policy makers gear monetary expansion to target rates of unemployment and inflation in the following way:

____No expansion if inflation exceeds 2%, no matter how large unemployment;

____2% expansion if inflation does not exceed 2% and unemployment exceeds 4%.

Initially the economy will be in full equilibrium, with no inflation and 6% normal unemployment. We have selected this rule in order to determine the effects of monetary expansion when its unemployment target is incompatible with the normal rate and when its inflation target is incompatible with inflation overshooting the rate of monetary growth. In this section we shall compare the dynamic effects of intermittent monetary expansion with the effects of constant 2% monetary growth. We shall show how intermittent monetary expansion with these targets produces greater variation in unemployment and inflation than constant monetary expansion with no target rate of unemployment and inflation.

In the fourth section of this chapter we shall consider the effects of monetary control rules. In contrast to the two preceding sections, however, we shall assume that the economy is not initially in full equalibrium, with no inflation and normal unemployment. Instead, we shall introduce exogeneous periodic shifts in investment demand during the adjustment process, which cause unemployment and inflation to deviate from their equilibrium values. In this section we shall again assume that monetary expansion responds to deviations between actual and target rates of inflation and unemployment. However, we shall now assume that the monetary targets are identical to the equilibrium rates of unemployment and inflation. Here the primary purpose of monetary policy is to stabilize unemployment and inflation at their equilibrium levels and not primarily to produce lower unemployment or inflation.

Finally, in the fifth section of this chapter we shall engineer a once over shift in the rate of investment. In this experiment monetary authorities remain completely passive: no monetary changes occur while the economy adjusts to the wave of exogenous investment. We shall then compare the Phillips Curve whirlwind set off by this experiment with the evolution of inflation and unemployment following a one-shot increase in the monetary growth rate. We shall relate both results to the actual evolution of the U.S. Phillips Curve in recent economic experience, and consider the validity of the "monetary" interpretation of economic history.

Section 2: The Dynamic Effects of Constant Monetary Growth

In Figure VI.1 we picture the dynamic adjustment of inflation and unemployment resulting from the two percent increase in the quarterly rate of monetary growth. Unemployment responds rapidly, while the adjustment of inflation is markedly slow. Unemployment drops by

3 percentage points five quarters after the monetary growth increase, whereas the rate of inflation reaches a half-way mark of 1% in the same period of time. Then we come into a 7 quarter period of "stagflation:" inflation ascends to a peak of 2.4% while the unemployment rate returns to its 6% normal level. Finally, from period 12 through 20 the rate of inflation gradually descends to its 2% long run value while unemployment hovers around its 6% normal rate.

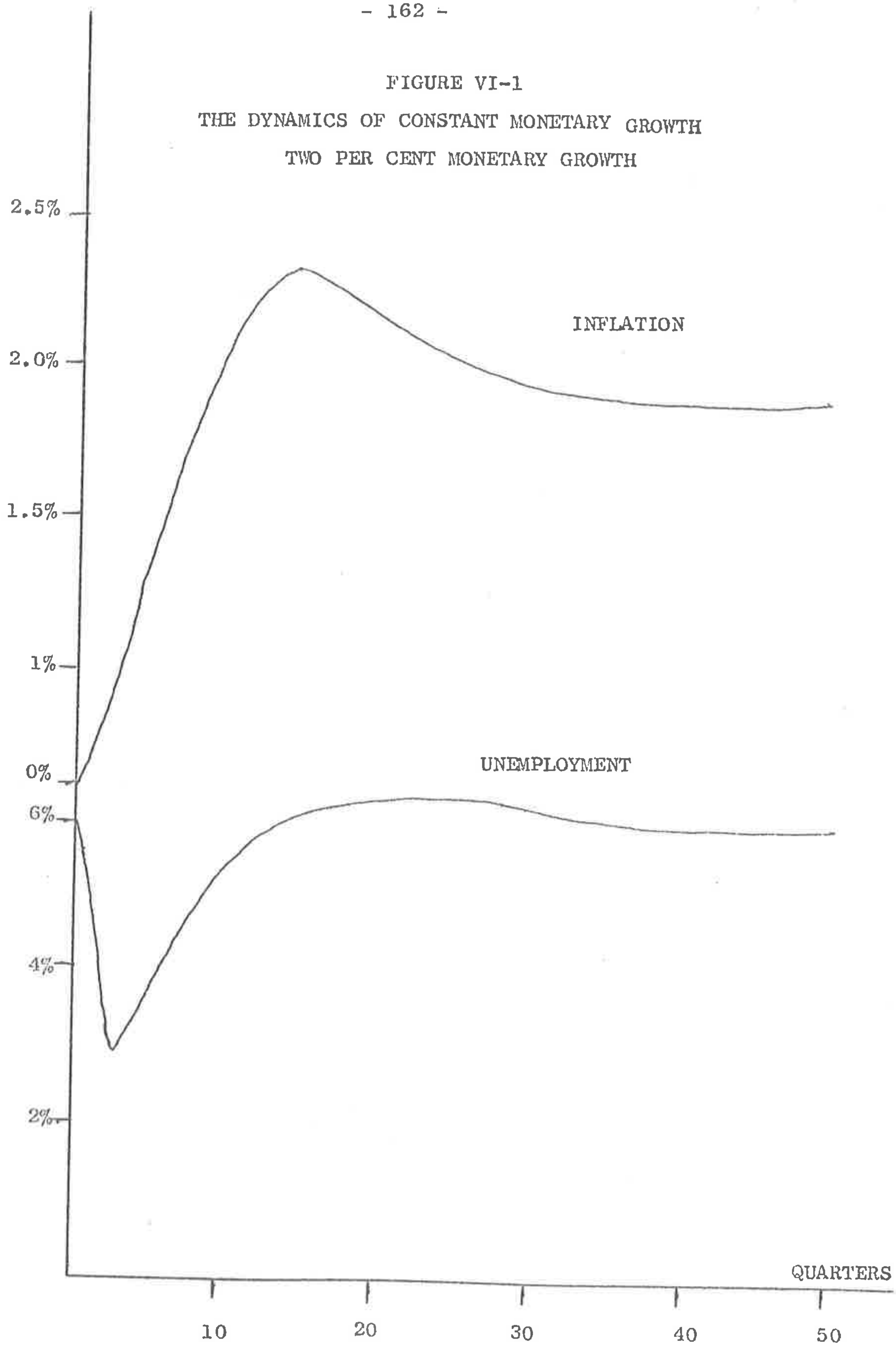
"Stagflation" thus appears in our model as a direct dynamic consequence of relatively slow price adjustment coupled with relatively fast labor market adjustment. There is nothing paradoxical at all about this event. Lags in expectations and money market adjustment link a slow upward movement of inflation with employment cutbacks due to rising wages and falling labor productivity.[1]

The adjustment of unemployment and inflation in Figure VI-1 pictures well the dilemma facing policy makers shortly before the recent wage-price controls were imposed. According to Cagan [(1972): p. 111], the problem facing policy makers in 1970 was not the traditional trade-off in which a permanently lower level of unemployment required a permanently higher rate of inflation. Rather, the economy was "in flux" and the permanent trade-off was "far off and largely unknown." [Cagan (1972): p. 112] Both inflation and unemployment could decline for a while, but the problem--depicted by our adjustment paths from period 15 onward--was that "inflation was coming down slowly and unemployment would remain high for some time unless policy makers took the risk of stimulating the economy much more vigorously."

FIGURE VI-1

THE DYNAMICS OF CONSTANT MONETARY GROWTH

TWO PER CENT MONETARY GROWTH



[Cagan (1972): p. 112]

While monetary expansion appears as an unfavorable policy for stimulating the economy, Figure VI-1 shows that monetary policy is not so bad for winding down the economy. Reversing our result in Figure VI-1, a 2% contraction in the rate of monetary growth would initially achieve a very fast increase in unemployment while the rate of inflation would come down at a slow pace: within a 5 quarter time period unemployment would rise by 3% but inflation would fall by less than 1%. Then we would come into a happy period of rising employment and falling inflation from period 5 through period 12 inflation would fall by almost 2% while the unemployment rate would drop by 3%. After three years, the effect of a 2% lower rate of inflation and an unchanged normal rate of unemployment.

In Figure VI-2 we picture the adjustment of the long run Phillips Curve generated by the 2% monetary growth increase. Following the initial inflationary and expansionary effects after the policy change, the paired combinations of inflation and unemployment move in a clockwise rotation over time. As our arrows indicate, inflation exhibits a non-linear relation to unemployment. Once unemployment has crossed back over its 6% normal level, the inflation-unemployment relation becomes progressively vertical. The clockwise whirlwind continues until it has brought inflation and unemployment to long run adjustment.

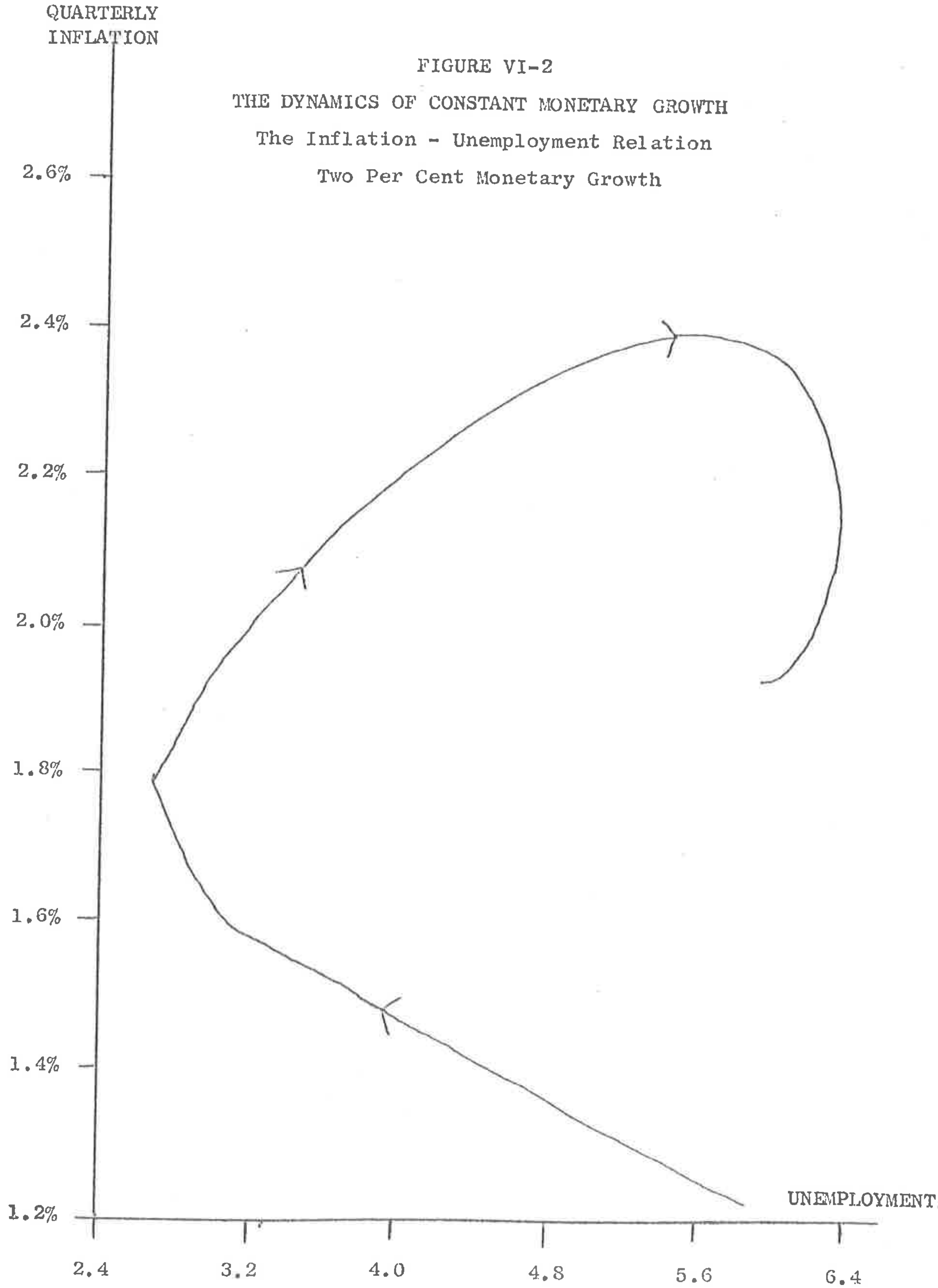
The adjustment of inflation and unemployment to increased monetary growth rates in our model agrees well with simulation results

FIGURE VI-2

THE DYNAMICS OF CONSTANT MONETARY GROWTH

The Inflation - Unemployment Relation

Two Per Cent Monetary Growth



obtained from the St. Louis Model. Starting with 1970 initial conditions, Anderson and Carlson [(1970): p. 177] expanded the money supply at several different constant growth rates through time. Each time they generated a clockwise movement of inflation-unemployment combinations through time.

In conclusion, a permanent increase in monetary growth registers no net change in long run employment and an equiproportional increase in long run inflation. During the adjustment process in our model employment expansion ceases very quickly, while inflationary-over-adjustment hangs on for a long time. A 2% contraction in monetary growth, on the other hand, is effective in unwinding inflation, and generates only short-lived increases in unemployment.

We shall now turn to intermittent monetary expansion to see what differences there are between this policy manoeuvre and constant monetary growth.

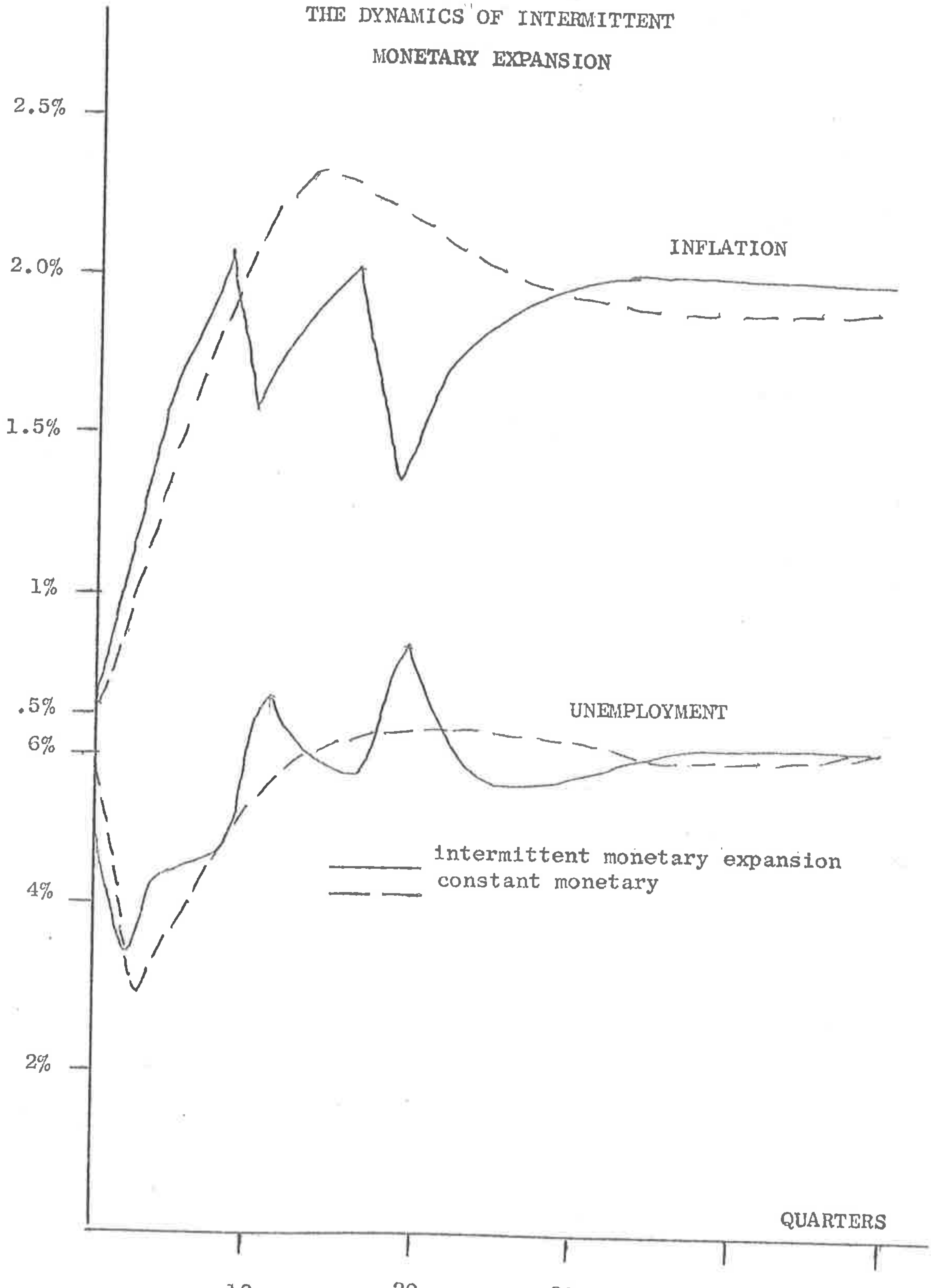
Section 3: The Dynamic Effects of Intermittent Monetary Expansion

In Figure VI-3 we picture the dynamic behavior of inflation and unemployment when monetary expansion is geared to a 4% target for unemployment and a 2% target for inflation. In this experiment policy makers let the money supply grow at a 2% quarterly rate whenever unemployment is above 4%, but if inflation exceeds 2% per quarter, policy makers discontinue monetary growth, even if the 4% unemployment target is not attained. We shall compare our results for this policy manoeuvre with those obtained for constant monetary control. The

FIGURE VI-3

THE DYNAMICS OF INTERMITTENT

MONETARY EXPANSION



broken curves in Figure VI-3 represent the dynamic effects of intermittent monetary expansion, while the broken curves represent our previously obtained results for constant monetary growth.

Comparing the solid curves in Figure VI-3 with the broken curves, we find that intermittent monetary expansion is a more unstable policy manoeuvre than constant monetary growth. With constant monetary growth overshooting characterized the adjustment of inflation, while unemployment simply declined and then returned to long run equilibrium. Now cyclical adjustment characterizes the behavior of inflation and unemployment. The oscillations persist for 25 quarters.

For the first five quarters inflation and unemployment closely track the results obtained for constant monetary growth. Then we again come into a period of stagflation: from period 5 through period 9 inflation continues to rise while unemployment slowly gravitates back to its normal level. Inflation comes to a peak of 2% and then drops down to 1.5% over the next 4 quarters as unemployment increases to a rate slightly above its initial "normal" level. A second cycle then begins at period 13 and ends at period 23. Finally inflation ascends to its long run 2% quarterly rate while unemployment drops down to its 6% normal level from a final peak of 7%.

In Figure VI-3 intermittent monetary expansion generates a long run 2% rate of inflation because the unemployment target is below the normal rate of unemployment. Consequently the economy ends up with the maximum rate of inflation which the inflation target allows. If the target rate of inflation had been set at zero, the economy would end up with 6% unemployment and no inflation. Hence in the long run monetary policy generates normal unemployment no matter what value the unemployment target takes on. The inflation target is all that matters in the long run.

The destabilizing influence of intermittent monetary expansion in our model is consistent with recent findings of Cooper and Fischer [(1972a, 1972b]. From stochastic simulation experiments with two very different theoretically developed econometric models, Cooper and Fischer found that monetary expansion geared to target rates of unemploymemt and inflation magnified the variations in unemployment and infaltion generated by constant monetary expansion. Finally, the span of each cycle generated by intermittent monetary expansion in our model is consistent with the average duration of historical business cycles analyzed by the National Bureau of Economic Research: the periods of boom and recession together fall within a two to three year time interval. [See Cagan (1969): p. 226].

In conclusion, the adoption of intermittent monetary expansion with target rates of inflation and unemployment does not improve the macroeconomic picture generated by constant monetary growth. In the long run the effects of both policy manoeuvres are the same. During the adjustment process, however, intermittent monetary expansion produces a series of fluctuations in unemployment and inflation. Because of these destabilizing effects we consider intermittent monetary expansion with target rates of inflation and unemployment less desirable than constant monetary growth.

Section 4: The Dynamic Effects of Monetary Control

We shall now consider the effects of monetary control rules. In contrast to the previous sections of this chapter, we shall now assume that monetary change is not the initial disturbance which jolts the economy from equilibrium. Instead, we have introduced an exogeneous increase in the demand for capital in the initial simulation period. We shall compare the adjustment of inflation and unemployment to this disturbance when there are no monetary reactions, and when proportional and derivative monetary control rules are implemented to stabilize the economy.

Conditions for Monetary Control

We engineered our initial disturbance by incorporating an additional term into our demand for capital equation. This term is a shift parameter which we set equal to 3% of the capital stock for the first 12 simulation periods. At the first period of our program we therefore created an excess demand for capital equal to 3% of the capital stock. In succeeding simulation intervals we gradually lowered the shift parameter until period 24 when our capital disturbances ceased. In Table VI-1 we summarize our series of exogenous shifts in the demand for capital for our monetary control rule simulations.

A more realistic method for these monetary control experiments would be to make X a random variable. In these policy experiments, however, we prefer to control the exact magnitude of exogenous capital disturbances so that we could isolate the effects of our planned disturbances on the rest of the system. We offer no justification for the particular magnitudes or for the way we varied the value of x from period to period. Preliminary results showed that our results changed very little when we altered the magnitudes or the time patterns of x.

TABLE VI-1

EXOGENOUS CAPITAL DEMAND SHIFTS FOR MONETARY CONTROL EXPERIMENTS

Demand for Capital

$$K^* = K(K, M/p, B/ip, h, g, r, i, \pi) + x$$

Simulation Periods	Value of x
0 - 12	3% of K
12 - 18	2% of K
18 - 24	1% of K
24 - 50	0% of K

Formulation of Control Rules

In our first experiment we adopted a proportional monetary control rule, in which changes in the monetary growth rate respond to deviations between actual and target rates of unemployment and inflation. We have set the target rate of unemployment at the long run natural rate of unemployment, u_0. Our target rate of inflation is the equilibrium rate of inflation, zero. For this reason only the actual rate of inflation need appear in our rule. Our proportional monetary rule has the following form:

(1) $\frac{\Delta M}{M} = \mu_1[u - u_0] - \mu_2[\frac{\Delta p}{p}]$

In our second experiment we adopted a derivative monetary control rule, in which changes in the rate of monetary growth respond to changes in unemployment and to changes in the rate of inflation. Our derivative control rule has the following form:

(2) $\frac{\Delta M}{M} = \delta_1[\Delta u] - \delta_2[(\frac{\Delta p}{p})_t - (\frac{\Delta p}{p})_{t-1}]$

Proportional and derivative control rules were first put forward by A. W. Phillips [1954]. Having simulated a multiplier-accelerator macroeconomic model with explosive cycles, Phillips found that the application of proportional and derivative monetary control rules on income stabilized his model. Phillips concluded from his study that "monetary policy based on the principles of automatic regulating systems would be adequate to deal with all but the most severe disturbances to the economic system." [Phillips (1954): p. 315]

More recently, Stein and Enfante [1973] embedded proportional monetary policy control rules on unemployment and inflation in a dynamic model of imployment, inflation, adaptive expectations, and Phillips Curve wage adjustment. Stein and Enfante concluded that proportional monetary control could stabilize their model regardless of whether there is or is not a "natural" rate of unemployment. [Stein and Enfante (1973): p. 558]

Our proportional rule formulation assumes that monetary authorities equally dislike deviations of employment above or below the normal rate. Similarly, they equally dislike deviations of inflation above or below the equilibrium zero rate of inflation. Assuming a macroeconomic cost function for disequilibrium in inflation and unemployment, Stein and Enfante showed that proportional control rules on these variables is the most efficient way to drive the "costs of disequilibrium" monotonically to zero without an unduly large amount of quantitative knowledge of the economic system. [Stein and Enfante (1973): p. 558]

A direct optimization approach to monetary control would impose "control costs" on changes in the money supply. Part of an optimal control problem would then be to balance the relative costs of controlling the economy with the costs of letting unemployment and inflation deviate from their equilibrium paths. [See Pindyck (1973)] In our formulation we are simply assuming that there are no "control costs" associated with changing the money supply. Hence our control rules do not come from an optimal control approach to stabilization policy.

Derivative monetary control rules were implemented by Cooper and Fisher in stochastic simulation experiments with the FRB-MIT-Penn and St. Louis Econometric Models. [See Cooper and Fisher (1973a, 1973b)] In their simulation experiments Cooper and Fisher found that derivative monetary controls on inflation and unemployment were more effective than proportional monetary control rules in reducing fluctuations in unemployment and inflation.

In our monetary control experiments we have assumed that the money supply changes come through transfer payments. Our monetary control experiments and control parameters are listed in Table VI-2.

Our asset demand coefficients, adjustment speeds, and initial conditions come from our original parameter listing in Table III-1.

TABLE VI-2

MONETARY CONTROL EXPERIMENTS

Proportional Control Rule: $\frac{\Delta M}{M} = \mu_1[\,u - u_0] - \mu_2[\frac{\Delta p}{p}]$

Derivative Control Rule: $\frac{\Delta M}{M} = \delta_1[\Delta u] - \delta_2[(\frac{\Delta p}{p})_t - (\frac{\Delta p}{p})_{t-1}]$

Simulation Picture	Control Parameters
Figure VI-4	$\mu_1 = \mu_2 = 1$
Figure VI-5	$\delta_1 = \delta_2 = 2$

Macroeconomic Adjustment with Exogenous Investment and Proportional Monetary Control

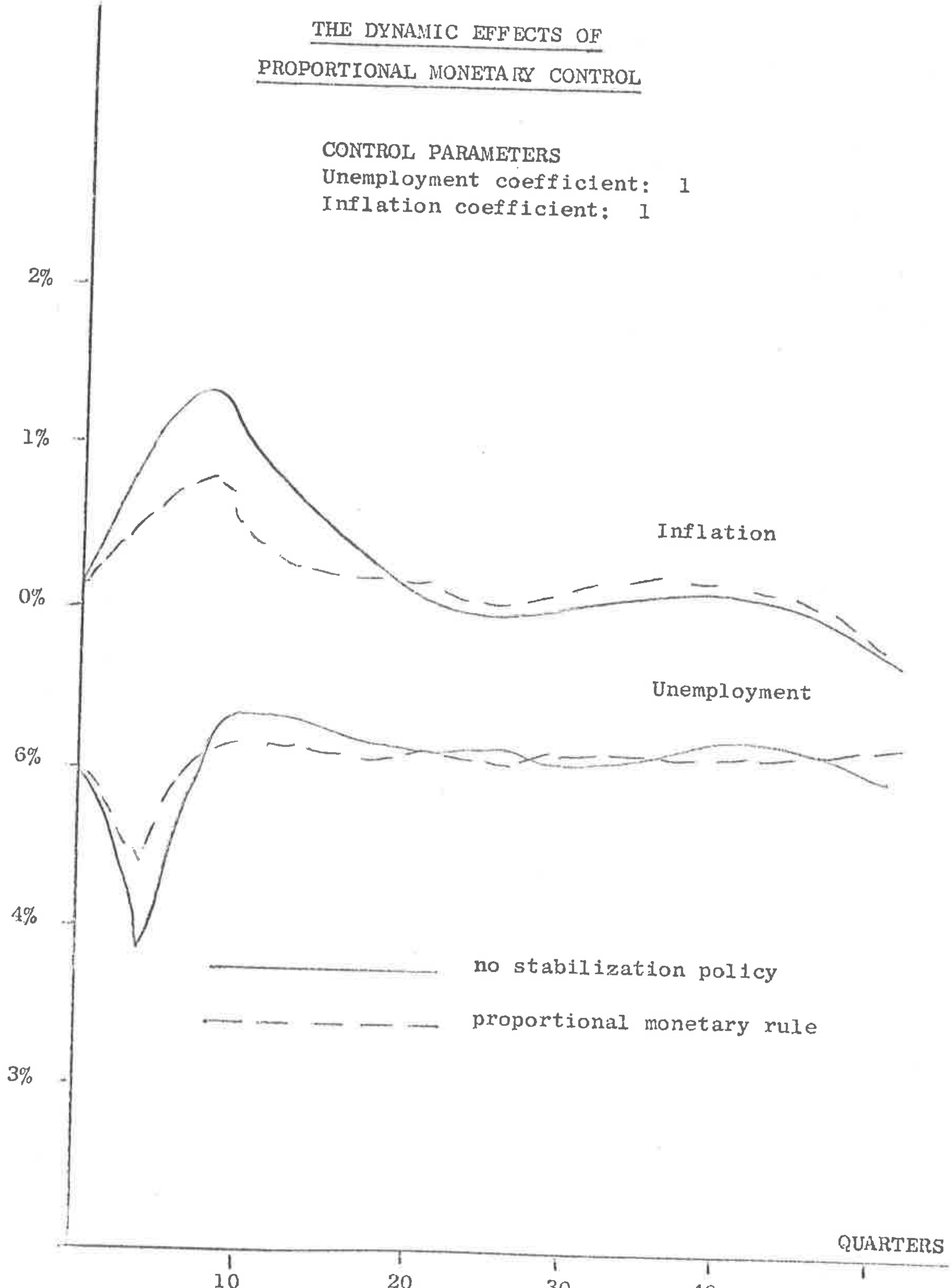
In Figure VI-4 we picture the adjustment of inflation and unemployment to exogeneous investment in the absence of proportional control and to exogeneous investment with proportional control. The solid curves represent the adjustment of inflation and unemployment generated by our series of exogeneous capital demand shifts listed in Table VI-1. The broken curves represent the alternative path of inflation and unemploymemt if proportional control rules are implemented.

Let us first consider the adjustment of the economy in the absence of any monetary stabilization rule.

We find that the increase in capital demand stimulates both employment and inflation. The behavior of inflation has a straightforward explanation. The increased capital accumulation resulting from

FIGURE VI-4

THE DYNAMIC EFFECTS OF
PROPORTIONAL MONETARY CONTROL



the upward capital demand shift directly increases employment by increasing the productivity of labor. The increase in employment in turn raises the capital yield by increasing the productivity of capital. The higher capital rate of return results in a lower demand for money, which requires an increase in inflation to reduced the real supply with the lower demand. Inflation continues when employment falls after period 5 because of lags in expectation. The past four-quarter experience of inflation leads to high rate of expected inflation by the fifth period. This in turn lowers the demand for money, and a higher inflation is again needed to reduce the real supply of money with the lower demand. After period 10, however, inflation falls because the increased capital accumulation starts to lower the capital rate of return. The lower capital yield in turn increases the demand for money, and a lower rate of inflation is now needed to increase the real supply with the higher demand.

The inflationary effects of exogeneous investment are therefore due to the relative speeds of adjustment of labor, wages, and capital. The initial spurt of capital accumulation has a strong initial effect in the labor market by increasing the employment of labor. On the other hand, the depressive effect of the first period increase in capital accumulation on the capital rate of return is small, and is dominated by the positive effect of the higher employment on capital productivity. In the later periods, however, when wages have adjusted and employment is back at its normal level, the full effect of higher accumulation on the stock of capital lowers the capital return, increases demand for money, and starts to lower inflation. If employment of labor therefore responded less quickly to the first spurt of capital accumulation, or nominal wages responded more quickly, then the inflationary effects of the capital demand increase would be modified.

Figure VI-4 also shows that exogeneous investment generates a period of rising inflation and falling employment from quarter 5 to quarter 12. We traced this stagflation process to the depressive effects of a higher expected rate of inflation on the demand for money. Stagflation thus occurs as an intermediate phase in the adjustment of the economy to real as well as monetary disturbances.

Finally, we see in Figure VI-4 that the effects of our later-period shifts in the demand for capital have very mild and almost unnoticeable effects on inflation and unemployment. At period 20 inflation falls slightly below zero, and then climbs slowly back to equilibrium. Both inflation and unemployment hover around their equilibrium levels until the end of our simulation period.

Now let us consider the adjustment process for the same disturbance when a proportional control rule determines changes in the money stock. Figure VI-4 shows that the control rule checks both the initial inflationary surge and the initial decline in unemployment. The peak of inflation under proportional control is about .5% lower than the peak of inflation in the absence of controls, and the trough of unemployment is 2% above the unemployment trough when no control rules were imposed. After their initial surge, we see that inflation and unemployment gravitate to their equilibrium levels, and then hover around their long run values for the duration of the simulation period. In terms of reducing the deviations of unemployment and inflation from their long run values, Figure VI-4 shows that our proportional rule was successful. Had there been no control rule, the economy would have suffered from more inflation and a more severe period of stagflation.

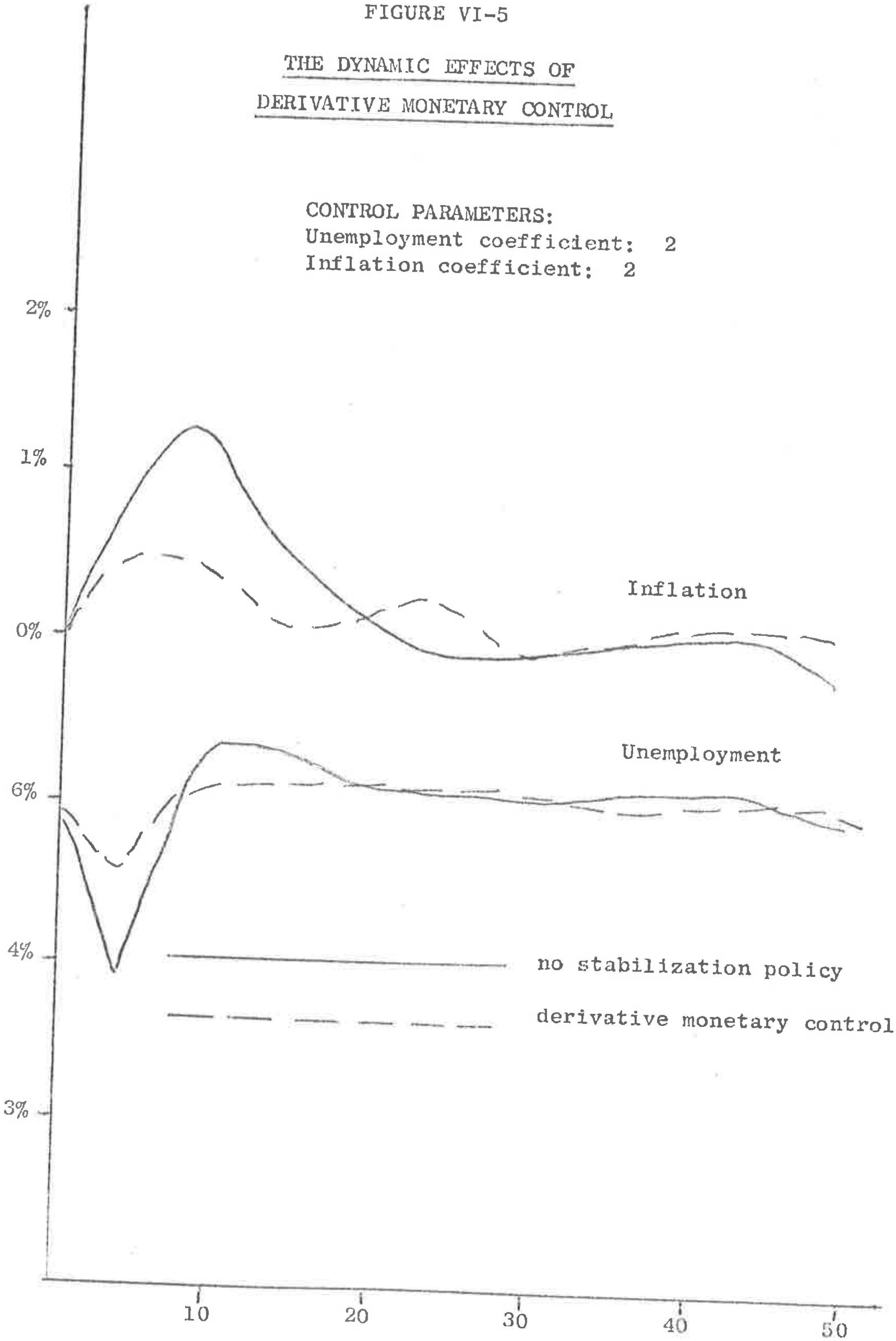
While our simulation evidence does point to the desirability of a proportional control rule for deviations in inflation and unemployment, we recognize one possible danger. The success of the control rule in Figure VI-4 rested on the normal rate of unemployment serving as the target rate of unemployment. Alternative simulations with target rates of unemployment lower than the normal rate showed that proportional rules magnified the variations in unemployment and inflation caused by the capital disturbance. When the control parameter μ_1 for unemployment took on values higher than 2, unstable adjustment occurred. However, when we set the inflation control parameter μ_2 to 2, we generated practically the same results as we pictured in Figure VI-1. Since the normal rate of unemployment may not always be known in conditions of disequilbirium, and the incorrect identification of this rate is a destabilizing factor, we believe that porportional monetary control rules work best when the control coefficients are only set for deviations in the rate of inflation.[2]

Macroeconomic Adjustment with Derivative Monetary Control

Let us now turn to Figure VI-5, where we compare the dynamic effects of our capital disturbance with and without derivative monetary

FIGURE VI-5

THE DYNAMIC EFFECTS OF DERIVATIVE MONETARY CONTROL



control. The broken curves represent the adjustment process under derivative control.

We again find that the adoption of a monetary control rule checks the initial surge of inflation and the initial drop in unemployment. The peak of inflation under derivative control is about .6% lower than the peak in the absence of controls, and the trough of unemployment is more than 2% above the unemployment trough when no control rules were used. Under derivative control both inflation and unemployment then gravitate to their equilibrium values, and hover around their equilibrium values for the duration of the simulation period. In terms of reducing the deviations of inflation and unemployment from their long run values, Figure VI-5 shows that derivative monetary controls are fairly successful.

The most noticeable differences between the "controlled" adjustment paths in Figures VI-4 and VI-5 are the slight oscillations in inflation under derivative monetary control. These oscillations disappeared when we set the derivative control on employment, δ_1, at zero, and the oscillations were magnified when δ_1 was increased to 4. The reason why derivative controls on both inflation and unemployment produces oscillations may be due to the offsetting effects of both controls on monetary expansion. In our adjustment pictures there are periods when both inflation and unemployment are rising. The rising inflation calls for a lower monetary growth rate, and the rising unemployment calls for a higher monetary growth rate. If the control on unemployment initially dominates, then derivative control would feed the rising inflation by expanding the money supply. The monetary expansion would continue until the rate of change of inflation grew so large that it reversed the effect of rising unemployment on monetary growth. Our simulations results therefore suggest that unemployment and inflation are incompatible for derivative control, and may amplify the variations in inflation and unemployment.

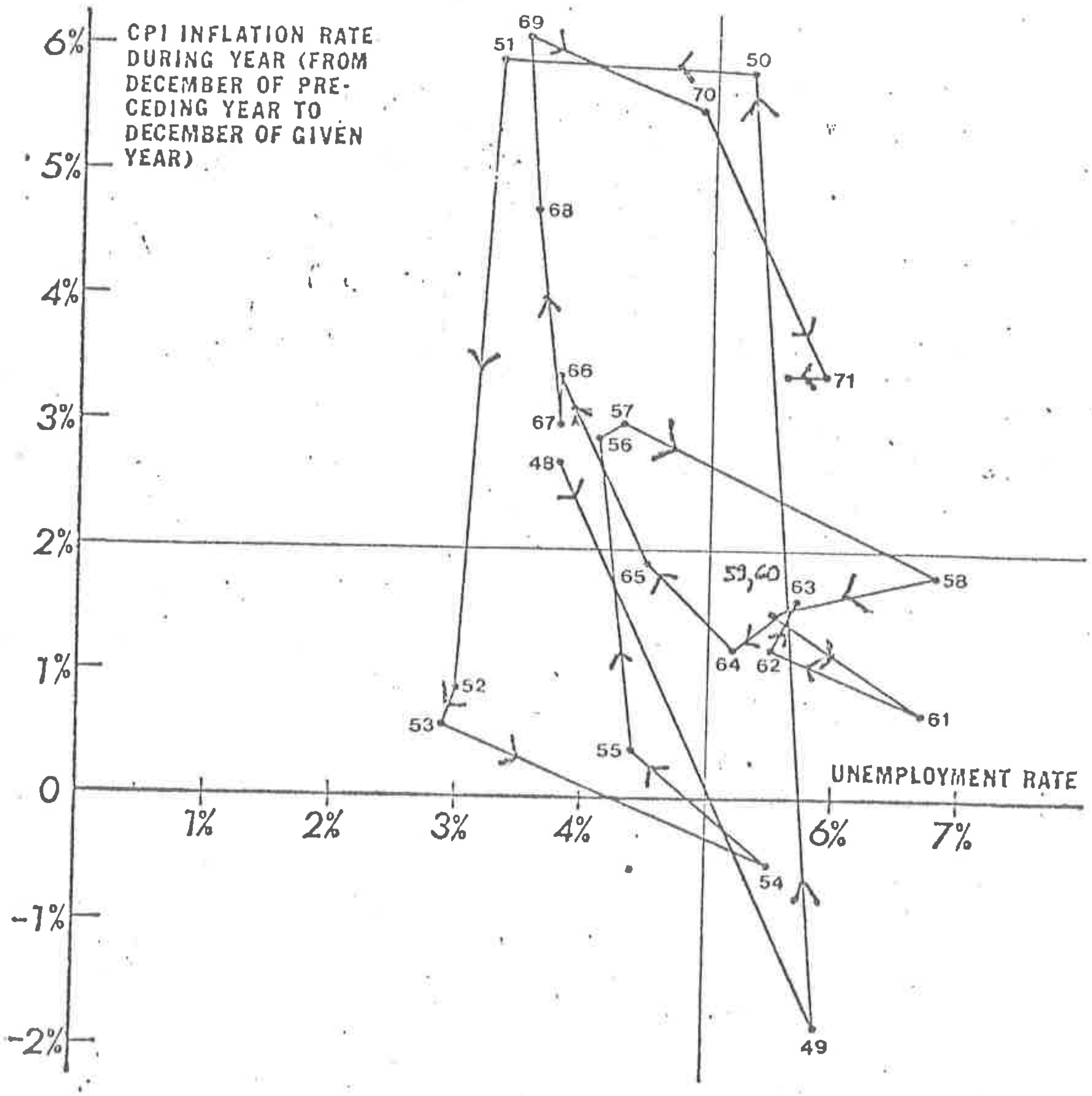
Both our proportional and derivative control rules proved somewhat successful in our simulation experiments. Our proportional control rule was successful because we correctly specified the normal unemployment rate as our target rate, and our derivative control proved successful because we did not specify a relatively strong control parameter on unemployment. Because there is always the danger of incorrectly identifying the normal rate, or setting too strong a derivative control on unemployment, we therefore believe that monetary rules are best suited for controlling inflation rather than unemployment or a combination of the two.[3]

Section 5: Economic Experience and the Dynamic Effects of Monetary Expansion and Exogenous Investment

Instead of concluding this chapter by summarizing our results on monetary expansion and exogenous investment, we shall now compare some of our results with economic experience.

In Figure VI-6 we present Carl Christ's picture of the adjustment of the Phillips Curve inflation--unemployment relation from 1948 through 1972. [See Christ (1973): p. 517] Tracing the movement of

FIGURE VI-6



THE INFLATION - UNEMPLOYMENT RELATION

1948 - 1972

inflation-unemployment combinations for the sub-period 1948-1956, we follow an unambiguous counter-clockwise rotation. Then the rotation shifts. For the sub-periods 1956-60, 1961-63, 1963-66, and 1967-71 we find a clockwise rotation. Except for the sub-period 1966-67, where there is a counter-clockwise rotation, inflation and unemployment have generally moved in clockwise loops from the late 'fifties through the 'sixties and early 'seventies.

In Figure VI-2 we pictured the adjustment of the long run Phillips Curve generated by a 2% increase in the quarterly rate of monetary growth. In accord with the monetary policy simulations of Anderson and Carlson [(1970): p. 177], inflation-unemployment combinations moved in a clockwise rotation along the Phillips Curve adjustment path in Figure VI-2. Accordingly, our monetary policy simulations replicate well the general clockwise direction of the Phillips Curve in recent history. Our results seem to be consistent with a monetary interpretation of economic history, which cites monetary events as the major determinant of actual movements in employment and price change.

However, while our simulation results do show that changes in monetary growth are consistent with the general clockwise evolution of the Phillips Curve, monetary change is not the only factor in our model which proves to be consistent with recent macroeconomic experience.

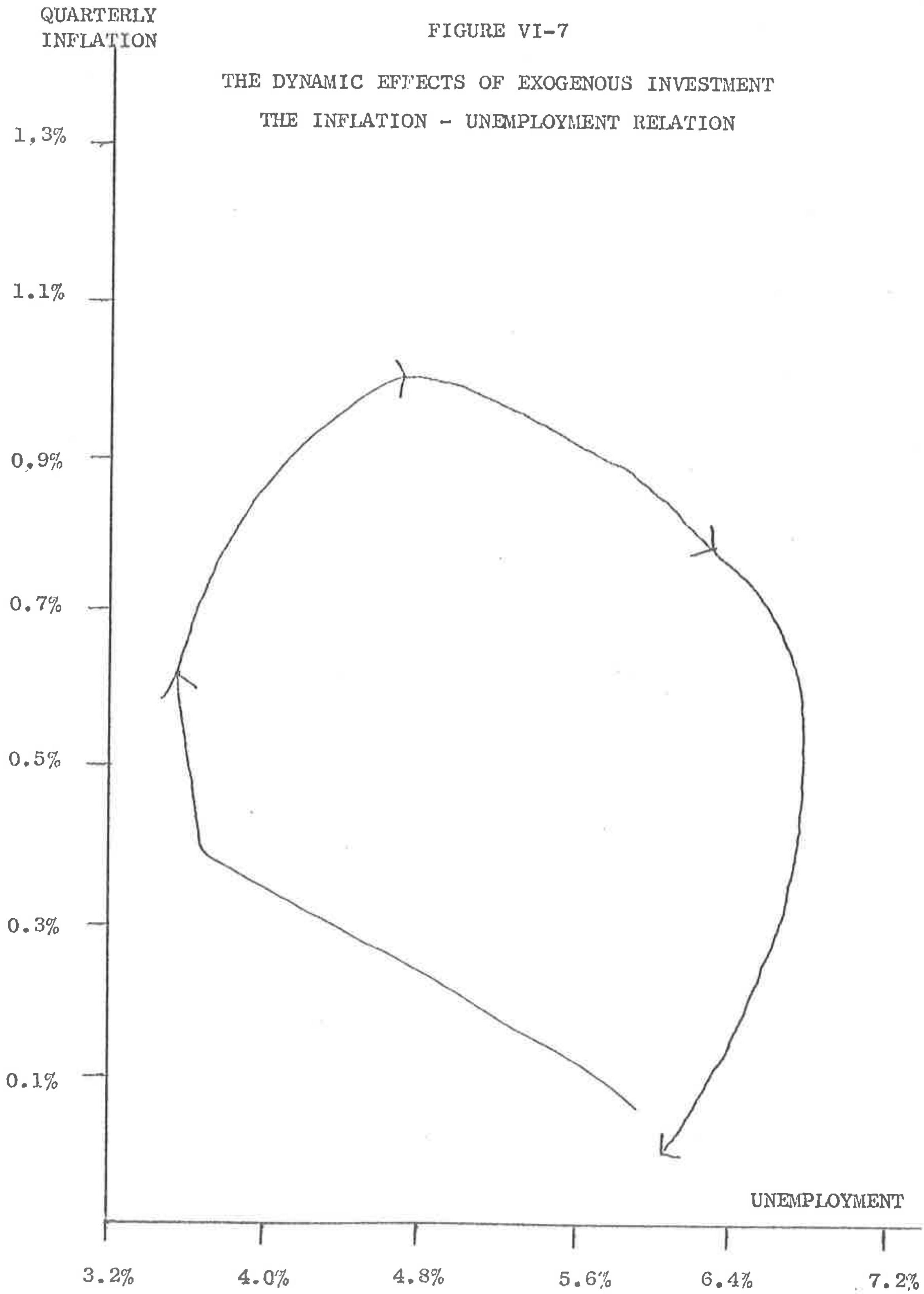
In Figure VI-7 we picture the adjustment of inflation-unemployment combinations generated by an exogenous shift in investment demand. In this experiment we set our capital demand shift parameter described in Table VI-1 equal to 1% of the total capital stock for the entire simulation period. Unlike our monetary control experiments we assumed that monetary authorities remained totally passive. Therefore no changes in the nominal stocks of bonds or money were engineered during this experiment.

Figure VI-7 shows that our capital disturbance also causes a clockwise evolution of the Phillips Curve in our model. Inflation initially surges to 0.6% five quarters after the investment demand shift, while unemployment falls to a level slightly below 3.5%. At period 6, the position of our first arrow, we then come into a period of stagflation: inflation steadily increases to a peak of 1% while unemployment climbs to 4.8%. At period 15, the location of our second arrow, inflation begins a slow process of decline while unemployment gravitates back to its long run 6% normal level. Finally, at period 25, indicated by our third arrow, unemployment rises above and then returns to its initial level while inflation slowly declines to zero. At period 30, the position of the last arrow on the Phillips Curve configuration, long run adjustment is completed, with unemployment at 6% and inflation terminated. Further simulations with alternative adjustment speeds for capital accumulation and alternative investment demand interest elasticities generated similar adjustment.

The adjustment process just described is quite similar to the adjustment process generated by monetary growth rate changes. In both adjustment processes unemployment declines rapidly while inflation increases slowly, both adjustment processes contain an intermediate

FIGURE VI-7

THE DYNAMIC EFFECTS OF EXOGENOUS INVESTMENT
THE INFLATION - UNEMPLOYMENT RELATION



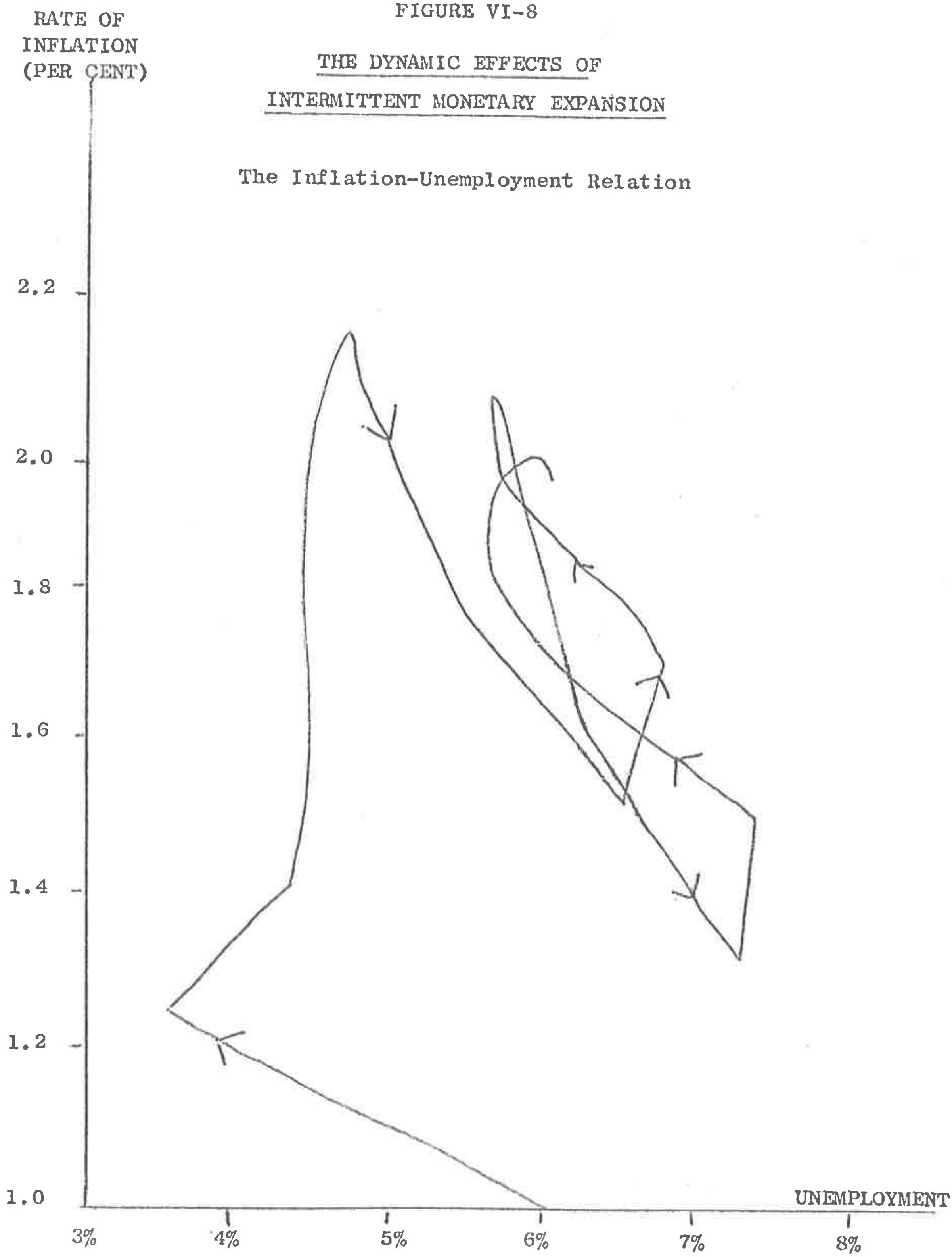
period of stagflation in which inflation continues to rise while unemployment starts to increase, and in both adjustment processes unemployment crosses back over its initial level, inflation unwinds very slowly, and the total period lasts about 30 quarters. Consequently, non-monetary as well as monetary changes in our model are capable of generating a clockwise adjustment of inflation and unemployment. We are thus tempted to conclude on a note of agnosticism: our model tells us that the observed pattern of clockwise Phillips Curve adjustment may or may not have been generated by monetary factors. So far, we cannot be sure if money is practically all that matters in economic experience.

However, the observed pattern of clockwise adjustment does not represent experience as a whole. In Figure VI-5 one sub-period in the 'sixties, 1966-67, as well as the entire 1948-56 period, showed counter-clockwise adjustment. Moreover, Phillips [1958] and Lipsey [1960] found that all the periods between 1861 and 1957 in the United Kingdom displayed counter-clockwise loops in the adjustment of wage inflation and unemployment. Finally, Brechling [1968] found that estimates of a Phillips Curve for U.S. data from 1948-65 generated both counter-clockwise and clockwise loops. Brechling included changes in the consumer price index, changes in unemployment, and seasonal dummy variables in his model of wage inflation. He found that "quarterly and annual data suggested overwhelmingly that there are counter-clockwise loops," but that clockwise loops would occur if "low or high unemployment rates are maintained for a sufficiently long period of

FIGURE VI-8

THE DYNAMIC EFFECTS OF
INTERMITTENT MONETARY EXPANSION

The Inflation-Unemployment Relation



time." [Brechling (1968): p. 734]

In a theoretical study of Phillips Curve adjustment, Robert Van Order [1974] drew attention to the counter-clockwise rotation of the U.S. Phillips Curve between 1966 and 1967. Unemployment dropped sharply in 1966 and remained constant for a while. Inflation increased at first and then briefly fell. It rose again, according to Van Order, because "expectations began to catch up." [Van Order (1974): p. 66] Van Order found both clockwise and counter-clockwise loops in his dynamic analysis when he added changes in employment to his "normal rate" model of wage inflation.[4] He concluded that the inclusion of counter-clockwise loops is quite important for discussing stabilization policy. [Van Order (1974): p. 66]

Without modifying our Phillips Curve wage equation, we have found that monetary policy is capable of generating both clockwise and counter-clockwise loops. This happens when monetary expansion is set for a target rate of unemployment lower than the normal rate. In Figure VI-8 we picture the Phillips Curve generated by our policy of intermittent 2% monetary expansion considered in Section 3 of this chapter. In this experiment the money stock grew at a 2% quarterly rate when unemployment was above 4% and inflation did not exceed 2%; when inflation did exceed 2%, however, monetary expansion stopped, even if the unemployment target was not attained. Figure VI-8 shows that the Phillips Curve initially moves in a clockwise direction. The Phillips Curve also moves in a clockwise whirlwind before settling down at the long run 2% rate of inflation and normal unemployment. In between, however, there are two counter-clockwise loops which indicate periods of falling unemployment and rising inflation. Clockwise and counter-clockwise loops were also generated by proportional monetary control rules when the unemployment target was set below the normal rate.

In contrast to specific monetary control experiments which generated both clockwise and counter-clockwise loops, alternative series of positive and negative exogenous shifts in capital demand usually kept a clockwise Phillips Curve rotation in motion. We set the capital demand shift parameter **X** in Table VI-1 alternately at positive and negative values for intervals of varying duration in five separate simulation runs. Counter-clockwise loops appeared only in one simulation run.[5]

In conclusion, our results seem to support a monetary interpretation of economic history. If we interpret economic history as a configuration of clockwise and counter-clockwise movements of inflation and unemployment, we find that monetary expansion geared to a target unemployment rate lower than the "normal rate" may well have produced the historical Phillips Curve pattern. Exogeneous investment shifts, on the other hand, seem to produce only a clockwise Phillips Curve rotation, and therefore do not explain the whole process of economic history. Of course, it is also possible that changes in government expenditures geared to a "lower than normal" target rate of unemployment may also produce clockwise and counter-clockwise loops. In this case our results would still be compatible with the monetarist view that "most of the major instabilities of the economic process result from the behavior of the government sector." [Brunner (1970): p.6]

FOOTNOTES TO CHAPTER VI

(1) In previous simulation experiments the use of very fast adjustment speeds for cash balance accumulation and expectations led to unrealistic results. With fast adjustment speeds for these equations inflation adjusted rapidly, thus contradicting econometric model evidence and recent historical experience. See Norhaus [(1971): p. 31] for a theoretical and empirical survey of sources of stickiness in short run price adjustment.

(2) It should be noted that the monetary authorities can set any target for inflation in the proportional rule without destabilizing the system. If they had set a 2% equilibirum rate of inflation, the proportional control rule would expand monetary growth until that target were reached; then the control rule would hold the economy at an equilibrium level of 2% inflation and 6% unemployment, and would change the rate of monetary growth only in response to outside disturbances.

(3) Alternative simulation showed that a combined proportional and derivative control on inflation also worked well in minimizing the variations in inflation and unemployment caused by our capital disturbance.

We did not consider the possibility of control rules on either of the rate of return. A combined inflation-interest rate or inflation-capital yield monetary control rule may prove even better. Brito and Hester, for example, found that there was no necessary conflict between controlling an interest rate and the money stock. [Brito and Hester (1974): p. 302]. For controlling the two variables Brito and Hester relied on two monetary policies: transfer money and open market operations. In our simulation experiments we relied only on transfer payments and left the nominal stock of bonds unchanged.

(4) Van Order's model includes adaptive expectations and a "normal" employment rate hypothesis for wage inflation:

$$(1)\quad \Delta\pi = \rho[\frac{\Delta p}{p} - \pi]$$

$$(2)\quad \frac{\Delta W}{W} = \omega[E - E_0] + \pi$$

By including the argument ΔE in equation (2), Van Order found both counter-clockwise (or Lipsey) loops as well as clockwise loops in his dynamic analysis. [See Van Order (1974): pp. 72-85]

(5) In our exogenous capital demand shifts, we set the shift parameter X in Table VI-1 at progressively increasing and then at progressively decreasing values in succeeding simulation intervals. The value of our shift parameters varied between 6% and -6% of the capital stock. In only one case did we fine a counter-clockwise or Lipsey loop. In this run most of our capital disturbances were positive and progressively increasing, and had kept employment from settling down at its normal rate for the first 30 periods. In this case the capital disturbances may have had the same effect as a control rule which would increase investment whenever unemployment fell below a "lower than normal" target rate.

In all of our simulations the adjustment of inflation and unemployment to the capital disturbances was stable. Both variables were returning to their equilibrium values at the end of our simulation runs.

CHAPTER VII

CONCLUSION

Section 1: Introduction

In this chapter we shall summarize the principal results of our study, and then assess the limitations of our research and possibilities for further development. While we recognize the drawbacks of our research, we believe that our results may have implications for monetary theory and macroeconomic policy. In the following section, therefore, we shall list our results under five separate topics, all of which we recognize as important issues in monetary research. When we turn to the limitations of our research in the third section of this chapter we shall then relate our shortcomings to these five monetary issues.

Section 2: Summary of Results

A. Monetarism and Fiscal Policy

In our simulation analysis of once-over money supply changes we have found that the dynamic and long run effects of money supplied through open market purchases closely resemble the corresponding effects of money supplied through transfer payment. When we respecified our model with very high and very low interest rate elasticities, alternative adjustment speeds, and a lower quantity of government bonds, we obtained the same result. In our model, therefore, the important thing seems to be the quantity of money, and not the way it is supplied to the economy. It makes little difference whether new money is supplied through transfer payments or open market operations. Our results therefore support the monetarist position, for money is practically all that matters.

Differences between currency-financed expenditures and transfer money, on the other hand, critically depended on the effects of government expenditures on private sector asset demand. If government expenditures have no effect on asset demand, then the macroeconomic effects of transfer payments and new "expenditure money" are identical. Tax-financed government expenditures in this case simply "crowd out" private demand, and would have no effect on output, employment, or prices. Similarly, bond-financed expenditures would matter very little. Fiscal policy is therefore "ineffective" when there are no asset-demand effects of government expenditures, and our model is again consistent with the proposition that money is almost all that matters.

When government expenditures did affect private sector asset demand, however, we found that fiscal policy did matter. In particular, we found expenditure money to be much less inflationary (during full employment) and much less expansionary in employment than transfer money when government purchases stimulated asset accumulation. In one case, when government expenditures increased the demand for all three assets, expenditure money was capable of increasing employment when wages were fixed and lowering the price level when employment was fixed and wages became flexible. On the other hand, when we allowed government expenditures to retard asset accumulation, expenditure money proved to be much more inflationary and expansionary than transfer money. Accordingly, if government expenditures do indeed affect private saving and asset accumulation, our model shows the macroeconomic effects of expenditure money and transfer payments to be quite different. Government expenditures therefore do not "crowd out" private demand. Depending on how expenditures affect asset demand, tax-financed or bond-financed expenditures may raise or lower employment, prices, and output.

B. The Gibson Paradox

Whenever we increased the money supply through transfers, open market purchases, or through government expenditures, a positive correlation between the rate of return on capital and the price level characterized the adjustment process in our Keynesian model. We obtained the same result when our model was respecified with alternative interest elasticities, adjustment speeds, and government bond valuation. We traced this price-capital yield rate correlation to the relative speeds of adjustment for employment and capital accumulation by examining the initial chain of events. Expansionary monetary policy first stimulated both employment and capital accumulation by lowering the level of real wages and the interest rate while increasing the price level. The increasing rates of employment and capital accumulation in turn pushed the capital yield in opposite directions. The increasing employment rate raised the marginal productivity of capital, and thus increased the rate of return on capital, while the increasing rate of capital accumulation lowered the marginal productivity of capital, and thus put downward pressure on the capital rate of return. Since we have specified a finite adjustment speed for capital accumulation and continuous labor market equilibrium in our model, the expanding effect of monetary policy on employment initially dominated the corresponding effect on capital accumulation, and thus caused the capital yield to rise in the early stages of the adjustment process. In our model, therefore, the Gibson Paradox had a straightforward explanation.

Our explanation of the Gibson Paradox proved to be quite different from that of Irving Fisher [1930]. Fisher accounted for the positive price-interest rate correlation by decomposing the observed interest rate into the real rate of interest (which he assumed to be constant) and the expected rate of inflation. By increasing the expected rate of inflation, a rising price level would thus increase the observed rate of interest. Unlike Fisher, however, we have suppressed the expected rate of inflation during the adjustment process. In our model the positive correlation between the capital yield and prices has nothing to do with inflationary expectations.

C. Interest Rates and the Effects of Alternative Monetary Policies

While comparing the macroeconomic effects of expenditure money and transfer payments in our classical, Keynesian, and Phillips Curve models, we found that the interest rate responded in the same way to both policies, even though their relative price and employment effects turned out to be considerably different. In our model, therefore, the interest rate served as a poor gauge for comparing the relative inflationary or expansionary effects of the alternative monetary policy options. Furthermore, interest rate behavior proved to be an unreliable signal of concurrent economic events: when government purchases stimulated the demand for all three assets, expenditure money was capable of lowering both the interest rate and the price level. Accordingly, we believe that policy makers should not regard interest rate time series as a gauge for ranking the expansionary effectiveness of alternative monetary policies. Time series showing similar interest rate effects of alternative policies may well show very different employment or price effects.

D. Monetary Control Rules and Macroeconomic Stability

In our Phillips Curve model we found that monetary control rules were effective in reducing variations in inflation and unemployment caused by exogenous disturbances in the demand for capital. Both proportional and derivative control rules worked well. However, we found that "lower than normal" target rates of unemployment for proportional control rules and strong derivative controls on unemployment were capable of distabilizing the system. Since the normal rate of unemployment may be incorrectly identified, we concluded that both control rules should be applied to inflation rather than a combination of inflation and unemployment.

E. The Monetary Interpretation of Economic History

Our picture of the historical Phillips Curve showed both clockwise and counter-clockwise rotations. Simulation results showed that once-over changes in monetary growth and exogenous investment caused clockwise rotation of our "artificially generated" Phillips Curve, and at first sight we were ready to adopt an agnostic interpretation of economic history. However further simulations revealed that intermittent monetary expansion with a "lower than normal" target rate of unemployment was capable of generating clockwise and counter-clockwise rotations of the Phillips Curve, while further simulations with exogenous investment shifts usually produced only clockwise loops. Simulations with proportional control rules with "lower than normal" unemployment targets also produced clockwise and counter-clockwise loops. We therefore concluded that government policy actions rather than private sector disturbances may provide a better explanation of observed patterns in inflation and unemployment in economic history.

Section 3: Assessment of Limitations and Future Research

The limitations of our results and the possibilities for future research may be assessed by the problems posed by each of the issues examined in this dissertation.

A. Monetarism and Fiscal Policy

Let us first consider the relative effects of monetary and fiscal policies. We see two avenues of future research, one theoretical, the other empirical.

First of all, we believe that the model-specificity of our results should be tested by conducting similar policy experiments under alternative dynamic systems. In our model, for example, we assumed that capital accumulation was always equal to desired investment. We therefore would like to consider the possible effects of introducing "frustration dynamics" into our model. Capital accumulation would then be less than desired investment but greater than desired saving.

The results obtained from our own model, however, point to a second avenue for research on the monetary-fiscal policy debate. Instead of specifying our model with econometric estimates, we obtained our parameter selections from recent empirical literature. We therefore could not establish the extent to which government expenditures actually do affect the demand for capital, cash balances, or bonds. Since the effectiveness of fiscal policy in our model crucially depends on the values of these parameters, we would like to make a case for or against fiscal policy through an empirical study of government expenditure effects on asset accumulation.

B. The Gibson Paradox

The positive correlation between the price level and the interest rate generated by our model critically depended on the very slow adjustment of capital accumulation and the vary rapid adjustment of labor. An amplified model of labor market adjustment, incorporating adjustment costs for labor and interrelated factor demand equations in the spirit of Nadiri and Rosen [1969], would thus tie price and interest rate behavior to lags in factor markets as well as in the accumulation of capital and financial assets. With such an extended model we could then study the Gibson Paradox under a more realistic model of factor market adjustment.

C. Interest Rates and the Relative Effects of Monetary Policy

In this dissertation we found that the interest rate did not serve as an adequate gauge of alternative monetary policies. Time series showing similar interest rate effects of two policies usually showed quite different employment and price effects. We therefore believed that interest rates should not be used for ranking the employment or price effects of particular policies.

In our model we assumed that the money stock consisted only of currency. An extended version of our model would explicitly treat the commercial banking system. We may find that the total money stock, free reserves, or credit may serve as a better gauge of the expansionary effects of alternative monetary policies.

D. Monetary Control and Macroeconomic Stability

In our study of control rules we did not consider changes in federal expenditures as a stabilization mechanism. Cooper and Fischer [1974], however, recently found monetary control rules to be superior to fiscal control rules in reducing fluctuations in inflation and unemployment in the St. Louis Econometric Model. We would therefore like to compare the effectiveness of monetary and fiscal control rules in the context of our own model, where government expenditures operate quite differently than in the St. Louis Model.

E. The Monetary Interpretation of Economic History

Our study of monetary and non-monetary impulses affecting macroeconomic fluctuations was confined to non-stochastic simulation experiments. Fully stochastic simulation experiments, however, would enable us to introduce spectral analytic methods into our study. More rigorous statistical comparisons between our own artificially generated data and actual data would then be examined.

Section 4: Concluding Evaluation

In our simulation study of monetary policy and macroeconomic adjustment we believe we have obtained important results directly related to long standing issues in monetary research. Having assessed the limitations of our research, however, we also believe that we have laid the groundwork for further study of these issues with our model. Accordingly, this dissertation represents both our own position in the ongoing monetary debates, and our own springboard for further research.

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