A Monetary Explanation of the Great Stagflation of the 1970s

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Abstract – The origins of stagflation and the possibility of its recurrence continue to be an important concern among policymakers and in the popular press. It is common to associate the origins of the Great Stagflation of the 1970s with the two major oil price increases of 1973/74 and 1979/80. This paper argues that oil price increases were not nearly as essential a part of the causal mechanism generating stagflation as is often thought. We provide a model that can explain the bulk of stagflation by monetary expansions and contractions without reference to supply shocks. Monetary fluctuations also help to explain variations in the price of oil (and other commodities) and help to account for the striking coincidence of major oil price increases and worsening stagflation. In contrast, there is no theoretical presumption that oil supply shocks are stagflationary. In particular, we show that oil supply shocks may quite plausibly lower the GDP deflator and that there is little independent evidence that oil supply shocks actually raised the deflator (as opposed to the CPI). The oil supply shock view also fails to explain the dramatic surge in the price of other industrial commodities that preceded the 1973/74 oil price increase and the fact that increases in industrial commodity prices lead oil price increases in the OPEC period.

Key Words: Stagflation, commodity prices, oil market, monetary policy.

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I. Introduction

It has been common to associate the origins of the stagflation of the 1970s with oil price shocks. Although there has continued to be a steady stream of papers about the relationship between energy prices and economic activity (e.g., Hamilton 1983, 1985, 1988, 1999; Hoover and Perez 1994; Rotemberg and Woodford 1996), research since about 1980 has not addressed the question of stagflation. Indeed, it typically does not mention the price level at all. This is in line with the tendency of modern business cycle research to avoid nominal variables (see Sims 1998).

The lack of academic interest in the phenomenon of stagflation is perhaps surprising given the preoccupation of policymakers and of the popular press with the origins of stagflation and the possibility of its recurrence. For example, *The Economist* (November 27, 1999) writes:

> Could the bad old days of inflation be about to return? Since OPEC agreed to supply-cuts in March, the price of crude oil has jumped to almost $26 a barrel, up from less than $10 last December and its highest since the Gulf war in 1991. This near-tripling of oil prices evokes scary memories of the 1973 oil shock, when prices quadrupled, and 1979-80, when they also almost tripled. Both previous shocks resulted in double-digit inflation and global recession […] Even if the impact will be more modest this time than in the past, dear oil will still leave some mark. Inflation will be higher and output will be lower than they would be otherwise.[1]

Academic economists, even those who may not fully agree with the prevailing view, have done little to qualify these accounts of stagflation. In fact, the treatment of the 1973 and 1979/80 oil price increases as examples of "aggregate supply shocks" in intermediate textbooks is consistent with the views of the origin of stagflation expressed in the popular press. Thus, the failure of modern macroeconomics to elaborate on the issue of stagflation has allowed popular opinion to stand unchallenged.

In this paper, we bring together a large number of elements to develop a coherent explanation of the macroeconomic history of the period 1968-87 that is quite different from conventional accounts, and has very different policy implications. The contribution of the paper is primarily synthetic. We develop in detail the relationship between monetary policy, stagflation and the oil market. In particular, we put into perspective the roles of oil price increases and monetary instability in generating stagflation in this period. We develop more

[1] Similarly, a recent article in the *Scientific American* (1998, pp. 77, emphasis added) states that "in 1973 and 1979, … prices first tripled in response to an Arab embargo and then nearly doubled again when Iran dethroned its Shah, sending the major economies sputtering into recession." "[Since the late 1980s, …] the ample supply has kept oil cheap *and* inflation low."

fully a latent dissent from the view that monetary considerations cannot account for the historical experience of the 1970s, and question the extent to which oil supply shocks played the dominant role in the generation of stagflation.[2]

Our analysis is informed by two recent themes in macroeconomic research: First, the existence of delayed or sluggish inflation (see Fuhrer and Moore 1995; Kiley 1996; Roberts 1997; Nelson 1998); and, second, the need to distinguish carefully between the gross output and value added concepts of quantities and prices. Bruno and Sachs (1985) and, to a lesser extent, Blinder (1979) discuss monetary expansion as one important source of stagflation, but their emphasis is on the inadequacy of money as an explanation of the bulk of stagflation and commodity price movements. In contrast, we stress that "go-stop" monetary policy can explain the bulk of the price and output behavior over that period without reference to supply shocks.

The data show a rather dramatic expansion in the world money stock (see McKinnon 1982), led by the behavior of the United States and facilitated by the breakdown of the Bretton Woods system. We view this expansion as the initiating cause of the stagflationary episode of 1973-1975. A similar monetary expansion preceded the second stagflationary episode of 1979-1982. The recessionary element is provided by the fact that money-induced booms contain the seeds of their own destruction. First, as prices adjust, output falls because real balances are destroyed (e.g., Rotemberg 1982, 1996; Blinder 1979). Second, actual (or incipient) increases in inflation invite contractionary moves by the Federal Reserve and other central banks (see Romer and Romer 1989; Shapiro 1994; Bohi 1989; Bernanke, Gertler, and Watson 1997; Hall and Taylor 1997), which help to explain the depth of the recession in response to an initial monetary expansion.[3]

We provide a simple monetary model that explains how stagflation may arise as a purely monetary phenomenon without reference to supply shocks. This model is consistent with the dynamic properties of the actual output and inflation data for 1971-1975. Because not only

[2] References that we identify with the "conventional wisdom" include Samuelson (1974), Blinder (1979), and Ball and Mankiw (1994). Pre-cursors of our alternative explanation of stagflation include Friedman (1975), Cagan (1979), McKinnon (1982), Houthakker (1987), and De Long (1997).

[3] An alternative, yet largely unsubstantiated view is that the monetary contraction in 1973/74 and 1979/80 was a direct response to higher oil prices (e.g., The Wall Street Journal, 1999). In contrast, we make the case that the Fed was in fact responding to the inflation triggered primarily by the cumulative effect of earlier monetary expansions. Our interpretation is partially supported by Bernanke et al. (1997) who provide empirical evidence that the monetary contraction in 1973/74 occurred not in response to higher oil prices, as is often claimed, but in response to higher non-oil commodity prices which are commonly viewed as predictors of inflation. Only for 1979/80 do they find some support for the view that the Fed was responding to oil price increases.

prices but also their rate of change are sluggish in our model, inflation itself will continue to rise as output is falling, and the period of highest inflation occurs only *after* the periods of maximal monetary growth and maximal output expansion. Thus, casual inspection of the data may give the mistaken impression that the increase in inflation must have been caused by some contemporaneous supply shock.

We discuss several reasons for being skeptical of the importance of commodity supply shocks in general, and the 1973/74 and 1979/80 oil price shocks in particular, as an explanation of the stagflation of the 1970s. First, we show that there is no theoretical presumption that oil price shocks are inflationary for the GDP deflator. We provide a simple counterexample in which oil price shocks are inflationary for gross output price measures (such as the CPI), but deflationary for the GDP deflator. Our example shows that there is an important distinction between gross output and value added that is often lost in policy debates. We will conclude that oil price shocks are just as plausibly adverse “aggregate demand shocks” as adverse “aggregate supply shocks” in the intermediate textbook analysis which takes value added as the output measure.

Second, we provide empirical support for the view that higher oil prices, although they may have contributed to the 1974/75 and 1980/81 recessions, are not a compelling candidate for explaining the inflation of the 1970s. We show that the rate of inflation in the deflator fluctuates not nearly as much as the CPI inflation rate during periods of commodity price fluctuations, consistent with our theoretical considerations. Moreover, the bulk of the increase in the deflator inflation rate (as opposed to the CPI inflation rate) occurred only well after the oil price increases of 1973/74 and 1979/80. Although the relative contribution of oil and money cannot be determined from these two episodes alone, the 1986 fall in oil price (which was not accompanied by major shifts in monetary policy stance or similarly drastic movements in other commodity prices), provides a natural experiment, the outcome of which casts doubts on the view that oil price shocks were important sources of inflation in the GDP deflator in the 1970s. In contrast, the monetary explanation we present is capable of explaining both the recessionary and the inflationary aspect of stagflation.

If oil price shocks are not the source of stagflation, what explains the striking coincidence of major oil price increases in the 1970s and the worsening of stagflation? We argue that oil prices (like other commodity prices) were in substantial part responding to macroeconomic forces, ultimately driven by monetary conditions. For example, during the period of the 1973/74 oil price increase, oil prices were only the last in a long line of commodity prices to experience dramatic increases, and ultimately rose only slightly more than the average raw industrial commodity. Our interpretation that oil prices contain an important endogenous component coheres well with existing microeconomic theories about the effect of real interest rate variation and output movements on resource prices. Given sticky final goods prices, this theory provides a conceptual link between monetary events and oil price changes. Our view is *not* that political factors played no role at all in the decision-making process of OPEC; rather we take the view that the two major OPEC oil price increases in the 1970s would have been far less likely in the absence of favorable macroeconomic conditions resulting in excess demand in the oil market.

The remainder of the paper is organized as follows. Section II outlines conditions under which stagflation may arise as a purely monetary phenomenon. In section III, we analyze the empirical support for the view that monetary policy played a central role in creating (and ending) the Great Stagflation of the 1970s. In section IV, we examine how convincing the traditional view is that exogenous supply shocks such as oil supply shocks were the primary cause of the stagflation of the 1970s. In section V, we discuss reasons for the coincidence of periods of rapid oil price increases and worsening stagflation in the 1970s. Section VI contains the concluding remarks.

II. A Purely Monetary Explanation of the Great Stagflation of the 1970s

The 1970s and early 1980s were an unusual period by historical standards. Table 1 describes the pattern of inflation and of GDP growth for each of the NBER business cycle contractions and expansions. We divide the post-1960 period into twelve phases of contraction and expansion corresponding to the NBER business cycle peaks and troughs. For each phase, we present data on nominal GDP growth and its breakdown into real and price components. Two critical observations arise immediately from Table 1. First, with one exception, the phase average of the rate of inflation rose steadily from 1960.II to 1981.II, and declined steadily thereafter. The exception is that inflation was two percentage points lower (9.48% compared with 7.07%) during the 1975.I-1980.I expansion than in the preceding contraction period from 1973.IV to1975.I.

The second, and most important, observation is the appearance of “stagflation” in the data.[4] Stagflation is defined as periods of low or negative output growth, and inflation that is high by historical standards. There were three episodes in which inflation, as measured by the growth in the GDP deflator, exceeded nine percent per annum. In two of these three episodes real output contracted sharply (i.e., in 1973.4-1975.1 and 1980.1-1980.2), and in the third it grew very slowly (i.e., in 1980.2 – 1981.2). Indeed, in all but one contraction (i.e., with the exception of the second Volcker recession in 1981.2-1982.4), average inflation during the contraction was higher than during the previous expansion.

What was the cause of this phenomenon referred to as the Great Stagflation by Blinder (1979)? The traditional explanation in intermediate textbooks is an adverse shift in the "aggregate supply" curve that lowers output and raises prices on impact. Indeed, it is hard to see in such a static framework how a shift in aggregate demand could have induced anything but a move of output and prices in the same direction. This fact has lent credence to the popular view that exogenous oil supply shocks in 1973/74 and 1978/79 are primarily responsible for the unique experience of the 1970s and early 1980s. In contrast, we make the case that the oil price increases were not nearly as essential a part of the causal mechanism generating stagflation as is often thought. We show how in a stylized dynamic model of the macroeconomy, stagflation may arise endogenously in response to a one-time monetary expansion and may be strengthened by the endogenous policy response of the central bank. This fact suggests that there are at least two alternative (and possibly complementary) explanations of stagflation, one based on cost shocks and the other based on the cumulative effect of monetary shocks. The purpose of this paper is to assess the plausibility of these alternative explanations of stagflation in light of empirical evidence and theoretical considerations.

Essential Features of a Monetary Model of Stagflation

In this section, we describe a stylized monetary model that illustrates how a strong and purely monetary stagflation may arise even in the absence of supply shocks when (a) inflation is inherently "sluggish" or persistent, and (b) the monetary authority follows a rule which prescribes a sharp contractionary response to increases in inflation. As stressed by Friedman (1992) and Rotemberg (1996), a generic feature of sticky price models in which money is nonneutral is that at least a weak form of stagflation is an unavoidable consequence of an

[4] The term "stagflation" was coined by Samuelson (1974).

exogenous monetary expansion. Because there is a period in which the price level rises less rapidly than the money supply (thereby producing an output boom), there must later be a period in which the price level rises more rapidly than the money supply (erasing the excess money balances such that long-run neutrality holds). During the latter period, inflation is above its steady state, while output is falling, corresponding to a period of stagflation.

This is a weaker notion of stagflation than one might entertain. A stronger notion would incorporate not only the feature that inflation is above its steady state while output is falling, but also the additional features that inflation continues to rise after output has reached its maximum and that output ultimately falls below full employment in response to the initial monetary expansion. This feature means that the response of inflation to money shocks is sluggish and inflation peaks only with a long delay. The periods of highest inflation occur only *after* the periods of maximal monetary growth and maximal output.

The latter notion of stagflation is closer to the pattern found in the U.S. data. It is one of a number of "ugly facts" to use an expression coined by Sims (1998) to describe phenomena that have proved extremely difficult to model with modern business cycle models. Notably, impulse response estimates from structural vector autoregressions indicate that a monetary expansion is followed by a prolonged rise not just in the price level, but in inflation. Nelson (1998) calls this phenomenon "sluggish inflation". Likewise, it is widely accepted that output exhibits a hump-shaped response to a monetary expansion. An important empirical regularity in VAR studies is that the response of output peaks after about 4-8 quarters, followed by a peak in inflation after about 9-13 quarters (e.g., Bernanke and Gertler 1995; Christiano, Eichenbaum and Evans 1996; Leeper 1997). Thus, the peak response of output occurs about one year before the inflation response reaches its maximum.[5]

Related, though not equivalent, is the fact that output leads inflation, the cross-correlation function showing (HP-detrended) U.S. GDP peaking about three quarters before inflation (see Kiley 1996). Similarly, Fuhrer and Moore (1995) report a lead of six quarters using linearly detrended GDP. This sluggishness is important for our work because it is during the period in which inflation still rises, whereas output has already peaked, that stagflation in the strong sense arises. Any explanation of the stagflation of the 1970s must take account of the lag of inflation

[5] Nelson (1998) presents estimates that the response of inflation to a monetary innovation peaks after 13 quarters, but his VAR only includes money and the price level.

behind output and of the fact that inflation peaks only after output in response to a monetary expansion.

What is the source of sluggish inflation? Sluggish inflation is not a property of the most commonly used monetary business cycle models (see Taylor 1979; Rotemberg 1982, 1996; Calvo 1983). In these models, both inflation and output jump immediately to their maximal levels, followed by a monotonic decline. Although recent research has demonstrated the inconsistency of the Taylor-Calvo-Rotemberg model with the stylized facts about inflation and output dynamics (see Nelson 1998), it has not provided a generally appealing alternative.

Some authors (e.g., Fuhrer and Moore, 1995; Fuhrer 1997) have treated inflation persistence as structural - a phenomenon that would hold in any monetary regime. In this paper, we instead take the position that sluggish inflation reflects the fact that agents are learning about changes in the monetary policy regime (also see Sargent 1998). Agents are always processing new information, but especially so in a period following regime changes as dramatic as the changes that occurred in the 1970s. The 1970s were a period of go-stop monetary policy and unusually high inflation, bracketed by periods of relatively low inflation and stable monetary policy in the 1960s and since the mid-1980s. Given the low and stable inflation rates of the 1960s, it is plausible that agents were slow to revise their inflationary expectations when confronted with an unprecedented monetary expansion under Arthur Burns in the early 1970s. This interpretation appears even more plausible considering the financial turmoil and uncertainty associated with the breakdown of Bretton Woods. Indeed, Klein (1975) argues forcefully that the greatly increased persistence of inflation dating from the late 1960s was a consequence of the gradual replacement of the gold exchange standard with one of fiat money. Similarly, inflationary expectations were slow to adjust in the early 1980s, when Paul Volcker launched a new monetary policy regime resulting in much lower inflation.

We propose a stylized model that formalizes the notion that in times of major shifts in monetary policy (defined in the model as a permanent change in the money growth rate) inflation is likely to be particularly sluggish. Consider a population consisting of two types of firms. A fraction ω_t of "sleepy" firms is not convinced that a shift in monetary policy has taken place and sets its output price (p_t^s) at last period's level adjusted for last period's inflation rate. One interpretation of this price-setting rule is that it represents "catch-up" for past inflation. Alternatively, it can be thought of as a rule of thumb for expectations of current inflation. The remaining fraction $(1-\omega_t)$ of “awake” firms is aware of the regime change and sets its output price at $p_t^w = p_t + \beta(y_t - y_t^f)$, where β is a constant, y_t denotes the log of real GDP and y_t^f the log of potential real GDP. As time goes by, the fraction of agents that is unaware of the regime change evolves according to $\omega_t = e^{-\lambda t}$. These considerations imply an aggregate price-setting equation of the form:

(1a) $$p_t = \omega_t p_t^s + (1-\omega_t)P_t^w = e^{-\lambda t}\left(2p_{t-1} - p_{t-2}\right) + (1-e^{-\lambda t})\Big(p_t + \beta(y_t - y_t^f)\Big)$$

This price equation is the source of the inflation persistence in our model. Equation (1a) is very much in the spirit of Irving Fisher’s (1906) reference to an earlier monetary expansion that “caught merchants napping”. Its motivation is closer to that of the Lucas supply schedule (see Lucas 1972, 1973) than to that of sticky price models. Agents are always free to adjust prices without paying “menu costs”. Moreover, by the choice of appropriate time-vaying weights ω_t, our inflation equation may account for the fact that agents learn more quickly about some shifts in policy than about others. For expository purposes, however, we postulate that these weights evolve deterministically.

The second building block of the model is the quantity equation

(1b) $$\Delta y_t = \Delta m_t - \Delta p_t,$$

where Δp_t is the inflation rate (which we will associate with the rate of change of the GDP deflator) and Δm_t is the rate of nominal money growth.

We complete the model by adding a policy reaction function. We posit that the Fed cannot observe the current level of the GDP deflator. We postulate a reaction function under which the Fed targets the steady state rate of inflation under the new policy regime. The Fed responds to periods of excessively high inflation by decelerating monetary growth by some small fraction γ of last period’s inflation rate.

(1c) $$\Delta^2 m_t = -\gamma \Delta p_{t-1} I(\Delta p_{t-1} > \pi^{new}) + \Delta\varepsilon_t,$$

where $I(\cdot)$ denotes the indicator function and π^{new} is the steady state rate of inflation under the new policy regime. ε_t represents exogenous changes in the money growth rate. In addition, by way of comparison, we will explore a much simpler model in which money supply growth follows a sequence of exogenous policy shocks ε_t and in which there is no policy feedback.

(1c') $$\Delta^2 m_t = \Delta\varepsilon_t .$$

We parameterize the model as follows. We postulate 3% steady state growth per annum to match the average growth rate in the U.S. data. The steady-state rate of inflation prior to the monetary expansion is set to match the average inflation rate of 3% per annum for 1960.I-1970.IV in Table 1. We follow Kimball (1995) in setting $\beta = 0.06$. The single most important parameter in the model is λ, which determines the fraction of agents "awake". We calibrate λ based on independent microeconomic evidence drawn from the literature on the entry of generics into the market for a branded drug (see Griliches and Cockburn 1994; Berndt, Cockburn and Griliches 1996).[6] We use micro time series data on the fraction of consumers who ignore arbitrage opportunities after the market entry of generic lower-priced drugs to calibrate the rate at which agents in our monetary model become aware of the abitrage opportunity from switching to the new pricing rule. Pooling the data reported by Griliches and Cockburn (1994, Tables 1,2) and Berndt et al. (1996, Table 3) for a total of nine generics, we determine the average fraction of agents who are "asleep" 24 months after the initial entry (i.e., agents who choose to ignore the arbitrage opportunity) to be 51.23%. The corresponding (unweighted) price of generics after 24 months is less than half of the brand price, indicating substantial potential gains from arbitrage. The market share of generics of 48.77% (measured in daily units) implies that after two years less than half of the consumer population has responded to the arbitrage opportunity. If agents in the monetary model respond to arbitrage opportunities following a monetary regime change with the same speed, and if we impose a deterministic transition function for the fraction of agents "awake" of the form $1-e^{-\lambda t}$, we arrive a value of $\lambda = 0.0836$. This choice implies that after 8 quarters exactly 48.77% of agents have recognized that a monetary regime change has taken place.

Finally, for the model with policy feedback, given the other parameter choices, the value of γ was set as large as possible, subject to the constraint that γ not produce disinflation in the

[6] As noted by Griliches and Cockburn (1994, pp. 1214), when the patent on the incumbent firm's branded product expires, several generic versions appear relatively quickly, selling at much lower prices, typically from 30% to 50% cheaper than the original versions. In all but a few cases, these generic products are certified by the Food and Drug Administration to be perfect substitutes for the incumbent's product. It is well established that there are rather large and persistent price differentials between the incumbent and the entrants. These price differentials represent a perfect arbitrage opportunity, yet some consumers appear to differ in their expectations about the efficacy and quality of the generic product, because they choose to pay a higher price for the branded product.

long run in response to a monetary expansion. Our choice of $\gamma = 0.05$ means that, if the inflation rate last period is 2 % for example, the Fed will decelerate monetary growth by –0.1 percentage points (one tenth of the initial monetary expansion).

Consider a permanent increase in the growth rate of money by one percentage point per annum in period 5, starting in steady state. Figure 1a shows that a monetary expansion produces the essential features discussed above. The model economy displays stagflation, sluggish inflation and a hump-shaped response of output to a monetary expansion. Most importantly, the output gap rises with the inflation rate initially, with output peaking about two years after the shock, whereas inflation peaks only after three years (close to the 13 quarters reported by Nelson 1988). Between these two peaks output and inflation move in oppposite directions, resulting in stagflation.

Although Figure 1a shows impulse responses to a one-time change in monetary regime, rather than a time path of the underlying process in response to a sequence of shocks, it is of some interest to consider the implications of this model for the correlation properties of the data in the absence of other shocks. The cross-correlation function for the data in Figure 1a shows a lead of 4 quarters of output over inflation (close to the lead of 3 quarters reported by Kiley (1996) for the U.S.). It is interesting to note that although the permanent increase in the money growth rate initially produces a Phillips curve correlation, the *overall* (contemporaneous) correlation between inflation and the output gap is small (0.24) and close to the value of 0.20 reported by Kiley (1996). Moreover, the correlation between money growth and inflation is only 0.39, despite the fact that, as a theory of money demand, the quantity theory holds by construction. This correlation is only slightly higher than the correlation of 0.29 reported by Nelson (1998) for the monetary base. Finally, the correlation between money growth and the gap is 0.79. This last feature is not robust across alternative policy rules, however.

We now address the extent to which a monetary regime change (defined in the model as a permanent change in the money growth rate) can explain the business cycle peaks and troughs over the 1971-1975 period. Consider the following thought experiment: Since we know that a strong monetary expansion took place starting in the early 1970s, we – somewhat arbitrarily - propose to date the monetary expansion in the model such that period 5 in Figure 1a corresponds to 1971.I. This thought experiment allows us tentatively to compare the behavior of output and inflation in the model in response to a monetary expansion with the actual U.S. data. Given this interpretation, the monetary model predicts a peak in GDP in 1973.I, followed by a peak in deflator inflation in 1974.II (shortly after the OPEC oil price increase) and a trough in GDP in 1975.II. Note that, although the NBER dates the end of the expansion in late 1973, Hodrick-Prescott detrended GDP peaks in 1973.I, at the same time as the gap peaks in our model. Thus, the timing of the cycle that would have been induced by the monetary expansion in 1971.I (after accounting for the Fed's reaction to the changes in inflation set in motion by this initial expansion) is remarkably close to the timing of the actual business cycle. Note that this coincidence of the timing of the business cycle peaks and troughs does not occur by construction, but arises endogenously given our choice of parameters.

Continuing with the same analogy, we now focus on the magnitude of the output and price movements induced by the monetary expansion. Of particular interest is the ability of the model to match the phase averages for the 1971.I-1973.III NBER expansion and the 1973.IV-1975.I NBER contraction. We find that the average per annum inflation rates for 1971.I-1973.III and 1973.IV-1975.I in the model are fairly close to the data. The model predicts average inflation rates of 5.0% and 10.9%, respectively, compared with 5.2% and 9.5% in Table 1. Thus, both the model and the data show a substantial increase in inflation during the NBER recession. Similarly, for GDP growth the model fit is not far off. The model predicts 5.0% growth for 1971.I-1973.III compared with 4.4% in the data, and –3.2% for 1973.IV-1975.I compared with –1.8% in Table 1. We conclude that the quantitative implications of this model are not far off from the data in Table 1, especially considering that we completely abstracted from other macroeconomic determinants. Also note that the Fed inflation target in our model economy becomes binding in early 1973, consistent with the empirical evidence of a monetary tightening in early 1973 in response to actual and incipient inflation (see section III). This example illustrates that go-stop monetary policy alone could have generated a large recession in 1974/75 even in the absence of supply shocks.

Clearly, the fit of the model may be improved further by allowing for more flexible determinants of ω_t. The extent of the model fit also depends on the choice of policy reaction function. Here we explore the latter dimension. A question of particular interest is how essential the endogenous policy response of the Fed is for the generation of stagflation. Some authors have previously argued that the 1974 recession may be understood as a consequence of the Fed's policy response to inflationary expectations (e.g., Bohi 1989; Bernanke, Gertler and Watson

1997). Figure 1b shows the policy reaction is an important, but by no means essential element of the genesis of stagflation. In fact, a qualitatively similar stagflationary episode would have occurred under the alternative policy rule (1c') without any policy feedback. The main effect of adding policy feedback ($\gamma > 0$) is to increase the amplitude of output fluctuations and to dampen variations in inflation.

In the model without policy feedback, all parameters are identical to the first model. The timing of the cycle induced by the monetary regime change is roughly similar to that in Figure 1a, except that the peak in inflation and the recession occur somewhat later than in the data. Figure 1b shows a peak in GDP in 1973.I, followed by a peak in inflation in 1974.III and a trough in GDP in 1975.III. On average, output leads inflation by 5 quarters, somewhat farther from the lead of 3 reported by Kiley (1996). The correlation between inflation and the output gap is still small, but negative in this alternative model (-0.08), and the correlation between money growth and the gap falls to 0.14. The low correlation between money growth and inflation, however, remains virtually unchanged (0.35). The model without policy feedback predicts an average annual inflation rate of 5.0% and 12.1% for 1971.I-1973.III and 1973.IV-1975.I, respectively, compared with 5.2% and 9.5% in Table 1. Average output growth per annum over these same subperiods is 5.0% and -2.1%, respectively, in the model compared with 4.4% and -1.8% in the data. We conclude that none of the quantitative implications of the model appear strongly counterfactual. Figure 1b illustrates that strong stagflation in response to a monetary expansion may arise even in the absence of endogenous policy feedback, although policy feedback tends to improve the fit of the model at least along some dimensions and appears to be an essential part of reality (as we will document below).

III. Support for the Monetary Explanation of Stagflation

What is the evidence in support of the monetary explanation of stagflation? We will present three pieces of evidence that are consistent with this explanation. First, we will show that episodes of “stagflation” were associated with dramatic swings in world-wide liquidity which dwarf monetary fluctuations elsewhere in our sample. Second, we will examine several indicators of U.S. monetary policy stance to show that U.S. monetary policy, in particular, exhibited a go-and-stop pattern in the 1970s. Finally, we will show that there were dramatic and across-the-board increases in non-oil, nonagricultural commodity prices in the early 1970s that do not appear to be related to commodity-specific supply shocks, but are consistent with an economic expansion fueled by excess monetary growth.

Worldwide Changes in Liquidity

The monetary model of stagflation sketched in the preceding section relies on some initial monetary expansion to induce the countercyclical movements in output and inflation. A first test of the model is to verify that the two main episodes of global "stagflation" in 1973/74 and 1979/80 were indeed preceded by unusually large increases in world excess money supply. Figure 2 provides one measure of liquidity for 1960-1989. One indicator of liquidity is world money growth. There are two reasons to be interested in world, rather than simply United States, money growth. First, a significant part of our analysis will focus on the determination of oil prices and non-oil commodity prices. These commodity prices are substantially determined in world markets, and are thus a function of worldwide demand. Second, although a significant share of the monetary expansion in the early 1970s - along with the deflationary process of the early 1980s - originated in U.S. monetary policy, it was amplified by the workings of the international monetary system, as foreign central banks attempted to stabilize exchange rates (see McKinnon 1982).

We focus on a suitably updated data set for GNP-weighted world money growth and inflation, as defined by McKinnon (1982). Figure 2a shows a sharp increase in world money growth in 1971-72 and in 1977-78 preceding the two primary stagflationary episodes in Table 1. The increase in world money growth is followed by an unprecedented rise in world price inflation in 1973-74 and in 1979-80 (see Figure 2b). This piece of evidence will be crucial in explaining commodity price movements. The data also show a third major increase in world money supply growth in 1985-86. This episode is fundamentally different from 1973-74 and 1979-80 in that it is associated with falling world inflation and high real interest rates rather than rising inflation and negative real interest rates. It represents the rebuilding of real balances after the restoration of the credibility of monetary policy following after the cumulative reductions in real balances between 1973 and 1980 (see Figure 2c).[7]

We now turn to the United States where the monetary expansions of the 1970s originated. Figure 3 shows that U.S. liquidity followed a pattern similar to that of other industrial countries.

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[7] Similar patterns of inflation and money growth have been documented for the period following the monetary reform that ended the German hyperinflation of 1923 (see Barro (1987), p. 206, Table 8.1).

Figure 3a shows two unprecedented spikes in money growth in 1971-1972 and in 1975-1977 that preceded two episodes of unusually high deflator inflation in 1974 and in 1980 (see Figure 3b) and that coincided with two episodes of significantly negative growth in real money balances in 1973-74 and 1978-1980 (see Figure 3c). Figure 3c also shows evidence of a rebuilding of real balances (and possibly of financial deregulation) after 1980. Real balances rise, as inflation falls and real interest rates remain high. By 1987, real interest rates fall to average levels, inflation stabilizes and the growth of real balances falls almost to zero.

Additional evidence of excess liquidity in the 1970s is provided by the U.S. real interest rate. Figure 3d shows that 1972-76 and 1976-80 were periods of abnormally low real interest rates, followed by unusually high real interest rates in 1981-86. This pattern is consistent with the view that the excess money growth in the early and mid-1970s depressed ex ante real interest rates via a liquidity effect and further depressed ex post interest rates by causing unanticipated inflation. Although it is possible in principle for oil price shocks to have resulted in unanticipated inflation which in turn depressed ex post real interest rates, the timing in Figure 3d seems to contradict this view. Real interest rates were negative well before the two major oil price increases, but only after the evidence of excess money growth. In fact, the timing of the 1973/74 and 1979/80 oil price increases coincided with a sharp rise in real interest rates. For that reason we conclude that the likely source of the low real interest rates observed in the 1970s is the preceding monetary expansion.

Evidence of Go-and-Stop Monetary Policy in the United States

An important component of the monetary explanation of stagflation is the behavior of the monetary authority, either as an endogenous response to the state of the economy, or as an exogenous intervention. We focus on the overall monetary policy stance, as opposed to exogenous monetary policy shocks, because the endogenous response of monetary policy to the state of the economy forms an important part of monetary policy (see Bernanke and Mihov 1998; Bernanke and Blinder 1992; Boschen and Mills 1995). Our evidence is based on several measures of the "total stance of monetary policy" for this period - some based on the behavior of the Federal Funds rate, some based on narrative evidence.

The Bernanke-Blinder index based on the Federal Funds rate shows a strongly expansionary stance from mid-1970 to the end of 1972. Interestingly, the Boschen-Mills index on the basis of narrative evidence is mostly neutral during this period with the exception of 1970/71. The reason is that the Boschen-Mills index is based on policy pronouncements as opposed to policy actions. Quite simply, the Fed's pronouncements in this period were uninformative at best and probably misleading.

Both the Boschen-Mills index and the Bernanke-Blinder index show a sharp tightening of monetary policy in early 1973. The Boschen-Mills measure, measured on a scale from +2 (very expansionary) to –2 (very tight), moves from neutral at the end of 1972 to –1 for the first three months of 1973, and then spends the next 6 months at –2, followed by two months at –1, ending the year in neutral. Further, the Federal Funds rate rises steadily and sharply relative to the Treasury bill rate in the first seven months of 1973, again suggesting that the Fed switched to a sharply contractionary stance during that period.[8] Similarly, the Bernanke-Blinder index based on the Federal Funds rate shows a sharp and prolonged contraction in monetary policy by early 1973 (see Bernanke and Blinder 1992). As noted by Boschen and Mills (1995), this contraction was an explicit response to rising inflation. It occurred long before the disturbances in the oil market in late 1973 and provides an alternative explanation of the recession in early 1974.[9] The contractionary response of the Fed in 1973 to the inflationary pressures set in motion by earlier Fed policy is a key element of our monetary explanation of stagflation. Note that the observed increase in inflation in 1973 is understated as a result of price controls (and the observed increase in 1974 is overstated due to the lifting of the price controls.)

As the U.S. economy slid into recession in 1974, the Fed again reversed course to ward off an even deeper recession. Indicators show a renewed monetary expansion that lasted into the late 1970s. The Bernanke-Blinder index from late 1974 into 1977 indicates that monetary policy was strongly expansionary. This expansion was not reflected in high inflation initially, consistent with a partial rebuilding of real balances (see Figure 3c) and the well-documented fact that inflation only occurs with a delay (see Nelson 1998). A similar if somewhat briefer expansion is recorded by Boschen and Mills. Around 1978, the monetary stance turned slightly contractionary, becoming strongly contractionary in late 1979 and early 1980 under Paul Volcker, as inflation continues to worsen. Once again, the monetary policy stance provides an alternative explanation for the genesis of stagflation.

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[8] This interpretation is consistent with Bernanke, Gertler and Watson's (1997) conclusion that the Fed in 1973 was responding to the inflationary signal in non-oil commodity prices, not to the oil price increase.

It is interesting to speculate why the Fed in the early 1970s did not anticipate the consequences of its own actions. Part of the explanation is that the global monetary system underwent dramatic changes in the early 1970s, and central bankers and agents alike slowly had to adapt to the new rules of the game. Another explanation, suggested by Hetzel (1998), is that then chairman Arthur Burns adhered to a special-factors theory of inflation which attributed increases in inflation to a variety of special circumstances ranging from unions and large corporations to government deficits and finally food and oil price increases. Hetzel argues that Burns systematically discounted any direct effects from increases in the money supply on inflation and did not appear to be overly concerned about the extent of the monetary expansion in the early 1970s. DeLong (1997) stresses that the inflation of the early 1970s was fueled in addition by Arthur Burns' efforts to facilitate Nixon's reelection through expansionary monetary policy. Alternatively, it has been argued that Burns felt that the social consensus was lacking for a tough anti-inflationary policy.

<u>Movements in Non-Oil, Non-Agricultural Commodity Prices</u>

An important piece of evidence that has received insufficient attention in previous research is the sharp and across-the-board increase in non-oil, non-agricultural commodity prices that preceded the increase in oil prices in 1973/74 (see Figure 4). Any plausible explanation of stagflation has to be able to account for this unusual increase in commodity prices in the early 1970s. It is interesting to note that these increases occurred as early as 1972, well before the October War, and are too broad-based to reflect supply shocks in individual markets (see Figure 4). They are, however, consistent with a picture of increased demand driven by the sharp increase in global liquidity documented earlier (see Figure 2).

There is significant evidence that poor harvests caused food prices to soar in the early 1970s (see Blinder 1979). Our data set deliberately excludes these agricultural commodities. Instead, we focus on industrial raw materials for which there is much less evidence of cartel-like behavior or of sector-specific supply shocks. Even commodities such as lumber, scrap metal, pulp and paper, for which there is no evidence of supply shocks, recorded rapid price increases in the early 1970s (see National Commission on Supplies and Shortages 1976). For example, the price of scrap metal nearly doubled between October 1972 and October 1973, and continued to

[9] There is no Romer date for 1973, despite the clear evidence of a shift in policy toward a contractionary stance.

rise until early 1974, to nearly four times its initial level. The price of lumber almost doubled between 1971 and 1974, as did the price of wood pulp. These commodity price data paint a picture of rapidly rising demand for all commodities in the early 1970s.

It is interesting to note that a similar increase did not occur in oil prices until late 1973. Similarly, the 1979 increase in oil prices was preceded by a boom in other commodity prices, consistent with the evidence of monetary expansion, although the commodity price increase is of lesser magnitude. In fact, a striking empirical regularity of the data in Figure 4 is that increases in non-oil, non-agricultural commodity prices tended to precede increases in oil prices over the 1972-1985 OPEC period (and similarly for decreases). This fact is evident for example in 1972, 1978, 1980, 1983 and 1984. A natural question is how the monetary explanation of stagflation proposed here can be reconciled with the delayed response of oil prices relative to other industrial commodities. The explanation appears to be that, unlike other commodity transactions, most crude oil purchases until the early 1980s did not take place in spot markets, but at long-term contractual prices. The sluggish adjustment of these contractual prices in response to demand conditions in commodity markets tended to delay the response of the oil price relative to the price of more freely traded commodities, until the spot market largely replaced traditional oil contracts in the early 1980s.

IV. How Convincing is the Aggregate Supply Shock Explanation of Stagflation?

The preceding section showed that the historical pattern of stagflation in Table 1 may in principle be accounted for by the effects of money. This view does not preclude the possibility that supply-side shocks played a major (or even the dominant) role in generating the stagflation. In fact, as noted in the introduction, a common explanation of stagflation is that oil price shocks accelerated inflation in the 1970s, while forcing the economy into a recession. In this section, we will show that the supply-shock explanation of stagflation is less convincing than commonly thought. First, we ask what the consequences of an oil price shock on GDP and the GDP deflator are in theory. We discuss mechanisms by which oil price shocks may affect GDP and show that the effect of oil price shocks on the GDP deflator is ambiguous. In fact, contrary to conventional wisdom, on theoretical grounds oil price shocks may plausibly lower the GDP deflator, even as they raise the CPI. Second, we study the changes in inflation in the GDP deflator during major oil price increases and contrast it with those in the CPI. The timing and magnitude of these changes mitigates against the supply shock view. Third, we study a natural experiment to distinguish between inflation driven by oil price shocks and inflation driven by monetary factors. We show that there is little independent evidence of an important effect of oil price shocks on the GDP deflator, whereas the inflation data appear fully consistent with explanations based on go-and-stop monetary policy.

Is the Textbook Analysis of "Aggregate Supply Shocks" Convincing?
Gross vs. Value-Added Concepts of Output and Price

The conventional view is that oil price shocks are by necessity inflationary. The only question of debate is the magnitude of the inflationary effect (see The Economist 1999). As we will show, however, this claim is unambiguously true only for the price of gross output, not for the price of value added. The following counterexample demonstrates that oil price shocks may in fact be deflationary for value added, even as they raise the price of gross output.

Suppose gross output Q is given by the production function $Y = Q[V(K, L, x), O]$, where x denotes a technology disturbance, O denotes the quantity of a foreign commodity import ("oil"), and $V(K$, L, $x)$ is value-added produced domestically. As is standard, we assume separability between O and the other factors in order to ensure the existence of a value-added production function and we assume (for the time being) that no oil is produced domestically. As is immediately clear, a decline in O, under separability, is *not* a shock to the production function for value-added - the ability to produce domestic output is unchanged. It follows that oil shocks cannot play the role of a technology shock in a standard real business cycle model (i.e., they do not alter value added holding constant capital and labor input), although they do lower the quantity of gross output.

Following Rotemberg and Woodford (1996), we consider an economy in which symmetric firms produce final output using the gross output production function

(2) $$Y_t = Q\left(V_t(L_t), O_t\right),$$

where O_t is the quantity of foreign oil used in production, Q is homogenous of degree one in its arguments, and V_t is a function of labor hours and capital. The capital stock is assumed to be fixed, ensuring concavity of V_t. Let gross output be the numeraire. V_t, the value added associated with capital and labor, should be thought of as real GDP. Nominal GDP is given by

$P_t Y_t - P_t^O O_t$, where P_t^O is the price of imported oil.

Further postulate that the demand for money balances is proportional to nominal gross output:

(3) $$M_t = k\, P_t\, Y_t$$

where P_t is the price of gross output. Thus, nominal gross output is determined by the money stock alone.

Now suppose that labor is supplied inelastically. Further suppose that all markets are perfectly competitive. Logarithmically differentiating (2) and (3) with respect to P_t^O we obtain

(4) $$\Delta Y_t = -\frac{s_O}{1-s_O}\varepsilon_{O,V}\,\Delta P_t^O$$

(5) $$\Delta P_t = \frac{s_O}{1-s_O}\varepsilon_{O,V}\,\Delta P_t^O$$

where Δ denotes percent changes. As Gordon (1984) and Rotemberg and Woodford (1996) note, the elasticity $\varepsilon_{O,V}$ must be less than unity, if a rise in the price of oil raises the cost share of oil, s_O. This means that an increase in the price of imported oil will tend to lower the quantity of gross output and raise the price of gross output.

Next consider the deflator for value added, defined as the ratio of nominal over real value added:

(6) $$P_t^V = \frac{P_t Y_t - P_t^O O_t}{V_t(L_t)} = \frac{P_t Y_t (1-s_O)}{V_t(L_t)}.$$

Again consider an increase in the price of imported oil. Clearly, under our assumptions the denominator of (6) does not vary with the price of oil. The numerator, however, will fall, since by (3) nominal gross output is determined solely by the money stock and the cost share of imported oil in gross output is assumed to rise in response to an oil price increase. Thus, the oil price shock *lowers* the price of value added, even as it raises the price of gross output.

This stylized example illustrates that the "aggregate supply shock" view of oil price shocks is questionable. Whereas "aggregate supply shocks" in the textbook model are stagflationary for value added, oil price increases may actually be *deflationary*. In this sense, in our example they are closer in spirit to "aggregate demand shocks" than to "aggregate supply shocks". How realistic is this counterexample? Clearly, to overturn our benchmark result would require a sufficiently sharp fall in real value added in response to an oil price shock, while holding the money stock constant. We now discuss several mechanisms by which oil price shocks may in principle generate a fall in the quantity of value added.

Our benchmark analysis ignores the possibility that capital utilization will be affected by the price of energy. It is sometimes argued that changes in the utilization rate of capital are one of the channels through which energy price shocks have stagflationary effects. For example, Finn (1996) studies a model in which energy price shocks lower output. It can be shown, however, that her result applies only to gross output and not to value added. In Finn's model, gross output is produced from labor and capital services:

(7) $$Y_t = (x_t L_t)^{\alpha} (K_t u_t)^{1-\alpha}$$

where x_t is a productivity shock and u_t is the utilization rate of capital. The utilization rate is related to the quantity of oil employed per unit of capital stock by:

$$O_t / K_t = \tfrac{v_0}{v_1} u_t^{\,v_1}, \quad v_0 > 0, v_1 > 1.$$

Note that for $v_1 \to 1$ Finn's production function for gross output becomes arbitrarily close to a function that is Leontief in capital and energy as in Atkeson and Kehoe (1999). Substituting for u_t in the gross output production function (7), we obtain

(7') $$Y_t \propto (x_t L_t)^{\alpha} (O_t^{1/v_1} K_t^{1-1/v_1})^{1-\alpha}$$

which is mathematically indistinguishable from a separable production function of the form $Y = Q[V(K, L, x), O]$, so, once again, oil price shocks do not affect value added given labor and capital inputs. This example shows that even allowing for changes in capital utilization does not necessarily overturn our conclusion that oil price shocks need not be stagflationary for value added.

The key to establishing that oil price shocks affect value added under perfect competition then must be showing that labor and capital inputs change in response to an oil price shock. One model that establishes such a link is the sectoral shifts model of Hamilton (1988). The principal propagation mechanism of the general equilibrium business cycle model explored by Hamilton is the possibility that an oil price increase will depress consumer purchases of oil-intensive durable goods such as automobiles. The dollar value of such purchases may be large relative to the value of the oil automobiles consume. If labor were able to relocate smoothly from one sector to another, most of the output lost in the automobile sector would be made up by gains in other sectors. On the other hand, if there are costs or delays associated with labor mobility, then the losses of the automobile sector need not be regained by other sectors, and the short-term aggregate loss can exceed the dollar value of the lost oil consumption by a substantial margin. Moreover, the period of unemployment is not necessarily limited by the amount of time necessary to relocate. If there is some probability of a return to better conditions, unemployed workers may rationally choose not to relocate, even if jobs offered in other sectors pay a wage that exceeds their marginal utility of leisure. The channel described by Hamilton is closely related to earlier work by Bernanke (1983). Bernanke showed in a partial equilibrium model that oil price shocks will tend to lower value added, because firms will postpone investments as they attempt to find out whether the increase in the price of oil is transitory or permanent.

An alternative line of argument focuses on the implications of imperfect competition. Under imperfect competition, as noted Rotemberg and Woodford (1996), an oil price shock does result in a rise in the supply price for all levels of value added. This increase occurs because firms apply the markup to all cost components, including imported oil, not just to capital and labor. The magnitude of this effect, however, is likely to be small for reasonable markup ratios, unless we allow in addition for substantial changes in the markup over time. The latter possibility is discussed by Rotemberg and Woodford (1996) who show that a model involving implicit collusion between oligopolists in the goods market can yield output responses to an oil price shock that are quantitatively important.

Even if we accept the view that an oil price shock lowers the real value added, however, there is no presumption that this shock in addition to being recessionary will also be stagflationary. First, consider the case of a fixed money supply. It is not enough to show that value added falls in response to an oil price shock. For the price of value added actually to rise when the money supply is fixed, value added must fall by *more* than the numerator in (6). More generally, the money supply will not be fixed. In that case, the direction of the change in the price deflator also depends on the Fed's reaction to the fall in value added. The optimal Fed behavior would be to contract the money supply in response to the fall in value added (see King and Goodfriend 1997). We already showed that indeed the Fed was conducting contractionary monetary policy at the time of the oil price shocks. Whether this monetary contraction would have been enough to stabilize the price level in response to a change in value added is an empirical question.

This discussion shows that the implications of an oil price shock are unambiguous only for the price of gross output measures such as the consumer price index (CPI). Although one could construct other examples, in which oil price shocks are inflationary for the price of value added (measured by the GDP deflator), there is no presumption that in general they are. The direction and strength of the effect of oil price shocks on the GDP deflator is an empirical question.

CPI vs. Deflator Inflation

The preceding discussion stressed the important distinction between inflation in prices of gross output (such as the CPI) and of value added (such the GDP deflator). In this section, we provide some empirical evidence about the timing and relative magnitude of the changes in the GDP deflator and the CPI during major oil price changes and consider a natural experiment that sheds light on the relative contribution of oil and money to the observed deflator inflation in the 1970s. Figure 5 shows the annualized inflation rates for gross output prices (as measured by the CPI) and the price of value added (as measured by the GDP deflator) for the United States in the 1960.I-1998.II period.[10] We use the PRXHS index of consumer prices that excludes housing and shelter. Despite the obvious differences in the content and construction of these two indices, there is strong comovement in the long run. For our purposes, it will be of interest to focus on four major episodes: the two major oil prices increases of 1973/74 and 1979/80, the major drop in oil prices in early 1986, and the invasion of Kuwait in 1990/91.

Figure 5 shows an unusual discrepancy between the deflator and CPI inflation rates during the four episodes of interest. CPI inflation rose sharply relative to deflator inflation between 1972 and 1974 and again in 1979 and early 1980. Similarly, the 1986 and 1990/91 episodes are characterized by a differential response of CPI and deflator inflation rates. This result is not surprising, as these periods were characterized by major fluctuations in world commodity markets. To the extent that imported oil and other imported commodities enter the CPI but not the deflator, our theoretical considerations suggest that we should expect to see a wedge between the CPI and the deflator inflation data. Moreover, it is well known that

[10] Our theoretical counterexample maintained the implicit assumption that no oil is produced domestically or alternatively that domestic oil production is properly accounted for in the computation of GDP as a depletion of natural resources. For the United States both assumptions are unrealistic. It is possible to construct GDP deflator data for the non-oil component of GDP. The resulting inflation rates will be lower than the total GDP deflator, but qualitatively similar under realistic assumptions.

especially price-sensitive items such as food (whether imported or not) have comparatively higher weights in the CPI than in the deflator, adding to the discrepancy.

Our main interest is in understanding the inflation rate in the GDP deflator. Although CPI inflation reached double-digit rates in early 1974, the bulk of the inflation in the deflator only occurred from mid-1974 to 1975. It is not immediately clear to what extent this increase in deflator inflation rates can be attributed to oil or to money. One possibility is that value added fell for the reasons described by Hamilton (1988), and monetary policy did not contract enough to prevent an increase in the price level. An alternative explanation is that the delayed inflation was caused by the earlier monetary expansion. The unusually long delay in the response of inflation to money can be explained by the presence of wage and price controls throughout 1973 and in early 1974. These controls effectively suppressed inflation rates. The lifting of price controls in April 1974 coincided with a sharp increase in deflator (as well as CPI) inflation.

Similarly, although CPI inflation rates rose sharply in 1979/80, the bulk of the deflator inflation occurred only in mid-1980-1981. The fact that the increase in deflator inflation rates in 1980/81 was smaller (if more sustained) than in 1974/75 is consistent with the interpretation that the lifting of price controls was instrumental in creating double-digit deflator inflation in 1974/75. Again, the delayed increase in deflator inflation seems consistent with both a delayed response to monetary expansion in the late 1970s and a delayed response to the 1970/80 oil price increases. Thus, it does not seem possible to disentangle the relative contribution of oil and of money based on evidence from the 1973/74 and 1979/80 periods alone.

The 1986 episode, however, provides a natural experiment because it coincides with a major change in oil prices, but no major change in non-oil commodity prices (see Figure 4) or in the monetary policy stance. Thus, the drop of the CPI inflation rate relative to the deflator inflation rate in Figure 5 can clearly be attributed to oil. The sharp deflation in the CPI in 1986, accompanied by only a minor reduction in deflator inflation, helps us to identify informally the effect of an oil price shock on inflation and casts doubt on the view that oil was responsible for deflator inflation in earlier periods. Together with the observation that the sharp rise of many industrial commodity prices in the early 1970s (well before the oil price increases) cannot be explained by supply shocks, this natural experiment is suggestive of a monetary explanation of stagflation.

V. The Relationship of Oil Prices and the Macroeconomy

In section IV, we showed that, although an oil supply shock may well cause a recession, its effect on the GDP deflator (as opposed to the CPI) is ambiguous in theory and appears to be small in practice. Thus, oil supply shocks are an unlikely source of stagflation. Nevertheless, casual observers continue to be impressed with the coincidence of sharp oil price increases in the 1970s and the worsening of stagflation. In fact, many observers seem puzzled by the absence of a close link between oil prices and stagflation at other times (for example, The Economist 1999).

In this section, we will argue that the almost simultaneous occurrence of sharp increases in oil prices and worsening stagflation in the 1970s was indeed no coincidence. Unlike conventional accounts based on exogenous oil supply shocks, however, we stress that oil prices were responding in substantial measure to conditions in the oil market which in turn were greatly affected by macroeconomic conditions (and ultimately by the monetary stance). Put differently, we reject the common notion of a simple one-way causal link from oil prices to the macroeconomy and allow for the possibility that oil prices (like other commodity prices traded in international markets) tend to respond to macroeconomic forces.

The view that oil prices contain an important endogenous component is not as radical as it may seem. In fact, the observed behavior of oil and non-oil commodity prices coheres well with economic theory about resource prices (see Heal and Chichilnisky 1991). Commodity prices rise in response to high output and low real interest rates due to excess liquidity. Our emphasis on the endogenous response of oil prices to global (and in particular U.S.) macroeconomic conditions does not rule out that political events played a role in the timing of the observed oil price increases, but it suggests that politically motivated increases in the oil price would have been far less likely in the absence of a conducive economic environment created by monetary policy.

Oil Prices Contain an Endogenous Component: Theory

Our starting point is the classic resource extraction model of Hotelling (1931). Applying this model to oil, marginal revenue (MR) net of marginal cost of extraction (MCE) must rise at the rate of interest, so that well owners are, on the margin, indifferent between extracting oil today and extracting oil tomorrow. Further, the transversality condition says that, in the limit, no oil should be wasted. Combining these two conditions, we have, for the special case of zero marginal extraction cost:

$$\text{(8)} \qquad \sum_{t=0}^{\infty} D_t^{oil}(\underset{-}{p_0^{oil}e^{rt}}, \underset{+}{y_t}) = S^{oil}$$

where p_0^{oil} = initial relative price of oil, S^{oil} = fixed stock of oil, r = real interest rate, y_t = aggregate output in period t, and D_t^{oil} = demand for oil in period t. Under perfect competition, equation (8) implies that the price of oil rises at the rate of interest until the fixed stock of oil is exhausted.

This simple model has direct implications for how monetary policy affects oil prices. First, a one-time permanent drop in *r* raises the initial price, and implies slower price growth thereafter. Second, a rise in aggregate real income shifts out the flow demand for oil. Since the oil is consumed more rapidly, the price of oil must rise to clear the market. The magnitude of these effect depends on the *size* and *duration* of the effects of monetary policy on *r* and *y*. Money is not normally thought to permanently change *r* or *y*. Thus, the magnitude of price adjustment in response to monetary policy in this model may not be large.

For the more general case of positive marginal extraction costs the first-order condition for profit maximization is that MR-MCE must rise at rate *r*:

$$\text{(9)} \qquad \left(\dot{MR} - \dot{MCE}\right) / \left(MR - MCE\right) = r$$

Note that the required rise over time in MR-MCE may be accomplished by a fall in MCE as new capacity is developed, even without a rise in the oil price (see Holland 1998). Indeed, this feature of the model allows for the oil price to fall over time.

A more realistic version of the Hotelling model in (9) postulates marginal costs that are increasing in the extraction rate (which – in the limit - may be interpreted as capacity constraints).[11] Unlike the standard Hotelling model, the model with capacity constraints may generate sharp increases in the price of oil as well as overshooting of the oil price in response to a shift in demand for oil. In the limit, if installed capacity is instantaneously fixed, the price of oil at a moment in time is determined entirely by demand. A rise in real GDP, or a decrease in the real interest rate, shifts the demand curve for oil to the right, sharply raising the market price

[11] Mabro (1998, p. 16) notes that "… exhaustibility as an ultimate outcome in a universal context is not very relevant [for the oil price] because the time horizon involved, even today, is far too long to have a noticeable impact. What matters is the relationship of current productive capacity to current demand and of planned investments in capacity to future demand. It is not the geo-physical scarcity of oil that poses problems … but the capacity issue at any given point in time."

of the given stock of oil. However, this price increase carries the seeds of its own destruction. If we began in steady state, the shadow price of capacity will now exceed its replacement cost at current levels of capacity. If the price remains high for extended periods, investment in drilling and distribution capacity takes place, and in the long run the price of oil will fall.

Oil Prices Contain an Endogenous Component: Evidence

The view that oil prices contain an important endogenous component is supported by the data. We have already reviewed the evidence for large swings in world liquidity, most notably reflected in the real interest rate and in the movements of GDP. The two most prominent increases in the price of oil in 1973/74 and 1979/80 were both preceded by periods of unusually low real interest rates (see Figure 3d) and economic expansion. In these periods low opportunity costs and booming demand for oil made it profitable to accumulate inventories. In contrast, the fall of oil prices after 1982 coincided with a severe global recession and unusually high real interest rates which made it unprofitable to stockpile oil.

Weakening demand also played a crucial role in undermining Saudi Arabia's efforts to shore up the oil price between 1982 and 1985 by reducing its oil supply. The fact that other OPEC members undercut the official OPEC price in the1982-85 period appears consistent with the view that, in the absence of effective monitoring and punishment, cash-starved oil producing countries (such as Iraq and Iran) had an incentive to undercut the cartel price in order to increase current revenue.[12] At the same time, competition from other oil producers increased. By the early 1980s, a large number of new oil suppliers such as Egypt, Angola, Malaysia, China, Norway and the U.K. had entered the market in response to the unusually high oil prices of the 1970s, while existing producers including the U.S. (Alaska), Mexico, and the U.S.S.R. had invested in new capacity and expanded oil production. By 1982, less than 50 percent of world oil was supplied by OPEC, compared with two thirds in 1977 (see Skeet (1988), p. 201). The resulting downward pressure on oil prices is consistent with the predictions of the Hotelling model with capacity constraints. Thus, there is considerable prima facie evidence that oil prices respond to macroeconomic forces.

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[12] This view is consistent with Chevalier and Scharfstein's (1996) argument that cash-strapped firms will reduce prices when demand is low and cheating is unverifiable. It also is consistent with empirical evidence in Suslow (1988) that the survival probability of cartels in the inter-war period tends to be procyclical.

Why Did the 1973/74 and 1979/80 Oil Price Increases Occur When They Did?

An intriguing question that sheds light on the relationship between oil prices and macroeconomic conditions in countries like the United States is why the two major and sustained oil price increases of the 1970s occurred when they did. The dominant view in the literature is that the timing was primarily determined by exogenous political events in the Middle East which are thought to have triggered supply cuts and thereby raised oil prices (see Hamilton 1999). However, as we will argue, sustained oil price increases are only possible under conditions of excess demand in the oil market. Such conditions are unlikely to occur in the absence of favorable macroeconomic conditions, notably economic expansion and low real interest rates. Thus the apparent success of OPEC oil producers in raising prices in the 1970s (and their failure to raise prices for sustained periods at other times) is no historical accident. The timing of the oil price increases in the 1970s coincided with periods of unusually strong demand for oil, driven in substantial part by monetary conditions in the world economy and amplified by the institutional arrangements of the oil market.

At the end of World War II, the U.S. was the leading supplier of oil worldwide. However, the post-war period witnessed dramatic changes in the structure of the international oil market, as new oil producers, notably in the Middle East, entered the market. The resulting decline in the international price of oil after the Suez crisis led to oil protectionism in the U.S., culminating in the introduction of oil import quotas in March 1959 that were to remain in place until April 1973. As a result, in the 1959-1973 period, the world oil market was effectively a two-tier market. In the U.S., production of oil was restricted and managed by the Texas Railroad Commission and similar regulatory bodies at the state level. In the Persian Gulf, output was reined in to what the major oil companies estimated was necessary to fill the gap between projected oil consumption and available production from the rest of the world. The excess capacity of the U.S. oil industry allowed the U.S. to play the special role of the supplier of last resort to Europe and Japan, in the event that oil supplies were threatened. The fact that the U.S. assumed the role of seller of last resort was an inadvertent consequence of the regulatory policies under the Texas Railroad Commission regime. Under that regime, rationing of production led to excess capacity and oil conservation (see Hamilton 1985). The ability of the U.S. to flood the market with surplus oil served as a deterrent against any attempt to raise international oil prices, and ultimately thwarted the effects of the 1956 and 1967 oil embargoes. There is no evidence that oil exporting countries during the 1950s and 1960s were able to effect a substantial increase in the price of oil.

What then were the changes in the world oil market that made the successful 1973 oil price hike possible? The main difference between the early 1970s and earlier periods was a dramatic surge in world-wide demand for oil that was fueled at least in part by monetary expansion. The unexpected growth in oil consumption soon exhausted spare capacity in the United States, and was met with an increase in oil output in the Middle East that kept the price of oil low and falling in real terms (see Figure 6). Mabro (1998, p. 11) notes that OPEC's average daily production increased from 23.4 mb/day in 1970 to 30.99 mb/day in 1973. All OPEC members but Kuwait, Libya and Venezuela increased production in this period. However, the reprieve was only temporary. Excess capacity was shrinking quickly in the Middle East. Seymour (1980, pp. 100) documents that the oil market had been tightening since 1972 in spite of the rapid increases in oil output. In late 1972, all of the main market indicators – tanker freight rates, refined product prices, and spot crude prices – started rising and continued their climb throughout 1973. While, of course, the recoverable reserves in the Middle East were huge, available production capacity was much more closely attuned to actual consumption. By September-October of 1973, immediately before the oil embargo, both Saudi Arabia and Iran had just about reached their maximum sustainable output. The capacity shortage was not limited to Saudi Arabia and Iran. In the absence of the oil embargo and the subsequent oil price increases, there would have been virtually no spare productive capacity available anywhere in the world on the basis of the then projected forecasts of oil consumption for the winters of 1973-74 and 1974-75 (see Seymour (1980), p. 100).[13]

In March 1971, U.S. oil production for the first time in history reached 100 percent capacity (see Yergin (1992), p. 567). In response, in April 1973, Nixon abolished the import quota system and rationed the allocation of crude oil to refineries. Oil imports as a share of U.S. oil consumption rose from 19 percent in 1967 to 36 percent in 1973 (see Darmstadter and Landsberg (1976), p. 31). The normal market response to this shortage would have been rising

[13] This growing capacity shortage did not go unnoticed. In November 1968, only one year after the successful defeat of the 1967 oil embargo, State Department officials announced at an OECD meeting that soon the U.S. would not be able to provide extra supply to the world in the event of an embargo (see Yergin (1992), p. 568). In November 1970, a U.S. diplomat in the Middle East filed a report stating that "the extent of dependence by western industrial countries upon [foreign] oil as a source of energy has been exposed, and the practicality of controlling supply as a means of exerting pressure for raising the price of oil has been dramatically demonstrated." (Yergin (1992), p. 587).

oil prices. However, U.S. price controls on oil imposed in 1971 as part of an overall anti-inflation program were discouraging domestic oil production while stimulating consumption, and left little incentive for exploration or conservation. Moreover, growing environmental concerns held back U.S. oil production, even as new large oil reserves were being discovered in Alaska (see McKie (1976), p. 73).

What made the year 1973 unique was the fact that the existing trend in oil consumption was exacerbated by cyclical factors. First and foremost, the sudden increase in energy consumption was a consequence of the remarkable surge in economic growth that occurred in 1972 and 1973 in Europe, Japan, and the United States at the same time (see Vernon (1976), p. 3). This unusual coincidence helps explain the unprecedented increase in non-oil commodity prices in Figure 4 at that time. It also served to reinforce the positive long-run trend in energy demand. Darmstadter and Landsberg (1976, p. 27) note that the world-wide economic expansion had dramatically depleted inventories of crude oil and petroleum products in the industrial countries just before the 1973 war, resulting in a drastic lowering of petroleum stocks. Thus, the observed OPEC oil price increase bears at least in part the features of a classic commodity price boom. In fact, there is reason to believe that the oil price boom was delayed only by OPEC's willingness, prior to 1974, to supply effectively limitless quantities of oil at the posted price.

The salient features of the oil market in 1973/74 that require an explanation are the huge increase in the quantity of oil sold at roughly constant nominal oil prices (but falling real prices) in the early 1970s, followed by a sharp increase in the nominal (and real) price of oil, accompanied by a fall in the quantity of oil sold in the last quarter of 1973. Although the simultaneous fall in the quantity and rise in the price of oil in late 1973 is suggestive of a contemporaneous supply shock in the oil market, we will propose a model that is capable of explaining the price and quantity movements without invoking supply shocks.

There are essentially two distinct reasons for the 1973/74 oil price increase. First, perhaps one third of the observed oil price increase corresponds to what would have been required to undo the cumulative effect of U.S. inflation and to restore the oil price in real terms to its level in the early 1960s. A further increase may have been intended to protect against future losses due to inflation. Indeed, early OPEC efforts to raise the nominal price of oil in the early 1970s were explicitly defended on these grounds (see Penrose 1976). Second, and more importantly, a good case can be made that excess demand in the oil market would have induced an unprecedented increase in oil prices at the end of 1973, even in perfectly competitive markets. The latter argument is illustrated in Figure 7. For expository purposes consider a two-period model of the oil market dynamics in the early 1970s. In period 1, starting from the equilibrium point A, a shift in demand for oil as a result of expansionary monetary policy raises the shadow price for oil. The new market clearing price at point B, however, is never realized, because the price of oil is effectively held back by long-term contractual agreements (see Penrose 1976).[14] Instead, we move from A to C, corresponding to an increase in the quantity of oil supplied at the old price. In period 2, OPEC reneges on the contractual price, and raises the oil price to the market clearing level (D=B) while reducing the quantity supplied (which is no longer needed at the new price). The price and quantity movements in period 2 have the appearance of an oil supply shock, yet the supply curve never shifts; we are witnessing the correction of a disequilibrium resulting from the earlier demand shift.

Our stylized model of the 1973/74 oil market dynamics is consistent both with the absence of significant increases in the real price of oil and the observed increase in oil production in the early 1970s. It also is consistent with the fall in the quantity of oil produced and the sharp increase in the OPEC oil price in 1973/74. Note that we do not claim that OPEC intended to set the oil price at market clearing levels, nor that the actual price was necessarily market clearing. Rather we demonstrate that the observed quantity and price behavior in the oil market in late 1973 could have been generated without invoking exogenous supply interruptions. The 1973/74 episode illustrates that a fundamental identification problem needs to be addressed before we can assess the effect of exogenous political events in the Middle East on the price of oil. As we have shown, the observed price and quantity movements in 1973/74 are consistent both with supply interruptions and with the restoration of equilibrium after the removal of price ceilings. Our model also is consistent with the views of oil economists such as Mabro (1998, p. 10) that "a major political crisis will not cause a price shock when capacity cushions exist in other countries, while excess demand would cause prices to flare even in the absence of any political crisis".

There is no direct evidence on the question of how close the January 1974 oil price level was to market clearing, but the magnitude of the increases in other commodity prices suggests

[14] The essential point here is that the price of oil in the early 1970s remained substantially below market clearing level in the presence of excess demand. The assumption of a fixed price is an oversimplification designed to allow us to abstract from the effects of inflation. The price of oil actually fell in real terms in the early 1970s (see Figure 6).

that the actual price was probably not far from the market clearing level and there is little evidence that OPEC used its market power to prop up the price of oil at this point. As we will argue later, OPEC market power played an important role in determining the price of oil only *after* January 1974, when it attempted to stabilize the price of oil at its peak level, even as the U.S. economy slid into recession and other commodity prices fell sharply.

We now turn to the second major oil price increase of the 1970s which took place in 1979/80. As in the early 1970s, there is clear evidence of an output boom, unusually low real interest rates and rising inflation prior to 1980. The rapid growth was fueled by the renewed world-wide monetary expansion documented in section III. Although this expansion was reflected in a sustained increase in non-oil, nonagricultural commodity prices in 1976-79, the increase in other commodity prices was dwarfed by the increase in oil prices that started in late 1978 (see Figure 4). Since the surge in oil prices not only far exceeded inflation adjustments, but also was not supported by a corresponding tightening in other commodity markets, it must have reflected additional developments specific to the oil market. Judging by the increase in non-oil, non-agricultural commodity prices in 1978/79, at best one third of the actual deflator inflation appears to be consistent with the monetary model. In that respect, the second oil crisis appears fundamentally different from the first oil crisis of 1973/74. Also note that, unlike in 1973/74 when oil prices doubled in a single day, the oil price increase in 1979/80 appears much more gradual. One reason is that – unlike in the early 1970s – oil prices had not been held back by what was effectively a price ceiling. Thus, the observed oil price dynamics cannot be explained by a disequilibrium adjustment of the kind described in Figure 7.

We do not attempt here to provide a detailed account of the developments in the oil market that may explain this discrepancy. We conjecture that one possible explanation of the bulk of the oil price increases from May 1979 into 1980 (prior to the outbreak of the Iran-Iraq war) is a speculative bubble in the oil market that was reinforced by market-specific institutional arrangements. Other possible explanations of this phenomenon that have been proposed include physical production shortfalls in some OPEC countries and an unprecedented temporary surge in precautionary demand in response to increased uncertainty about future oil supplies (see Hamilton (1999), Adelman (1993), pp. 428). We note, however, that none of these explanations seems plausible in the absence of taut demand conditions in the oil market which in turn were driven in no small measure by a booming economy and low real interest rate. It is no coincidence that oil prices (as well as non-oil commodity prices) peaked shortly after Paul Volcker launched a sharp monetary contraction resulting in a global recession and high real interest rates. The long slide in all commodity prices (including oil) that began in 1981 and was completed by 1986, is qualitatively consistent with the predictions of the Hotelling model with capacity constraints.

The focus of this section has been to explore to what extent the two major oil price increases in the 1970s can be explained as a response to excess money growth. We showed that essentially all of the 1973/74 price hike can be explained as the delayed correction of a disequilibrium in the oil market driven largely by monetary conditions, whereas a best a third of the 1979/80 price hike can be accounted for as a response to excess money growth.

A further question that we do not attempt to address in this paper is what explains the long delay in the decline of oil prices - both in the mid-1970s and in the early 1980s – after the initial monetary expansion had run its course. This question is of considerable interest. After all, one would not expect a monetary expansion to rationalize more than a transitory increase in oil prices. Indeed, Figure 6 shows that non-oil, nonagricultural commodity prices tended to drop sharply in response to recessions and higher real interest rates, as theory would suggest.   Oil prices, however, remained at a much higher level than other commodity prices during 1974-78 and again during 1981-1985. This differential response *after* the onset of the 1974/75 and 1981/82 recessions is suggestive of the use of OPEC market power to prop up oil prices.

We note that, although sharp oil price increases tend to come on the heels of shifts in the demand for oil that – in our view - are directly or indirectly fueled by monetary expansion, OPEC seems to have been adept at restraining official price cutting even in the presence of significant excess capacity. As Nordhaus (1980, pp. 367) notes, in periods of excess demand, there is little OPEC can do (or would want to do) to impede oil price increases. Once official OPEC prices have risen, however, they tend to be sticky, even when there is a glut in the oil market. Indeed, empirical and anecdotal evidence lends support to the view that OPEC was most influential not in 1973/74 or in 1979 during the time of the most rapid oil price increases - as popular opinion would suggest - but in preventing oil prices from falling as rapidly as they should have when oil demand subsided (also see Mabro (1998), p. 10-11).

VI. Concluding Remarks

The origins of stagflation and the possibility of its recurrence continue to be an important concern among policymakers and in the popular press. We argued that a coherent explanation of the Great Stagflation of the 1970s must account for five stylized facts:

1) the simultaneous occurrence of a fall in GDP and higher GDP deflator inflation;
2) the sharp increases in oil and other industrial commodity prices in the early 1970s;
3) the fact that changes in non-oil, nonagricultural commodity prices lead changes in oil prices in the 1970s and early 1980s;
4) the coincidence of the two major oil price increases in the 1970s and worsening stagflation; and
5) the differential response of CPI and GDP deflator inflation during major oil price increases.

We made the case that go-stop monetary policy provides a coherent explanation of all five facts. In contrast, the prevailing view that exogenous oil supply shocks are the primary source of stagflation appears less convincing. Although higher oil prices due to oil supply shocks may explain part of the 1974/75 and 1981/82 recessions - and part of the increase in CPI inflation - we showed that there is no theoretical presumption that oil supply shocks are inflationary for the GDP deflator and little independent empirical evidence of such effects. Moreover, the supply shock view fails to explain the differential response of the deflator and CPI inflation rates to oil price shocks, the sharp increase in non-oil, nonagricultural commodity prices in the early 1970s, and the lead of changes in non-oil, nonagricultural over changes in oil prices in the 1970s and early 1980s. Finally, it is not clear to what extent the observed increases in oil prices were due to supply interruptions, as opposed to increased demand for oil.

Our analysis suggests that in substantial part the Great Stagflation of the 1970s was due to misperceptions of policy makers and could have been avoided, had the Fed contained velocity-adjusted money growth in the early 1970s. Moreover, the misperception that the observed inflation in 1973/74 was due to contemporaneous supply shocks (notably an oil price shock) prevented the Fed from learning from its mistakes and caused it to repeat the stagflationary cycle in the late 1970s. This point is important because to the extent that stagflation is due to exogenous supply shocks, any attempt to lower inflation would worsen the recession. In contrast, if we are right that stagflation is first and foremost a monetary phenomenon, then stagflation does not present an inevitable “policy dilemma”. We conclude that oil price increases by themselves are unlikely to reignite stagflation, as long as the Federal Reserve refrains from excessively expansionary monetary policies. Moreover, even with a resurgence of OPEC, a sustained increase in the real price of oil is unlikely in the absence of a conducive macroeconomic environment.

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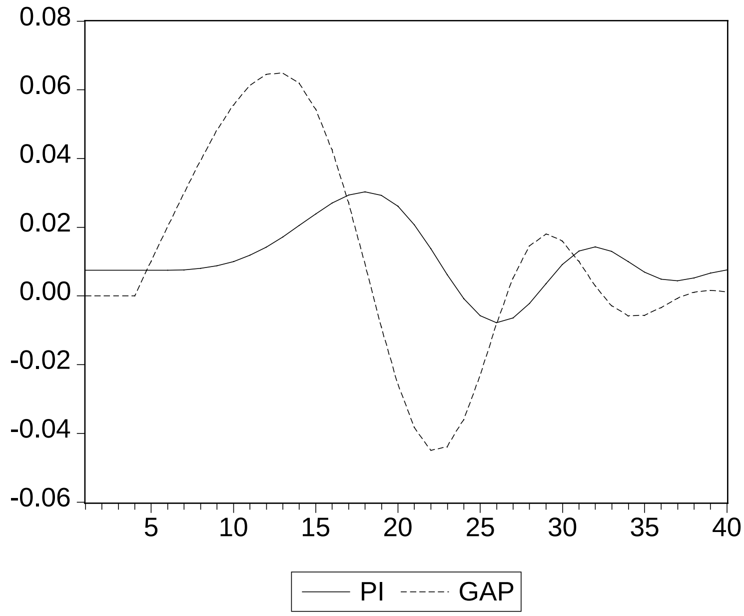
Table 1: Real Growth, Inflation, and Nominal Growth in the United States 1960-1997

NBER Business Cycle Dates	State of the Economy	Percent Change Per Annum		
		Real Growth	Inflation	Nominal Growth
1960.2-1961.1	Contraction	- 1.22	+ 1.37	+ 0.15
1961.1-1969.4	Expansion	+ 4.62	+ 2.58	+ 7.20
1969.4-1970.4	Contraction	- 0.48	+ 5.00	+ 4.52
1970.4-1973.4	Expansion	+ 4.38	+ 5.24	+ 9.62
1973.4-1975.1	Contraction	- 1.84	+ 9.48	+ 7.64
1975.1-1980.1	Expansion	+ 3.69	+ 7.07	+ 10.76
1980.1-1980.2	Contraction	- 3.89	+ 9.03	+ 5.14
1980.2-1981.2	Expansion	+ 0.30	+ 9.32	+ 9.62
1981.2-1982.4	Contraction	- 1.48	+ 6.15	+ 4.67
1982.4-1990.2	Expansion	+ 3.76	+ 3.57	+ 7.33
1990.2-1991.1	Contraction	- 1.72	+ 4.54	+ 2.82
1991.1-1997.2	Expansion	+ 2.53	+ 2.53	+ 5.06

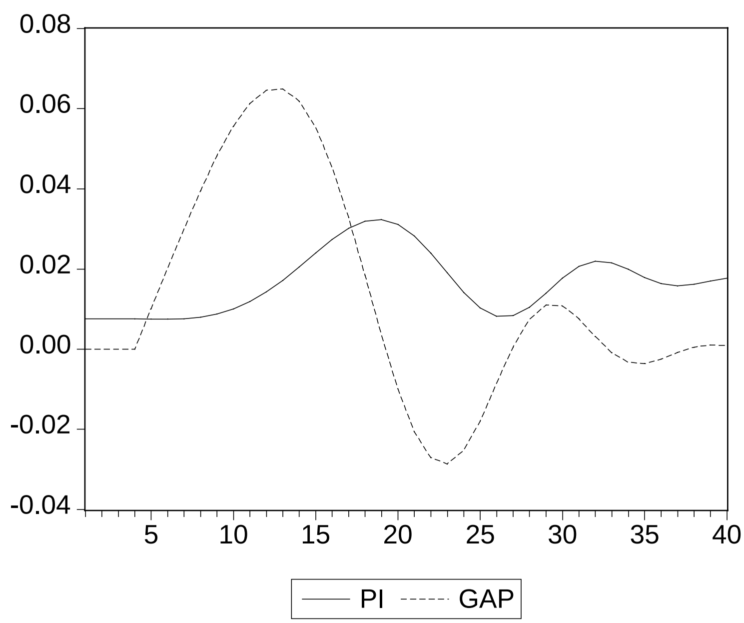
Source: Based on quarterly GDP (GDPQ) and GDP deflator (GDPD) data from DRI for 1960.1-1997.2. The business cycle dates are based on the NBER dating.

Figure 1: Implications of a Purely Monetary Model of Stagflation

(a) Model with Policy Feedback

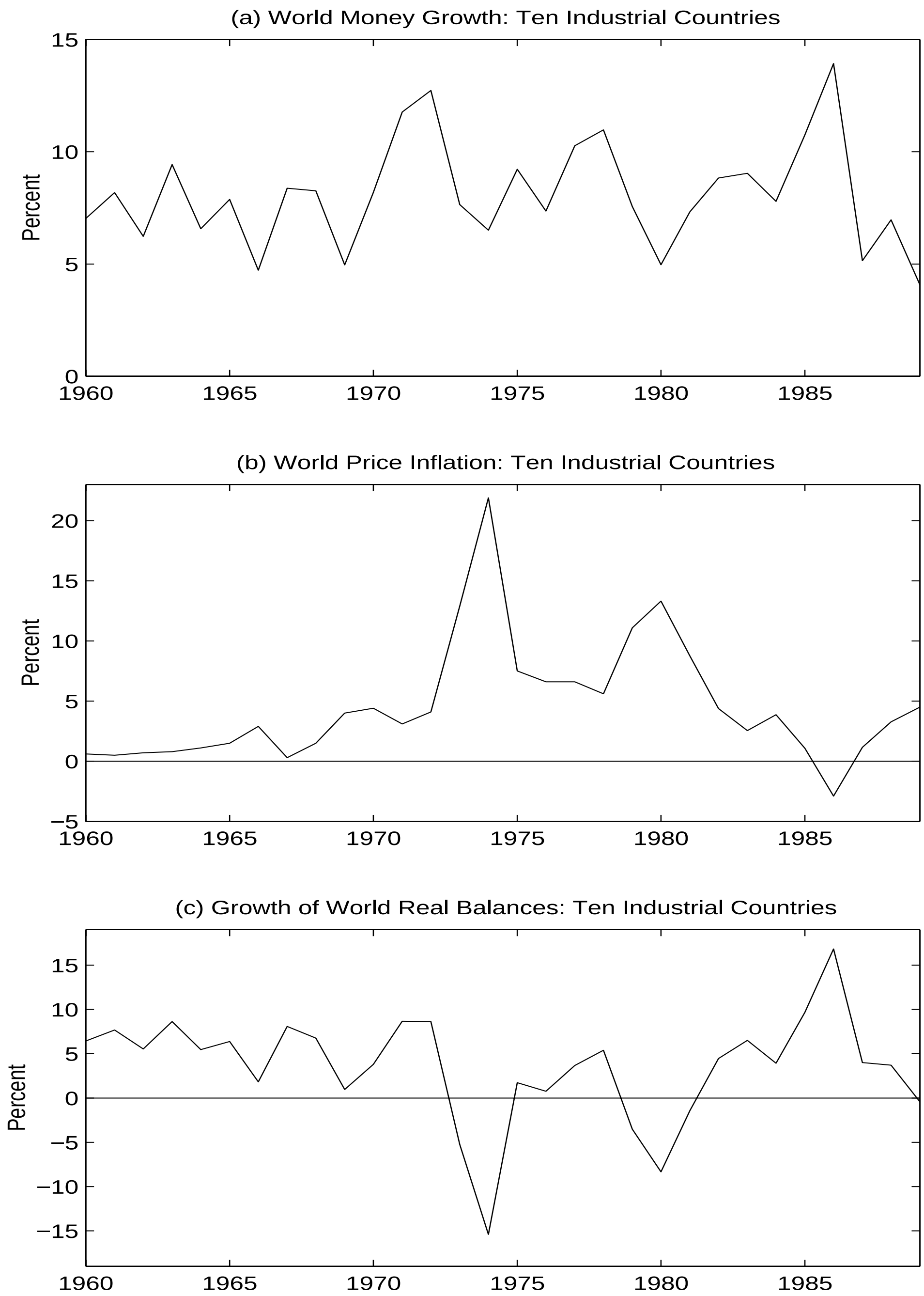


(b) Model without Policy Feedback



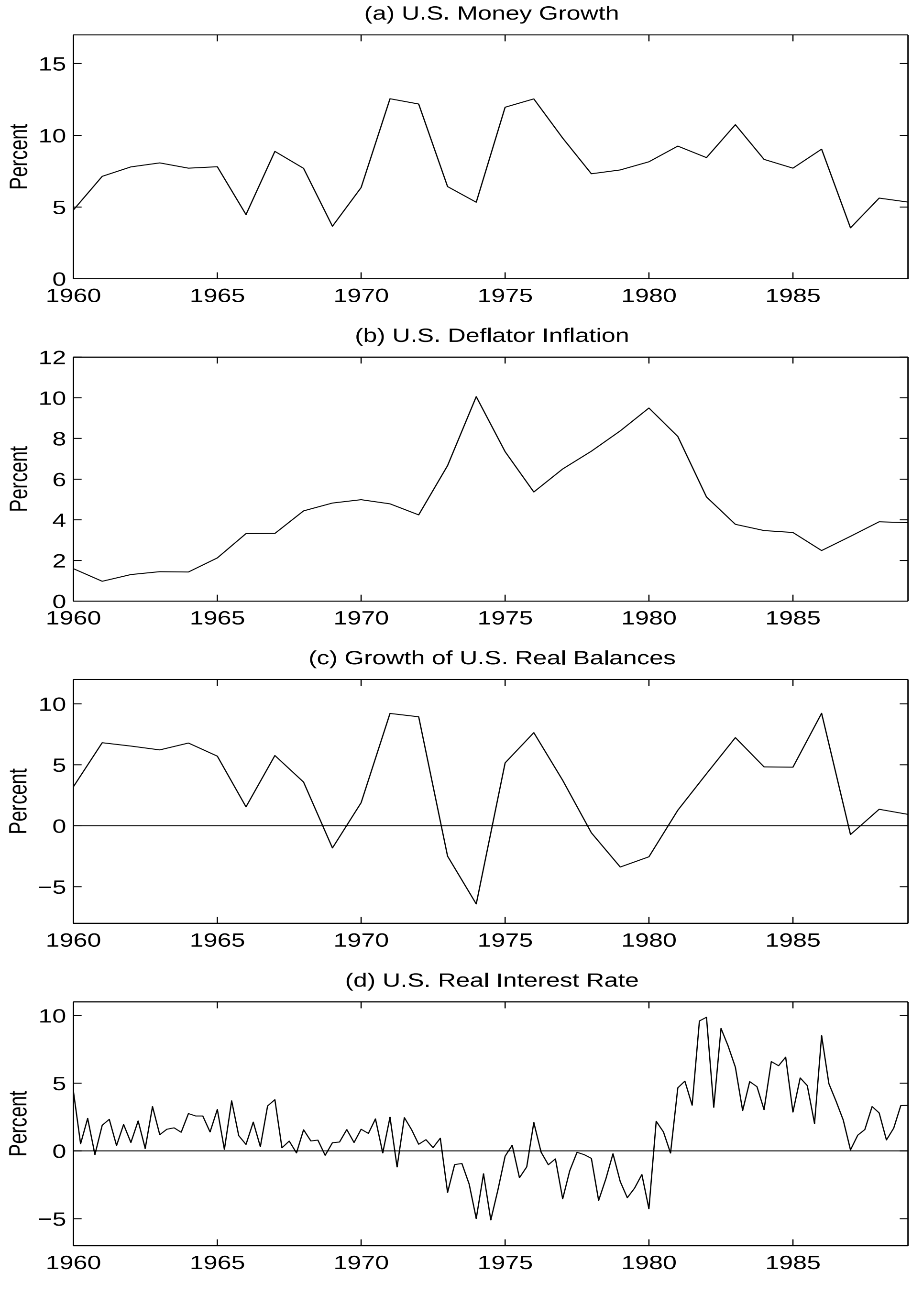
NOTES: PI = inflation. GAP = output gap. Models described in text. Responses to a permanent 1% increase in the money growth rate in period 5.

Figure 2: Measures of World Liquidity



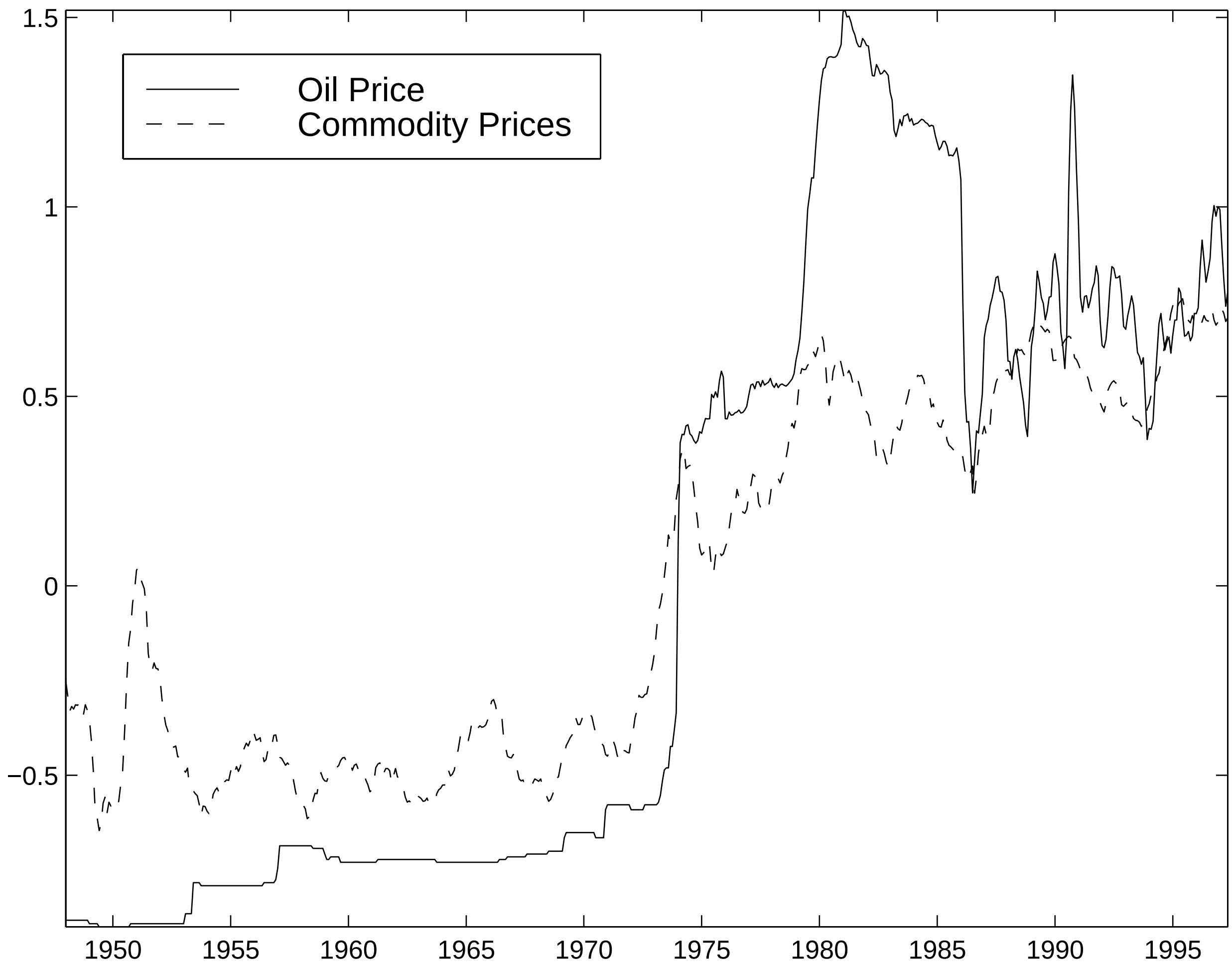
Source: Inflation and money are GNP-weighted growth rates per annum as defined by McKinnon (1982, pp. 322), based on IFS data for 1960.1-1989.4.

Figure 3: Measures of U.S. Liquidity



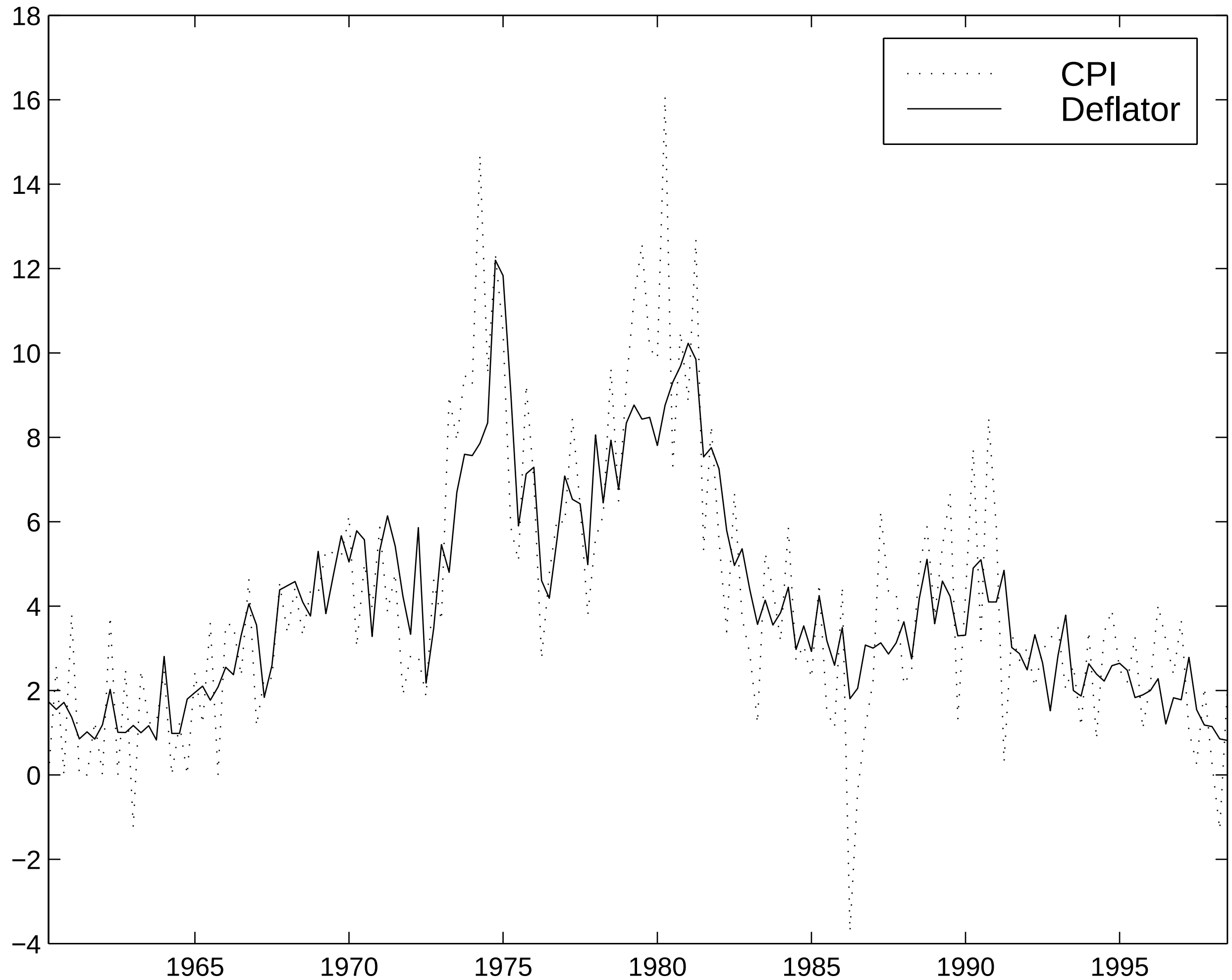
Source: (a) Based on DRI series FM2.
(b) Based on DRI series GDPD.
(c) Based on DRI series FM2 and PRXHS (consumer prices excluding shelter).
(d) Based on DRI series FYGM3 and PRXHS.

Figure 4: Monthly Price Indices for Crude Oil and for Non-Oil, Non-Agricultural Commodities 1948.1-1997.5



Source: All data are logged and demeaned. We use the composite oil price index (DRI code: EEPRPC) for 1974.1-1997.5. This index is a weighted average of refiner's acquisition cost of imported and domestic crude oil. We use the U.S. producer price index for oil (DRI code: PW561) to extend the data from 1974.1 back to 1948.1. The commodity price index shown is the index for nonagricultural commodity prices (DRI code: PSCMAT). Virtually identical plots are obtained using the index for sensitive materials (DRI code: PSM99Q).

Figure 5: Quarterly U.S. Inflation Rates for 1960.I-1998.II

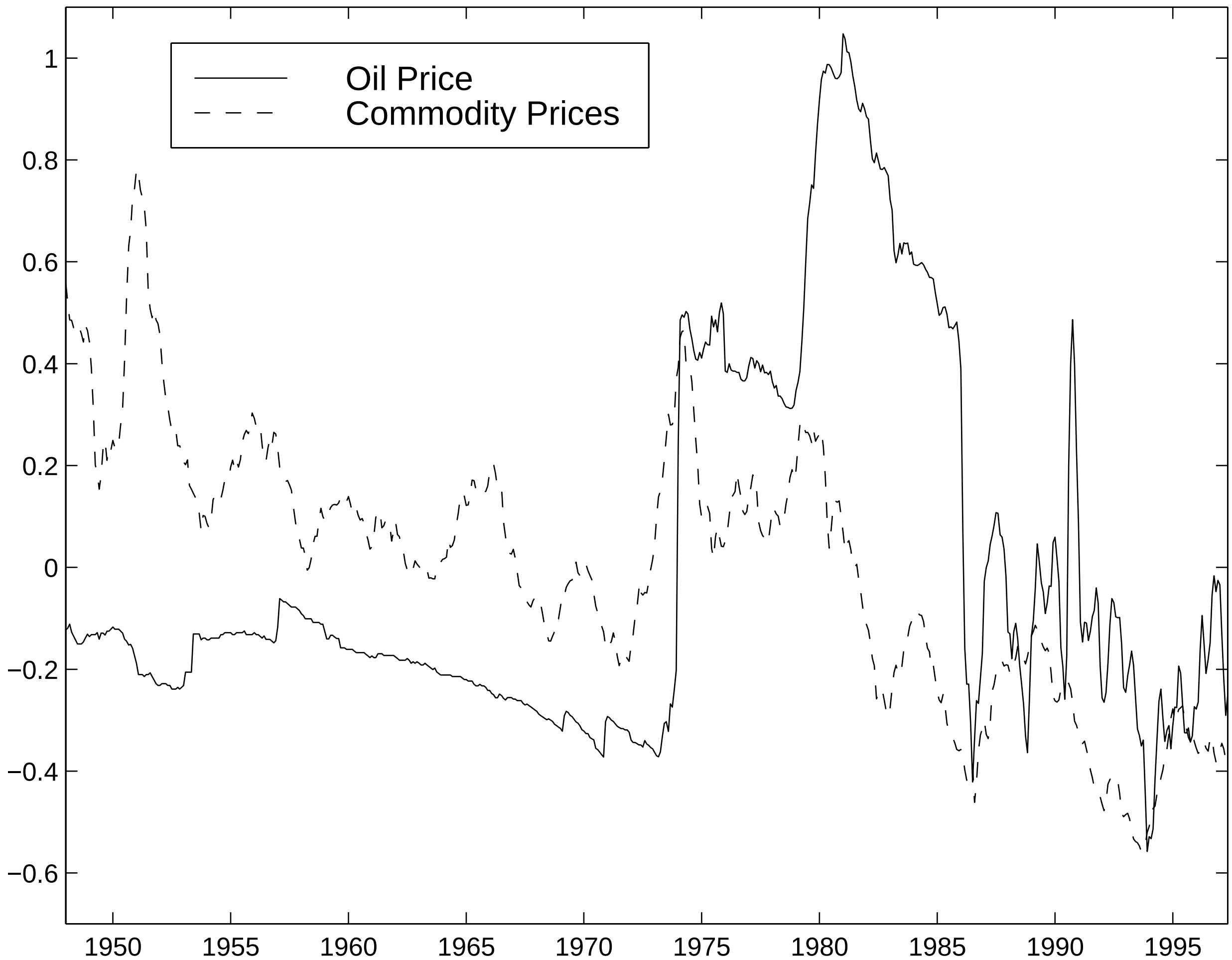


Source: All data are growth rates per annum. All data are taken form the DRI database. We use PRXHS (consumer prices excluding shelter) as the CPI measure, and GDPD as the implicit GDP deflator.

Figure 6: Monthly Price Indices for

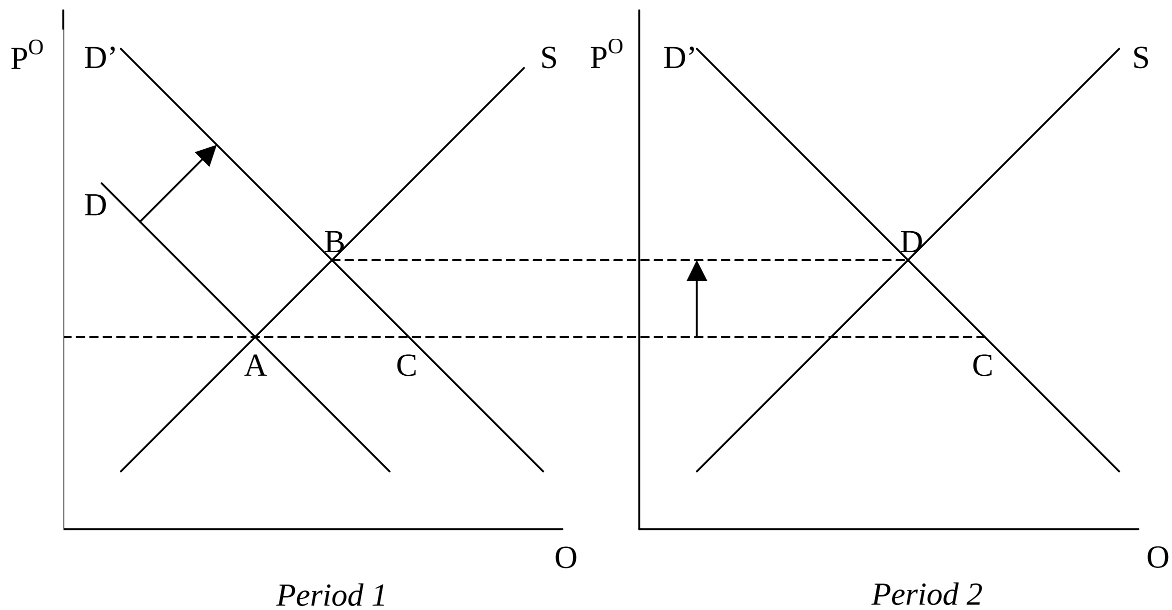
Crude Oil and Non-Oil, Non-Agricultural Commodities in Real Terms

1948.1-1997.5



Source: See Figure 3 for a description of the data. The price data have been deflated using the CPI index excluding shelter (PRXHS).

Figure 7: A Disequilibrium Analysis of the Oil Market



NOTES: In period 1, starting from the equilibrium point A, a shift in demand for oil as a result of expansionary monetary policy raises the shadow price for oil. The new market clearing price at point B, however, is never realized, because the price of oil is effectively fixed by long-term contracts. Instead, we move from A to C, corresponding to an increase in the quantity of oil supplied at the old price. In period 2, OPEC reneges on the contractual price, and raises the oil price to the market clearing level D=B while reducing the quantity supplied (which is no longer needed at the new price). The price and quantity movements have the appearance of an oil supply shock, yet the supply curve never shifts; we are witnessing the correction of a disequilibrium resulting from the earlier demand shift.