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ABSTRACT

This paper examines the choice of monetary policy in response to seasonal fluctuations in the economy. It discusses the costs and benefits of smoothing interest rates over the seasons, which has been the Fed's policy since its founding in 1914, and presents simulations suggesting how the economy would behave under the alternative policy of stabilizing the money stock. Finally, it presents evidence that the smoothing of interest rates in 1914 changed the seasonal business cycle.

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"The economy is experiencing an exogenous increase in the demand for goods and services. How should the Fed respond?"

This question could come from an exam for a standard undergraduate course in macroeconomics. On its face, it seems simple enough. Yet this question is instructive to ponder, for it provides a Rorschach test for one's beliefs about the role of monetary policy in economic fluctuations.

The typical undergraduate is trained in the Keynesian tradition and would recognize that the question concerns an expansionary shift in the IS curve. He would likely base his recommended response on the standard assumption that the goal of monetary policy is to stabilize output and employment. The answer, therefore, is that the Fed should induce a contractionary shift in the LM curve. In response to the increased demand for goods and services, the Fed should "lean against the wind" by reducing the money supply and raising interest rates.

Although this answer will seem natural to many economists, it is precisely the opposite to the policy pursued by the Fed in one important instance--seasonal fluctuations in demand. Over the year, the demand for goods and services fluctuates substantially and predictably; the most prominent example is the increase in the demand for consumer goods around Christmas. Yet the Fed does not follow the simple Keynesian prescription of leaning against the wind. Nor does it follow the recommendation of Milton Friedman (1982) that it keep the money supply growing smoothly over the seasons. Instead, the Fed pursues a policy of smoothing interest rates by expanding the money supply during those times of the year when the demand for goods and services is high. Not surprisingly, those months of high demand are also months of high employment and low unemployment.

Our goal in this paper is to appraise the seasonal monetary policy that the Fed has pursued since its founding in 1914. We should admit in advance that we will not advocate here a particular alternative policy. Rather, our goal is to raise a question that has received too little attention from monetary economists. Our search of the literature has found almost no discussion of how monetary policy should respond to seasonal fluctuations in demand. Yet, as Robert Barsky and Jeffrey Miron (1989) document, seasonal fluctuations in output and employment are as large as business cycle fluctuations. It is remarkable that economists have largely ignored these seasonal fluctuations and the Fed's policy of smoothing interest rates over the seasons.

We proceed in this paper as follows. In Section I we document some facts about seasonal fluctuations in interest rates. We emphasize, in particular, the contrast between the periods before and after the founding of the Federal Reserve System in 1914. Before 1914, short-term nominal interest rates exhibited a substantial seasonal pattern, whereas since 1914 interest rates have been much less seasonal. Hence, the elimination of any seasonal in interest rates has been a consistent feature of Fed policy throughout the institution's history.

In Section II we discuss reasons that such a policy may be desirable or undesirable. We argue that in a classical world in which prices are fully flexible, the policy of stabilizing interest rates over the year may be optimal, because this policy minimizes the deadweight losses associated with the inflation tax. Yet in a Keynesian world in which some prices are fixed in the short run, seasonal monetary policy may influence the seasonal pattern of output and employment. The welfare implications of unstable output can potentially outweigh those of stable interest rates.

In Section III we present a simple, stylized model of seasonal fluctuations. The purpose of the model is to examine how a change in Fed policy might alter seasonal fluctuations in the economy. Such a task is largely speculative, because there is not yet agreement among economists on how to model economic fluctuations, either over the business cycle or over the seasonal cycle. We therefore examine different sets of assumptions about economic behavior. Simulations of the model suggest how alternative monetary policies might alter the seasonal pattern of fluctuations in output, prices, and interest rates.

In Section IV we discuss the change in monetary regime in 1914. The founding of the Federal Reserve in this year provides a natural experiment with which one can try to evaluate alternative views of seasonal fluctuations. Specifically, one can test the classical hypothesis that a change in seasonal monetary policy will affect nominal variables but not real variables. When we examine data on output and real interest rates from before and after 1914, we find some evidence that the seasonal pattern in real variables did change. In particular, the smoothing of interest rate seasonality in 1914 appears to have coincided with an increase in the seasonality of real output. The episode thus provides some evidence for non-neutrality of seasonal monetary policy.

We conclude in Section V.

I. The Smoothing of Interest Rates in 1914

One of the most striking changes in the behavior of short-term interest rates occurred in 1914, the year the Fed began operations. A large part of this change was the almost complete elimination of regular seasonal fluctuations.

Figure 1 presents the estimated seasonal pattern in the 4-6 month commercial paper rate during three different sample periods: the period before the founding of the Fed (1890:2-1914:11), the interwar period (1919:1-1940:12), and the period since World War II (1947:1-1988:12). We estimate the seasonal pattern by regressing the interest rate on twelve seasonal dummies; we then normalize by subtracting the mean of the dummy coefficients.

The figure shows that the nominal interest rate was extremely seasonal during the pre-Fed period, displaying a pattern with amplitude greater than 100 basis points measured at an annual rate. During both the interwar and post-war periods, however, the nominal rate has displayed much less seasonality. The amplitude of the cycle fell to 28 basis points during the interwar period and then rose again to 43 basis points during the postwar era.

Formal statistical tests confirm the visual impression one gets from Figure 1. To perform the tests, we regress the change in the interest rate on seasonal dummies and calculate the standard errors allowing for serial correlation using the procedure suggested by Whitney Newey and Kenneth West (1987). The tests show that the nominal rate is seasonal at a statistically significant level during all three periods. Moreover, the change in the pattern is strongly significant between the period before 1914 and either of the later periods. Yet one cannot reject the hypothesis that the later two periods have the same seasonal pattern. The overall conclusion is that Fed policy has not completely eliminated seasonality in nominal interest rates: it has, however, reduced its amplitude substantially.

The striking results in Figure 1 are also robust to alternative data on short-term interest rates. In previous work we have examined the three-month time loan rate (Mankiw and Miron 1986, Mankiw, Miron, and Weil 1987). These data exhibit a similar change in seasonality in 1914.

The obvious interpretation of this fact is that the Fed began smoothing interest rate seasonals shortly after its founding in 1914, an interpretation that is supported by the finding that the change in the seasonality of rates occurred extremely quickly after 1914 (Clark 1984, Mankiw, Miron and Weil 1987). Miron (1986) argues that the elimination of seasonal and other transitory variation constituted one of the primary reasons for the founding of the Federal Reserve System. Participants in financial markets before the founding of the Fed viewed transitory variation in rates as a crucial link in the propagation of financial crises and, therefore, wanted this variation eliminated.

There are, however, alternative interpretations of the disappearance of interest rate seasonality in 1914. Truman Clark (1984) shows that interest rate seasonals diminished in England, France, and Germany at the same time that they diminished in the United States, and he argues that the seasonality of the U.S. high-powered money stock did not change until two years after the decrease in seasonality of nominal rates. He suggests that the abandonment of the international gold standard, rather than the actions of the Fed, is a more likely explanation for the change in seasonality of interest rates.

We do not find Clark's interpretation of these events persuasive, for three reasons. First, he does not explain why the suspension of the gold standard would have produced either the disappearance of interest rate seasonality or the lag between the change in seasonality of interest rates and that of high-powered money. Second, Barsky, Mankiw, Miron, and Weil (1988) show that the simultaneous disappearance of interest rate seasonality in many countries might have been the result of the introduction of a central bank in the United States: even if the United States was not itself large enough to sterilize world interest rate seasonals, the introduction of a U.S. central bank could have induced changes in monetary policy abroad. Third, as Marvin Goodfriend (1988) argues, the United States may have been sufficiently large in the world economy to eliminate seasonality in interest rates worldwide.

Raymond Fishe and Mark Wohar (1990), like Clark, also question whether the founding of the Federal Reserve was responsible for the change in the behavior of interest rates in 1914. They suggest that factors such as the outbreak of World War I and the closing of bond and stock markets may have been more important. These explanations appear implausible, however, because the change in the behavior of interest rates was permanent, as documented in Figure 1, while the factors cited by Fishe and Wohar were all transitory.

Mark Toma and Steven Holland (1989) suggest that the Fed's role as a lender of last resort, rather than its manipulation of the supply of high-powered money, was the main factor leading to the decline in interest rate seasonality. The essence of their argument is that by reducing the riskiness of loans, the Fed made the supply of bank loans (and the demand for excess reserves) more elastic, implying smaller interest rate seasonals for any given seasonality of asset demands. Although logically consistent, this argument has the strongly counterfactual implication that reserve-deposit ratios should have become much more seasonal after 1914, because banks would have become more willing to loan out extra reserves in times of high demand. The view that the Fed simply accommodated the seasonality of asset demands implies that the reserve-deposit ratios should have become less seasonal, which is in fact what happened.

To sum up, there can be no dispute that the behavior of short-term interest rates changed substantially in 1914--in particular, that interest rates became much less seasonal. There is more room for dispute about what caused this change. In our view, the most likely hypothesis is that the elimination of the seasonal in interest rates was the direct result of Federal Reserve policy.

II. The Cases for and against Smoothing Interest Rates

The normative question of whether the Fed should smooth interest rates over the seasons is inexorably tied with the positive question of how the economy behaves. We therefore discuss the normative question in two steps. We first consider classical economies, in which real variables such as output and employment are unaffected by monetary policy. We then consider Keynesian economies, in which price rigidities lead to monetary non-neutralities.

Classical Arguments

In a classical world, seasonal monetary policy--or indeed monetary policy of any sort--is not very important. The variables that matter most for economic welfare, such as real incomes, employment, and relative prices, are independent of monetary policy. Monetary policy influences only nominal variables, such as the price level and the nominal interest rate.

Yet even in such a world, monetary policy can affect welfare by ensuring that individuals are not unnecessarily conserving on real money balances. Because the nominal interest rate is the opportunity cost of holding money, a high nominal interest rate reduces the quantity of real balances people hold and, thereby, their welfare. As Milton Friedman (1969) emphasized, this reasoning suggests that the money supply should grow--or, more likely, shrink--just enough to produce a zero nominal interest rate.

Edmund Phelps (1973) pointed out a possible exception to Friedman's optimal money rule. If seigniorage is an efficient way for the government to raise revenue, then the optimal nominal interest rate may be greater than zero. In essence, the nominal interest rate is the tax on holding real money balances. Because lump-sum taxes are unavailable, a positive tax on real balances may be optimal.

If these public finance considerations are central to the conduct of monetary policy, then smoothing the interest rates over the seasons is likely to be the appropriate policy. A tax rate on any economic activity that varied systematically over the seasons would induce people to move inefficiently some of that economic activity from high tax seasons to low tax seasons. In the specific case of monetary policy, if the nominal interest rate varied systematically, the policy would fail to minimize the social cost of collecting seigniorage (Mankiw 1987).

The implication of this line of reasoning is that Milton Friedman's (1982) suggestion that the money stock not fluctuate over the seasons is inconsistent with his optimal quantity of money arguments. With a constant money stock, a season of high output would also tend to be a season of high money demand, low prices, high expected inflation, and thus high nominal interest rates. If the nominal interest rate is to be kept smooth, the money stock must adjust to accommodate seasonal fluctuations in output.

Some Suggestive Calculations

To gauge the welfare gain from smoothing interest rates over the seasons, it is instructive to carry out a few calculations. Here we take the standard approach of measuring the welfare costs of high nominal interest rates by the lost consumer surplus from money holding. That is, we measure social welfare by the area under the money demand curve. (See, for example, McCallum, 1989, Chapter 6.) We assume that the Fed can control the money stock perfectly, that real output and the real interest rate are exogenous, and that prices are completely flexible. We also abstract from uncertainty, so there is no shock to the money demand equation and both output and the real interest rate are purely seasonal.

Under these conditions, the only effect of the Fed's choice of seasonal policy is whether the seasonality in output and the real interest rate is absorbed in the price level or the money stock. If the Fed chooses to keep the money stock non-seasonal, then the price level must move seasonally to clear the money market, and both the price level and the nominal interest rate will be seasonal. If instead the Fed makes the money stock seasonal in a way that makes the seasonal in the inflation rate equal to the negative of the seasonal in the real rate, then the money market clears without any seasonal in the nominal interest rate.

The Fed's seasonal actions thus impinge on the economy only through the inflation rate, and the welfare effects are limited to the distortion of agent's optimal pattern of money holdings. If the Fed eliminates seasonality from the money stock, there are welfare losses from insufficient money holding in those seasons when interest rates rise above their average level that are not fully offset in the seasons when interest rates fall below their average level. In this case, therefore, a policy of smoothing nominal interest rates raises welfare.

This conclusion is illustrated in Figure 2, which compares a constant money supply rule to a constant nominal interest rate rule for an economy with only two seasons. When the Fed stabilizes the nominal money stock, the nominal interest rates fluctuates between i_{low} and i_{high}. (Note that because of seasonality in prices the real money stock is not constant under this policy.) Alternatively, when the Fed stabilizes the nominal rate at i^*, the real money stock alternates between $(M/P)_{low}$ and $(M/P)_{high}$. There is a welfare cost of following the constant money policy instead of the constant interest rate policy because, under constant money, the gain from having low interest rates in the low demand season (the area ABCD) is less than the loss from having high interest rates in the high demand season (the area AEFG).

We can provide some approximate values for the welfare gain from stabilizing nominal rates in the U.S. economy. We use the conventional money demand function

$$m_t - p_t = \theta_t - \beta(r_t + p_{t+1} - p_t)$$

where m_t and p_t are the logs of money and the price level, and r_t is the real interest rate. The term θ_t represents exogenous seasonal shifts in money demand, including those due to changes in output. We assume the economy is fully classical, so r_t is exogenous with respect to the determination of prices. We can therefore calculate the effects of alternative monetary polices on prices from the money demand equation. The solution for p_t is

$$p_t = (1+\beta)^{-1} \sum_{j=0}^{\infty} \left(\frac{\beta}{1+\beta}\right)^j (m_{t+j} - \theta_{t+j} + \beta r_{t+j})$$

Of course, the nominal interest rate is

$$i_t = r_t + p_{t+1} - p_t$$

which implies

$$i_t = \beta^{-1}(\theta_t - m_t) + [\beta(1+\beta)]^{-1} \sum_{j=0}^{\infty} \left(\frac{\beta}{1+\beta}\right)^j (m_{t+j} - \theta_{t+j} + \beta r_{t+j})$$

With these expressions for equilibrium prices and interest rates and estimates of the seasonals in money demand, we can compute the seasonal in nominal interest rates that would result from having the Fed make the nominal money stock non-seasonal, and we can compute the welfare gain from stabilizing nominal interest rates.

The procedure for calculating the effects on nominal interest rates and welfare is as follows. First, because the nominal interest rate has been essentially non-seasonal, we set the seasonal pattern in θ_t to equal the seasonal in real balances in post-war data. Second, for a given i* (chosen to equal the 1988 value of 6.7 percent per year), we compute the pattern in the growth rate of money required to produce that i*. Third, we compute the implied seasonality of interest rates for a constant money growth rate policy. Fourth, we calculate the seigniorage from each of these two policies. Fifth, we iterate to find the constant money growth rate that yields the same real seigniorage as the constant nominal interest rate policy. Finally, for this rate of money growth, we compute the welfare gain to interest rate stabilization (the increase in consumer surplus) as

$$\text{GAIN} = -\sum_{s=1}^{12} \int_{i_s}^{i^*} \exp(\theta_s - \beta i)\, di$$

To calibrate, we chose the average value of θ so that the money demand equation "fits" when evaluated at the 1988 average values of m (ln M1), p (ln CPI), and i (3-month Treasury bill rate). In addition, consistent with the results in Barsky and Miron (1988), we assume the real interest rate is non-seasonal; the calculations are invariant with respect to its value.

Table 1 shows the seasonal in nominal interest rates that would result from a non-seasonal money stock policy. The table also shows the welfare gain from stabilizing nominal rates, compared to stabilizing the money stock. We present the results for alternative values of the interest elasticity of money demand (which, evaluated at i*, equals βi^*).

Three results are apparent from these calculations. First, if the Fed adopted the policy of making the money stock non-seasonal, the nominal interest rate would be highly seasonal, perhaps with an amplitude as high as 500 basis points. Second, the welfare gain from stabilizing the interest rate is greatest when the interest elasticity of money demand is small, because under a constant money stock policy, the smaller the interest elasticity, the greater the seasonality in the nominal interest rate. Third, for any reasonable interest elasticity, the benefit of stabilizing interest rates is extremely small. Even in the most extreme case, the benefit of eliminating the seasonal in nominal interest rates amounts to less than $1.00 per person per year.

Table 1

The Welfare Gain from Interest Rate Smoothing

β	9	18	45
Implied Interest Elasticity at $i^*=6.7\%$	0.05	0.10	0.25
Nominal Interest Rate (annual rate)			
Jan	9.47	8.06	7.22
Feb	5.43	5.95	6.36
Mar	5.41	5.97	6.37
Apr	7.74	7.17	6.86
May	4.95	5.75	6.28
Jun	6.01	6.32	6.53
Jul	6.37	6.52	6.61
Aug	5.39	6.04	6.42
Sep	5.83	6.29	6.53
Oct	6.21	6.51	6.62
Nov	7.27	7.06	6.84
Dec	9.93	8.37	7.37
Welfare Gain in 1988 Dollars Per Person	0.32	0.16	0.07

Keynesian Arguments

Economists in the Keynesian tradition emphasize that economic fluctuations often reflect inefficient failures of coordination, and that monetary policy can potentially raise welfare by stabilizing these fluctuations. There are many models of fluctuations that fall within this tradition. Most of these models--including general disequilibrium models (Barro and Grossman 1971, Malinvaud 1977), labor contracting models (Fischer 1977, Gray 1976), and menu cost models (Ball, Mankiw, Romer 1988, Blanchard and Kiyotaki 1987)--give a role to monetary policy because prices are not completely flexible in the short run.

In evaluating whether these models are useful to understanding seasonal monetary policy, the key question is whether prices are flexible in response to deterministic seasonal fluctuations. Certainly, there are prices that do move over the seasons--the prices of vegetables and hotel rooms in the Caribbean are two examples. At the same time, Stephen Cecchetti's (1986) study of magazine prices and Anil Kashyap's (1988) study of catalog prices show that there are also many prices in the economy that are fixed for years at a time. These findings suggest that some firms exhibit nominal price rigidity in response to seasonal fluctuations in demand.

Microeconomic evidence on price rigidity is hard to evaluate in part because the implications for the overall economy are subtle. It may be sufficient that only some firms exhibit nominal rigidity to make the aggregate supply of goods and services highly elastic at a fixed nominal price. If other firms in the economy do not desire large changes in their relative prices--what Laurence Ball and David Romer (1990) call real rigidity--then a small amount of nominal rigidity can make the overall price level sticky.

If the price level is sticky over seasonal fluctuations, then seasonal monetary policy will likely be able to influence output and employment. This assumption is implicit in, for example, William Poole and Charles Lieberman's (1972) discussion of seasonal monetary policy. It is hard to say whether a policy of stabilizing output would be desirable, however. Keynesian economists typically presume that the level of output should be kept close to the natural rate level. But not all models of price rigidity imply that fluctuations are undesirable, even if the fluctuations would not have occurred in an economy with flexible prices. In some Keynesian models, booms raise welfare and recessions lower it, so the net effect of fluctuations on welfare is ambiguous (Ball and Romer 1989). The question for seasonal policy is whether the Fed should give up the high employment in the fourth quarter in exchange for higher employment in the first quarter.

In evaluating whether the Fed should make this tradeoff, the rate at which it can exchange output in high demand seasons for output in low demand seasons seems crucial. Many models adopt the natural rate hypothesis as a starting point, so that monetary policy can influence only the second moment of output, not the first. Yet economists are starting to question the natural rate hypothesis, asking whether monetary policy can raise output and employment during recessions without having an equal and opposite effect during booms (DeLong and Summers 1988). If, for example, firms face capacity constraints that are binding during the season of high output, then stabilizing demand can potentially raise the average level of output. This line of reasoning led Simon Kuznets (1933) to conclude that seasonal fluctuations in the real economy are socially inefficient. It is thus conceivable that stabilizing demand over the year might have substantial welfare benefits.

III. A Model of Seasonal Monetary Policy

In the previous section we addressed the normative question of whether the Fed's policy of smoothing interest rates over the seasons is desirable. Here we turn to the positive question of how a change in seasonal monetary policy would influence the behavior of the economy. In particular, what would happen to incomes, prices, and interest rates if the Fed were to pursue an alternative seasonal monetary policy, such as Milton Friedman's recommendation that the Fed remove seasonal fluctuations in the money supply?

Estimating how the economy would respond to a change in seasonal monetary policy requires a model of seasonal fluctuations. Yet, just as there is no model of the business cycle that would command a consensus among economists, there is no model of seasonal fluctuations about which all economists would agree. In some ways, the situation is even worse for seasonal fluctuations. Because the business cycle has received much attention from researchers over the years, there are many models--indeed, too many--from which one could choose. Seasonal fluctuations, on the other hand, have been largely ignored by researchers. There are, therefore, no models from which to choose when addressing a question of seasonal macroeconomic policy.

In this section we propose a simple model of seasonal fluctuations. We have three goals. First, we want the model to incorporate, as special cases, classical and Keynesian perspectives on seasonal fluctuations. Second, we want the model to highlight some of the important questions that must arise in any attempt to explain seasonal fluctuations. Third, we want to use the model to simulate, for alternative sets of parameter values, how a change in seasonal monetary policy would influence seasonal fluctuations.

The Elements of the Model

The model is intended to describe deterministic seasonal fluctuations in incomes, prices, and interest rates. All variables in the model are in logs (except for interest rates) and represent deviations from the annual mean. The model is composed of the following three equations:

$$m_t - p_t = \alpha y_t - \beta(r_t + p_{t+1} - p_t) + \epsilon_t^m \qquad (1)$$

$$y_t = -\lambda r_t + \epsilon_t^d \qquad (2)$$

$$y_t = \gamma p_t + \delta r_t + \epsilon_t^s \qquad (3)$$

where

m is the money stock,

p is the price level,

y is real output,

r is the real interest rate, and

ϵ^m, ϵ^d, and ϵ^s are the exogenous seasonal shifts in the three equations.

This model is conventional in many ways. Equation (1) says that the supply of real money balances equals the demand and that money demand depends positively on output and negatively on the nominal interest rate. Equation (2) says that the demand for goods depends negatively on the real interest rate. Equation (3) says that the supply of goods depends positively on the price level and positively on the real interest rate.

If γ equals zero, then the model is a classical model similar to the one presented, for example, in Robert Barro's (1990) textbook. The supply of output depends positively on the interest rate because the interest rate influences intertemporal substitution in leisure: the higher the real interest rate, the higher the cost of leisure today relative to leisure in the future and thus the greater the supply of labor. Because equations (2) and (3) by themselves determine output and the real interest rate, the money supply influences the price level and the nominal interest rate but not any real variable.

If δ equals zero, then the model resembles a textbook Keynesian model. Equation (1) describes the LM curve and equation (2) describes the IS curve. Equation (3) describes the short-run aggregate supply curve. Because some wages or prices are sticky, increases in aggregate demand raise both prices and output. The slope of the aggregate supply curve (the parameter γ) determines how changes in aggregate demand are split between prices and output.

We can represent both of these special cases on a familiar diagram of aggregate demand and aggregate supply, as in Figure 3. The quantity of output is on the horizontal axis and a "price" is on the vertical axis.

The definition of "price", and the interpretation of this figure, depends on the case being assumed.

In the classical case, the "price" in Figure 3 is the real interest rate. The aggregate demand curve represents goods demand (equation 2), and the aggregate supply curve represents goods supply (equation 3). When discussing the determination of output in the classical model, we can safely ignore the money market equilibrium condition (equation 1).

In the Keynesian case, the "price" in Figure 3 is the price level. The aggregate demand curve represents the joint solution to the LM and IS curves (equations 1 and 2). The aggregate supply curve again represents goods supply (equation 3), but now goods supply depends on the price level rather than the real interest rate.

The Lesson from Christmas

With this model in mind, consider the impact of Christmas on the economy. Christmas causes an exogenous increase in the demand for goods and services--that is, a large value of ϵ^d. This exogenous increase in demand shifts out the aggregate demand curve, as shown in Figure 4. What we should observe, therefore, is an increase in output and an increase in the "price."

What is actually observed, however, is puzzling from both classical and Keynesian perspectives. As the model predicts, the economy does experience an increase in output around Christmas: the seasonal pattern of real GNP reaches its peak in the fourth quarter when it is 4.3 percent above the annual average. Yet there is no evidence of an increase in "price" under any interpretation. As Barsky and Miron (1989) document, there is little seasonality either in market interest rates or in aggregate price indices.

There are two ways to reconcile the model with the facts. The first is to posit that the exogenous shift in aggregate demand just happens to coincide with an exogenous shift in aggregate supply. This explanation would be plausible if, for example, students' summer vacation from school occurred in the fourth quarter rather than in the third, implying a large increase in labor supply. Yet we can think of no important event that can explain such a large shift in aggregate supply in the fourth quarter.

The second and more plausible way to reconcile the model with the facts is to posit that the aggregate supply curve is infinitely elastic. Many economists have in the past suggested that aggregate supply is highly elastic over the business cycle (Hall 1986, Murphy, Shleifer, and Vishny 1989). This assumption is even more compelling for seasonal fluctuations, because these are more transitory than business cycle fluctuations.

An economist with a classical perspective could argue that aggregate supply is highly elastic because people are very willing to substitute leisure intertemporally over short periods of time. Workers may be happy to reschedule vacations or overtime from one month of the year to another in response to small incentives. Real business cycle models often incorporate this sort of high intertemporal substitution over short periods with non-time-separable utility functions (Kydland and Prescott 1982). For our simple model of seasonal fluctuations, these considerations argue that the supply parameter δ is very large.

An economist with a Keynesian perspective could argue that aggregate supply is highly elastic because firms do not alter their prices in response to temporary fluctuations in demand. This high elasticity arises if some firms have fixed prices (nominal rigidity) and if the remaining firms desire little change in their relative prices in response to temporary changes in output (real rigidity). In our model of seasonal fluctuations, we can represent this stickiness in the price level by making the parameter γ very large.

Regardless of whether one accepts the classical or Keynesian interpretation of events, monetary policy has an important role in completing the story of seasonal fluctuations. In the classical case, a flat aggregate supply curve ensures that seasonal changes in demand do not alter the real interest rate. Monetary policy must be acting to prevent prices and nominal interest rates from fluctuating seasonally. In the Keynesian case, a flat aggregate supply curve ensures that seasonal changes in demand do not alter the price level. Monetary policy must be acting to prevent nominal and real interest rates from fluctuating seasonally. In both cases, the Fed's smoothing of nominal interest rates is crucial for explaining observed seasonal patterns.

Calibrating the Model

So far we have suggested that aggregate supply is highly elastic over seasonal fluctuations. We therefore calibrate the model assuming infinitely elastic supply. In the classical simulations, δ is set to infinity; in the Keynesian simulations, γ is set to infinity. In both cases, the values of the other supply parameter and the supply shock ϵ^s do not matter.

The next step is to choose values for the parameters α, β, and λ. We choose these based on our reading of the relevant literature. We admit, however, that the literature gives us less guidance than we would like.

For the money demand equation (1), we follow Miquel Faig's (1989) suggestion that the money demand function is non-seasonal--that is, that ϵ^m equals zero. Because the nominal interest rate is essentially non-seasonal, all fluctuations in real balances therefore come from changes in output. As Faig points out, this restriction allows one to estimate α, the elasticity of money demand with respect to output, using the seasonal variation in the data. We use Faig's estimate of α of 0.25 in the simulations.

The value of the interest semi-elasticity of money demand, β, is chosen so that the interest elasticity of money demand, evaluated at the 1988 value of the nominal rate, is .1. This value is on the low side of the range in the literature. But, since we are analyzing only transitory fluctuations, and since many estimated money demand equations imply slow adjustment, a low estimate seems reasonable.

The most difficult parameter to choose is the elasticity of demand with respect to the real interest rate. We set λ to be 12. This value implies that if the real interest rate (measured at an annual rate) rises by 100 basis points, the demand for goods and services falls by 1 percent.

This leaves us to choose ϵ^d, the seasonal shift in the demand for goods and services. Because the real interest rate is essentially non-seasonal, seasonal fluctuations in output must reflect seasonal fluctuations in ϵ^d. We therefore set the seasonal in this error term equal to the current seasonal in output, which we proxy with real retail sales.

Simulations of Alternative Monetary Policies

We now use the model to simulate the effects of two policies. The first adjusts the money stock to hold the nominal interest rate constant; this approximates current policy. The second holds the money stock constant, letting the nominal interest rate be whatever is required to fit the model. Figure 5 show the effects of these two policies on the nominal interest rate under the classical assumption that real output and the real interest rate are determined independently of monetary behavior. Figures 6 and 7 show the effects of the two policies on the nominal interest rate and real output under the Keynesian assumption that the price level is predetermined.

Both sets of simulations show that, if the Fed stopped stabilizing the seasonal in nominal rates, interest rates would be extremely seasonal. In both simulations, the implied amplitude of the seasonal cycle in nominal rates is about 500 basis points. Of course, the exact magnitude of the cycle depends on the parameters used to conduct the simulations. A decrease in the income elasticity of money demand, or an increase in the interest elasticity, for example, implies a cycle of smaller amplitude.

It is noteworthy that the magnitude and timing of the cycle are extremely similar across the two extreme assumptions about the behavior of the economy. Evidently one does not have to decide whether one is classical or Keynesian to have a good idea of what would happen to nominal rates if the Fed altered its seasonal monetary policy.

We see in Figure 7 that, even under the extreme Keynesian assumption that the price level is predetermined, the policy of holding the money stock constant does not have a quantitatively large impact on real output. The explanation is that our choice of parameters, and any choice consistent with the range of estimates in the literature, makes the interest elasticity of the demand for goods relatively small, implying that the IS curve is steep. A steep IS curve seems even more plausible for seasonal fluctuations than for business cycle fluctuations because many catagories of demand would plausibly not respond to clearly transitory variation in the short-term interest rate. (Inventory investment is the most likely exception, because it is the most quickly reversible form of capital accumulation.) Therefore, the model implies that interest rate stabilization has a relatively small effect on output.

One might also ask, under the Keynesian parameterization, what monetary policy would stabilize output over the seasons. We find that output stabilization would require a huge seasonal in the interest rate. For our parameters, the amplitude of the interest rate seasonal would need to be 3000 basis points. Again, this conclusion arises because the current seasonal in output is large, and the response of demand to the short-term interest rate is small. Therefore, large changes in the interest rate are required to exert much influence on output.

IV. What Can We Learn from the Monetary Changes in 1914?

The model simulations suggest the kinds of effects that alternative policies towards seasonal fluctuations might have. Yet this exercise cannot settle the question of what effects alternative policies actually would have. In this section we present evidence on the effects of the

Fed's policy on the actual behavior of the economy. The founding of the Fed in 1914 provides a natural experiment for examining the effects of alternative policies. As we discussed in Section I, the nominal rate was strongly seasonal before 1914 but much less seasonal afterwards. Here we examine whether this change in the seasonality of the nominal rate was accompanied by a change in the seasonality of real variables.

We begin with the most important real variable--output. The output series we examine is the monthly index of industrial production presented in Miron and Romer (1990). This series is a weighted average of the production of thirteen industrial products, such as pig iron, anthracite coal, textiles, and food products such as sugar, beef and pork.

Although this output series is the best available for our purposes, it is not perfect. In many cases the index uses data on shipments or purchases of raw materials to proxy the output of a particular commodity. It is therefore difficult to assign a precise interpretation to the timing of the seasonal peaks and troughs in the index. For example, output of anthracite coal is proxied with shipments, so the peak in the index lags the true peak; similarly, output of coffee is proxied with imports of coffee beans, so the peak in the index leads the true peak. Under the null hypothesis that monetary policy is neutral, however, there is no reason to suppose that these timing relationships changed with the introduction of the Federal Reserve. Therefore, the index should be useful for examining whether there was a significant change in the real behavior of the economy in 1914.

Figure 8 shows the estimated seasonal in the log of real output for the two periods: 1890:2-1914:11 and 1919:1-1928:12. The seasonals in the level of output are computed by first estimating the seasonal pattern in the growth rate and then integrating seasonal coefficients for the growth rates to form an estimate of the seasonal in the level. The results are, however, robust to alternative ways of estimating the seasonal pattern: our estimates are almost identical to those obtained from the detrended log level of output, where the detrending consists of regressing out a quadratic trend.

The figure shows that the estimated seasonal is noticeably different in the two sample periods. We can strongly reject the hypothesis that the seasonal pattern in the growth rates remains constant over the two samples. (This is true even allowing the mean growth rate in the two samples to differ.) Moreover, the seasonal in output is larger under the post-1914 policy of interest rate smoothing, as one would expect if money is non-neutral because of Keynesian price rigidities.

The size of the change in the seasonality of output is surprising. Our simulations above suggest that interest rate smoothing should have only a small effect on output, even under the Keynesian assumption of predetermined prices. Yet Figure 8 shows that the change was large. It is possible that our parameter measuring the response of goods demand to the interest rate (λ) is too small for the subset of goods in the Miron-Romer index. A larger value of this parameter would imply a greater effect of interest rate smoothing.

We have also examined the seasonal behavior of real interest rates before and after 1914. Although point estimates of the seasonal pattern change dramatically and suggest a smoothing of real rates after 1914, the data are so noisy that one cannot reject any interesting hypothesis about the seasonal patterns. This finding is consistent with the results in the literature (Shiller 1980, Barsky, Mankiw, Miron and Weil 1988).

Overall, the natural experiment of the founding of the Fed appears consistent with the view that seasonal monetary policy is non-neutral. In particular, the data show a significant increase in the seasonality of real output after 1914. Undoubtedly, there can be other possible explanations for this change, just as there have been other explanations for the change in the behavior of interest rates in 1914. Yet this episode leaves open the possibility that alternative seasonal monetary policies can influence the seasonal business cycle.

V. Conclusion

Since the Federal Reserve began operations in 1914, its policy has been to smooth nominal interest rates over the year. Under this policy, neither the overall price level nor the real interest rate has exhibited a significant seasonal pattern, while real output and employment have exhibited substantial seasonal fluctuations. Our goal in this paper has been to discuss whether this policy is desirable and how the economy would be different if it were changed.

With economists' current understanding of fluctuations, and especially seasonal fluctuations, any analysis of alternative seasonal monetary policies must be tentative. To evaluate the policy now in effect, or alternative ones that the Fed might consider, there is a crucial issue that must be addressed before all others. Would introducing a seasonal pattern in the nominal interest rate cause a seasonal pattern to emerge in the real interest rate? Or would such a policy merely induce a seasonal pattern in inflation that would mirror the seasonal in the nominal interest rate? In other words, does seasonal monetary policy have real effects?

If one gives the classical answer that seasonal monetary policy cannot influence real variables, then the current policy of smoothing nominal interest rates is probably optimal. The nominal interest rate is the implicit tax on holding real money balances. Because it would be inefficient to make this tax rate vary over the year, the Fed should smooth the nominal interest rate, as it has done. The benefits to this policy, however, are probably very small. Compared to a policy of a non-seasonal money stock, a policy of a non-seasonal nominal interest rate raises welfare by less than $1.00 per person per year.

One might give a more Keynesian answer that seasonal monetary policy can influence the real interest rate and, therefore, output and employment. Many economists believe that wage and price rigidities are important for understanding the business cycle in general and the short-run effects of monetary policy in particular. If these rigidities are also important for understanding the seasonal cycle--and the evidence from 1914 suggests they might be--then there is no reason to presume that the seasonal fluctuations in output and employment are optimal or unalterable. Making welfare judgments about alternative monetary policies in the presence of price rigidities is a difficult task that we leave for future research.

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Figure 1: Seasonal in Nominal Interest Rate

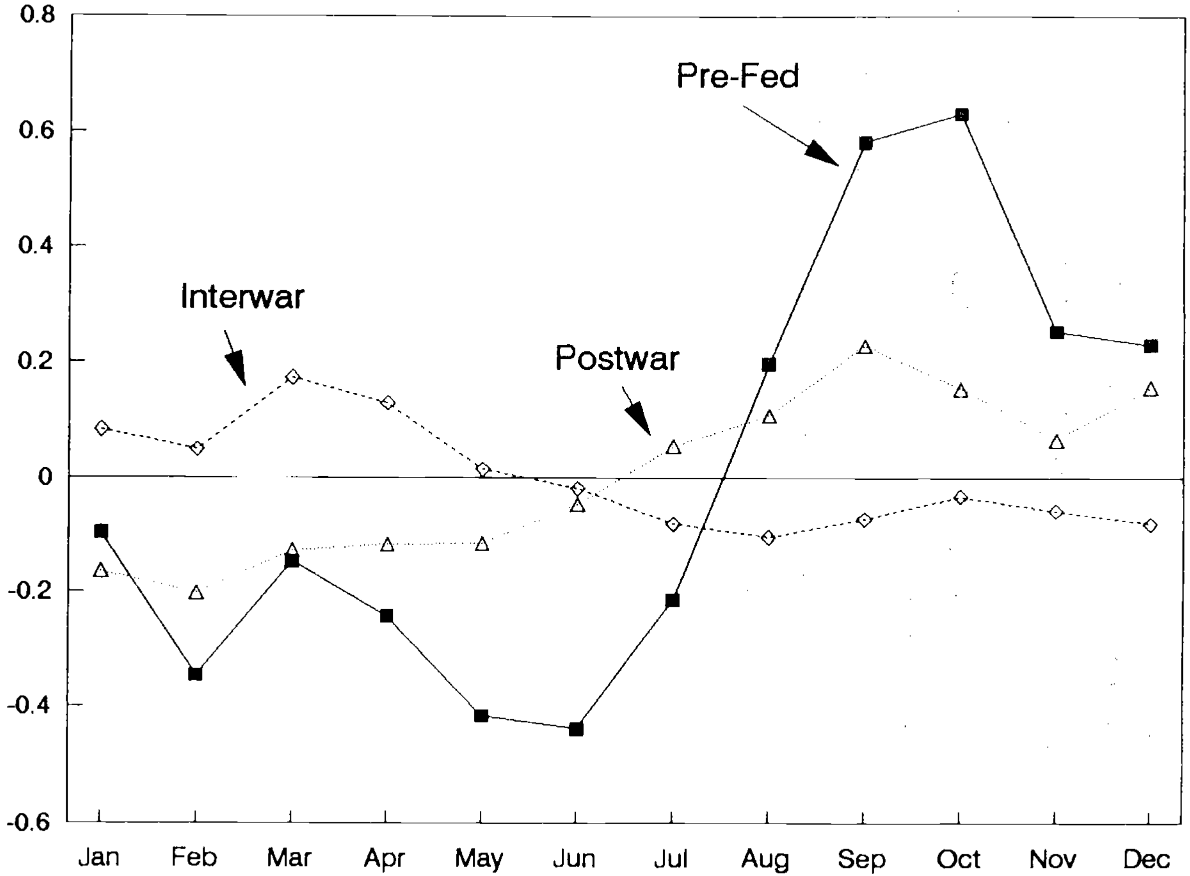

Figure 2: Welfare Effects of Stabilizing Nominal Interest Rates

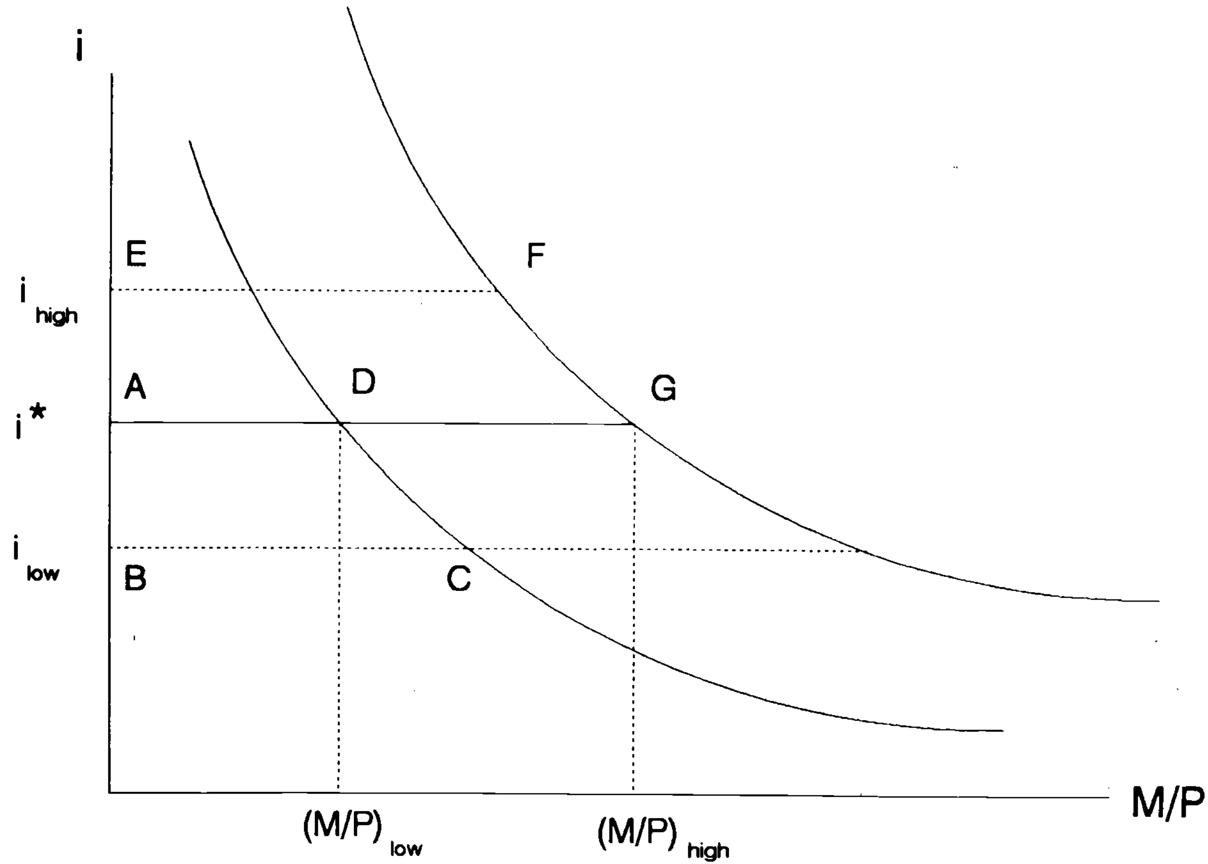

Figure 3: Aggregate Supply and Demand

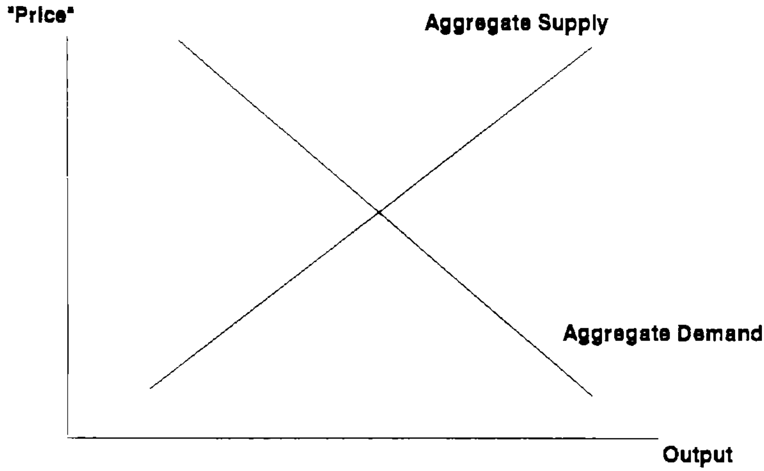

Figure 4: Alternative Aggregate Supply Assumptions

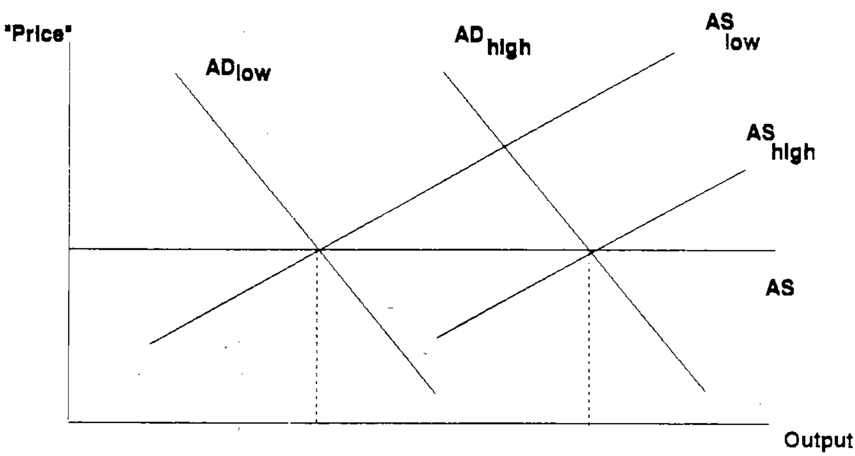

Figure 5: Seasonal in Nominal Interest Rate, Classical Case

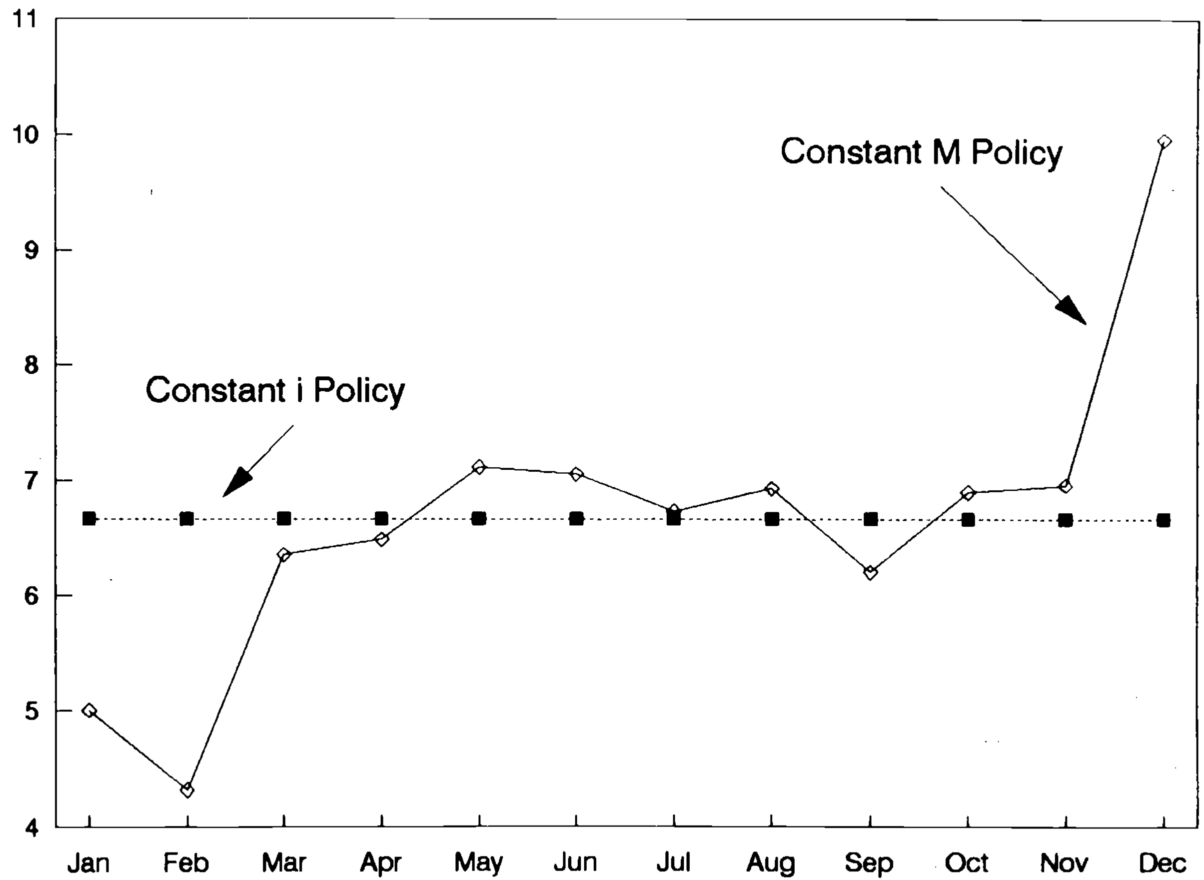

Figure 6: Seasonal in Nominal Interest Rate, Keynesian Case

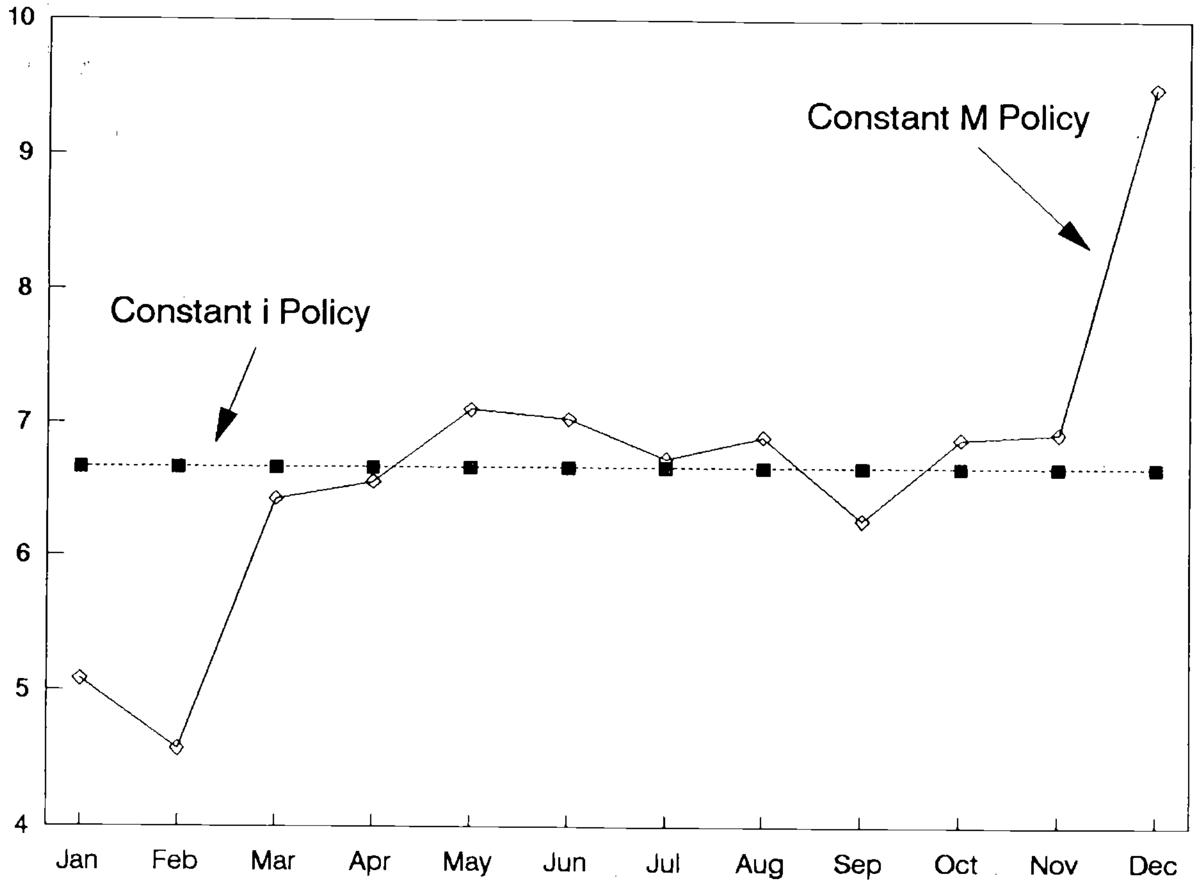

Figure 7: Seasonal in Real Output, Keynesian Case

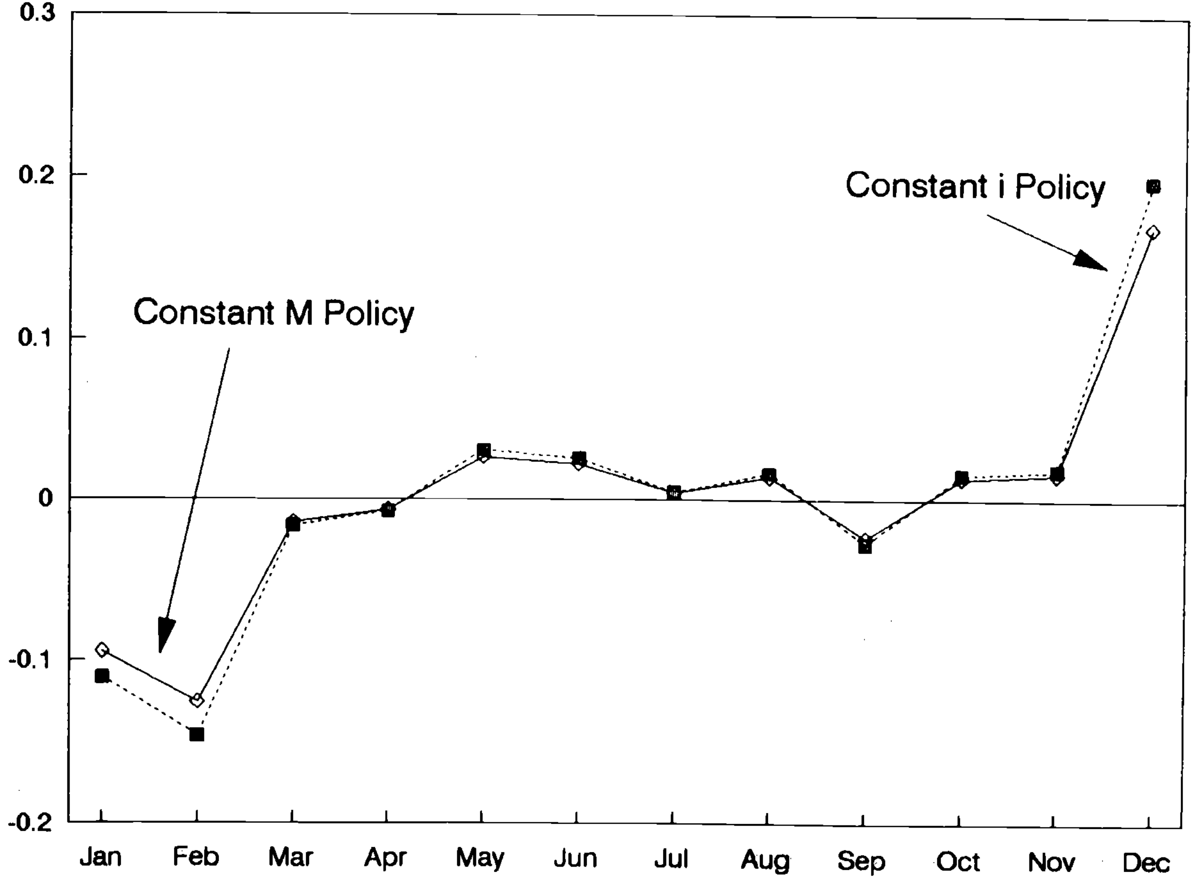

Figure 8: Seasonal in Real Output, Pre- and Post-Fed