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Simple Models of the Funds Rate in USA, and Some Implications for Monetary Policy

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INTRODUCTION

This paper reviews and modifies some simple macro-models of the Federal Funds Rate in USA (or simply the funds rate). In Section 1 the importance of and determinants of the funds rate are discussed, followed by a brief discussion of the historical relation between the funds rate and the discount rate. Section 2 reviews some simple macromodels of the funds rate, and points out their important weaknesses. Section 3 contains the main-contribution of this paper in the form of some modifications of the models reviewed in Section 2, under various assumptions about the Fed's behaviour. Section 3 concludes with some implications of the results for the monetary policy.

THE FUNDS RATE

Federal Funds are short term loans of "Immediately Available Funds" including deposits at the Fed (the Central Bank of USA) not subject to reserve requirements, and collected liabilities of commercial banks and other depository institutions.

Several authors have proposed various reasons for the importance of the funds market. Some of these reasons are: (a) The Funds Market is the largest of the US domestic money markets, (b) Fed Funds are the most liquid of all financial assets, (c) The funds rate is the closest thing to an instantaneous spot rate observed in the actual financial market, and (d) The funds are the shortest maturity instruments with huge volume of transactions.

DETERMINANTS OF THE FUNDS RATE

The funds rate is market-determined, unlike the officially fixed discount rate. It is highly responsive to changes in the cost of alternative forms of bank borrowing, especially the discount rate, the T-bill rate, and the Eurodoller rate. Another determinant of the funds rate (from the demand side) is the financing needs of government securities delears.

The central bank can influence the funds rate in a variety of ways:

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(a) Open Market Operations: As illustrated by Wood and Wood for the year 1978 the Fed in US was able to control the funds rate within a narrow margin by monetary policy actions which change bank reserves (a supply side action).

(b) Discount Rate Changes: The central bank can also affect the funds rate through discount rate changes (a demand side action).

(c) Noninterest Costs: The central bank can affect the funds rate by changing the noninterest costs imposed on discount window borrowings.

(d) Monetary Policy Changes: Perhaps the most important determinant of fluctuations in the funds rate is the focus of monetary policy. For instance, when the focus US changed from interest rate targetting to Reserve targetting in October 1979, there was a dramatic increase in the fluctuations in the funds rate.

HISTORICAL RELATION BETWEEN THE FUNDS RATE AND THE DISCOUNT RATE

Until the later half of the 1960s it was widely believed in USA that the funds rate would not move above the discount rate because, if it did, banks would substitute cheaper discount window borrowings. For a substantial period during the 1960's the funds rate behaved as if such substitution was tasking place. But the funds rate has been above the discount rate for much of the period since 1965 when for the first time it exceeded the discount rate. Lucas et al. have tried to explain this trend in the following way:

In USA there has been a steady rise in liability management practices since the early 1960's. Since frequent borrowing at the discount window (which is supposed to be available mainly for short term adjustments) could not be done, banks using Fed Funds for liability management continued bidding for Fed Funds, and the rate rose and exceeded the discount rate. This type of explanation is consistent with the so-called "reluctance to borrow hypothesis". But there is much evidence against this hypothesis. In fact, it is the central bank's "reluctance to lend" type discount window policy that prevents banks from borrowing all they desire through the window.

MODELS OF THE FUNDS RATE

Macro vs. Micro Models

There are two types of models found in the literature. Some models use an aggregative framework without explicit reference to the actual market in which the funds are traded. P.A. Spindt argues that this type of analysis does not embody enough institutional detail to be useful for studying the relationship between the funds rate and other short-term rates or for analyzing interesting variations in monetary policy.

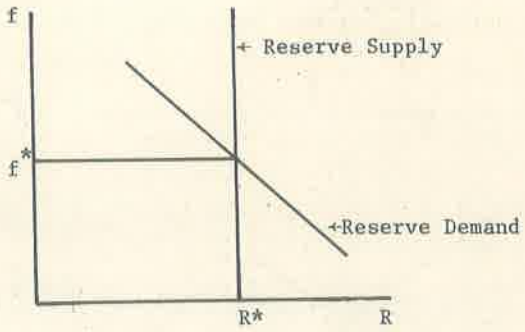
Then there are other models which try to explicitly consider the behaviours of actual market participants including the banks, in order to analyze the underlying or micro determinants of the funds rate. But a serious problem with micro models which want to explain the behaviour of macro variables is that of aggregation. Quite often do economists trying to explore the micro foundations of macro variables commit the infamous 'fallacy of composition'. Moreover, it is often the case that the exogenous variables in micro models alter their role to become endogenous variables when applied in macro framework, leading to the problem of simultaneous casualty.

Therefore, in the following we will review some models of the macro type, although the tool of analysis will be the demand and supply in a single market, that is, the partial equilibrium method of microeconomics.

Model I: Funds Rate Without Discount Borrowings:

Goodfriend, and Goodfriend and Whelpley have developed a simple model in which the funds rate is completely determined as that value which equilibrates the aggregate supply and demand for banking system reserves. The demand for bank reserves is negatively sloped in relation to market interest rate as shown in Figure 1.

Figure 1
Funds Rate without Discount Borrowing



The authors try to explain the negative slope by the fact that the market rate of interest is the opportunity cost of holding checkable deposits. As this cost rises the public's demand for checkable deposits falls which in turn reduces the aggregate demand for bank reserves. But this explanation is inadequate because demand for reserves would slope downwards even if deposits were fixed. The demand for reserves does not arise only in connection with the demand for required reserves created by the public's demand for checkable deposits. Moreover, the demand for reserves would be negatively related to its price as any other demand because a rise in price for reserves would make banks less willing to increase loans unless the rate earned by banks also rises.

The aggregate stock of reserves available to the banking system is under the control of the central bank, that is, exogenously given to the banking system at some level say R*. The intersection of the two aggregate forces determines the market clearing funds rate, f*.

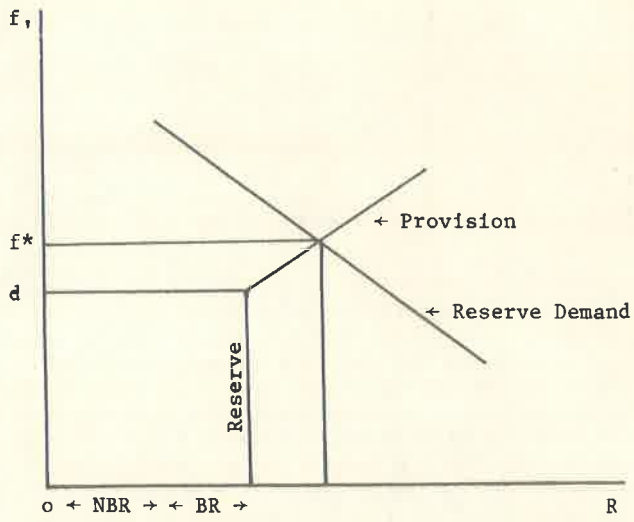
Under the total reserve targetting the funds rate would be allowed to rise and fall with the shifts in the aggregate reserve demand. However, in practice, the Fed in US has almost always targetted the funds rate instead of the total reserve. Under the funds rate targetting the market forces affect only the volume of reserves which is to be supplied to or withdrawn from the banking system by the open market purchases and sales of the Fed. In that case the supply curve of reserves would be horizontal rather than vertical.

Model II: Funds Rate with Discount Borrowings:

Goodfriend and Whelpley introduce discount window borrowing into the simple model described above. In this case reserves are provided in two forms - as Nonborrowed Reserves (NBR) through open market operations, and as Borrowed Reserves (BR) through the discount window lending.

The following figure reproduced from Goodfriend and Whelpley shows that discount window borrowing plays a role in determining the funds rate whenever the Fed restricts the supply of NBR so that the funds rate exceeds the discount rate.

Figure 2
Funds Rate with Discount Borrowing



The reserve provision locus is vertical up to the point where the funds rate equals the discount rate (d), and is sloped positively above the discount rate. The reason is that below d the banking system has no incentive to borrow from discount window, whereas above d the noninterest costs of borrowings imposed by the Fed increases with the size of borrowing.

The main weakness of the above model is that the Reserve Provision locus is not a simple supply curve for total reserves unlike the total reserves in Figure 1. It is a combination of supply of reserves by the Fed and the demand for borrowing by the banking system both combined into one. Hence the demand and supply analysis used seems to be incorrect because the forces determining the demand for reserves affects both the demand curve and a part of the supply curve, leading to the problem of identification.

MODIFICATIONS OF THE MODELS

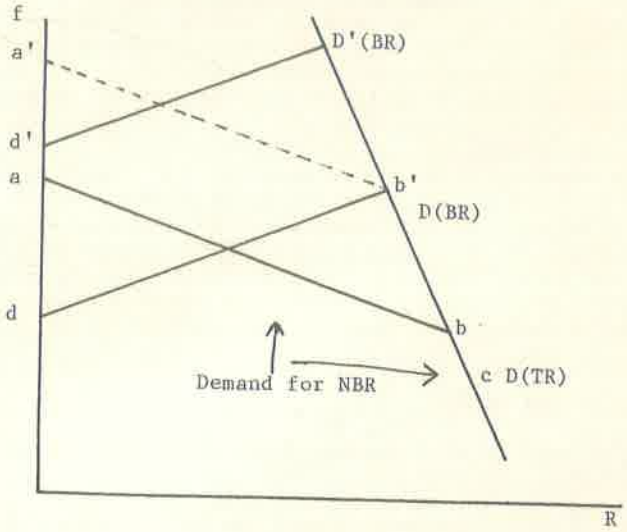
In this section we will improve Model II in many directions. First, we will explicitly take into account the two components of total reserves demand to derive what may be called the "Residual Demand" for the Fed Funds. Next, we will introduce various behavioural modes of the central bank with regard to its discount window policy. Discount window policy involves any measure by the central bank affecting the cost and availability of the central bank's credit. It includes both changes in the discount rate and changes in the conditions of access and noninterest costs to central bank credit.

Model III: Residual Demand for Federal Funds:

In this model we assume that the Fed targets NBR and also imposes increasing noninterest costs upon increased borrowings through the discount window. As above, the demand for total reserves is negatively related to market rate of interest and is shown by the D(TR) schedule in Figure 3. The demand for borrowed reserves is shown by D(BR) and is zero until f (the funds rate) rises to the discount rate, d. Above that level D(BR) is upward sloping because the demand for BR increases as the opportunity cost (the spread f-d) for NBR increases. However the steepness of D(BR) depends on the cost imposed by nonprice measures used by the Central Bank to limit the amount of borrowing. Thus the D(BR) schedule shows the equilibrium levels of borrowings when marginal benefit of savings on the funds rate is balanced by the marginal cost including both the discount rate and the noninterest costs. For an evidence of strong positive relationship between the spread f-d and discount window borrows,

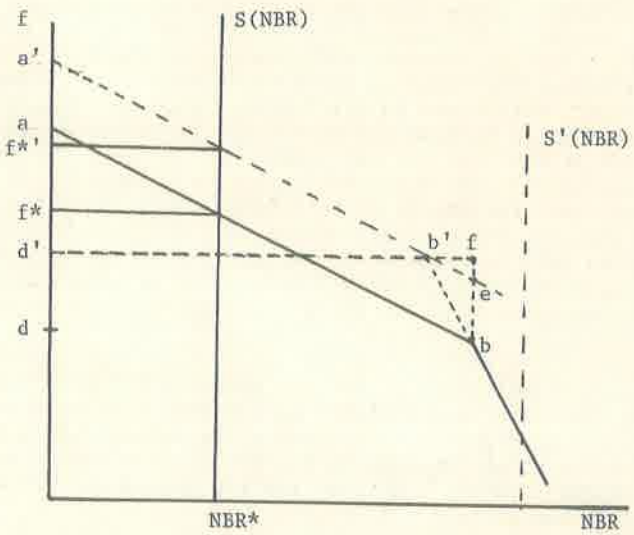
The horizontal difference of the two curves D(TR) and D(BR) gives the demand for NBR which is the kinked line D(NBR) passing through the points a, b, and c in Figure 3. At point a the spread f-d is so high that all demand for total reserves is met by discount window borrowing. The dotted line and points a', b' show the new demand for NBR when the discount rate is changed to d'.

Figure 3
Residual Demand for Fed Funds



Now we combine D(NBR) with the supply of NBR under the assumption that the supply of NBR, shown by S(NBR) in Figure 4, is exogenously determined by the Fed. Note that D(NBR) is relatively more elastic above the current discount rate d, because the discount borrowing becomes a substitute (although imperfect) for fed funds when the spread f-d is positive.

Figure 4
The Funds Rate Determination



In the above figure, the intersection of D(NBR) and S(NBR) gives the equilibrium funds rate f* which can also be below d if the supply of NBR is increased to S'(NBR).

Some important implications of this model are as follows:

(a) If the central bank keeps its target level of NBR at NBR* and increases the discount rate to d', then the funds rate increases (to f*'). Comparing the distances dd'=bf and aa'=be, we see that the change in the funds rate is less than the change in the discount rate. Goodfriend and Whelpley also find a similar result.

(b) When the equilibrium rate is below the discount rate as in the case of S'(NBR), then a marginal change in the discount rate has no effect on the funds rate - another result similar to Goodfriend and Whelpley.

(c) When the equilibrium rate is above the discount rate, a given change in the funds rate requires a larger change in the supply of NBR compared to the situation when the equilibrium rate is below the discount rate. This is clear from the different elasticities in the two branches of D(NBR). One implication of this result is that the Fed has more control over the interest rate when the equilibrium rate is below the discount rate.

(d) Consider Figures 3 and 4. The larger is the noninterest cost imposed on the discount borrowings, the steeper is the section ab of D(NBR) above d. And the steeper is ab, the more control the central bank has over the interest rate (that is, the Fed requires to bring about a smaller change in the supply of NBR to cause a given change in the funds rate). This is so because the discount window borrowing becomes a less and less attractive substitute for Fed funds as the noninterest costs of borrowing are increased, and therefore the funds rate becomes more and more sensitive to the availability of fed funds, which is pretty much under the control of the central bank.

(e) For a given discount rate and a given supply of Fed Funds, the higher is the noninterest cost associated with discount window borrowing the higher is the funds rate. This follows directly from the discussion in (d) and by noting that increased noninterest cost implies reduced D(BR) and increased D(NBR).

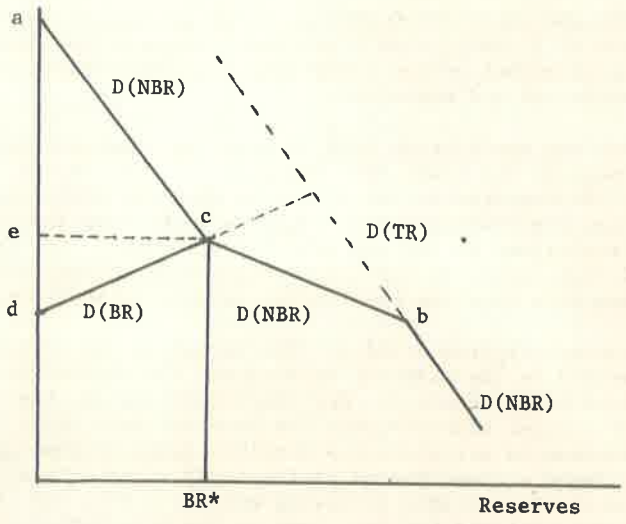
(f) If the central bank targetted the funds rate [say at f*, then the S(NBR)] line would be horizontal, and the discount rate would be irrelevant for the funds rate determination, but changes in discount rate would bring about large swings in NBR.

In the next subsection we will study the model described above under the assumption that the central bank puts a ceiling on BR.

Model IV: Funds Rate with Ceiling on Borrowing:

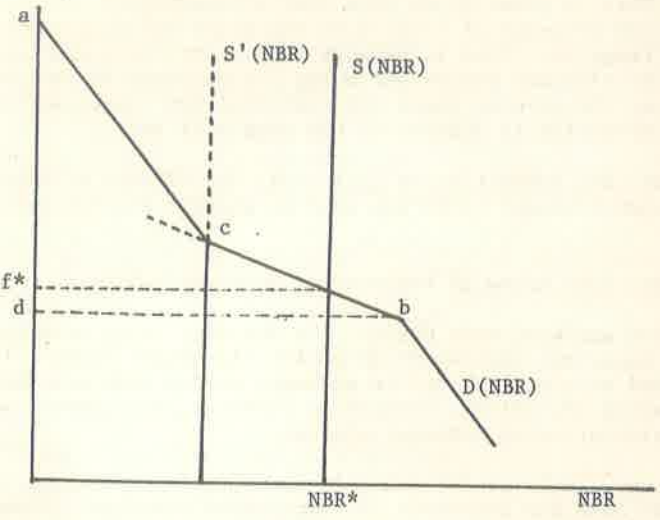
Suppose the central bank not only imposes a noninterest cost of borrowing increasing with volume, but also puts a ceiling on borrowings through the discount window. In that case the demand for BR and the resultant demand for NBR look as in Figure 5.

Figure 5
Ceiling on BR and the Demand for NBR



The level BR* is the ceiling for BR. We see that D(NBR) has two kinks, the first at point b, and the second at point c, and thus passes through points a,c,b. Using this form of D(NBR) we have the following funds rate determination diagram. Note that the points on D(NBR) to the right of the second kink correspond to the levels of the funds rate at which the ceiling on BR is nonbinding. Conversely, the points to the left (or above) of the second kink c, correspond to the level of the funds rate at which the ceiling is effectively working as a constraint.

Figure 6
The Funds Rate with Ceiling on BR



Some of implications of this model are:

(a) If the ceiling on BR and the supply of NBR are such that the equilibrium rate occurs at points far off from the second kink level (which is likely when the ceiling is relatively high and the supply of NBR is sufficiently large-making the ceiling non-binding), then a marginal change in the ceiling has no effect on the equilibrium rate.

(b) Conversely, when the ceiling is relatively low and so is S(NBR) such that the equilibrium occurs in the neighbourhood of c (say slightly to the left), then a slight change in the ceiling for BR has a significant impact on the funds rate. For example, when the supply is S'(NBR), then a small increase in the level of BR made accessible to the banking system (would move point c to the left and) would lower the equilibrium rate.

(c) The funds rate is more sensitive to changes in the target level of NBR when the ceiling and S(NBR) are relatively low such that the equilibrium occurs to the left of the second kink c, or when the supply of NBR is so large that the equilibrium occurs to the right of the first kink b. Thus we can say that the elasticity of the funds rate with respect to changes in the supply of NBR is low when the ceiling on BR is nonbinding and the supply of NBR is not too large - an intuitive result.

(d) By lowering the ceiling on BR the central bank can expand the range of funds rate levels over which it has strong controls. This is clear if we note that a lowering of ceiling on BR implies movement of point c to the right and a narrowing of the range cb. This is because more restrictive and binding ceilings on discount window borrowing forces banks to rely more heavily on the federal funds and therefore the funds rate becomes more sensitive to changes in the supply of NBR.

In the next subsection we will study the effects of discount rate changes, when discount rates are used as signals for coming monetary policy.

Model V: Discount Rates as Precusor of Monetary Policy:

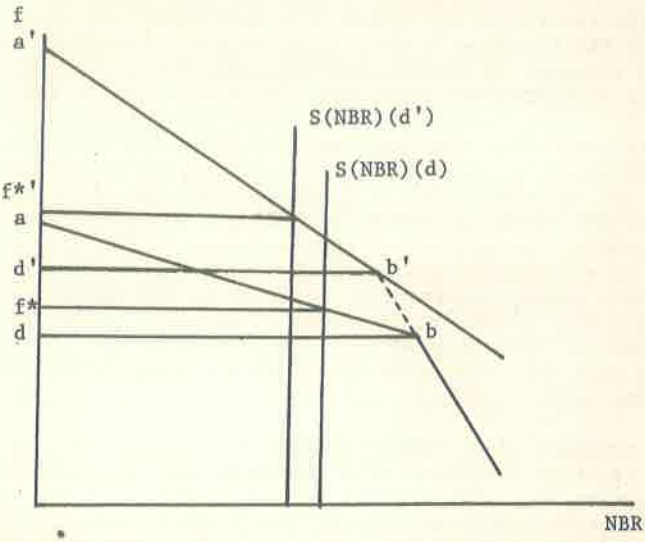
As Wood and Wood have argued, the discount rate, although not by itself an important instrument of policy (in recent years), has been frequently used to signal shifts in monetary policy that are then implemented by open market operations, changes in reserves requirement, and more-or-less administration of discount windows.

Although a multiperiod analysis is suitable to analyze this problem, we will use here the technique of comparative statics. If we consider a long enough period of say 3 months in our model so that we can assume that a change in discount rate is accompanied by a reinforcing change in monetary policy within the period, then Model III can be modified in two alternate ways. First, we assume that the banks do not incorporate the implied change in monetary policy into their expectations - not a very realistic assumption. Alternatively, we assume that the banks do adjust their behaviour according to the expected change in monetary policy announced through the change in the discount rate.

Case I: In the first case the supply of NBR is assumed to be a function of the discount rate. An upward change in the discount rate is supposed to be accompanied by a reduction in the supply of NBR, and conversely for a downward change in the discount rate. Moreover, we assume that an upward change in the discount rate is accompanied by more stringent administration of the discount window and increased noninterest costs imposed on discount borrowing.

The first assumption implies that an increase in the discount rate is accompanied by a leftward shift in the S(NBR) schedule. The second assumption implies that an increase in the discount rate is followed by a steeper slope of the kinked portion of the D(NBR) schedule. Both of these changes imply that an upward revision of the discount rate causes a significant jump in the funds rate as illustrated in the following figure:

Figure 7
Discount Rate as Precursor of Monetary Policy



The important difference in results between the present Model and Model III is made clear by comparing Figures 4 and 7. According to Figure 4, a 1 percent increase in the funds rate requires a more than one percent change in the discount rate. But Figure 7 shows that a 1 percent increase in the discount rate when followed by reinforcing changes in monetary policy, leads to substantially larger increase in the funds rate. This result is different from that of Goodfriend and Whelpley too.

Another important difference in results is that discount rate changes are not irrelevant for the funds rate even when the equilibrium rate occurs below the current discount rate. This is because of the changes in S(NBR) and other monetary policy instruments following a change in the discount rate. Thus the discount rate always retains its relevance at least as a harbinger of coming monetary policy.

Considering the point made in the previous paragraph it seems unlikely that the banking system ignores the message embodied in the changes in discount rate. Therefore, in the following we will study the case when the banking system reacts to such message.

Case II: Suppose the banking system looks at a change in the discount rate as a forerunner of coming monetary policy changes. According to the concept of Rational Expectations, (money) market participants form expectations of future prices and interest rates partly on the basis of their observations of Fed actions. Wood and Wood argue that, if market participants believe that discount rate increases tend to precede contrac-

tions of Fed credit and the money supply, their inflationary expectations will be revised downward, putting a downward pressure on interest rates.

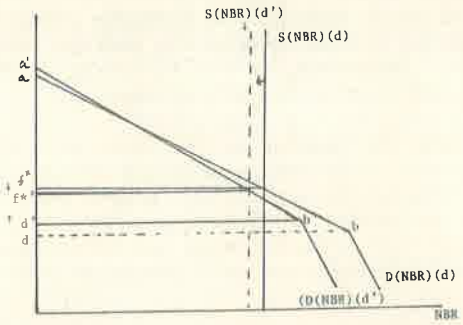
In the context of our Model III, such behaviour would imply that the demand for NBR schedule is also a function of changes in the discount rate. An increase in the discount rate would cause a leftward [(or downward shift in D(NBR)] and conversely for a decrease in the discount rate.

It is clear that the resultant change in the funds rate becomes theoretically ambiguous in this case and depends on the relative magnitudes of the various shifts in S(NBR), D(NBR) and the slope of the kinked portion of the D(NBR) schedule, following a change in the discount rate. Loosely speaking, we can assert that a change in the discount rate will be followed by an opposite change in the funds rate if the actual change in the monetary policy is less than expected by the market participants. On the other hand, if the actual change in monetary policy following a change in the discount rate is more than expected by market participants, then the funds rate will change in the same direction as the preceding change in discount rate.

The evidence (for example in Wood and Wood ch. 9, Table 9.2) suggests that the relative frequency of a change in the US. T-bills rate in opposite direction to an immediately preceding change in the discount rate is almost 75 percent (all but nine of thirty eight observations in Wood and Wood). Moreover, T-bills rate and the funds rate are highly positively correlated (see for example Wood and Wood Figure 9.1, p. 231, and Goodfriend and Whelpley 1986, Chart 1, p. 16). This is so because, as Goodfriend and Whelpley argue, arbitrage among alternative money market instruments generally keeps their yields in line, abstracting from differences due to transaction costs and risk differentials.

Therefore, we can infer that in practice more often than not, it is the case that an increase in discount rate will be followed by a decrease in the funds rate a few months later. This situation is consistent with the case when the market participants anticipate the future changes in monetary policy following a change in the discount rate, and is illustrated in Figure 8 below.

Figure 8
Changes in Discount Rate and The Funds Rate



As shown in the above figure, an increase in the discount rate from d to d' may lead to a decline in the funds rate (from f* to f*') despite the fact that the monetary policy following the discount rate change is more restrictive (as shown by the leftward movement of S(NBR) and the steeper slope of a'b'). This happened because the banking system significantly revised (downward) its inflationary expectations causing a significant leftward shift in the D(NBR) schedule. This result was hinted by Wood and Wood, but is not found in most models of the funds rate. However, this result is quite significant, because it shows that restrictive monetary policy of the central bank may fail to cause an upward movement in the market rates if the market participants revise their expectations in advance accordingly. Conversely, an expansionary monetary policy may lead to a rise in market rates (which may be opposite to what the Fed has intended), if the market participants anticipate the central bank's policy.

Such results are quite popular in Rational Expectations Models, one of whose major results is that monetary policy is effective only when it can persistently surprise the market participants. But the theory of rational expectations has its own weaknesses.

At any rate, it seems safe to conclude that, if discount rate changes are honest presages of monetary policy, then those changes may also make the coming monetary policy changes ineffective.

On the other hand, as illustrated by Wood and Wood, for the year 1978 the Fed in US is able to control the funds rate within a narrow margin. This may largely be because of the fact that the Fed was targetting the funds rate itself, rather than fixing the supply of reserves. The significant success of the Fed in US in controlling the funds rate may also be due to the fact that the Fed in practice does surprise market participants, at least in degree if not in direction. Considering the unpredictable changes in the emphasis of monetary policy, it is hardly a surprising fit to achieve.

Monetary policy should of course be effective, but if the effectiveness is obtained by destabilizing behaviour, then the cost may outweigh the benefits. This aspect of monetary policy is also pointed out by Wood and Wood, and is an alternative explanation to the empirical fact that changes in discount rate usually precedes opposite changes in market rates. According to this view the central bank acts procyclically (perhaps unintentionally). For example the central bank worsens economic fluctuations by tightening credit just at the ends of economic expansions or even after the onset of recessions of that discount rate increases tend to occur in a weakening economy with declining credit demands [in the context of our model during leftward shifts in D(NBR)] that cause interest rates to fall.

The moral of these discussions is that, the lags and wrong timings of monetary policy formulation and implementation, and the requirement of remaining unpredictable to be effective, suggest that monetary policy is not an appropriate tool for fine tuning of the economy. However, one cannot deny that monetary policy should have long run perspective of creating and maintaining the environment for steady expansion of the economy.

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