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Controlling Monetary Aggregates: The Discount Window

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ABSTRACT

This paper argues that current discount window policy, coupled with non-borrowed reserve targeting of the Federal Reserve, makes the quantity of high-powered money endogenous. Examination of the advisability of this procedure in a stochastic environment is conducted using a general equilibrium financial model. It is concluded that the current policy reduces the destabilizing effects of shifts between various depository financial assets, but increases the effect of other asset portfolio shifts and aggregate supply disturbances. These results are consistent with the work of Poole inasmuch as the current debate over discount policy is a repackaging of the debate over interest rate or aggregates control for monetary policy.

IT HAS BEEN THREE years since the October 1979 announcement made by the Federal Reserve in which the operating procedure of open-market operations shifted to a pronounced reliance on monetary aggregates. Since then, policy has aimed, to a greater extent, at monetary control. It has shifted its target from interest rates, i.e., the Fed funds rate, to monetary aggregates using a non-borrowed reserves path to obtain the goal of monetary growth. During the intervening period results have been, at best, disappointing. The variance in monetary aggregate growth rates on a week-to-week basis has been quite high and considerably higher than *a priori* estimates might have expected. In fact, the continuation of this variability has led to increasing interest in a shift away from aggregate dependence in targeting monetary policy.[1]

Two reasons have been offered for this rather poor showing, viz., (a) lagged reserve accounting and (b) discount window policy. Opponents of the looseness in weekly monetary aggregate movements have argued that both of these technicalities lead to higher variance in monetary growth rates relative to trend.[2] The first, by allowing both a time interval between reservable items and reserves, as well as differential treatment of currency and reserve balances, loosens the linkage between the base and relevant aggregates. The second, by allowing access to additional reserves through the window, weakens the Bank's ability to accurately control reserves themselves. Increasing pressure is being brought to bear on the Federal Reserve to close these two sources of slippage to obtain a closer

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[1] See the most recent pronouncements by Volcker [12].

[2] For a full review and list of citations on these two issues, see the Board of Governors of Federal Reserve System report of February 1981 [1].

control on monetary aggregates. The Federal Reserve has recently announced a reduction in the lag in reserve accounting.[3] In addition, it has been suggested that some adaptation of the non-borrowed reserve targeting procedure is taking place.[4]

In any case, the present situation in which these two technical aspects of Federal Reserve monetary policy exist reduces the Fed's ability to control the path of money growth. Indeed, anything which permits unexpected changes in either the multiplier or the quantity of high-powered money will have this effect. Advocates of the existing structure argue that such looseness should be present to accommodate unexpected economic disturbances which shift the optimal path. They argue, in essence, that rigid adherence to a monetary growth path precludes adaptation to disturbances and increases the effect of some shocks on the aggregate economy. Unfortunately, the type or types of disturbances that are mitigated by the current policy structure are not enumerated nor is evidence offered to suggest that these shifts are of substantial importance in the present environment.

This paper concentrates upon the discount window policy issue. Using a general equilibrium model developed elsewhere, the impact of various economic disturbances on the financial sector and the real sector is analyzed to see if and when current discount window policy is optimal. The results of the analysis indicate that current policy cannot be defined categorically as either optimal or non-optimal. This will, in general, depend upon the source of the underlying disturbances to the economy. These results are consistent with previous work on monetary policy procedures. In fact, the current debate over discount window policy can be shown to be a repackaging of the debate over interest rates or aggregate control for monetary policy. This insight notwithstanding, it is interesting to note that a plausible argument can be offered in the current environment to suggest that existing discount policy is appropriate.

I. Current Discount Window Policy and Aggregates Control

It is important at the outset to explain the role that the discount window currently plays in overall monetary control. Since the 1979 movement to emphasis on aggregates, the Federal Reserve Trading Desk has been operationally using a non-borrowed reserve path to obtain monetary totals. Beginning with a monetary aggregate target path, the Fed Staff extracts a path for total reserves from a detailed multiplier framework. An estimate of borrowing is subtracted to arrive at the target path for non-borrowed reserves. The controversy over discount window policy's role in monetary control centers around (a) the ability of banks to borrow reserves in an amount that is different from the estimated amount and (b) the reaction of the Desk to intraweekly and, at times, interweekly deviations of borrowing from its expected path. These two issues were quite prominent in the Board Staff Studies of February 1981 [1] in which an evaluation of the new

[3] For a description of this proposal see U.S. Financial Data [3]. Note that the proposed changes are not effective until 1984.

[4] See footnote 1.

operating procedures was attempted. Much of the mechanics of Fed policy can be gleaned from these documents.[5]

On the issue of discount window policies at the regional Banks and the behavior of total borrowings, the work by Peter Keir entitled "Impact of Discount Policy Procedures on the Effectiveness of Reserve Targeting" lends considerable insight. Here he argues that the discount window has been fairly open during the period: "Although discount policy procedures were modified somewhat by the recent revision of Regulation A, Reserve Bank discount officers still rely primarily on broad administrative guidelines to control borrowing by individual institutions" (p. 1).

This fairly passive role of the discount officer leads to easy access to the window by banks wishing to arbitrage funds within some notion of reasonable limits. This is particularly true given the sluggishness with which the discount rate moves with open-market rates: "Since the discount rate continues to be adjusted to changes in market rates on a judgmental basis and typically with an appreciable lag, its spread against other rates tends to vary substantially as market rates fluctuate" (p. 1).

Examining the statistical significance of the relationship of borrowing to the interest rate differential, the author concludes: "The results strongly suggest that the level of borrowing is significantly correlated with the spread between the two interest rates but not with the absolute level of those rates . . . A few variables tested that showed little relation to the level of borrowing also are important to note. Several different measures of the degree of administrative pressure for all member banks were added to the test models but were never close to being statistically significant" (p. 19).

Concluding on the issue of the magnitude of borrowings, he finds: "This admittedly still tentative finding suggests that an increase of 10 basis points in the spread of the funds rate over the discount rate has been associated on average with an increase in borrowing at the window of $110 million, whereas for the period tested before October 6 a similar change in the spread was associated with an increase in borrowing of only $40 million" (p. 19).

The Keir paper, therefore, illustrates the clear ability of the member banks to borrow from the window. The institutions can borrow and have done so to offset liquidity needs and, perhaps most importantly, to obtain funds at a reduced cost. Such discretionary borrowing is of a reasonably large magnitude and statistically significant in its relationship with the differential in cost of funds to the bank.

To evaluate the importance of this borrowing activity to the issue of monetary control, the reaction of the Trading Desk to bank borrowing is of paramount importance. If borrowing is offset by a reduction in non-borrowed reserves, monetary control is not affected by the window. If, however, no reaction is triggered, total reserves are altered. On this issue, the paper of Fred Levin and Paul Meek entitled "Implementing the New Operating Procedures: The View From the Trading Desk" is the clearest statement of reserve targeting procedures

[5] It has been suggested that, subsequent to these documents, the Desk has been somewhat more aggressive in offsetting greater-than-expected borrowings. The question remains, however, as to the appropriateness of any of these discount window procedures.

and the role of borrowed reserves in that process:

> "The Desk begins each intermeeting period with a path for non-borrowed reserves (the total reserve path estimated by the Board staff less the Committee's initial assumption for borrowing at the discount window). Each week, as new information becomes available, senior Board staff and Account Management review, and revise, if appropriate, the reserve paths to maintain their consistency with the Committee's aggregate objective. Then the Desk must translate the reserve paths into weekly operating objectives for non-borrowed reserves. This is done in the following way: First, the staff projects the demand for total reserves–that is, required reserves based on actual or estimated deposits plus excess reserve. Second, the average projected demand for total reserves over the period is compared to the average non-borrowed reserve path over the period. This, given actual levels of borrowing in earlier weeks, provides an estimate of average borrowing over the remaining weeks if the average non-borrowed reserve path is to be achieved. Finally, this steady level of borrowing is subtracted from the projected demand for total reserves in each of the remaining weeks to give a series of weekly non-borrowed reserve objectives" (p. 7).

The procedure, then, uses regressive expectations of borrowing which are independent of the change in unborrowed reserves as well as both current rate spreads and future rate spreads between open-market rates and the discount rate. Borrowing, the authors go on to say, expands when money market rates rise and contracts in a falling rate environment. Unless these borrowings consistently increase at unreasonable rates, they are allowed to alter the path of total reserves over the period or a series of periods: "There were many weeks when borrowing deviated significantly from expectations, and the Desk chose to accept a miss on its weekly non-borrowed reserve objective rather than provide over-abundant total reserves or force a huge end-of-week rise in borrowing" (p. 12).

The net result of this pattern of discount window accessibility and reserve path targeting is to make borrowed reserves of the financial system endogenous, at least to some degree. Given the discount rate, borrowing is determined to a large extent by the willingness of the banking system to borrow given the rate differential or arbitrage profit potential that develops over the period. Total reserves, given that non-borrowed reserves do not generally react to offset increases in borrowing, become a positive function of open-market rates in at least the short and intermediate run. In the long run, the existence of "base drift" assures that this flow variation in reserves will be incorporated into changes in the stock of base money in the system, at least to some extent. "Base drift" is a phenomenon whereby the Federal Reserve accepts the new higher total of money balances and proceeds to forecast growth patterns with these as an initial state. The effect of this targeting procedure is that even the long run monetary stock will be affected by borrowing patterns. Formally, this discount policy, then, is equivalent to allowing the total quantity of high-powered money to be determined endogenously by the banking industry's willingness to borrow, which, in turn, is a positive function of the differential between the open-market borrowing rate and the Federal Reserve discount rate.

The advisability of such an arrangement is dependent upon two interrelated factors, viz., (a) the determinants of the quantity of borrowed reserves desired by the banking industry; and (b) the nature of the disturbances in the economy which would have differential effects under different discount window procedures. Obviously, the effect of this non-borrowed reserve targeting procedure depends critically upon how the banking industry responds to the discount policy. If bank borrowing is fairly aggressive when differentials exist between open market rates and the discount rate, the effect of a general increase in rates caused by some exogenous disturbance will be different from the case where there is an abhorrence of borrowing. While the cited studies [1] above suggested that borrowing has increased in response to the current mix of aggregates control and discount window policy, a better analytical understanding of the bank's desire to borrow is necessary. In addition, the type of disturbances which can alter the economy will affect the desirability of the present procedures. In fact, it will be shown below that for some classes of exogenous disturbances, the present discount policy may be optimal.

II. Determinants of Bank Borrowing

There is a long literature on the determinants of bank borrowing from the Federal Reserve Discount Window. This issue was most recently addressed in the 1960s when Federal Reserve policy centered upon the stabilization of free reserves. The work of Meigs [5], Brunner and Meltzer [2], Polakoff [6], and Goldfeld and Kane [4] are the most notable contributions here. The last of these is perhaps the most important as it develops a microeconomic model of the banking firm to analyze the determinants of commercial bank borrowing demand. Using a utility function of the firm which depends upon the cost of acquiring non-borrowed reserves, and the level of borrowing which affects the subjective cost to the bank of Fed borrowings, the authors derive the borrowing demand function:[6]

$$BR^d = BR^d(r_B - r_F, r_B, \Delta R) \tag{1}$$

where borrowing demand is derived to be a function of the differential between open market rates, r_B, and the discount rate, r_F, the level of market rates themselves, r_B, and the level of reserve needs which precipitates borrowing.[7] Evaluating the partial derivatives of this function in the neighborhood of zero borrowing, using standard Slutsky equation techniques, they obtain

$$\frac{\partial BR^d}{\partial(r_B - r_F)} > 0, \quad \frac{\partial BR^d}{\partial r_B} > 0 \quad \text{and} \quad \frac{\partial BR^d}{\partial R} > 0$$

The economic intuition behind these results is straightforward. Increases in the differential between market rates and the discount rate increases borrowing demand to exploit the relatively inexpensive source of funds. This is supported

[6] Those readers interested in the theoretical development of Equation (1) are referred to Goldfeld and Kane [4], pp. 500–3.

[7] Subsequent to the Goldfeld and Kane work, the Federal Reserve instituted a system of carry-over options in 1968. As the present paper will analyze the financial markets in full stock equilibrium, this additional factor in the institutional arrangements is irrelevant to the model below. It is, therefore, neglected.

by all of the above cited references, including the Federal Reserve studies in which a positive relationship is reported for borrowing in the post-1979 data.[8] The increase in borrowing when market rates increase follows from the bank's attempt to increase profits. Given the cost of liquidating alternative assets a rise in market rates encourages borrowing, even at a fixed rate spread. Finally, as borrowing needs expand due to a shift in reserves that is unique to the individual bank, borrowing demand expands as a way to reduce the total cost of obtaining the necessary funds.

The theoretical and empirical studies cited above also indicate that the borrowing relationship is not completely static. Borrowing is affected by the time series properties of reserves, previous borrowing patterns of the firm, and the extent to which the bank views the current reserve deficiency as symptomatic of a permanent change in its reserve base. While all these points are valid, they are less germane to the present study, which centers upon the optimality of discount window policy at any time. The effect of alterations in discount policy in this financial model will translate to the dynamic framework. On a practical level, furthermore, the latter is much more difficult to analyze without a dynamic model of all financial markets. Accordingly, the static equation (1) is taken to be the bank's borrowing function from the discount window.

III. Current Discount Policy within A General Equilibrium Framework

We are now in the position of determining the effect of current discount policy on the economy. In Section II, the demand function for bank borrowing is developed. In Section I above, the supply policy governing the window is outlined. These, together with a general equilibrium framework of the entire financial environment, will allow us to examine the effect of discount policy on economic activity. To examine whether the present procedure of discount policy is preferred to a more rigid total reserve operating procedure, a general equilibrium framework of the financial sector is used, which is derived from the work of Santomero and Siegel in two related papers, [8, 9]. The basic framework employed is similar to the work of Tobin and Brainard [11] and concentrates on the effect of differing discount window policies on the stock of outstanding assets and the vector of endogenous rates of return and prices in the financial system. This method of analysis transcends the microeconomic discussions cited above in the debate over borrowing policy. The latter concentrates upon the weekly flow rather than the resultant stock effects. As these stock effects are dominant in terms of the macroeconomic implications of a borrowing policy, the present analysis will analyze these stock equilibrium issues exclusively.

Three sectors exist in the economy: the household or public sector, h; the banking or financial institution sector, f; and corporate or firm sector, c. Each sector's demands and supplies satisfy balance sheet constraints and substitution

[8] There is some discussion in Polakoff [6] and Goldfeld and Kane [4] concerning a sign reversal in this relationship at very high borrowing levels. As this has not been observed empirically, it is neglected in the text discussion.

properties that are characterized by gross asset substitutability and normality. There are four types of assets in the economy: high-powered or base money, H, which consists of non-borrowed reserves, borrowed reserves and currency in circulation; deposits at financial institutions, D; bonds issued by the firm sector, B; and equity, E. First, the system will be developed and the equilibrium solution defined. Stochastic disturbances will then be added to the system to analyze the impact of such shocks on the variability of endogenous variables under different discount window policy procedures.

A. The Model Framework

To begin the formal analysis, consider the sectoral budget constraints. Within the model, each sector is constrained by a budget constraint limiting asset purchases. Financial institutions, as internal financial entities, must sum to zero in real value so that the budget constraint for institution i, issuing deposit liability i, may be written as:[9]

$$D^d_{jf_i} + H^d_{f_i} + B^d_{f_i} = D^s_{f_i} + BR_{f_i}\ \forall_i = 1 \cdots n \tag{2}$$

where superscript s indicates supply and these institutions are viewed as demanding borrowed reserves to finance their portfolio of assets, viz., deposits at other institutions, bonds, and high-powered money.[10] By definition, high-powered money, $H^d_{f_i}$, is equal to non-borrowed reserves, NBR, and borrowed reserves, BR. For the household sector, real asset demand is constrained by wealth, so that

$$H^d_h + \textstyle\sum_{i=1}^n D^d_{ih} + B^d_h + E^d_h = W \equiv K + H/P \equiv K + NBR/P + C/P \tag{3}$$

where wealth has been defined alternatively as the sum of real high powered money, real deposits in financial firm i, real bonds and equity of non-financial firms held by the household sector, or, equivalently, as total firm capital plus currency and non-borrowed high-powered money in real terms. Finally, the firm sector obtains funds from debt and equity to maintain its fixed capital and holds neither high-powered money nor deposits. Therefore, its constraint is:

$$B^s_c + E^s_c = K \tag{4}$$

This view of the financial sector can be characterized as a set of stock equilibrium conditions for each of the above assets. Assuming the general absence of money illusion, the borrowed reserve market equilibrium condition may be written as:[11]

$$\textstyle\sum_{i=1}^n BR^d_{f_i}(r_{D_i}, r_B, r_F) = BR^s(r_F) \tag{5}$$

[9] In a fuller model of the banking firm, the derivation of the borrowing equation would be embedded in a model that derives all the demand functions in Equation (2). As interest centers on the aggregate implications of the supply of discount window credit, such a model was not attempted in Section II above. The model, however, would lead to demand functions equivalent to those contained in Equations (5) through (13) below.

[10] For convenience, equity capital is excluded in the discussion in the text and in the budget constraint, Equation (2). Readers interested in the role of financial firm equity in a general equilibrium financial framework are referred to Santomero and Watson [10].

[11] This formulation assumes that *real* borrowings are endogenously determined by the open market and discount rates. This seems consistent with overall absence of money illusion.

where Equation (4) is the general form of Equation (1) above. Borrowing demand is seen as a function of open market rates, r_B; deposit interest rates offered by financial institutions including the bank itself, denoted by the vector r_{D_i}; and the Fed Discount rate, r_F. The supply of discount funds is viewed as elastically available at the discount rate, r_F. To be sure, other factors affect Fed supply of borrowed reserves. However, as noted above, the availability of credit in the post-October 1979 period appears to be driven primarily by demand at the discount rate r_F. The comparable equation in the non-borrowed reserve market is

$$H_h^d(r_{D_i}, r_B, r_E, Y, W) + \textstyle\sum_{i=1}^n NBR_{fi}^d(r_{D_i}, r_B, r_F) = \frac{NBR + C}{P} \tag{6}$$

where r_{D_i}, r_B, and r_F have been previously defined, r_E is the return on equity, Y is income, and W is wealth. Equation (6) may also be written in an alternative form. The definition of high-powered money was given above as

$$H^d = NBR + BR + C$$

The financial institution sector's demand for high-powered money, therefore, may be written as

$$\textstyle\sum_{i=1}^n H_{fi}^d = \sum_{i=1}^n NBR_{fi}^d + \sum_{i=1}^n BR_{fi}^d \tag{7}$$

Substituting Equation (7) into Equation (6), the non-borrowed reserve market equilibrium condition may be written as

$$H_h^d(r_{D_i}, r_B, r_E, Y, W) + \textstyle\sum_{i=1}^n H_{fi}^d(r_{D_i}, r_B, r_F)$$
$$= \frac{H^s}{P} = \frac{NBR}{P} + \frac{C}{P} + \textstyle\sum_{i=1}^n BR_{fi}^d(r_{D_i}, r_B, r_F) \tag{8}$$

where the quantity of high-powered money is derived endogenously by bank borrowing behavior and the interest rates in the financial markets. The equilibrium condition for the market for each depository asset, D_i, is

$$D_{ih}^d(r_{Di}, r_B, r_E, Y, W) + \textstyle\sum_{j=1\ j\neq i}^n D_{if_j}^d(r_{Di}, r_B) = D_i^s(r_{Di}, r_B); \quad i = 1 \ldots n \tag{9}$$

where $D_{if_j}^d$ is the demand of the jth financial institution for the ith deposit. The equilibrium condition for the bond market is

$$B_h^d(r_{Di}, r_B, r_E, Y, W) + \textstyle\sum_{i=1}^n B_{fi}^d(r_{Di}, r_B) = B_c^s \tag{10}$$

where B_{fi}^d is the demand of the ith financial asset for bonds. Likewise, the equilibrium condition for the equity market is

$$E_h^d(r_{Di}, r_B, r_E, Y, W) = E^s \tag{11}$$

Following the work of Santomero and Siegel [8, 9], three adjustments are made to the view of the financial institution sector. First, it will be assumed that the demand for total high-powered money centers around the required ratio, denoted as $\hat{\rho}_0$, and is affected inversely by the opportunity cost of reserve, i.e., r_B. Therefore, H_{fi}^d is replaced by the multiplicative expression $\hat{\rho}(\hat{\rho}_0, r_B)D_b^s$ in the market for high-powered money. Second, it will be assumed that the supply of deposits, D_b^s, is perfectly elastic at a given deposit rate r_D. This will be true if either (1) the supply of deposits exhibits constant returns to scale in high-powered money and bonds, so that the competitive deposit rate is $r_D = (1 - \rho)r_B - k$, where k represents a constant per unit cost of producing deposits; or (2) the deposit rate, r_D, is fixed below the equilibrium value.[12] Third, reduced form reserve ratios, which include both the reserves supporting household sector's deposits and the reserves supporting a financial institution's deposits at other institutions will be defined.[13] Denote these general reserve ratios as ρ_i. The effect of these adjustments is to contract the system to a three equation set:

$$H_h^d(r_D, r_B, r_E, Y, W) + \textstyle\sum_{i=1}^n \rho_i(r_B, \rho_0)D_{ih}^d(r_D, r_B, r_E, Y, W)$$

$$= \frac{H^s}{P}\left(\overset{+}{r_B}, \overset{-}{r_f}\right) \equiv \frac{NBR + BR(r_B, r_F) + C}{P} \qquad (12)$$

$$B_h^d(r_D, r_B, r_E, Y, W) + \textstyle\sum_{i=1}^n [1 - \rho_i(r_B, \rho_0)]D_{ih}^d(r_D, r_B, r_E, Y, W)$$

$$+ \frac{BR}{P}(r_B, r_F) = B_c^s(r_B, r_E, K) \qquad (13)$$

$$E_h^d(r_D, r_B, r_E, W) = K - B_c^s(r_B, r_E, K) \qquad (14)$$

where $BR(r_B, r_F)$ is the aggregation of total banking industry borrowing functions.[14]

This stock equilibrium model may be solved for three unknowns, determined by the general equilibrium system of Equations (12), (13), (14), and the definitional equation for wealth. It is properly viewed as a financial market equilibrium framework which must be added to a real sector analogue to jointly determine P, r_E, r_B, and Y. If the real sector is viewed as a full employment model which obtains output at potential supply with the real return on equity equal to the marginal return on capital in the real sector, the financial sector will determine P and r_B conditional upon that solution. On the other hand, if the real sector is viewed as a Keynesian demand-determined model with P and r_E fixed in the output and labor markets, then the financial market model will determine Y and r_B conditional upon that data. The present model framework has been analyzed under both assumptions for the real sector in Santomero and Siegel [8] and [9], respectively. For the present purposes, both versions yield qualitatively identical results; consequently, the choice is irrelevant. For expositional ease, the full employment version of the model will be used here. The solution of the model is evaluated at the point where the rate of return on equity, r_E, is equal to the fixed marginal product and output is evaluated at its full employment value. As noted above, this reduces the analysis to two independent market equations, in two unknowns, viz., P and r_B. Section III.C explicitly introduces uncertainty in r_E into the analysis, while maintaining the full employment framework.

It will prove convenient to consider Equation (12), the high-powered money

[12] See Santomero and Siegel [8] for a more general treatment and discussion of this point, as well as the consideration of implicit returns in the current context.

[13] Derived reserve requirements require the netting of intra-industry demand deposit balances. For this type of liability $\rho_i = 0$.

[14] See Goldfeld and Kane [4], pp. 507–9, for the problems of aggregation subsumed here.

equation, and the sum of (12) and (13), which may be denoted as the liquid asset equation. The latter contains the demand and supply of all assets in the system with the exception of equity, and has an equilibrium condition:

$$H_h^d(r_D, r_B, r_B, r_E, Y, W) + \textstyle\sum_{i=1}^n D_{ih}^d(r_D, r_B, r_E, Y, W)$$

$$+ B_h^d(r_D, r_B, r_E, Y, W) = B_c^s(r_B, r_E, K) + \frac{NBR + C}{P} \tag{15}$$

Converting Equations (12) and (15) to excess demand notation is accomplished by letting H be the real excess demand for high-powered money, and A the real excess demand for liquid assets, as indicated in (15). The model may be written in reduced form:[15]

$$H(\overset{-}{r}_B, \overset{-}{r}_E, \overset{?}{r}_D, \overset{+}{\rho}_0, \overset{-}{NBR}, \overset{-}{C}, \overset{+}{P}) = 0 \tag{16}$$

$$A(\overset{+}{r}_B, \overset{-}{r}_E, \overset{+}{r}_D, \overset{-}{NBR}, \overset{-}{C}, \overset{+}{P}) = 0 \tag{17}$$

The assumption of gross substitutes accounts for the deterministic signs on r_B, and r_E. The ambiguity of $\frac{\partial H}{\partial r_D}$, denoted henceforth as H_D, results from the offsetting effect of r_D increases on the households' and banks' demand for high-powered money. If high-powered money and deposits are net substitutes, the sign of H_D is negative. If they are complements, the opposite is implied. The signs of both NBR, C, and P in Equations (16) and (17) follow directly from the normality assumptions above. Equilibrium in the system is obtained for a unique set of r_B and P, denoted r_B^* and P^*.[16]

As noted at the outset, attention will center upon the stochastic characteristics of the economy and how discount policy affects it. Two types of random disturbances can be considered on the financial side. First, there may be a randomness associated with the market for high-powered money. Any change in the demand for financial assets with different reserve ratios causes a shift in this market. This is equivalent to a shift in the H locus of Equation (16). Second, there may be randomness in the demand for liquid assets with an equal but opposite disturbance to the equity market. For example, shifts in the demand for equity at the expense of bonds are captured by this sort of disturbance. This is represented by a shift in the A locus given by Equation (17). Disturbances which affect both high-powered money and equity will shift both the H and A equations. For example, a shift from currency to equity affects both markets as would a shift from a reservable asset to the equity market. In general, the shocks to these two markets are correlated, with the degree of correlation and its sign dependent upon the specific disturbance.

To consider the impact of stochastic disturbances analytically under various discount policy regimens, the solution to the model must be specified more

[15] Evaluating the model at full employment converts Y to a constant which need not appear in subsequent analyses.

[16] The referee correctly points out that uniqueness of the solution is assumed here, rather than proven. For such a proof, additional assumptions as to the nature of the demand functions would be necessary. This is true for all models of this stock general equilibrium formulation.

exactly. This is done by linearizing the system around its equilibrium values of Equations (16) and (17).

$$H_p\tilde{p} + H_B\tilde{r}_B = -H_D\tilde{r}_D - H_E\tilde{r}_E - H_\rho\tilde{\rho}_0 + H_p\log\tilde{H} + \epsilon_H \tag{18}$$

$$A_p\tilde{p} + A_B\tilde{r}_B = -A_D\tilde{r}_D - A_E\tilde{r}_E + A_p\log\tilde{H} + \epsilon_A \tag{19}$$

where p represents the log of the price level, the subscripted excess demands represent the partial derivatives evaluated at equilibrium; tilda ($\sim$) represents deviations from the equilibrium values; and ϵ_H and ϵ_A are the random disturbances outlined above. It will be assumed the expected values of both disturbances are zero, $E(\epsilon_H) = E(\epsilon_A) = 0$, and $E(\epsilon_H, \epsilon_A) = \sigma_{AH}$, $E(\epsilon_A^2) = \sigma_A^2$, and $E(\epsilon_H^2) = \sigma_H^2$. Further, it will be assumed that the random disturbance terms are proportional to the inverse of the price level so that variations in the price level will not change the relative importance of the disturbances.

For any given value of the disturbance terms ϵ_H and ϵ_A, the equilibrium price level from Equation (18) and (19) becomes

$$\tilde{p} = \frac{(A_B\epsilon_H - H_B\epsilon_A)}{(H_pA_B - H_BA_P)} \tag{20}$$

and the variance of the log of the price level is

$$\mathrm{var}(\tilde{p}) \equiv \sigma_p^2 = \frac{A_B^2\sigma_H^2 + H_B^2\sigma_A^2 - 2\sigma_{AH}A_BH_B}{(H_pA_B - H_BA_p)^2} \tag{21}$$

The focal point of the analysis will be the effect of different discount policies on the variance term of Equation (21). Given the full employment nature of the model, the concern with the variance in price follows directly. If the effect of a non-borrowed reserve policy is an increase in the variance of p relative to a total reserve policy, then current Fed procedure accentuates aggregate control problems, and in this sense is a detrimental shift. Of course, a decrease in the variance of p is salutory.

B. The Effect of Discount Policy on the Financial System

As described above, the current discount window policy combined with the non-borrowed reserve targeting procedure, leads to an endogenous high-powered money supply through the banks' borrowing demand function. Accordingly, the financial system responds in two distinct ways to an increase in the bond rate. First, as the opportunity cost of holding various monetary assets increases, the demand for high-powered money declines. Currency demand by households falls, as does the demand for reserves by institutions offering deposit-type liabilities. Second, as the bond market rate increases, the demand for and, hence, the supply of borrowed reserves increases through the discount window. Accordingly, the (negative) sensitivity of the excess demand for high-powered money is greater with the present discount window policy than in a total reserves environment. To analyze the effect that this policy will have on the variance of the price level, one need only evaluate the impact of a change in H_B on that variance.

The effect of an endogenous high-powered money supply on the variance of the price level is therefore equivalent to the negative of the sign of the effect of an increase in H_B on σ_p^2. The latter may be written as

$$\frac{\partial \sigma_p^2}{\partial H_B} = \frac{2A_B[\sigma_H^2 A_B A_p + \sigma_A^2 HH - \sigma_{AH}(A_B H_p + H_B A_p)]}{(H_p A_B - H_B A_p)^3} \tag{22}$$

The sign of Equation (22) is dependent upon the sign of the bracketed term in the numerator. In general, its value is ambiguous and depends upon the values of σ_H^2, σ_A^2, and σ_{AH}. However, polar examples illustrate the economics of the situation. The current discount window policy flattens the *HH* curve in Figure 1. Shifts in *HH* are reduced in severity while shifts in *AA*, shown in Figure 2, have a greater effect on prices with a flatter *HH*. It follows quite directly that if disturbances prevail primarily in the market for high-powered money, either because of a shift to direct participation in the financial markets or because of a shift to lower reserve deposits within the financial institution structure, current discount policy is preferable to a strict adherence to a total reserve path. On the other hand, if there are shifts into the equity markets from the debt markets, the current structure is undesirable.

In a world in which deregulation and financial innovations are causing considerable uncertainty as to the disposition of the fractions of household wealth into various financial institutions, a case can be made for the current discount policy. To be sure, it does not rest upon just the uncertainty of the demand for money.[17] The case centers upon the size of the relative variances in Equation (22) and the presumption that the size of the variance associated with the derived demand for the high-powered money, not just the direct demand for this asset, is large. With desired asset stocks subject to disturbances associated with recent financial innovations, and the trend towards financial deregulation, the derived demand for base money has become uncertain in the current environment. However, as these distribution issues within the financial structure begin to stabilize and portfolio allocation stabilizes, the burden of proof shifts to the Fed to explain, why, on an *a priori* basis, one should expect that the variance associated with depository disturbances should dominate the variance related to shifts between debt and equity investments. In sum, the presumption of the preferred nature of the current discount policy may be a transitory phenomenon.

C. Real Disturbances and Discount Window Policy

Thus far, the analysis has examined the effect of discount policy on the system with financial disturbances only. This section expands the focus of the analysis by considering the impact of discount procedure on the system's behavior when faced with real shocks. To analyze disturbances in the real sector, the financial sector model is converted to (r_E, P) space following the approach used by Santomero and Siegel [8]. Equations (18) and (19) can be solved for p in terms of r_E and the disturbance terms as

$$\tilde{p} = F_E r_E + \tilde{\epsilon}_F \tag{23}$$

[17] This is the view frequently embraced by the Federal Reserve. See Axilrod in [1], especially page 25.

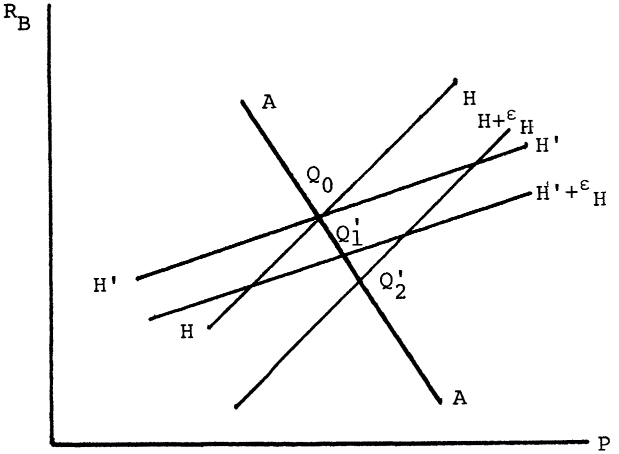

Figure 1. Disturbance in the High-Powered Money Market under Two Discount Window Regimes

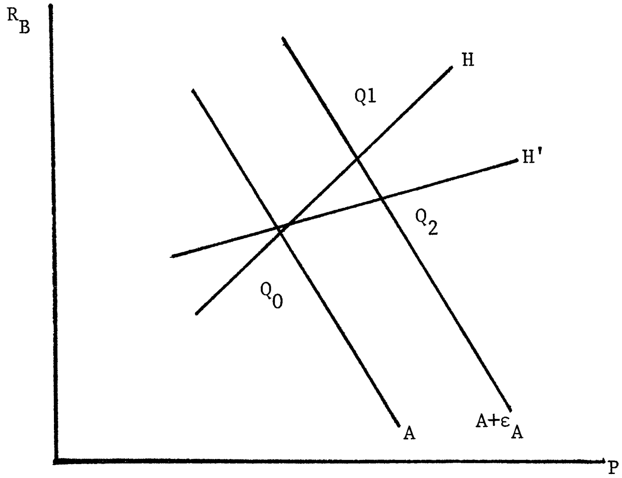

Figure 2. Disturbance of the Demand for Liquid Assets under Two Different Discount Window Regimes

where

$$F_E = \frac{H_B A_E - A_B H_E}{H_p A_B - H_B A_p} > 0 \quad \text{and} \quad \tilde{\epsilon}_F = \frac{A_B \tilde{\epsilon}_H - H_B \tilde{\epsilon}_A}{H_p A_B - H_B A_p}$$

Equation (23) can be interpreted as the *mutatis mutandis* financial locus and is an upward sloping locus, in (r_E, p) space. The slope coefficient is denoted F_E, and the effect of the financial disturbances is captured in the ϵ_F term.

The commodity market locus may be added to the financial sector's to obtain the general equilibrium solution of the model. For simplicity, assume that the flow commodity or output demand function, C^d, is a function of only the equity rate.[18] Output supply, C^s, is exogenously determined at its equilibrium level. Both the supply and demand for output are subject to zero mean real shocks, ϵ_R^d and ϵ_R^s. The equilibrium condition for the output market can be written as

$$C^s = C^d(r_E) + \tilde{\epsilon}_R, \qquad C_E = \frac{\partial C^d}{\partial r_E} < 0, \qquad \tilde{\epsilon}_R = \tilde{\epsilon}_R^d - \tilde{\epsilon}_R^s \tag{24}$$

The locus of points where the commodity market is in equilibrium could be represented by the horizontal line CC in Figure 3.

Linearizing Equation (24) above and substituting into Equation (23) yields the following solution for the price level and variance

$$\tilde{p} = -\frac{F_E}{C_E}\tilde{\epsilon}_R + \tilde{\epsilon}_F \tag{25}$$

$$\sigma_p^2 = (F_E/C_E)^2\sigma_R^2 - 2(F_E/C_E)\sigma_{RF} + \sigma_F^2 \tag{26}$$

Abstracting from the financial disturbances that have been treated above, the effect of current discount policy on the variance of price due to real shocks can be written as

$$\frac{\partial \sigma_p^2}{\partial H_B} = \frac{2F_E}{C_E^2}\cdot\frac{\partial F_E}{\partial H_B}\sigma_R^2 \tag{27}$$

The sign of Equation (26) is, therefore, determined by the sign of $\frac{\partial F_E}{\partial H_B}$, the effect that the discount window availability has on the slope of the FF locus. It is obvious from inspection, and the work of Poole in an analogous context, that the disturbances originating in the real sector have a greater impact on the price level when the FF locus in Figure 3 is flatter. Analyzing the result of a change in H_B on the slope of F_E, which determines the variance from real disturbances, one obtains

$$\frac{\partial F_E}{\partial H_B} = \frac{A_B(H_pA_E - A_pH_E)}{(H_pA_B - H_BA_p)^2} < 0 \tag{28}$$

The sign of Equation (28) is unambiguously negative. Hence, the slope of the FF curve decreases in the case where discount policy allows for borrowed reserves to expand without offsetting non-borrowed reserve contraction. This rotation of the financial locus increases the aggregate price impact of exogenous disturbances to the real sector. Such a discount policy, therefore, works to the detriment of economic stability in the face of aggregate demand or supply shifts.

The results of the analysis can now be neatly summarized. The model indicates that there are three distinct types of disturbances that can affect the economic stability of the system, viz., disturbances to the demand for high-powered money, disturbances to the demand for liquid assets *in toto*, and disturbances to the real sector. The current discount window policy reduces the overall price variance due to shifts in base money, but accentuates the variance due to liquid assets or

[18] Assuming that the flow commodity demand function is jointly affected by both r_E and p results in a negatively sloped locus in Equation (24). By inspection one can verify that the qualitative results obtained below would still obtain.

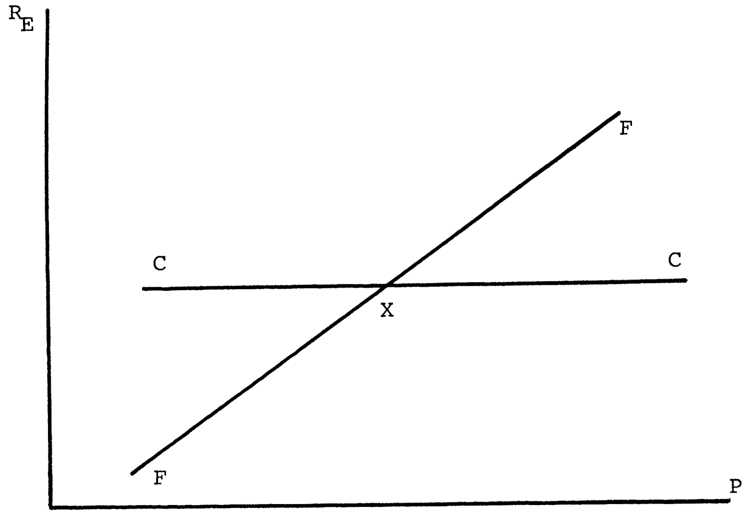

Figure 3. General Equilibrium Solution of the Model

real disturbances. The advisability of the policy rests upon some *a priori* estimation of the likelihood of various disturbances.

IV. The Approximate Equivalence of Various Policy Instruments

The previous sections have argued that appropriate policy response is dependent upon the source of aggregate disturbances. This general result has found its way into the literature on policy instruments before. Indeed, the Poole [7] article articulated this position in a simple ISLM framework more than a decade ago. In his case, of course, the issue was not discount policy, but the choice of interest rates or monetary aggregates targets for money policy. His conclusions indicated that interest rate policy is preferred in an environment with money demand shocks, while aggregates targets are preferred in an environment with real sector disturbances. One may view the policy debate over the discount window as an extension of the interest rate versus aggregates controversy.

The present controversy about the discount window can be viewed as an indirect debate over the appropriateness of aggregates targets themselves. To see this point, consider the limits of discount window policy. In a regime without a lender of last resort, the slope of the *HH* function in Figure 1 and the *FF* function in Figure 3 is dependent upon the underlying substitutability of financial assets and wealth effects. In both figures, the loci are upward sloping. In a regime with complete and free access to the window, both the *HH* and the *FF* loci become more horizontal. In the limit, if the banking industry were willing, an unlimited (positive or negative) position can be taken with the discount window. In essence, this situation is equivalent to an interest rate pegging policy in which the banking system itself insures a stable interest rate by arbitraging against the discount window.[19] The only distinction between totally free use of the discount window,

[19]Philip Cagan points out that the discount window gives evidence of the quality of excess demand and in this sense may be more informative than a single rate pegging policy.

ignoring negativity constraints, and an interest rate policy, is the operating officer at the Fed; in one case it is the Bank Services officer, while in the other it is the Trading Desk officer.

To be sure, the current policy of discount window accessibility is not equivalent to free and unlimited access.[20] Availability restriction, penalty rates, and moral suasion all act to significantly limit borrowing at the window. Yet, the qualitative impact of the current window policy remains. Disturbances to the high-powered money market due to shifts in the mix of depository liabilities is today's counterpart of the money demand shift of Poole. An endogenous money supply, accomplished by whatever means, mitigates the effect of such disturbances. On the other hand, alterations in the financial portfolio that do not cause a change in high-powered money demand, such as a shift from debt to equity, are accentuated by an endogenous base policy. The same obtains for real disturbances, as higher rates cause increases in high-powered money and further expansion of demand forces.

As noted above, one could make a case for the current discount policy in today's environment of regulatory change and financial innovation. Such a case would rest upon the assertion that the variance of monetary disturbances is currently relatively large. However, this argument about *a priori* notions of the relative sizes of variances is unlikely to be assured for all time periods. Therefore, the arguments in favor of a more strict adherence to the long-term aggregates path would seem somewhat more appropriate over the longer run.

V. Summary and Conclusions

This paper has argued that current discount window policy, coupled with the non-borrowed reserve targeting procedure employed at the Trading Desk is tantamount to making the quantity of high-powered money endogenous. The quantity of borrowing, then, is determined by the banking industry's willingness to borrow at current rates. Examination of the advisability of this procedure in a world with stochastic disturbances in the financial and real sector was conducted using a general equilibrium model. Here, it was concluded that the current policy reduces the destabilizing effects of shifts between various depository financial assets, but increases the effect of other asset portfolio shifts and aggregate supply disturbances. These results were shown to be consistent with the work of Poole inasmuch as the current debate over discount window policy is, in fact, a repackaging of the debate over interest rate or aggregates control for monetary policy.

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[20] In this sense, the current discount policy is analytically closer to Poole's mixed policy than either extreme.

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