DEPOSIT DEREGULATION AND MONETARY POLICY

by

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Financial structure is the result of both economic necessity and the regulatory framework. These two factors jointly determine the shape and texture of a financial environment. Over the past fifteen years the regulatory framework of the financial structure has undergone a steady and ever increasing rate of change. This process, known as financial deregulation, has been both broad and pervasive. From the time that the Hunt Commission was appointed to investigate the regulatory environment in 1970 to the present we have seen a change in the structure of financial institutions from one that imposed strict regulation on all deposit rates to one in which over 85% of all deposits in banking institutions are free from interest rate controls.

This transition in financial structure has been met with mixed reviews. On the industry level many financial institutions subject to increased competition have resisted and lamented this movement while aggressive banks and "new breed" financial firms such as money market mutual funds and brokerage houses have welcomed the newly-found freedom. Consumers on the whole have enjoyed increased deposit rates but have also increasingly been charged the marginal costs of financial services, a natural outcome of increased competition and the unbundling of transactions services pricing.

Although generally lauding the increased microeconomic efficiency of deregulation, economists have disagreed about the macroeconomic effects of this trend.[1] Tobin (1983) and Hester (1981) have voiced concern that the structural change may lead to new instabilities and, perhaps, a reduced effectiveness of monetary policy. Other economists, such as Davis (1982) have warned that deregulation reduces the Federal Reserve's ability to formulate traditional monetary policy, since the historical definitions of monetary aggregates have been so altered. Cagan (1979) has advocated the uniform re-

imposition of reserve requirements on all transactions balances. Kareken (1984), however, has argued that deregulation will have limited macroeconomic effects and no shift in regulations is warranted.

This paper investigates the influence of deposit deregulation on the effectiveness of monetary policy in a general equilibrium model, a framework consistent with the work of Brunner and Meltzer (1964) and (1972), Tobin and Brainard (1963), and Tobin (1969). Specifically, we analyze regulatory regimes ranging from one which exercises total control on explicit and implicit deposit rates to a totally unregulated, competitive regime in which deposit rates respond quickly to open market rates.

It should be noted that although this study provides an exhaustive analysis of the effect of deposit rate regulation on the macroequilibrium, space limitations require us to ignore other important aspects of financial deregulation that may have a bearing on the monetary aggregates. We do not consider the effect of deregulation on the rate of return or the adequacy of bank capital, or the impact of such deregulation on Federal deposit insurance. Furthermore, we do not consider quantitative credit controls or the effect of interstate banking and the integration of other financial services into the banking industry.

The major results of this study are stated at the outset:

(1) Although deposit deregulation causes the real demand for broader monetary aggregates such as M1 and M2 to become less sensitive to interest rates, a result that has frequently appeared in the literature,[2] the interest sensitivity of the real demand for the monetary base is likely to increase. This is especially true if the effective reserve level on deposits is low. Hence, the price level is likely to become more sensitive to interest rate fluctuations. Under these circumstances, the Central Bank may have to pursue

stronger countercyclical policy against interest rate changes in order to stabilize the price level.

(2) The change in the response of the nominal money supply due to deposit rate deregulation is apt to be greater than either that of the real money supply or the price level. In contrast to the situation when deposit rates are regulated, deposit rate deregulation causes the nominal money supply (for a given amount of monetary base) to become positively related to market rates of interest.

(3) Deposit deregulation reduces the income elasticity of the real demand for the monetary base and broadly defined money. Deregulation may even reverse the response to real income of the nominal money supply from positive to negative. The effects of deregulation on the income elasticities have been ignored in most of the deregulation literature, but they are equally important as changes in interest elasticities in determining the slope of the LM curve.

(4) Monetary policy can, through appropriate open market policies, offset changes in the interest elasticity of any of the monetary aggregates. However, changes in the income elasticities cannot be offset directly by central bank policy and hence may constitute a greater threat to the control of the price level.

I. Interest Rate Deregulation Since 1970

We begin the analysis with a short review of regulatory change over the past fifteen years. Although, prior to 1970 there had been a series of financial deregulation investigations, such as the Commission on Money and Credit,[3] it was not until the Hunt Commission was appointed in 1970 that the move toward deregulation truly began. Perhaps this can be explained by the

confluence of competitive pressures and increasing interest rates brought about by high levels of inflation. These pressures led to new and unique attempts to circumvent regulatory ceilings due in no small measure to the need of financial institutions to retain funds that were increasingly leaking into the primary money market.

Table 1 outlines the process of deregulation of depository interest rates and changes in reserve regulation over the past 15 years. The center of early rate deregulation activity on consumer demand deposits was obviously in New England, which initiated in the early 1970's the NOW account or negotiable order of withdrawal, which were tantamount to interest-bearing demand deposits. These accounts started unsuccessfully in Maine, but gradually moved down the Northeastern coastline. Competitive pressure to offer these accounts nationwide culminated with the passage of the Depository Institutions Deregulation and Monetary Control Act of 1980. Title II of this Act formalized the procedure of deregulating deposit rates by establishing the Depository Institutions Deregulation Committee with powers and a timetable for deregulating deposit rates. This committee expanded NOW accounts nationally in 1982, and super NOW accounts, with no deposit rate ceiling, were authorized in 1984. In the interim, new accounts without deposit rate ceilings had been created both within the banking system, e.g., Money Market Deposit Accounts, and from its competitor industries, e.g., the Cash Management Account of brokerage firms and money market mutual funds. By March 31, 1986, only demand deposits issued by commercial banks will continue to have a zero explicit interest rate as mandated under the Banking Act of 1933.

Reviewing the deregulation movement from the view of its impact upon the economy, one can see impacts in four important areas.

(1) There has been an increase in the allowed explicit ceiling on

deposit rates. All rates on all deposits, except demand deposits, have been increased since the deregulation process began in 1970. This is perhaps the most straightforward type of deregulation. As will be discussed in Section II, the existence of explicit deposit rate ceilings on banks has led to indirect compensation to depositors. The increase in explicit deposit rates allows the banks to substitute explicit for implicit interest.

(2) There has been a trend toward freeing deposit rates from regulation, in effect removing the deposit rate as a central bank control variable. In 1970 no deposit rate was market determined, not even those of large certificate of deposits, but by early 1986 all deposit rates (except demand deposits) will be free of interest rate ceilings. This type of deregulation both increases the level of deposit rates as in (1) above and increases the sensitivity of such deposit rates to the market rate of interest.

(3) Deposit deregulation has affected the types of liabilities that require reserves and the level of those reserves. Some of the changes in reserve regulations are given in Table 1B. The required reserve ratios on transactions accounts were reduced from a range of 13 to 17 ½ % in 1970 to 0 to 12% in 1982. The average reserve ratio (ratio of reserves to M1 deposits) on transactions deposits in 1984 equaled 7.11%, down from 12.52% in 1970. The average reserve ratio against all deposits (as compiled in M3) has dropped from 4.65% in 1970 to 1.39% in 1984. Both ratios are currently at historically low levels. This drop in reserve ratios has occurred despite the fact that the Monetary Control Act of 1980 mandated reserves, for the first time in history, on all financial institutions, whether or not they were members of the Federal Reserve System.

(4) Substitutes have been created for standard transactions deposits. The rise in interest rates, coupled with fixed deposit rates and costly

reserve requirements led to the development of alternative financial assets which served as both liquid assets and transactions media paying market rates of interest and avoiding reserve requirements. Prominent among these were the money market mutual funds, cash management accounts, and new deposits such as short-term (overnight) repurchase agreements offered by the banking industry which offer market rates of interest and checking privileges.

II. The Micro Economic Effects of Deregulation

In order to analyze properly the effect of deregulation on monetary policy, it is necessary to understand the origins of the demand and supply functions for these assets and the impact of deregulation on these functions. In this section we review the micro foundations of the demand and supply and the effect of deregulation on these functions. There are two sectors considered: the household sector and the financial institution sector, henceforth denoted banks.

II.A. The Household Sector

At any moment of time, there exists a stock of household real wealth. It is generally assumed that the household wishes to maximize the discounted flow income from these assets but is constrained by the need to transact, using either deposits or currency, in order to obtain predetermined consumption baskets. Such transactions involve nonzero transfer costs. Modeling optimal behavior in this manner leads to transactions networks such as documented in Baumol (1952), Tsiang (1969), Frankel and Jovanovic (1980), and Santomero (1974) and (1979), and result in demand equations of the general form:

$$(1A) \qquad C^d = C^D(\bar{r}, \overset{+}{r}_C, \bar{r}_D, \overset{-}{\tau}_D, \overset{+}{\tau}_C, \overset{+}{Y}),$$

$$(1B) \qquad D^d = D^d(\bar{r}, \bar{r}_C, \overset{+}{r}_D, \overset{-}{\tau}_C, \overset{+}{\tau}_D, \overset{+}{Y}),$$

$$B^d = B^d(\overset{+}{r}, \bar{r}_D, \bar{\tau}_C, \bar{\tau}_D, \overset{+}{Y}), \tag{1C}$$

where C^d, D^d, and B^d are the real demands for currency, deposits, and bonds, r is the open market interest rate, r_C is the presumed zero rate on currency, r_D is the return on demand deposits, τ_C and τ_D are the transfer costs into both C and D from other assets, and Y is real income. The signs over the arguments refer to the signs of the partial derivatives.

As might be expected, the own rate of return has a positive effect on own demands; cross rates have a negative effect. The transfer costs also affect demands, with higher cash transfer costs leading to less frequent exchange and higher demands in the less attractive (lower yielding) asset.

Central to any discussion of deregulation is the effect of such regulatory changes on the variables in the demand functions above. Specifically, to the extent that deregulation results in the simple ceteris paribus increase in r_D, the effect will be a reduction in both currency and bond demands and an increase in deposit demand. A second area in which the effects of deregulation are likely to be felt is in the transfer cost variables. To the extent that deregulation reduces the cost of currency transfer and the ease of switching from bonds to deposits, this will have effects on the given demand functions. Such cost reductions may be an outgrowth of technological improvement as Niehans (1982) has recently suggested, or a change in the price charged consumers induced by deregulation. In any case, the effect of such changes is felt through the household sector demand functions above.

The entire discussion above, however, is conditional upon the presumed effectiveness of the prior deposit rate regulation. The monetary economics literature has long recognized the distinction between de jure and de facto regulation. In this context, some authors, e.g., Klein (1974) and Rush (1980)

have suggested that such regulation is totally ineffective. Others have argued that deposit rate regulation has been at least partially offset by side payments or implicit returns to depositors along the lines outlined by Barro and Santomero (1972) and Startz (1979). All of these authors have suggested that overbranching, subsidized transfer costs, and excessive services have been used in lieu of direct payments to lure depositors and dissipate excess profits. In the wake of deregulation, explicit payments will substitute or significantly alter such implicit payments. This, in turn, will affect the demand functions outlined above. To analyze the response relationship between these two forms of payments, however, it is necessary to turn to the bank behavior models to examine that sector's response to the deregulation of explicit interest on deposits.

II.B. The Banking Sector

There is a fairly extensive literature, which has recently been reviewed in Santomero (1984), on the theory of the banking firm. Therefore, this section will neither develop fully a structural model of the banking firm nor attempt to extend this theoretical literature. Rather, it will attempt to spotlight the effects of deregulation within standard modeling approaches. The discussion is centered upon the impact of regulatory change on the banks' pricing structure with specific reference to the effect of explicit interest on implicit payments to depositors.

There are two competing ways of looking at the effect of deregulation of deposit rates on bank behavior. The first and most common centers around a view of the implicit payments to depositors as a simple enhancement of explicit deposit rates. The literature dates back at least to Marty (1961) in which the notion of compensatory implicit payments to deposit holders was first suggested. Others who have used these arguments include Cagan and

Schwartz (1975) and Startz (1983).

The fact that implicit rates exist has been documented extensively in the literature, e.g., Barro and Santomero (1972), Becker (1975), and Startz (1979). The change in implicit rates in the face of deregulation, however, is more debatable. Here, two versions appear to exist. If the implicit payments are (a) produced efficiently, (b) valued in exactly the same manner as explicit payments, and (c) can be produced in sufficient quantity to circumvent the regulatory constraint, deregulation is irrelevant. In this case, deregulated deposit rates will lead to an ambiguous effect on explicit rates paid on deposits because both consumers and banks find that there are no necessary gains from shifting the return to depositors between implicit and explicit payments. In fact, the non-taxable nature of implicit returns may encourage the status quo.

However, if any of the three conditions above are not satisfied, deregulation will have significant effects upon the deposit market. If the cost to the banking sector differs from the benefits perceived by the households, we have the case suggested by Startz (1983). Likewise, if the implicit rate is not fully effective as a method of regulatory avoidance, deregulation will increase the perceived deposit rate. The empirical evidence offered by Barro and Santomero (1972) and Startz (1979) suggests that the latter may indeed be the case. The important implication of the discussion is that the deposit rate regulation must have been effective for there to be substantive aggregate effects associated with its elimination.

It should be noted that in considering deregulation in terms of rates of return, we are ignoring potentially important effects of deregulation on the cost of transferring from one asset to another. There exists a second strand of monetary literature, developed by Mitchell (1979), Saving (1979), and

Santomero (1979), which examines more broadly the effect of financial deregulation on deposit demands. Rather than concentrating all bank activities and services into a single portmanteau variable r_D, as discussed above, this literature develops the role of transaction costs between currency and deposits and deposits and bonds. In this framework, implicit payments to depositors are achieved through the subsidization of transactions and transfers such as free checking and low cost automatic transfers. These services are often only loosely related to deposit balances and hence cannot be summarized by the deposit rate variable discussed above.

Within this second view of the banking environment, deposit deregulation is much more complex. Increases in the explicit rate on deposits cause a change in transaction subsidies, but these do not have a simple translation into increasing or decreasing demands for deposits.[4] According to this view, the net effect of deregulation is not necessarily an increase in the desirability of the depository liability. This may be seen with reference to Section A above. Currency demand may actually increase at the expense of deposits as the transactions subsidy is reduced in light of deregulation. As deposit ceilings rise, transaction subsidies decline, transactions become more expensive (τ_C rises) and deposits in the banking sector may decline.[5]

The impact of deposit deregulation at the microbank level, therefore, is less than obvious. If it can be summarized by the deposit rate, the results are straightforward. If regulation is ineffective, then deregulation can be expected to have little aggregate impact. If, however, regulation leads to subsidies at the transactions level, deregulation's effect can only be conjectured. Nonetheless, the profession seems driven to the conclusion that deposit deregulation ought to increase deposit attractiveness. Despite some doubts, we shall interpret such deregulation as working its way through

effective rates of return on deposits.

II.C. The Implications of Deregulation on Deposit Rates

The previous discussion indicates that the effective deposit rate r_D, defined as the sum of implicit and explicit interest paid on deposits, can be expressed as

$$r_D = f(\overset{+}{r}, \overset{+}{r}_0, \overset{-}{k}_D, \overset{+}{r}_r, \overset{-}{\phi}) \quad , \tag{2}$$

where r is the market rate of interest, r_0 is the government mandated ceiling for the explicit rates paid on deposits, k_D is the effective reserve ratio on deposits, and r_r is the rate of return (if any) paid by the central bank on required reserves. The ϕ variable measures the effectiveness of the regulation enforcing the deposit ceiling, r_0, on deposits. The regulatory variable ϕ can be indexed from zero to one, the former indicating no effective regulatory control on deposit rates so that implicit deposit rates can substitute one-for-one for explicit rates, while the latter indicates a total control situation in which no implicit rate is paid to depositors. The market rate of interest, the explicit deposit rate, and the rate of return on reserves positively influence the effective deposit rate while the effective reserve ratio and the state of regulation negatively influence the deposit rate.

The effective reserve ratio on deposits, k_D, is chosen by the profit maximizing decisions of the financial institution in light of a mandated reserve ratio (if any). This can be expressed in the following functional form, using any of the micromodels of reserve determination surveyed in Santomero (1984), e.g., Poole (1968) or Baltensperger (1980),

$$k_D = g(\overset{-}{r}, \overset{+}{k}_0, \overset{+}{r}_r) \tag{3}$$

where k_0 is the explicit required reserve ratio on deposits. A rise in the market rate of interest will reduce the effective reserve ratio, while a rise in explicit reserve requirements and the interest rate on reserves will increase reserve ratios. Given r, r_0, k_0, r_r, and the state of regulation, ϕ the equilibrium effective reserve ratio, k_D, and the effective deposit rate, r_D, can be determined.

In order to illustrate the effects of deposit deregulation, it is instructive to analyze a specific form of the function, which may be viewed as a synopsis of the above discussion, i.e.,

$$r_D = (1 - \phi)[(1 - k_D)r + k_0 r_r - \psi] + \phi r_0 \tag{4}$$

where ψ is the marginal cost of producing deposits. If rate ceilings on deposits are totally ineffective, so that $\phi = 0$, then the deposit rate is equal to the term in brackets on the right hand side of equation (4), a weighted average of the market rate of interest and the interest paid on reserves, less the marginal cost of producing deposits. If regulation is totally effective, so that $\phi = 1$, then $r_D = r_0$, and the effective deposit rate is equal to the deposit ceiling. Taking the derivative of equation (4) with respect to the market rate of interest leads to

$$dr_D/dr = (1 - \phi)[(1 - k_D) + k_0 dr_r/dr] \ . \tag{5}$$

Since the terms in the bracket of equation (5) are non-negative, dr_D/dr is a decreasing function of the state of regulation, indicated by ϕ. Therefore, one of the important effects of deposit rate deregulation is the increase in the interest sensitivity of the effective deposit rate. The case where $dr_D/dr = 0$ corresponds to completely effective regulation of deposit rates ($\phi = 1$), while $dr_D/dr = 1$ corresponds to the case where there is no

deposit regulation and reserves are negligible or reserves pay the market interest rate.[6]

III. The Demand for Monetary Assets

In this analysis, we continue to use the simplification that there are three classes of assets, viz., currency, deposits, and all other earning assets, which we refer to as bonds. The many classes of deposits are aggregated into one composite deposit for this analysis. Neglecting transfer costs, the log of the real aggregate demand for currency and deposits can be written in compact form, adapting Equation (1), as

$$c^d = c^d(\overset{+}{r_C}, \bar{r}_D, \bar{r}, \overset{+}{Y}) \tag{6A}$$

$$d^d = d^d(\bar{r}_C, \overset{+}{r_D}, \bar{r}, \overset{+}{Y}) \ , \tag{6B}$$

where r_C is the rate of return on currency, r_D is the effective return on deposits (including both explicit and implicit interest), r is the market rate of interest, and Y is real income.

III. A. Interest Elasticity of Real Currency and Deposit Demand

The change in the log demand for currency and deposits with respect to the market rate of interest r is derived from Equations (6) as:

$$\frac{dc^d}{dr} = \frac{\partial c^d}{\partial r} + \frac{\partial c^d}{\partial r_D}\frac{dr_D}{dr} \ , \tag{7A}$$

$$\frac{dd^d}{dr} = \frac{\partial d^d}{\partial r} + \frac{\partial d^d}{\partial r_D}\frac{dr_D}{dr} \tag{7B}$$

We shall assume that asset demands are characterized by (weak) gross substitutability, i.e., asset demands are positive functions of their own rate of return and non-positive functions of alternative rates of return. This

assumption, which is frequently made in the literature on monetary assets demands, follows from the asset demands derived from the networking analysis cited in Section II.

Due to the gross substitutability property, both $\partial c^d/\partial r$ and $\partial c^d/\partial r_D$ are negative, implying that dc^d/dr is negative. As dr_D/dr ranges from zero to one, dc^d/dr decreases algebraically, so that the real demand for currency becomes more sensitive to the market rate of interest. This is illustrated in Figure 1.

As can be seen by Equation (7B), if deposit rates are fixed, so that $dr_D/dr = 0$, then dd^d/dr is negative. However, increasing dr_D/dr algebraically increases the demand for deposits. In the case where $dr_D/dr = 1$, dd^d/dr must be positive. Due to the condition of gross substitutability, the own effect $\frac{\partial d^d}{\partial r_D}$ must outweigh any cross effect. Therefore, when market and deposit rates rise equally, deposit demand must rise. This effect is also illustrated in Figure 1. Clearly, by continuity, there is a sensitivity of the deposit rate to the market rate of interest between zero and one where deposit demand is insensitive to the market rate of interest.

III.B. Real Money Demand

III.B.1 Definition and Interest Elasticity

We shall define the money supply, M, (sometimes referred to as "broadly defined money") as the sum of currency and deposits,

$$M \equiv C + D \; . \tag{8}$$

The change in the demand for the log of the real money supply, m^d, with respect to the market rate of interest r is

$$\frac{dm^d}{dr} = \frac{d \log(C^d + D^d)}{dr} = \alpha \frac{dc^d}{dr} + (1 - \alpha) \frac{dd^d}{dr} =$$

(9)

$$\alpha \frac{\partial c^d}{\partial r} + (1 - \alpha) \frac{\partial d^d}{\partial r} + \left[\alpha \frac{\partial c^d}{\partial r_D} + (1 - \alpha) \frac{\partial d^d}{\partial r_D}\right] \frac{dr_D}{dr}$$

where $\alpha = C^d/(C^d + D^d)$, $c^d = \log(C^d)$, $d^d = \log(D^d)$. Equation (9) states that the semi-elasticity of the demand for real money with respect to the market rate of interest is a weighted average of the semi-elasticities of currency and deposit demands. The weights are the percentage of currency and deposits in the money supply. In 1984, $\alpha = .285$, where deposits are defined as in M1, while, in 1970, the currency to money ratio equalled .224.

If the rate of return on deposits is fixed, i.e., $dr_D/dr = 0$, then clearly $dm^d/dr < 0$ since both $\partial c^d/\partial r$ and $\partial d^d/\partial r$ are negative. However, for values of dr_D/dr near unity, it is possible that the demand for deposits may rise sufficiently to offset the drop in currency, so that the demand for real money may become positively related to the interest rate. Such a condition would arise when an equal increase in the deposit rate and the market interest rate shifted demand from bonds to deposits and offset the decline in currency demand. This shift could occur even in the context of gross substitutability. Throughout this analysis we shall assume that $dm^d/dr < 0$, although the reverse sign is possible.[7]

III.B.2. Effects of Deregulation on Interest Elasticity

There are two effects of deposit deregulation on the real demand for money: (1) increasing dr_D/dr, and (2) increasing the level of r_D. The first can be easily analyzed by referring to Equation (9). An increase in dr_D/dr unambiguously reduces the interest elasticity of the demand for real money because by the property of gross substitutability, $[\alpha\partial c^d/\partial r_D + (1-\alpha)\partial d^d/\partial r_D]$ must be positive.[8] This is illustrated in Figure 2, where dm^d/dr is a

weighted average of dc^d/dr and dd^d/dr shown in Figure 1. Because of gross substitutability, the positive slope of the real deposit demand must exceed the negative slope of the real currency demand, resulting in a positive slope for real money demand.

The second effect of deposit deregulation is a discrete rise in the effective deposit rate, r_D, caused, for example, by the removal of deposit rate ceilings. This must increase the real demand for deposits and reduce the real demand for currency, causing a drop in the coefficient α . If we make the empirically plausible assumption that $|\partial d^d/\partial r| > |\partial c^d/\partial r|$, so that, for a given deposit rate, real deposit demand is more sensitive to market rates than is real currency demand, then a shift towards deposits will increase the interest elasticity of the demand for real money for the case where $dr_D/dr = 0$. However, when $dr_D/dr > 0$, then a decrease in α has an ambiguous effect on the interest elasticity, since the bracketed term in equation (9) must be positive. In fact, when $dr_D/dr = 1$, a decrease in α must decrease the interest elasticity of the demand for money.

Historically, deposit deregulation has involved both of the above effects: increases in the responsiveness of deposit rates to the market rate and discrete increases in the effective deposit rate. Both of these effects work in the same direction of lowering the interest sensitivity of real money demand unless there is little response of deposit rates to market rates of interest.

III.C. Real High-Powered Money Demand

III.C.1. Definition and Interest Elasticity

In order to analyze the effects of deregulation in a general equilibrium model, it is important to determine the total effect of the market rate of interest on the demand for high-powered money, defined as the sum of currency

plus reserves, i.e.,

$$H = C + k_D D \quad . \tag{10}$$

The effect of a change in the market rate of interest on the log of the real demand for high-powered money, h^d, is

$$\frac{dh^d}{dr} = \frac{d \log(C^d + k_D D^d)}{dr} = \beta dc^d/dr + (1-\beta)(dd^d/dr + d \log k_D/dr) \tag{11}$$

$$= \beta\, \partial c^d/\partial r + (1 - \beta)\partial d^d/\partial r + \frac{dh^d}{dr_D}\frac{dr_D}{dr} + (1 - \beta)(d \log k_D/dr)$$

where

$$\frac{dh^d}{dr_D} = [\beta\, \partial c^d/\partial r_D + (1 - \beta)\partial d^d/dr_D] \quad . \tag{12}$$

The weight $\beta = C^d/(C^d + k_D D^d)$, is the ratio of currency to high-powered money, which reached 80.1% in 1984, the highest level for which there are historical records, up from 62.3% in 1970. The parameter β is greater or equal to α, and equal only when $k_D = 1$. As in the analysis of equation (9), it is straightforward to show that dh^d/dr is negative as long as $dr_D/dr \leq 1$ and certain weak assumptions are placed on asset demands.

It is of interest to examine how the interest sensitivity of the demand for real high powered money, h^d, compares to that of real, more broadly defined money, m^d. Figure 2 illustrates their relationship. Equation (11) is identical to equation (9) except that β replaces α , and a negative term involving the reserve response to interest rates appears in dh^d/dr. Hence a sufficient, but not necessary condition for h^d to be more interest sensitive than m^d is that $|dd^d/dr| < |dc^d/dr|$. This would be true, as shown in Section II and Figure 1, if dr_D/dr is near unity. If dr_D/dr is nearer zero, the magnitude of the interest elasticities of h^d and m^d may be reversed, as illustrated in Figure 2.

III.C.2. Effect of Deregulation on Interest Elasticity

In contrast to the analysis of real money demand, where increasing deposit rate flexibility must decrease the interest sensitivity of real broadly defined money, it is impossible to determine whether increasing dr_D/dr will necessarily increase or decrease dh^d/dr. This is so because the sign of dh^d/dr_D, the response of the demand for real high-powered money with respect to the deposit rate, is ambiguous. Although gross substitutability implies the real demand for deposits rises by more than the real demand for currency falls, whenever r_D rises, the demand for reserves may not rise by more than currency falls. Hence, the demand for real high-powered money may fall in response to a rise in the deposit rate.

It can be seen that the effect of r_D on the demand for real high-powered money must be increasing in k_D; the effect must be negative when $k_D = 0$, and positive when $k_D = 1$. If reserves are negligible, the interest sensitivity of the demand for real high-powered money becomes the interest sensitivity of the demand for real currency, and hence deregulation of deposit rates must increase the interest sensitivity of the demand for real high-powered money. The reason for this can be understood as follows. If deposit rates are fixed, currency must be shifted to bonds to take advantage of higher interest rates, and hence the interest elasticity of currency is likely to be small. If deposit rates are deregulated, currency holders can switch to both bonds and deposits, and the interest elasticity of the demand for real currency must increase. For this reason, we believe it may be unwise to extrapolate the low interest elasticities of currency estimated in the post-War period into a deregulated financial environment. In an extensively deregulated banking system with a low effective reserve ratio, flexibility of deposit rates is

likely to increase the interest sensitivity of the demand for real high-powered money while at the same time reducing the interest sensitivity of more broadly defined monetary aggregates.

In the conventional terminology, an increase in the deposit rate raises the demand for real high-powered money if deposits and high-powered money are complements, and lowers the demand in the case where they are substitutes. The lower the reserve ratio, the more likely high-powered money and deposits are substitutes. Therefore at low reserve ratios such as exist today, increasing the flexibility of the deposits rate to market rates of interest will increase the interest sensitivity of the demand for real high-powered money.[9]

As in the case of real money demand, a one-time increase in the level of the effective deposit rate will increase deposit demand and hence α will decrease. If $|\partial d^d/\partial r| > |\partial c^d/\partial r|$, as we discussed above when analyzing this case in Section III.B.2, then a rise in deposit rates increases the elasticity of the demand for real high-powered money to the market rates of interest if $dr_D/dr = 0$. In the case where $dr_D/dr > 0$, then the effect of an increase in the deposit rate on dh^d/dr depends on whether high-powered money and deposits are substitutes or complements. If they are substitutes, as occurs when reserve ratios are low, then the interest sensitivity of the demand for real high-powered money must also increase, just as in the case of the more broadly defined monetary aggregates.

In summary, the removal of deposit rate ceilings is likely to increase the interest elasticity of the real demand for high-powered money. Although deposit rate deregulation has a theoretically ambiguous effect on the demand for real high-powered money, the lower is the reserve ratio, then the more likely the interest elasticity of real high-powered money will increase.

Therefore, in marked contrast to the effect on real money demand, deposit deregulation is likely to increase the interest sensitivity of the demand for real high-powered money with respect to the market rate of interest.

III.D. Income Elasticities of Monetary Aggregates

Although much of the literature analyzing the effects of deposit deregulation on macroeconomic policy has concentrated on changes in interest elasticities, deregulation may have equally important effects on the income elasticities of monetary assets. Deposit deregulation entails an increase in the level of deposit rates relative to market rates and hence reduces the opportunity cost holding deposits relative to bonds. This means that, at the margin, the characteristics that distinguish at least some deposits from bonds will decrease.

In the case where the deposit rate is at, or near, the bond rate, then it is likely that the income elasticity of deposit demand will drop substantially. Deposits will be held as interest bearing liquid assets, rather than just to facilitate transactions. In fact, it is even conceivable that the income elasticity of deposits may become negative as individuals switch from deposits to currency when their income and level of transactions increases.

The influence of a change in the income elasticities on the demand for monetary aggregates can be analyzed directly by differentiating Equations (8) and (10) with respect to (the log of) income, y:

$$\frac{dm^d}{dy} = \alpha \frac{dc^d}{dy} + (1 - \alpha) \frac{dd^d}{dy} , \tag{13A}$$

$$\frac{dh^d}{dy} = \beta \frac{dc^d}{dy} + (1 - \beta) \frac{dd^d}{dy} . \tag{13B}$$

Since $\beta > \alpha$, the slope of dm^d/dy will be greater than dh^d/dy if and only if dd^d/dy is greater than dc^d/dy. Clearly, a reduction in dd^d/dy resulting from deposit deregulation will reduce the income elasticity of the real demand for both broadly defined and high-powered money. The relative impact of changing income elasticities on these two aggregates depends crucially upon the relative elasticity of deposits and currency. To the extent that deposit demands are more sensitive to income than currency, real money demand will be more sensitive than real high-powered money to changes in output. If deposit deregulation causes dd^d/dy to fall below dc^d/dy, then the income elasticity of broadly defined money will fall below that of real high-powered money.

The effect of the change in the income elasticities, as well as the interest elasticities on the general equilibrium of the system will be analyzed in depth in the next section. However, it should be pointed out that economists who emphasize the importance of the slope of the LM curve in analyzing the effects of financial deregulation, would make incorrect inferences about the impact of financial deregulation if the change in income elasticities is ignored. Even though dm^d/dr is reduced under deregulation as shown above, the reduction in dm^d/dy may be sufficient so that the LM curve viz., $dr/dy = (-dm^d/dy)/(dm^d/dr)$ becomes flatter under deregulation rather than steeper, as usually depicted.

IV. Monetary Assets in a Macroeconomic Model

IV.A. The Real Sector

In order to examine the effect of deposit rate deregulation on the equilibrium in a macroeconomic model, we construct a flexible price stochastic neo-classical economy where the monetary sector, which determines the price level, is dichotomized from the real sector, which determines real income and

the real interest rate.

One example of such a model is patterned after Barro (1984) and can be specified by

$$y_t^d = y^d(r_t) + \varepsilon_t^D \qquad \partial y^d/\partial r < 0 \tag{14}$$

$$y_t^s = y^s(r_t) + \varepsilon_t^S \qquad \partial y^s/\partial r \geq 0 \tag{15}$$

$$y_t^d = y_t^s \tag{16}$$

where y_t^d and y_t^s are the (log of) real output demanded and supplied at time t. The demand for real output is assumed to be negatively dependent on the real rate of interest, r_t, because of the standard intertemporal substitution of commodity demand. The real supply for real output is non-negatively dependent on the real rate of interest due to the intertemporal substitution of leisure. The terms ε_t^D and ε_t^S represent stochastic shocks to real output demand and supply. The solution determines the level of real income and the real rate of interest, which are functions of the stochastic shocks and the structural parameters.

IV.B. The Monetary Sector

The monetary sector of the economy, which is similar to that analyzed by Siegel (1985), is a stochastic version of the functions derivable from Section II and analyzed in Section III above. In order to simplify the notation of the model, monetary demands are specified in log-linear form, i.e.,

$$c_t^d = c_r i_t + c_y y_t + \eta_t^c , \qquad c_r \leq 0,\ c_y > 0 \tag{17}$$

$$d_t^d = d_r i_t + d_y y_t + \eta_t^d , \qquad d_r \leq 0,\ d_y > 0 \tag{18}$$

$$i_t = r_t + E(p_{t+1}) - E(p_t) . \tag{19}$$

The coefficients c_r and d_r represent the total response (both direct and indirect effects induced by changes in r_D) of real currency and real deposit demand to the rate of interest i_t, and thus are affected by the state of deregulation. The coefficients c_y and d_y are the income elasticities of the real demands for currency and deposits, respectively, and are likewise influenced by deposit deregulation. The nominal rate of interest, i_t, is defined as the sum of the real rate plus the expected rate of inflation over the next period. Both real currency and real deposit demands are subject to stochastic shocks, n_t^c and n_t^d.

Given the specifications above, the nominal demand for the (log of) high-powered money, denoted n_H^d, can be expressed as

$$(20) \qquad n_{H_t}^d = \log[P_t(C_t^d + k_D D_t^d)] \ ,$$

where C_t^d and D_t^d are the real (arithmetic) levels of currency and deposit demand, P_t is the price of output in terms of a unit of high-powered money, and k_D is the effective reserve ratio on deposits. The nominal supply of high-powered money n_H^s is controlled without error by the central bank and may be dependent, by direct (open market operations) and indirect (discount borrowings) policies, on tne nominal rate of interest, i_t, such that

$$(21) \qquad n_{H_t}^s = H_{0t} + H_r i_t$$

where H_{0t} is a time dependent path, and H_r is a controllable policy response parameter of the central bank.

In similar fashion, the (log of) the nominal money supply, M_t is denoted by

$$(22) \qquad M_t \equiv \log [P_t(C_t + D_t)] \ .$$

By linear approximations of equations (17) through (22), the monetary sector can be summarized by the following log-linear equations:

$$(23A) \qquad {}^{n}H_t^d = p_t + h_t^d$$

$$(23B) \qquad h_t^d = (\beta_t c_r + (1-\beta_t)(d_r + k_r))r_t +$$

$$(\beta_t c_y + (1-\beta_t)d_y)y_t + \beta_t \varepsilon_t^c + (1-\beta_t)\varepsilon_t^d$$

$$(23C) \qquad {}^{n}H_t^s = H_{0t} + H_r i_t$$

$$(23D) \qquad {}^{n}H_t^d = {}^{n}H_t^s$$

$$(23E) \qquad M_t \equiv p_t + \alpha_t c_t + (1 - \alpha_t)d_t$$

where

$$\beta_t = C_t/(C_t + k_D D_t),\ \alpha_t = C_t/(C_t + D_t)\ ,\ \text{and}\ k_r = d \log k_D/dr\ .$$

Equation (23A) states that the demand for the log of nominal high-powered money is the sum of the (log) price level plus the real demand for high-powered money. Equation (23B) linearizes the real demand for high-powered money and is taken from equations (11) and (13B). Equation (23C) repeats equation (21), the supply function for high-powered money. Equation (23D) is the equilibrium condition for the monetary sector, indicating that the supply of high-powered money is willingly held by the public and the banks. It is assumed that there is a perfectly elastic supply of deposits at the going deposit rate r_D and that there is no disequilibrium in the market for currency and deposits, so that the equilibrium quantities of these assets, C_t and D_t, and hence M_t, are identical to that demanded by the private non-bank sector. Equation (23E) indicates that the log of the nominal money supply can be expressed as a weighted average of nominal currency and nominal deposits, with

the weights equalling the ratio of currency to total money and deposits to total money, respectively. The coefficients α and β represent, as before, the equilibrium values of the currency-money and currency-high powered money ratios. As indicated in Section III, these ratios may be influenced by the state of financial deregulation, particularly the level of the deposit rate. To simplify the subsequent analysis, the time subscripts will be removed from α and β.

IV.C. Solution of the Price Level

In order to simplify the solution of the model, it is assumed that the central bank controls the nominal supply of high-powered money in such a way that there are no inflationary expectations in the economy. This is done by revealing to economic agents a time sequence of exogenous high-powered money, H_{0t}, such that, conditioned on all current information, the expected value of the price level in the next period, $E(p_{t+1})$, is identical to the expected price level in the current period. Therefore, the real rate of interest is equal to the nominal rate. This assumption only requires that the central bank accommodate any expected changes in the demand for base money in the next period, and permits us to substitute r_t for i_t in the analysis.

Equations (23A) through (23D) can be used to solve for the price level, p_t, in terms of r_t and y_t and the shocks to the monetary demands, η_t^c, and η_t^d, to obtain

$$(24) \qquad p_t = H_{0t} - (\beta c_r + (1-\beta)(d_r + k_r) - H_r)r_t - (\beta c_y + (1-\beta)d_y)y_t - (\beta\eta_t^c + (1-\beta)\eta_t^d)$$

Except for the policy term H_r, the coefficient of the interest rate, r_t, and real income, y_t, are exactly the negative of the interest and income

elasticities of the demand for real high-powered money, as given in equations (11) and (13B) of Section III. Note that since r_t and y_t are determined exogenously to the monetary sector, equation (24) represents an explicit solution for the price level.

IV.D. Solution of the Nominal Money Supply

Although the characteristics of the real demand for high-powered money are important for the determination of macroequilibrium, the Federal Reserve sets its target on the nominal quantities of such broadly defined variables as M1 and M2. The nominal money supply results from the interactions of forces which determine the real demand for currency, deposits, and the price level. Only if the reserve ratio were unity, in which case broadly defined money would equal high-powered money, does the targeting of one become equivalent to the other.

We can solve for the expression for the nominal money supply in terms of the interest rate, output, and the monetary demand shocks. Substituting equation (24) into (23E) yields the model's solution for the nominal supply of money, M_t,

$$(25) \quad M_t = H_{0t} + (\beta - \alpha)\left[\left((d_r - c_r) - k_r(1 - \beta)/(\beta - \alpha) + H_r/(\beta - \alpha)\right)r_t + (d_y - c_y)y_t + n_t^d - n_t^c\right] .$$

It is important to note that M_t is simply the sum of the (log) real money demand, m_t^d, and the (log) price level, p_t. Hence, the coefficients of r_t and y_t in equation (25) are the sum of the respective interest and income elasticities of real money demand as derived in Equation (19), and the price level, shown in Equation (24).

Equation (25) can be interpreted as follows. The nominal money supply is

homogeneous of degree one in the systematic component of high-powered money. The term ($\beta - \alpha$), which is always non-negative, measures the difference between the fraction of currency in high powered money and the fraction of currency in broad money, and is thus inversely related to the reserve ratio, k_D. If k_D equals unity, then $\beta = \alpha$ and the nominal money supply is equal to the nominal supply of high-powered money. If $k_D < 1$ (and H_r and k_r are zero), then the nominal money supply is influenced by the rate of interest and real output only if the interest rate and income elasticities for the demands for real currency and deposits differ. This reflects the fact that the nominal money supply, for a given quantity of nominal high-powered money, is only influenced by changes in the relative real demands for currency and deposits.[10]

V. Effect of Deposit Deregulation in a General Equilibrium Framework

V.A. The Price Level

From the analysis of equation (24) we are able to analyze the effect of deposit deregulation on the price level. Given that output and the interest rate are determined in the real sector, the impact of deposit deregulation is captured by its effect on the coefficient of r_t in equation (24)[11]. Since the coefficient of the interest rate in the price level equation (for $H_r = 0$) and the demand for real high-powered money, equation (11), are identical, except for sign, deposit deregulation has, theoretically, the identical ambiguous effect on the interest sensitivity of the price level as it has on the demand for real high-powered money. However, as indicated in Section III.C.2. above, since it is likely deposit deregulation will increase the interest sensitivity of the demand for real high-powered money, especially if reserve ratios are low, the same must hold true of the price level. Under these conditions,

fluctuations in the interest rate must result in an increased variability in the price level, holding the quantity of nominal high-powered money and output constant. This is illustrated in Figure 3, where the values of dp/dr, plotted against the deregulation parameter dr_D/dr, must be the exact mirror image or the response of the real demand for high-powered money to the market rate of interest, dh^d/dr.

V.B. Nominal Money Supply

The effect of financial deregulation on the nominal money supply can be obtained by examining the coefficient of r_t in equation (25).[12] For a constant level of high-powered money, this is equivalent to analyzing the effect of deregulation on the difference in interest elasticities of currency and deposits, minus the sensitivity of the reserve ratio to the market rate of interest, k_r. From Equations (7A) and (7B) the first of these terms may be written:

$$(26) \qquad d_r - c_r = \frac{\partial d^d}{\partial r} - \frac{\partial c^d}{\partial r} + \left(\frac{\partial d^d}{\partial r_D} - \frac{\partial c^d}{\partial r_D}\right) \frac{dr_D}{dr} .$$

If deposit rate regulation is completely effective, so that $dr_D/dr = 0$, then $(d_r - c_r)$ will be negative, if deposit demand is more sensitive to markets rates of interest for a given deposit rate, as we assumed. Since $(\partial d^d/\partial r_D - \partial c^d/\partial r_D) > 0$, then as dr_D/dr increase, $(d_r - c_r)$ will increase, and it must turn positive when $dr_D/dr = 1$, by the property of gross substitutability. Therefore, under a deregulated environment, the response of the nominal money supply to changes in the market rate of interest must be positive.

These sensitivities are illustrated in Figure 3. The dotted line represents the interest sensitivity of m^d and h^d taken from Figure 2. The sensitivity of the equilibrium price level to market interest rates is given by dp/dr, which is a mirror image of dh^d/dr. The sensitivity of the nominal

money supply to the market rate, dM/dr, is simply the sum of dp/dr and dm^d/dr. It should be noted that, notwithstanding whether the dp/dr locus is upward or downward sloping, dM/dr in Figure 3 must be upward sloping by the properties of Equation (26) above. If the dp/dr locus is upward sloping, the change in the response of the nominal money supply to deposit deregulation must be greater than for either the real demand for high-powered or broadly defined money.

An alternative way of visualizing the changes in interest sensitivities is shown in Figure 4. The arrows from the solid to the dotted lines indicate the changes in interest sensitivites associated with increases in dr_D/dr. The clockwise rotation of the nominal money supply must occur whether or not the h^d curve rotates counter-clockwise as a result of deregulation. This occurs, as noted earlier, since deposit deregulation must algebraically increase $(d_r - c_r)$. In terms of Figure 4, if deregulation rotates the h^d curve clockwise, the m^d curve will rotate further, so that the difference, which defines the nominal money supply, must also rotate clockwise.

VI. Monetary Policy

VI.A. Controlling Interest Elasticity of Price Level

Since interest rates and output are determined by the real sector of the model, the goal of monetary policy is the stabilization of the price level.[13] This is achieved by changing the sensitivity of the monetary aggregates to the market rate of interest. The central bank can influence the interest rate response of the price level and the nominal money supply through both deposit deregulation, which changes dr_D/dr, and by manipulating H_r, the interest response of the supply of high-powered money through open market operations.

Figure 5 illustrates the response of the nominal money supply and the price level with respect to the market interest rate. The solid lines represent the same initial case as Figure 4. When $H_r = 0$, the response of the price level, as indicated by equation (24), is the negative of the interest response of the real high-powered money. Therefore, the price-interest rate locus is the mirror image of h^d of Figure 4.

It is straightforward to analyze the effects of a nonzero H_r on the price and nominal money supply locus. As equations (24) and (25) indicate, the Federal Reserve policy parameter H_r will identically influence the slopes of the price and nominal money supply curves in Figure 5. For example, a positive H_r will rotate both curves counter-clockwise by an equal distance as pictured.

If the goal of monetary policy is to minimize the variation of p given the underlying disturbances captured in the ε and η terms in equations (14) through (18), the central bank must choose an H_r such that the price locus in Figure 5 becomes vertical. Such a policy involves reducing the quantity of nominal high-powered money in response to interest rate increases, i.e., $H_r < 0$. This may be seen analytically as follows. The variance of the price level, from Equation (24) is

$$\sigma_p^2 = a_r^2\sigma_r^2 + a_y^2\sigma_y^2 + \sigma_\eta^2 + 2a_r a_y\sigma_{ry} + 2a_r\sigma_{r\eta} + 2a_y\sigma_{y\eta} \tag{27}$$

where
$$a_r = -(\beta c_r + (1-\beta)(d_r + k_r) - H_r)$$
$$a_y = -(\beta c_y + (1-\beta)d_y)$$
$$\sigma_\eta^2 = \text{var}\left[\eta_t = -(\beta\eta_t^c + (1-\beta)\eta_t^d)\right] .$$

If we assume, for the purpose of simplification, that the real shocks captured by variations in the real interest rate, r_t, are independent of shocks to real

output and pure monetary shocks, η_t, then minimizing the variance of the price level by a central bank policy rule, H_r, is equivalent to setting H_r such that a_r above is zero.[14] Since a_r represents the interest sensitivity of the demand for real high-powered money and must be negative, setting a_r at zero implies $H_r < 0$. Under this policy, both the price and nominal money supply locus will rotate counter-clockwise by the amount needed to make the price level insensitive to interest rate movements. Therefore, in response to deposit deregulation, which increases the interest sensitivity of the demand for real high-powered money, the central bank must engage in stronger countercyclical policy, i.e., reduce H_r even further, in order to stabilize the price level. It can be seen that such a monetary policy may make the nominal money supply more responsive to interest rate movements. Therefore, stabilizing the price level is not accomplished by stabilizing the nominal money supply, or even making the nominal money supply less responsive to interest rates. Rather, the demand and supply of the monetary base plays a crucial role in determining nominal income, a result consistent with the policy recommendations of Brunner and Meltzer (1964) and Meltzer (1984).

Clearly in our model there is no necessary virtue to stabilizing the nominal money supply. Nominal money is only an intermediate variable that imperfectly conveys information about the state of the economy.[15] Minimizing the interest sensitivity of the nominal money supply means setting H_r such that the M locus is vertical. This policy may actually increase the interest response of prices if the M locus is negatively sloped, as illustrated in Figure 6, which occurs when h^d is steeper than m^d in Figure 4. This situation occurs in the early stages of deposit rate deregulation, when dr_D/dr is low (and must occur when $dr_D/dr = 0$). To stabilize the nominal money supply in this case, H_r must be positive so that the M locus rotates clockwise.

However, this policy flattens the price locus, increasing its response to interest rate movement.

It should be indicated that solving for the endogenous variables in the presence of such policy rules as H_r does not violate the "Lucas Critique" which warns that the structural parameters of the system are not invariant to government policies. This is because central bank policy is based on known values of the interest rate. Therefore, H_r is already factored into the price equation. As long as the central bank maintains its control of the systematic part of monetary policy so that inflationary expectations are zero, there is no channel by which policy can alter the structural parameters of the model.

VI.B. Other Influences on Monetary Policy

VI.B.1. Changes in Income Elasticities

As noted in Section II, deposit deregulation influences the income elasticity of the demand for monetary assets as well as the interest elasticity. Deposit rate deregulation can be expected to reduce the income elasticity of the demand for deposits as deposits become a store of short-term wealth closer to bonds in their characteristics. Hence, the income elasticity of the demand for both real broad money and real high-powered money will be reduced. Because of the latter, financial deregulation will reduce the price level response to changes in real output.

As in the case of interest rate elasticities, the effect of financial deregulation on the nominal money supply is more marked. The coefficient of the nominal money supply from equation (25) is $(\beta - \alpha)(d_y - c_y)$, , so that the sign of the coefficient depends on the relative size of the income effects on deposits and currency. A reduction in the income elasticity of deposits may cause $(d_y - c_y)$ to turn negative, so that the nominal money supply will change

in the opposite direction to changes in real income.

In some ways, the effect of financial deregulation on the income elasticity of the nominal money supply is of greater importance than the effect on interest elasticities. In the latter case, the Central Bank has a policy tool, namely H_r, that can be used to offset structural changes in d_r and c_r induced by deposit deregulation. This is true because the interest rate is instantaneously known to all market participants, including the central bank. In the case of shifts in income elasticities, there is no policy tool that the central bank can employ to offset these changes, since aggregate real output, in contrast to the rate of interest, is not instantaneously known to economic agents. Furthermore, if unexpected changes in the nominal money supply can be considered a signal for changes in real output and the price level as Siegel (1985) suggests, deregulation may substantially alter the information content of nominal monetary aggregates.

VI.B.2. Changes in Exogenous Shocks to Money Demand

Of final importance in the analysis of the effect of interest rate deregulation on macroequilibrium is the influence of such deregulation on the exogenous shocks to currency and deposits, η_t^c and η_t^d. It could be argued along the lines of Kane (1981) that deposit demand is subject to greater shocks under rate ceilings because of the relative discreteness of financial innovations to evade such restrictions. In a deregulated regime, financial innovation designed solely to avoid deposit rate restrictions would be absent and the demand for deposits may be a much tighter function of the endogenous variables, such as market rates of interest and real output. To that extent, the variance of η_t^d would decrease under deregulation.

On the other hand, Tobin (1983) has recently suggested that as deposits become more substitutable with bonds, the shocks that influence the latter

will also influence the former. This might be particularly relevant if reserves paid market rates of interest, so that no margin would exist between the yields on these instruments (assuming transaction fees, such as checks, are paid marginally). However, Paulus (1982) claims that short-run investment balances have a higher degree of stability than transaction balances. Such an observation may be made by examining the stability of market determined assets in broader monetary aggregates. While it is our opinion that deposit demands would be more predictable, in the sense of fitting known exogenous variables under deregulation, this entire line of reasoning is in fact, little more than conjecture.

The effect of financial deregulation on the shocks to currency demand is less clear, since the deposit and market rates of interest are considered to have smaller bearing on currency holdings. Although currency demand would become more sensitive to the rate of interest, and perhaps more variable in an absolute sense, this does not mean that unexpected shocks will increase. In fact, analogous to the situation with deposits, the lack of discrete structural changes in a deregulated environment is likely to reduce unexpected currency movements. Overall, it is our opinion that the shocks to the demand for high-powered money are likely to be reduced under financial deregulation.

VII. Summary and Conclusion

The effects of financial deregulation on the macroeconomic equilibrium have been analyzed within the context of an economy where the price level is determined in the market for high-powered money, comprising currency and reserves. We find that deregulation impacts this market through its influence on effective deposit rates and reserve ratios, changing both the magnitude of monetary aggregates and their income and interest elasticities.

We find that although deposit rate deregulation causes the real demand

for broader monetary aggregates to become unambiguously less sensitive to market rates, the effect on the interest sensitivity of the real demand for high-powered money is likely to be positive. Under these circumstances, the price level becomes more sensitive to interest rate fluctuations despite the increased insensitivity of real money demands. Furthermore, deregulation will significantly alter the income elasticities of deposit demands, a result that has been ignored in most deregulation analysis and impacts importantly on the behavior of the nominal money supply.

The characteristics of the nominal money supply are likely to be most influenced by financial deregulation. It is quite possible that the money supply multiplier will become positively related to market rates of interest and negatively related to real income, a situation that is reversed from a regime of strict deposit rate regulation. Therefore, the movements in the nominal money supply may give much different signals as to the state of unobservable macroeconomic variables as real income and the price level than they did under strict deposit rate regulation. Furthermore, there is no special virtue to targetting the nominal money supply, and doing so may lead to greater instabilities in the price level.

In summary, we believe that deposit deregulation significantly changes the interest elasticities of broader nominal monetary aggregates. In this regard we confirm the conjectures of Tobin (1983), Hester (1981), and Startz (1979). However, deregulation may have a quite different effect on the demand for high-powered money, a point not emphasized by the previous authors. Since the equilibrium price level is determined by the supply and demand for high-powered money, it is misleading to examine the change in the interest sensitivity of the broader monetary aggregates in order to judge the effect of interest rate fluctuations on the price level. Because of the likelihood of

deregulation increasing, the interest sensitivity of base money, we conclude that a central bank policy of more strongly leaning against interest rate changes may be required under deregulated deposits to reduce fluctuations in the price level. However, contrary to those who have expressed concern that the move to deposit deregulation threatens monetary stabilization, the present analysis suggests that monetary policy remains strong and effective in the deregulated environment.

Footnotes

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[1] A substantial number of economists have investigated various aspects of deregulation and its effect on monetary policy. In addition to those explicitly cited below, see Lindsey (1977), Hadjimichalakis (1982), Judd (1983), Loeys (1984) and the entirety of the Asilomar Conference, Federal Reserve Bank of San Francisco (1982).

[2] See, for example, Lindsey (1977), Tobin (1982) and Startz (1983).

[3] The academic outcome of this study was the often cited volume, Carson (1963).

[4] At one extreme, the increase in the deposit rate ceiling results in an increased transaction subsidy as Mitchell (1979) demonstrates. More generally, the subsidy declines as Saving (1979) illustrates.

[5] This counterintuitive result is somewhat supported by recently released data in which a decline in the percentage of the population holding bank accounts was reported. These data can only be used anecdotally as there is a clear distinction between the number of deposit accounts and the total deposit balances. See Boyd (1973) and Santomero (1979) for a discussion of these issues.

[6] dr_D/dr may also equal unity if banks put their reserve costs into the price of transfering between deposits and currency. See Black [1975].

[7] It can be shown that if the real demands for assets given in Equation (9) are additively homogenous of degree zero in all rates of return, such that demand functions of $r_C + \lambda$, $r_D + \lambda$, $r + \lambda$ equals those of r_C, r_D, r, then $dm^d/dr < 0$ whenever $dr_D/dr \leq 1$. We shall term this condition interest rate homogeneity.

[8] Throughout this paper, "increase" or "decrease" in the elasticity (or sensitivity) refers to the change in the absolute values, unless otherwise specified.

[9] From equation (12) it can be seen that high-powered money and deposits are substitutes if and only if $|(\partial d^d/\partial r_D)/(\partial c^d/\partial r_D)| \gtrless \beta/(1 - \beta)$. Substituting $\beta = .8012$ from 1984 figures indicates 4.03 as the critical relative semi-elasticity. However, as noted in Table 1B. on deregulation of reserves, if only reserves behind transactions deposits are used in the calculation, the currency to high-powered money ratio rises to 85.7% and hence the critical value of the relative semi-elasticities rises to 6.0.

[10] For a general equilibrium derivation of the money supply formula see Santomero and Siegel (1982).

[11] Deregulation may also affect the coefficient of y_t, as noted above in Section III.D. The income effects will be treated separately in Section VI.B.1. below.

[12] When discussing the effect of deregulation on the nominal money supply, we are actually speaking of the effect of the ratio of broadly defined money (M) to high-powered money (H), or the money supply multiplier.

[13] For a discussion of the benefits of price stability, see Fischer (1984).

[14] If the shocks are not independent, considerations such as analyzed in Poole (1970) must be taken into account. Although this will not lead to making the dp/dr locus vertical in Figures 5 and 6, all the qualitative conclusions in this text will continue to hold.

[15] This is also the opinion of Pierce (1982) as voiced in the Asilomar Conference. For further analysis of the information content of nominal monetary aggregates, see Siegel (1982).

Table 1A

Interest Deregulation

As of Jan.	1970	Rate ceilings in effect: 4.5% on savings accounts, 5% on time deposits greater than 90 days maturity. On large CD's (over $100,000) rates ranged from 5.5% to 6.25%.
	1970	Appointment of the Hunt Commission to study financial system and its abilities to meet the needs of the economy.
June	1970	Deposit ceilings lifted on 30-90 day large CD's (over $100,000). First removal of deposit rate ceiling
Late	1970	Androscoggin County Savings Bank of Lewingston, Maine began offering demand deposits to customers. Bank commissioner issued a cease and desist order upheld by the courts.
January	1972	Hunt Commission published Report of the President's Commission on Financial Structure and Regulation. Recommended elimination of interest rate ceilings on time and saving deposits over a 5 ½ year period. Federally charted institutions granted NOW accounts, EFTS, and greatly expanded deposit service powers.
Mid	1972	Massachusetts authorization of NOW accounts by state-chartered mutual savings banks. Allows 5 1/4% interest to be paid on demand deposits. NOW accounts authorized for similar institutions in New Hampshire.
May	1973	Rate ceiling abolished on all large CDs over 30 days maturity.
July	1973	Ceilings lifted on all CDs (over $1000) over 4 years maturity. Ceiling reimposed at 7.25% on November 1. Only example of reversed deposit deregulation during period.
January 1,	1974	The "NOW experiment": Authorization to offer NOWs given to all depository institutions in Massachusetts and New Hampshire. Rate set at 5%.
	1975	Senate passes Financial Institutions Act. Proposed interest payments on demand deposits. (Not passed in House.)

Spring	1975	Maine passes new Financial Institutions Law. New law allowed all financial institutions in Maine to issue NOW accounts as soon as Federal law permits.
	1976	Financial Reform Act introduced in the House (HR 13077). Would establish Deposit Insurance Rate Control Committee, having authority over interest on deposits. Committee to be dissolved after 5 ½ years (Bill did not pass Senate).
February 1,	1976	NOW accounts permitted throughout New England by change in federal law.
	1977	Legislation for nationwide NOW accounts drafted by Federal Reserve Board and members of the House and Senate Banking Committees. (1) Interest rate ceilings to be discontinued after several years. (2) Limitations of accounts to individuals
July	1977	Fed states that Merrill Lynch Cash Management Accounts (CMA's) do not violate Fed regulations. Customers of Merrill Lynch can borrow, write checks, and make Visa card purchases against the CMA accounts.
July	1977	Saving account rates raised to 5%.
	1978-1980	Deregulated instruments (All Savers and Small Saver Certificates) authorized offering deregulated yields.
June	1978	Authorization of 6 month Money Market Certificates tied to treasury bill rate, minimum denomination $10,000. First deregulated rate offered to consumers.
November	1978	Preauthorized (Automatic) Transfer Accounts authorized. Funds in savings accounts automatically flow to checking accounts to cover checks, effectively paying interest on demand deposits. Later held by courts to be illegal.
November	1978	NOW accounts legalized in New York State.
April 20,	1979	District Court of Appeals in Washington, D.C. outlaws: (a) Automatic Transfer Services for banks (b) Remote Service Units for S&L's, and (c) Share drafts for credit unions. Ruled regulators overstepped their bounds by authorizing these. Gave Congress until January 1, 1980 to legalize such accounts.
July	1979	Saving account rate raised to 5.25%
November	1979	Automatic Transfer Service Account became legal. Permits banks to transfer funds automatically from savings to checking to cover checks.

December 1979	NOW accounts authorized in New Jersey.
March 31, 1980	Depository Institutions Deregulation Act of 1980 (1) Establishes Depository Institutions Deregulation Committee (DIDC) to "provide for the orderly phaseout and ultimate elimination of limitations on the maximum rates of interest on deposit accounts." (2) As of March 31, 1986, all authorities to impose interest rate ceilings are repealed and DIDC ceases to exist. Title III: Consumer Checking Account Equity Act of 1980: (1) Provision for Nationwide NOW and ATS trasfers for consumers and non-profit institutions. (2) Increases FDIC Insurance immediately to $100,000 per account.
December 31, 1980	Introduction of nationwide NOW accounts. Ceiling raised to 5.25%. As per DIDA 1980, all depository institutions can now offer checking services.
May 1, 1982	DIDC authorized ceiling-free 3 ½ year CDs to some banks.
October 1, 1982	Depository Institutions Act (Garn-St. Germain Act) Accelerated process of deregulation. Required DIDC to authorize, within 60 days a new account to be "directly equivalent to and competitive with money market mutual funds." Free of interest rate ceilings. Should allow at least 3 preauthorized transfers and 3 third-party transfers per month. If only 3 transfers authorized, the account is to be treated as a non-transaction account, not reservable for personal depositors. Also allows DIDC to create interest-ceiling-free account with unlimited third-party transfers to be treated as a transactions account and thus subject to usual reserve requirements.
December 1982	Authorization of money market deposit account (MMDA). Minimum balance $2500. No ceiling on deposit rate.
January 1, 1983	NOW accounts over $2500 (called Super NOW) are freed from all deposit rate ceilings.
January 1, 1984	Saving Account rate raised to 5.50%.
January 1, 1985	Super NOW and MMDAs accounts minimum balances reduced to $1000.

Table 1B

Required Deregulation of Required Reserve Ratios

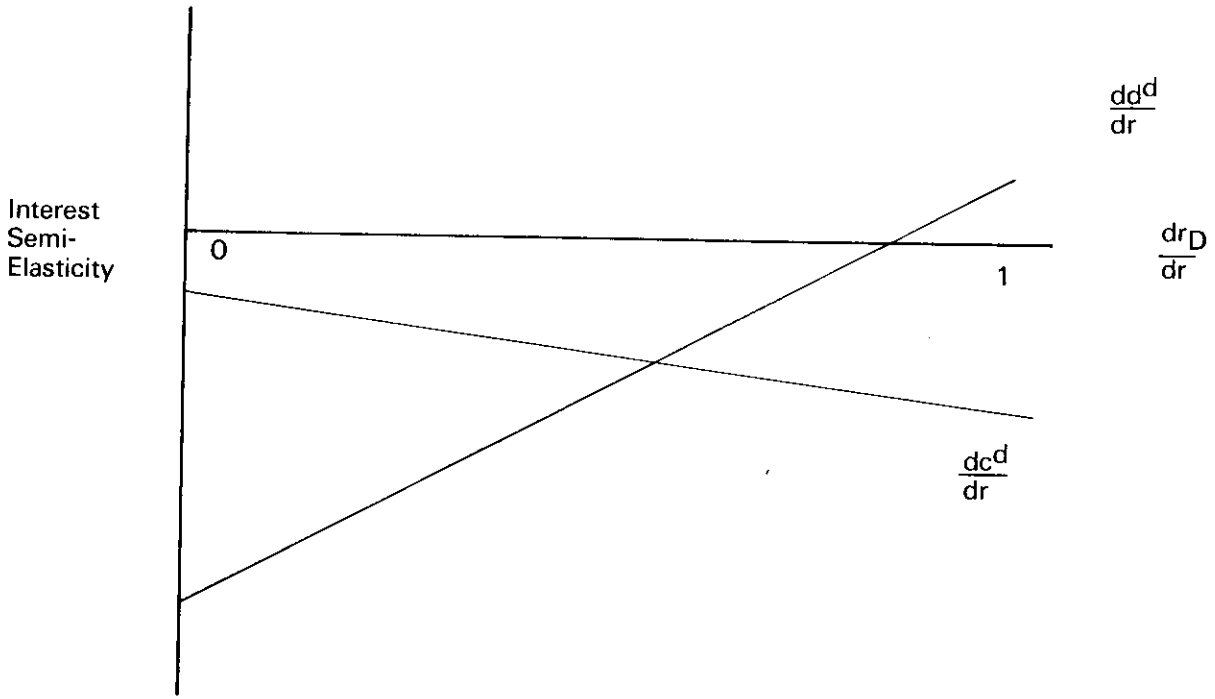
Legal Limits from Federal Reserve Act:

Demand Deposits: Reserve City, Max. 22%, Min. 14%
Country, Max. 14%, Min. 7%
Time Deposits: Min. 3%, Max. 6%

October	1970	Range on Demand Deposits (DD): 13-17.5%. Range on Time (and Saving) Deposits (TD) 3-5%
November	1972	Banks over $400 million net demand deposits designated "Reserve City." Under $400 million designated "Country" for purposes of establishing legal limits.
February	1975	Range on DD reduced to 7.5% to 16.5.
October	1975	Range on TD 1-3% except for large (30-180 day) CDs at 6%. Min for time deposits over 4 years reduced to 1%. Legal limit "broken" for individual deposit, but average must equal 3% for all TDs.
December	1976	Range on Demand Deposits reduced to 7 to 16.25%. No further changes in reserve ratios until Monetary Control Act.
	1977-78	Legislation drafted by Federal Reserve Board and House and Senate Banking Committee authorizing interest on member bank reserves.
November	1980	Monetary Control Act: (1) All depository Institutions under Reserve Requirements. (2) 3% Reserve Requirements for Transactions Accounts under $25 million. (3) 12% over $25 million (legal range 8% to 14%). (4) 3% on all non-personal Time deposits less than 4 years and eurodollars (legal range 0 to 9%). (5) Zero on all other deposits. (6) Supplemental Reserve of 4% permitted if interest paid on supplement. (7) $25 million cutoff rises each year with change in aggregate deposits. (8) 4 years phase-in for member banks, 8 years for non-members.
April	1982	No reserves on TD less than 3 ½ years.
December	1982	No reserves on first $2.1 million deposits by the Garn-St. Germain Depository Institutions Act. To rise over time with aggregate deposits.

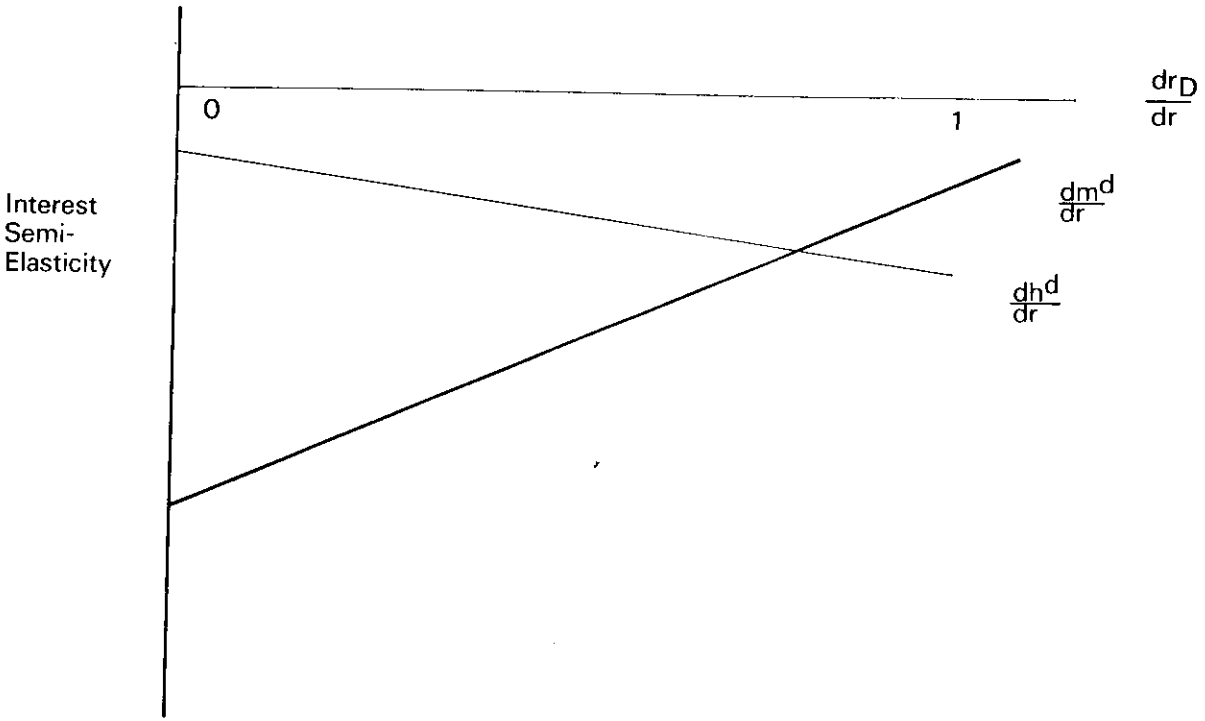
December	1982	Rep. Barnard and Sen. Heinz introduced legilation that would authorize to pay a market-related interest rate on reserves held against non-personal MMDA's and NOW accounts. Reintroduced in January 1983 and August 1983. Has yet to pass Congress.
March	1983	Reserves abolished on TD less than 2 ½ years.
October	1983	Reserves abolished on TD less than 1 ½ years.
December	1984	Cutoff for 12% reserves on DD raised $29.8 million.

Figure 1



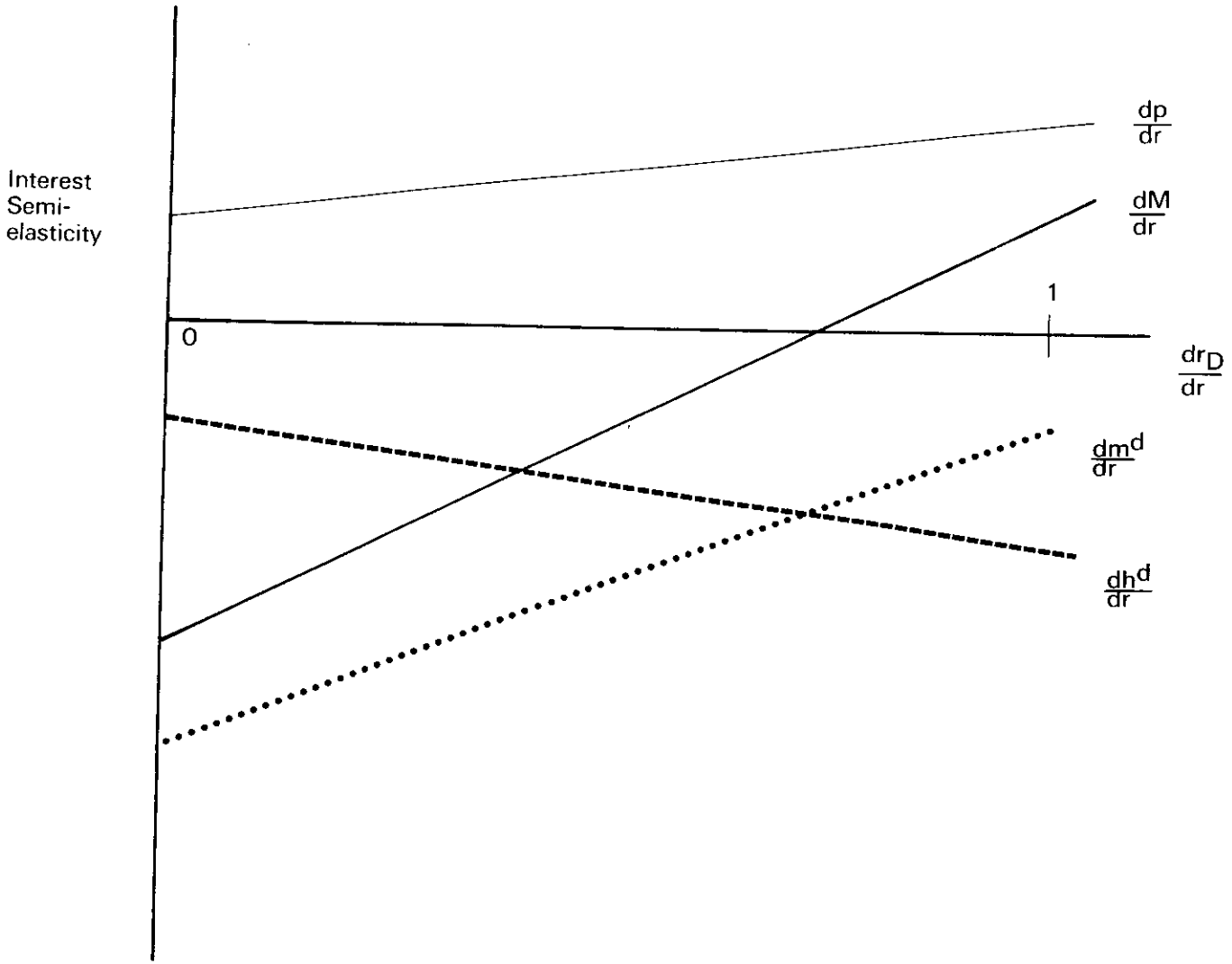
Interest Semi-elasticity of Real Currency Demand (c^d) and Real Deposit Demand (d^d)

Figure 2



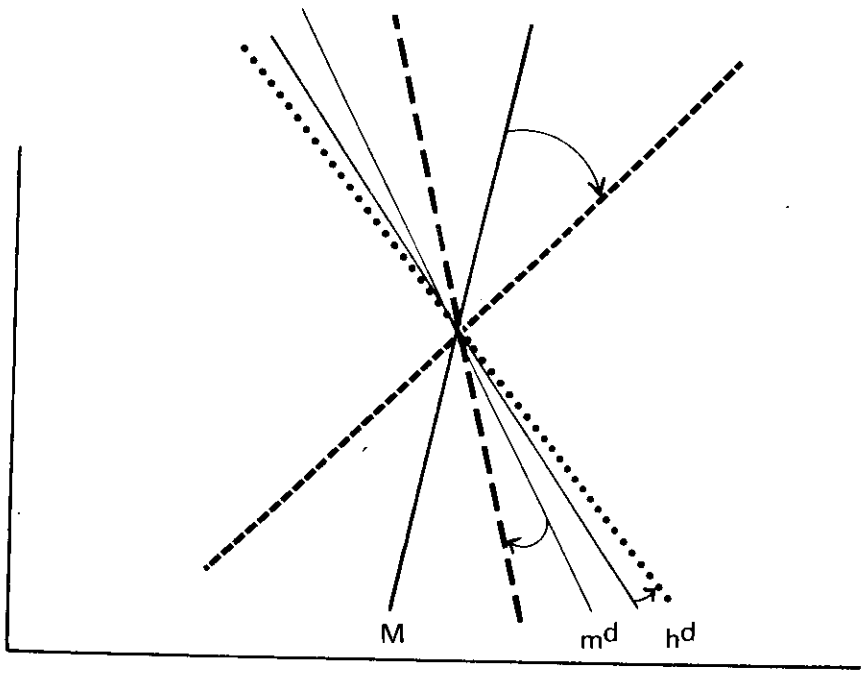
Interest Semi-elasticity of Real Money Demand (m^d)
and Real High Powered Money Demand (h^d)

Figure 3



Interest Semi-elasticity of the Equilibrium Price Level (p)
and Equilibrium Nominal Money Supply (M)

Figure 4



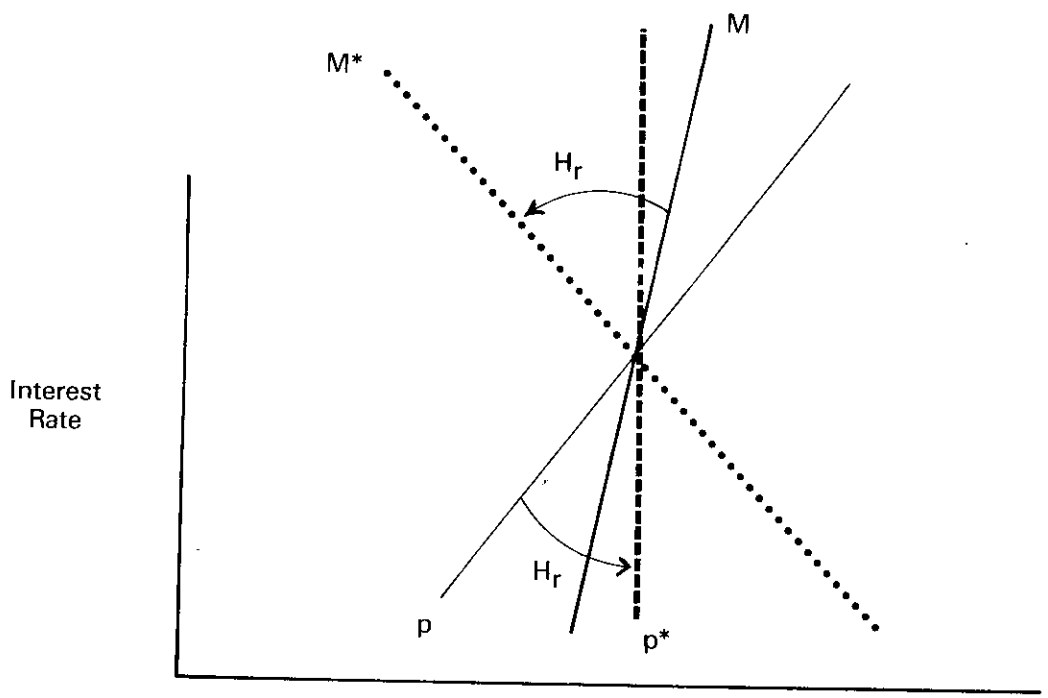
Effect of Financial Deregulation on the
Interest Elasticity of Monetary Aggregates

h^d = real high-powered money

m^d = real broad money

M = nominal money

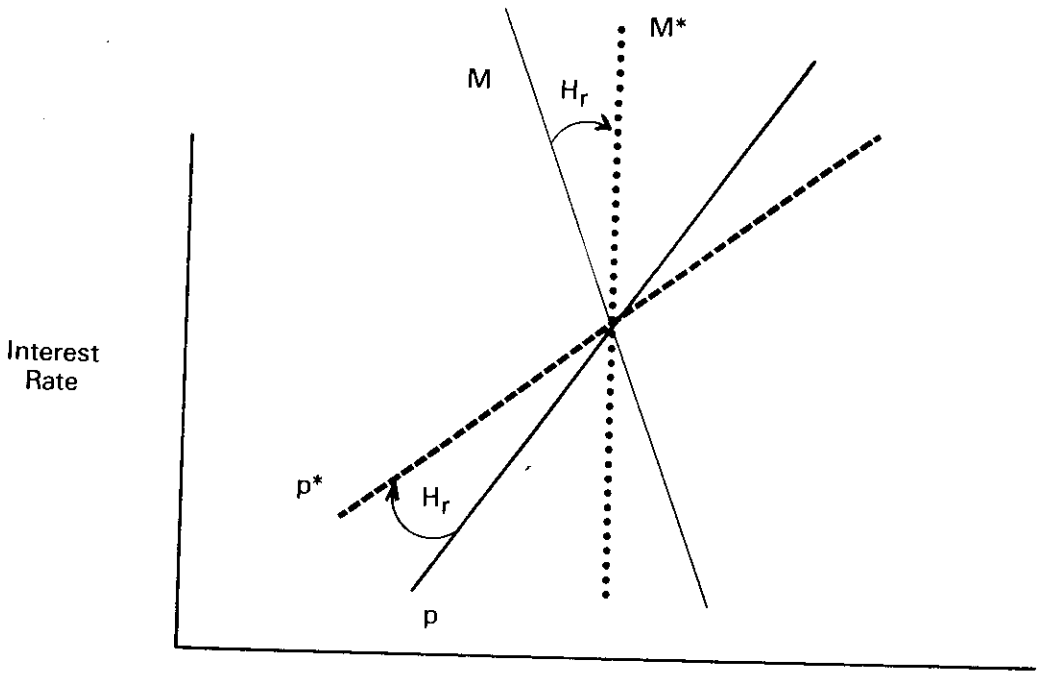
Figure 5



Price Level and Nominal Money Supply

Effect of Setting H_r^* so that p is Independent of Interest Rate.
p and M when $H_r = 0$, p* and M* when $H_r^* < 0$.

Figure 6



Price Level and Nominal Money Supply

Effect of Setting H_r^* so that M is Independent of Interest Rate.
p and M when $H_r = 0$, p* and M* when $H_r^* > 0$.

Bibliography

Barro, R. J
(1984) Macroeconomics. New York: John Wiley.

Barro, R. J. and Santomero, A. M.
(1972) Household money holdings and the demand deposit rate. Journal of Money, Credit and Banking **4**:397-413.

Baltensperger, E.
(1980) Alternative approaches to the theory of the banking firm. Journal of Monetary Economics **6**:1-37.

Baumol, W. J.
(1952) The transactions demand for cash: an inventory theoretic approach. Quarterly Journal of Economics **66**:545-56.

Becker, W. E.
(1975) Determinants of the United States currency-demand deposit ratio. Journal of Finance **30**:57-74.

Black, F.
(1975) Bank funds management in efficient markets. Journal of Financial Economics **2**:323-39.

Boyd, J. H.
(1973) Bank strategies in the retail demand deposit markets. Journal of Banking Research **4**:111-21.

Brunner, K. and Meltzer, A. H.
(1964) The Federal Reserve's attachment to the free reserves concept. Washington, D.C.: House Committee on Banking and Currency.

Brunner, K. and Meltzer, A. H.
(1964) Some further investigations of demand and supply functions for money. Journal of Finance **19**:240-83.

Brunner, K. and Meltzer, A. H.
(1972) Money, debt and economic activity. Journal of Political Economy **80**:951-77.

Cagan, P.
(1979) Financial developments and the erosion of monetary control. Contemporary economic problems 1979. American Enterprise Institute.

Cagan, P. and Schwartz, A. J.
(1975) Has the growth of money substitutes hindered monetary policy? Journal of Money, Credit and Banking **7**:137-59.

Carson, D. (ed.).
(1963) Banking and monetary studies. Homewood, Illinois: Richard D. Irwin.

Federal Reserve Bank of San Francisco
(1982) Asilomar Conference. Interest rate deregulation and monetary policy,

Fischer, S.
(1984) The benefits of price stability. Price stability and public policy. Federal Reserve Bank of Kansas City.

Frenkel, J. A. and Jovanovic, B.
(1980) On transactions and precautionary demand for money. Quarterly Journal of Economics **95**:25-43.

Hadjimichalakis, M.
(1982) Monetary policy and modern money markets. Lexington, Massachusetts: Lexington Books.

Judd, J. P.
(1983) Deregulated deposit rates and monetary policy. Economic Review (Federal Reserve Bank of San Francisco) :27-44.

Kane, E. J.
(1981) Accelerating inflation, technological innovation and the decreasing effectiveness of banking Regulation. Journal of Finance **36**:355-67.

Kareken, J. H.
(1984) Bank regulation and the effectiveness of open market operations. Brookings Papers on Economic Activity, 405-55.

Klein, B.
(1974) Competitive interest payments on bank deposits and the long run demand for money. American Economic Review **64**:931-48.

Lindsey, D.
(1977) The implications of removing the demand deposit rate prohibition for monetary control and the conduct of monetary policy. Board of Governors of the Federal Reserve System, Special Studies Paper #104.

Loeys, J. G.
(1984) Interest rate Deregulation and monetary policy. Working paper, Federal Reserve Bank of Philadelphia.

Marty, A. L.
(1961) Gurley and Shaw on money in a theory of finance. Journal of Political Economy **69**:56-62.

Meltzer, A. H.
(1984) Overview. Price stability and public policy. A Symposium sponsored by the Federal Reserve Bank of Kansas City.

Mitchell, D. W.
(1979) Explicit and implicit demand deposit interest. Journal of Money, Credit and Banking 11:182-91.

Niehans, J.
(1982) Innovation in monetary policy. Journal of Banking and Finance **6**:9-28.

Paulus, J.
(1982) Discussion. Interest rate deregulation and monetary policy. Asilomar Conference, 70-77.

Pierce, J.
(1982) Panel discussion. Interest rate deregulation and monetary policy. Asilomar Conference, 215-220.

Pierce, J.
(1982) How regulations affect monetary control. Journal of Money, Credit and Banking **14**:775-86.

Poole, W.
(1968) Commercial bank reserve management in a stochastic model: implications for monetary policy. Journal of Finance **23**:769-91.

Poole, W.
(1970) Optimal choice of monetary policy instruments in a simple stochastic macro model. Quarterly Journal of Economics **84**:197-216.

Rush, M.
(1980) Comment and further evidence on "implicit interest on demand deposits." Journal of Monetary Economics **6**:437-51.

Santomero, A. M.
(1974) A model of the demand for money by households. Journal of Finance **29**:89-102.

Santomero, A. M.
(1979) The role of transaction costs and rates of return on the demand deposit decision. Journal of Monetary Economics **5**:343-64.

Santomero, A. M.
(1984) Modeling the banking firm: a survey. Journal of Money, Credit and Banking **16**:576-602.

Santomero, A. M. and Siegel, J. J.
(1981) Bank regulation and macro-economic stability. American Economic Review **71**:39-53.

Santomero, A. M. and Siegel, J. J.
(1982) A general equilibrium money and banking paradigm. Journal of Finance **37**:357-70.

Saving, T. R.
(1979) Money supply theory with competitively determined deposit rates and activity charges. Journal of Money, Credit and Banking **11**:22-31.

Siegel, J. J.
(1982) Monetary stabilization and the information value of monetary aggregates. Journal of Political Economy **90**:176-80.

Siegel, J. J.
(1985) Money supply announcements and interest rates: does monetary policy matter? Journal of Monetary Economics **15**:163-76.

Startz, R.
(1979) Implicit interest on demand deposits. Journal of Monetary Economics **5**:515--525.

Startz, R.
(1983) Competition and interest rate ceilings in commercial banking. Quarterly Journal of Economics **98**:255-65.

Tobin, J.
(1969) A general equilibrium approach to monetary theory. Journal of Money, Credit and Banking **1**:15-29.

Tobin, J.
(1983) Financial structure and monetary rules. Kredit und kapital :155-71.

Tobin, J. and Brainard, W. C.
(1963) Financial intermediaries and the effectiveness of monetary controls. American Economics Review **53**:383-400.

Tsiang, S. C.
(1969) The precautionary demand for money: an inventory theoretical analysis. Journal of Political Economy **77**:99-117.

Weiner, S. E.
(1985) Payment of interest on reserves. Economic Review (Federal Reserve Bank of Kansas City) **70**:16-31.