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A Theoretical Framework for Evaluating the Impact of Universal Reserve Requirements

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ABSTRACT

This paper provides an appropriate framework to evaluate the impact of the universal reserve requirements called for by the new DIDMC Act of 1980. We derived the optimal reserve ratios for a dual banking system under the objective of controlling the monetary aggregates and the level of output. Then optimal reserve requirements were calculated from illustrative money market and macroeconomic parameters since the usual comparative statics were not useful. The results, generally, suggested optimal reserve ratios which were significantly higher than the old dual or the new universal reserve regimes for all targets. However, the calculation of values for the loss functions under various reserve regimes suggests that attainment of r_1^*, r_2^*, and t^* may not be imperative, since the discrepancy between losses for optimal and various nonoptimal reserve schemes were not large. A major result of this paper, observed for both monetary and real targets, was that the differences in the instability of the targets for the old dual reserve ratios and the Fed's new universal reserve scheme were small. This result clearly suggests that although the DIDMC Act may solve the Federal Reserve's membership problem, it will not significantly enhance the Fed's effectiveness in controlling monetary or real sector aggregates.

For 30 years, the Federal Reserve has argued for and finally obtained legislation that would force nonmember state chartered commercial banks to satisfy the same level of reserve requirements which nationally chartered banks satisfy. Until the Depository Institutions Deregulation and Monetary Control Act of 1980 (DIDMC), reserve requirements for nationally chartered commercial banks were more burdensome than state requirements because they were higher and satisfied only with vault cash and deposits with the Fed.[1] The Federal Reserve's quest for universal reserve requirements became more intense in the late 1970s with the erosion of Reserve membership accelerating due to the increasing opportunity costs of Fed memberships; see [3]. By the middle of 1980, the percentage of commercial banks belonging to the Fed had declined to 39 percent compared with 45 percent at the end of 1966. Arthur Burns [4] argued that the Fed's declining membership eroded its ability to control the money supply because the existence of dual reserve requirements decreased the predictability of the relationship between bank reserves and the relevant monetary aggregate.

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[1] In this discussion, state chartered banks which have voluntarily joined the Federal Reserve System are treated as nationally chartered banks since they satisfy member bank reserve requirements.

The effect of nonmember banks on the Fed's ability to control the money stock has previously been considered in an empirical setting. One common starting point has been to examine the impact of nonmember banks upon the stability of the money multiplier; see [1] and [15]. The presumption has been that state chartered banks would increase the volatility of the money multiplier and reduce the controllability of the money supply since the reserve ratio on nonmember bank demand deposits is lower than those of member banks. However, Starleaf [15] has shown empirically that the money multiplier is actually more stable with nonmember banks than without them. In addition, a host of other studies have concluded that the existence of nonmember banks does not adversely affect the controllability of the money supply. For instance, Benston [1] found that the ability of monetary authorities to predict demand deposits for biweekly settlement periods is not affected by nonmember banks. Veasey [17] has empirically established that the Fed offsets changes in reserves which accompany shifts in demand deposits between banks with different reserve requirements. Thus, he concludes that nonmember banks have no effect on monetary control.

The objective of this paper is to evaluate and anticipate the impact of one provision of the DIDMC, universal reserve ratios. We begin the paper by constructing an IS schedule and an expanded LM schedule. Uncertainty is introduced into the model by including stochastic error terms in the three money demand equations and the product market. We then solve for the mean value of the target variables and define loss functions for the relevant targets. Optimal reserves ratios under a dual banking system are then derived, for monetary and real targets, to determine if optimal ratios are uniform and to compare the optimals with the new universal reserve ratios. Finally, loss function values are calculated in order to determine differences in the stability of various targets under several reserve schemes including the universal scheme provided by the DIDMC and several others of interest.

Thus we evaluate the relative effectiveness and the impact of the universal reserve ratio provision of the DIDMC using a textbook model of the economy. When using the model to simulate the effects of different reserve regimes, we assume that the underlying behavioral relationships remain fixed, i.e., the simulation and evaluation of each reserve scheme is conditioned on existing behavioral patterns. However, imposing 100 percent reserve requirements, for example, could significantly alter the structure and behavioral relationships underlying the money market portion of the model. Since changes of this type are impossible to forecast, many of the results we outline in this paper must be taken as being an approximation of the impact of any given reserve scheme.

I. The Model

In order to obtain optimal reserve ratios under dual banking, a macroeconomic model with a goods market and a money market is needed. We assume that whatever the ultimate complexity of the goods market, an IS schedule can be generated such that

$$i = \frac{AY - K + z}{j} \tag{1}$$

where i and Y are the interest rate and nominal income respectively, A is the denominator of a simple income determination multiplier, K is the sum of all autonomous terms, and j is the interest coefficient in the investment schedule. Uncertainty is brought into the goods market as a random shock, z, either added to the savings function or subtracted from the investment function. We assume the mean of z is zero and its variance, σ_z^2.

In deriving the LM equation we make use of the following detailed model of the money market. Equations (2a) and (2b) specify member and nonmember bank demand deposit demand. The currency demand equation is given in (2c), time deposit demand in (2d), and total demand deposit demand in (2e).[2]

$$D_1 = m_{10} + m_1 Y + k_1 i + x_1 \tag{2a}$$

$$D_2 = m_{20} + m_2 Y + k_2 i + x_2 \tag{2b}$$

$$C = c_0 + cD + u \tag{2c}$$

$$T = n_0 + nD + v \tag{2d}$$

$$D = D_1 + D_2 \tag{2e}$$

The parameters c and n relate currency and time deposits to the level of demand deposits; m_i and k_i relate demand deposits to income and the rate of interest. The u, v, x_1, and x_2 are stochastic errors with zero means, and variances equal to σ_u^2, σ_v^2, $\sigma_{x_1}^2$, and $\sigma_{x_2}^2$. The covariation between the error terms will be denoted by $\rho_{ij}\sigma_i\sigma_j$, where ρ_{ij} is the correlation coefficient. The monetary base B is defined to be

$$B \equiv r_1 D_1 + r_2 D_2 + tT + C \tag{3}$$

where r_1, r_2, and t are the demand and time deposit required reserve ratios.[3]

In Equation (3), we have explicitly recognized dual reserve ratios on demand deposits. However, only one time deposit reserve ratio is used, because, while the reserve ratios on demand deposits were significantly different in our dual banking system before the DIDMC, the difference between time deposit ratios was small.[4]

M_1 will be used to denote the level of demand deposits plus currency, M_2 the sum of M_1 and time deposits, and Y the level of output. The determination of the equilibrium and mean levels of M_1, M_2, and Y is achieved by using Equations (1), (2), and (3). Details for finding the equilibrium Y and $E(Y)$ are given in Appendix A.

[2] The specification of the currency and time deposit demand equations omits the interest rate as a determinant of either variables. The interest rate does indirectly influence both variables through the demand deposit equations. The inclusion of interest in the specification of (2c) and (2d) would not affect r_1^*, r_2^*, and t^* for the monetary targets, but explicit optimal reserve ratios for the income target would be impossible to solve for in such a context. It should be added that the currency and time deposit equations we used are generally consistent with the rough and ready specifications of the money supply literature.

[3] The expression for the monetary base ignores both excess reserve holdings by either nationally or state chartered banks and the possibility of less than perfect control of the base.

[4] Kane [7] argues that although the distinction between the time deposit reserve ratio at national and state chartered banks is small, it is important in explaining the declining membership of the Federal Reserve System.

II. The Loss Functions

Generally, economists are concerned with deviations of an economic variable from its optimal level. That is, monetary economists typically minimize $E[Y - Y^*]^2$ where, for example, Y is output and Y^* is the desired level of the final target. However, we partition the relevant expected loss functions into bias and variance components. For an output target, we rewrite $E[Y - Y^*]^2$ as $E[E(Y) - Y^*]^2 + E[Y - E(Y)]^2$. $E[E(Y) - Y^*]^2$ is the squared bias and represents the social disutility of policymakers selecting an expected level of output which is different than Y^*. $E[Y - E(Y)]^2$ is the variance component and is the economic loss incurred due to the inability of stabilization authorities to achieve perfectly the expected level of output.[5] In this paper, optimality with respect to controlling the level of income occurs by minimizing the variance of Y about its mean or target value, i.e., minimizing the loss function $L_Y = E[Y - E(Y)]^2$. Optimality with respect to narrow money occurs by minimizing $L_{M_1} = E[M_1 - E(M_1)]^2$, the variation of M_1 about its mean value.

Squaring the deviation of each of the possible targets and taking the expectation will allow us to write loss functions for M_1, M_2, and Y as follows:

$$L_{M_1} = \frac{\begin{aligned}&\sigma_u^2(r_1 + tn - 1)^2 + (1 + c)^2t^2\sigma_v^2 + (1 + c)^2(r_1 - r_2)^2\sigma_{x_2}^2 \\ &\quad - 2(1 + c)t(r_1 + tn - 1)\sigma_{uv} \\ &\quad + 2(1 + c)(r_1 - r_2)(r_1 + tn - 1)\sigma_{ux_2} \\ &\quad - 2(1 + c)^2t(r_1 - r_2)\sigma_{vx_2}\end{aligned}}{J_1^2} \tag{4a}$$

$$L_{M_2} = \frac{\begin{aligned}&(r_1 + tn - n - 1)^2\sigma_u^2 + (r_1 + c - t(1 + c))^2\sigma_v^2 \\ &\quad + (1 + c + n)^2(r_1 - r_2)^2\sigma_{x_2}^2 \\ &\quad + 2(r_1 + tn - n - 1)(r_1 + c - t(1 + c))\sigma_{uv} \\ &\quad + 2(r_1 + tn - n - 1)(1 + c + n)(r_1 - r_2)\sigma_{ux_2} \\ &\quad + 2(r_1 + c - t(1 + c))(1 + c + n)(r_1 - r_2)\sigma_{vx_2}\end{aligned}}{J_1^2} \tag{4b}$$

$$\begin{aligned}L_Y = \frac{1}{F^2}\{&J_1^2\alpha + J_2^2\lambda + j^2\sigma_N^2 + 2J_1J_2\beta + 2J_1j(\sigma_u\gamma + t\sigma_v\eta) \\ &+ 2J_2j(\sigma_u\phi + t\sigma_v\theta)\}\end{aligned} \tag{4c}$$

where:

$$\begin{aligned}
A_1 &= Ak_1 + jm_1 & \alpha &= k_1^2\sigma_z^2 + j^2\sigma_{x_1}^2 + 2jk_1\sigma_{x_1z} \\
A_2 &= Ak_2 + jm_2 & \lambda &= k_2^2\sigma_z^2 + j^2\sigma_{x_2}^2 + 2jk_2\sigma_{x_2z} \\
J_1 &= r_1 + tn + c & \beta &= k_1k_2\sigma_z^2 + jk_1\sigma_{x_2z} + jk_2\sigma_{x_1z} + j^2\sigma_{x_1x_2} \\
J_2 &= r_2 + tn + c & \gamma &= k_1\rho_{uz}\sigma_z + j\rho_{ux_1}\sigma_{x_1}
\end{aligned}$$

[5] See Theil [16] for an extended discussion of the bias and variance components of the expected squared deviation of the target from its optimal value.

$$F = J_1A_1 + J_2A_2 \qquad \eta = k_1\rho_{vz}\sigma_z + j\rho_{vx_1}\sigma_{x_1}$$

$$\sigma_N^2 = \sigma_u^2 + t^2\sigma_v^2 \qquad \phi = k_2\rho_{uz}\sigma_z + j\rho_{ux_2}\sigma_{x_2}$$

$$\theta = k_2\rho_{vz}\sigma_z + j\rho_{vx_2}\sigma_{x_2}$$

Before determining the optimal levels for r_1, r_2, and t, two important points should be noted. First, the monetary base does not enter any of the loss functions and thus will have no effect in determining optimal reserve ratios regardless of the target chosen. Thus, the optimal ratios should be set and changes in the mean level of a target should be achieved by changing the base through open market operations. That is, the monetary base should be used to minimize the squared bias of a target's mean value from its optimal value. Second, for each of the targets, a relatively small set of parameters will affect the loss and a still smaller set will effect optimal reserve ratios. For all targets the currency and time deposit ratios, c and n, will potentially affect the loss and optimal ratios, as will the currency and time deposit variance and covariance terms. For the Y target the whole range of variance and covariance terms will affect losses and the optimal reserve ratios, and in addition the income and interest rate parameters will also affect the losses. However, since F is a multiplicative term for L_Y, it will not affect optimal r_1, r_2, or t. It is clear, then, that shifts in any of the autonomous spending or other constant terms will not affect optimal reserve ratios, unless à la Lucas [11], changes in K (fiscal policy) have an impact on the product market parameters A and j. In this case, the optimal reserve ratios *would* be affected by a change in autonomous spending.

III. The Optimal Reserve Requirements

If M_1 is the target, by inspection L_{M_1} is minimized by values of r_1^*, r_2^*, and t^* of: 1, 1, and 0 respectively, and narrow money is completely controllable (with these ratios $L_{M_1} = 0$). With these reserve requirements, movements of funds between state and federally chartered banks or between currency and demand deposits will have no affect on M_1. This result for r_1^* and r_2^* corresponds to the plan proposed by the 100 percent reserve advocates of the Chicago School in the 1930s (e.g., see Simon [13] and Smith [14]). In addition $t^* = 0$ simply means that if there is uncertainty in time deposit demand and time deposits are not considered part of the money supply, then, as the Commission on Money and Credit argued in 1961, the obvious choice is to remove time deposit reserves from the base. This result of perfect controllability must be regarded as suggestive since our assumption of fixed behavioral and structural relations would probably be undermined by such a severe scheme of differential reserve requirements. In particular, $r_1^* = r_2^* = 1$ and $t^* = 0$ might serve as incentive to banks to develop monetary substitutes.

If variability of M_2 is of interest, then again by inspection L_{M_2} is minimized (and equals zero) with r_1^*, r_2^*, and t^* all set at unity. With this setting movements of funds between demand deposits (or currency) and time deposits will have no effect on M_2.

Since the Fed generally considers control of both narrow and broad money to be of importance, the loss function $L = \alpha L_{M_1} + (1 - \alpha)L_{M_2}$ could be used to derive the optimal reserve ratios. In which case, minimizing L with respect to r_1, r_2, and t yields values of:

$$r_1^* = 1, \tag{5a}$$

$$r_2^* = 1, \tag{5b}$$

$$t^* = 1 - \frac{\alpha(1 + c)}{1 + c + n - \alpha n}. \tag{5c}$$

The results in (5) highlight the fact that optimal reserve ratios on member and nonmember bank demand deposits are invariant to the monetary target and always 100 percent. This must be viewed as indirect support for the universal reserve ratio provision of the DIDMC Act. The optimal reserve requirement for time deposit ranges between 0 and 1 and depends on c, n, and α.

If the level of output is the sole target, then L_Y is to be minimized. In contrast to the results for the monetary targets, the optimal values of r_1^*, r_2^*, and t^* are not intuitive.

$$r_1^* = \frac{j\{\sigma_u\theta(A_1\phi - A_2\gamma) + t^*\sigma_v(A_1(\theta^2 - \lambda) - A_2(\theta\eta - \beta))\}}{A_1[\eta\lambda - \beta\theta] + A_2[\theta\alpha - \eta\beta]} - t^*n - c \tag{6a}$$

$$r_2^* = \frac{j\{\sigma_u\eta(A_2\gamma - A_1\phi) + t^*\sigma_v(A_1(\beta - \theta\eta) - A_2(\alpha - \eta^2))\}}{A_1[\eta\lambda - \beta\theta] + A_2[\theta\alpha - \eta\beta]} - t^*n - c \tag{6b}$$

$$t^* = \frac{\sigma_u\{\eta(\lambda A_1 - \beta A_2) + \theta(\alpha A_2 - A_1\beta) + (\phi\eta - \theta\gamma)(A_2\gamma - A_1\phi)\}}{\sigma_v\{\gamma(\lambda A_1 - \beta A_2) + \phi(\alpha A_2 - A_1\beta) + (\phi\eta - \theta\gamma)(A_1\theta - A_2\eta)\}} \tag{6c}$$

Optimal reserve settings now involve knowledge of the variances and covariances of the error terms in the product and the money market, as well as interest and income coefficients of the economic system. Some intuition can be obtained from (6c) if we assume that $\rho_{ux_1} = \rho_{vx_1}$, $\rho_{ux_2} = \rho_{vx_2}$, and finally if $\rho_{uz} = \rho_{vz}$. These three assumptions are not unreasonable since they imply that the errors in the two demand deposit equations and the error in the product market are each equally correlated with u and v. Given this assumption, then, $\gamma = \eta$ and $\phi = \theta$ which means that:

$$t = \frac{\sigma_u}{\sigma_v} \tag{7}$$

Since the volume of time deposits is roughly five times as large as currency, one ad hoc estimate of the ratio of σ_u/σ_v would be 1/5. In this case, t^* would be 20 percent for the output target.

It is clear from the results so far, that in general a reserve scheme setting $r_1 = r_2 = t$ will not be optimal. Although consideration of such a reserve regime may seem irrelevant, it should be kept in mind that proponents of 100 percent reserve requirements often argue that the reserve ratios on demand and time deposits should be set equal to one another. In addition, in many developed countries reserve requirements are indeed the same for demand and time deposits. Thus, the character of the optimal reserve requirement, under the constraint that $r_1 = r_2 = t$, is certainly of interest.

Minimizing L_{M_1} with respect to $r_1 (= r_2 = t)$ yields an optimal value of:

$$r_1^* = r_2^* = t^* = \frac{(1+n)\sigma_u^2 - c\sigma_{uv}}{(1+c)c\sigma_v^2 - (1+n)(1+2c)\sigma_{uv} + (1+n)^2\sigma_u^2} \tag{8}$$

It is interesting to note that (8) involves the parameters, variances, and the covariation of just the currency and time deposit equations. Examining (4a), we see that constraining $r_1 = r_2 = t$ drops $\sigma_{x_2}^2$, σ_{ux_2}, and σ_{vx_2} from the loss function and removes any effect these three terms would have on $r_1^* (= r_2^* = t^*)$. The optimal constrained solution for L_{M_2} is simply $r_1^* = r_2^* = t^* = 1$ as shown above.

Alternatively, minimizing L_Y with respect to $r_1 (= r_2 = t)$ would result in:

$$r_1^* = r_2^* = t^* = \frac{j(1+n)\sigma_u^2 + c(1+n)\sigma_u(\phi + \gamma) - c^2\sigma_v(\eta + \theta)}{jc\sigma_v^2 + c(1+n)\sigma_v(\eta + \theta) - (1+n)^2\sigma_u(\phi + \gamma)} \tag{9}$$

IV. Some Numerical Estimates

In order to obtain some insights into the possible range of estimates for r_1^*, r_2^*, and t^*, and to find values of loss functions for various reserve schemes, we specify money market and macroeconomic parameters under a range of reasonable assumptions.[6] Our specifications are shown in Table I and are discussed in Appendix B.

Our results for r_1^*, r_2^*, and t^* are shown in Table II for the range of assumptions presented in Table I. The results for M_1 and M_2 targets have already been discussed except for the constrained optimal case, with M_1 as the target. In this case, $r_1^* = r_2^* = t^* = 15.3\%$—a value not too far removed from current levels of reserve requirements on demand deposits.

Under the output target, $t^* = 20\%$ for any of our range of assumptions. Across correlations, r_1^* hovers at a level that certainly approaches the spirit of 100 percent reserve advocates. At the same time, r_2^* strains the bounds of feasibility since r_2^* is generally greater than 100 percent. For a given combination of ρ_{ux_1} and ρ_{ux_2}, the level of r_1^* increases and r_2^* decreases as the magnitude of $\rho_{x_1x_2}$ increases.[7]

[6] The usual comparative statics is uninteresting here since the signs of all the relevant partial derivatives crucially depend on the relative size of the variance terms and the sign of the covariance terms. Rather than such an analysis, then, it seems more appropriate to calculate the optimal reserve ratios and determine the value of the loss functions for illustrative parameters.

[7] The effect of differential reserve requirements is likely to be offset to some extent by commercial bank avoidance activity. A more realistic version of our money market would have included a modified specification of D_1 and D_2 to reflect this possibility. For instance, demand deposits could be written as:

$$D_1' = [1 - \gamma(r_1 - r_2)]D_1$$

where $0 < \gamma < 1$ and

$$D_2' = D_2 + \gamma(r_1 - r_2)D_1.$$

D_1' nets out demand deposits lost due to member banks leaving the system because of the reserve requirement discrepancy. D_2' records the change in deposit demands with the change in the number of state chartered banks. However, introduction of D_1' and D_2' into the model is a substantial complication which would preclude an analytic solution to the optimal reserve ratios. (It should be noted that this type of avoidance activity is not likely to change the total level of demand deposits; consequently D_1' and D_2' should be set up in such a fashion that $D_1' + D_2' = D_1 + D_2$.)

Table I

Specifications for the Model

Macroeconomic and Money Market Parameters:

$c = 0.3$
$n = 1.3$
$k_1 = -8.0$
k_2 ep-1.0
$m_1 = 0.11$
$m_2 = 0.05$
$A = 0.4$
$j = -20.0$

Standard Deviation of Random Errors:

$\sigma_u = 1$ ($ billion)
$\sigma_{x_1} = 2$
$\sigma_{x_2} = 1$
$\sigma_v = 5$
$\sigma_z = 3$

Table II

Optimal Dual Reserve Requirements

For M_1 Target: $r_1^* = 1$, $r_2^* = 1$, $t^* = 0$, or $r_1^* = r_2^* = t^* = .153$
For M_2 Target: $r_1^* = 1$, $r_2^* = 1$, $t^* = 1$
For the Output Target:

The Correlations						
$\rho_{x_1 x_2}$	$-.250$	$-.250$	0.0	0.0	0.250	0.250
ρ_{ux_1} $(= \rho_{vx_1})$	$-.250$	$-.125$	$-.250$	$-.125$	$-.250$	$-.125$
ρ_{ux_2} $(= \rho_{vx_2})$	$-.125$	$-.250$	$-.125$	$-.250$	$-.125$	$-.250$
The Optimals						
r_1^*	.879	.869	.962	1.041	1.087	1.352
r_2^*	1.680	2.011	1.350	1.830	.850	1.528
t^*	.200	.200	.200	.200	.200	.200
$r_1^* = r_2^* = t^*$	.249	.259	.249	.259	.249	.259

This suggests that the greater the interdependence of member and nonmember state chartered banks, the higher the reserve ratio on demand deposits of federal banks. Significantly, in contrast to the results for the monetary targets, optimal control of the income target does not produce uniform reserve ratios for r_1 and r_2.[8]

The constrained optimum cases, for the output target, show great stability in the values of $r_1^* (= r_2^* = t^*)$ over the range of possibilities. The results suggest, in general, a constrained optimal of about 25 percent. It is interesting to note that

[8] Theoretical results regarding the relative magnitude of r_1^* and r_2^* can be obtained if we assume that D_2 is proportional to D_1. In particular, if

$$D_2 = fD_1 \qquad k_2 = fk_1$$

$$m_{20} = fm_{10} \qquad \sigma_{x_2} = f\sigma_{x_1}$$

$$m_2 = fm_1 \qquad 0 < f < 1$$

the effect of varying assumptions about the magnitude of $\rho_{x_1x_2}$ is completely negated with uniform reserve ratios.

V. Numerical Results for the Loss Functions

We have found the optimal levels of reserve requirements on bank demand deposits at member and nonmember banks, and time deposits for monetary and real targets. This finding seemingly implies that the Congress should modify the DIDMC to set reserve ratios at their optimal levels for Federal Reserve member and nonmember banks. However, under the criterion of controllability of the targets, we should investigate the importance of attaining the optimal reserve ratios. That is, it is possible that the additional losses from using the new universal reserve ratios or other nonoptimal schemes could be small and that the level of reserve requirements are not important for control purposes. The reader should keep in mind, as pointed out earlier, that our analysis assumes that behavioral and structural relations remain fixed across different reserve requirement schemes. Consequently, since shifting and avoidance activity by commercial banks is a real possibility, but assumed away, some of the following quantitative results must be taken as approximations.

In Table III, the square roots of loss function values are listed for optimal reserve ratios, a number of interesting nonoptimal regimes, and the universal reserve ratios provided by the DIDMC.[9] The square root values are shown as multiples of the standard deviation of currency demand (σ_u). Thus, for every billion dollars of currency demand uncertainty, as measured by σ_u, the resulting standard deviation of the target is the indicated multiple of a billion dollars. The standard deviations of the various targets are shown for r_1 = 12%, r_2 = 0, and t = 3%, these ratios roughly correspond to the reserve scheme which existed before the DIDMC Act. The selection of $r_2 = 0$ reflects the belief of many economists that nonmember reserve ratios were low to begin with and nonexistent, in effect, since interest earning assets were used to satisfy the requirement in most states. Losses are also listed for the case in which $r_1 = r_2$ = 12% and t = 3%. This scheme is thought to be consistent with the DIDMC legislation. More progressive legislation would set $r_1 = r_2 = t$ = 12%. "Universal reserve ratios" should be uniform across types of deposits as well as across types of charters since the emergence of NOW accounts has blurred the distinction between demand and time deposits.

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then

$$r_1^* - r_2^* = \frac{j\sigma_u(1-f)}{2f(k\rho_{uz}\sigma_z + j\rho_{ux}\sigma_{x_1})}.$$

The existence of an expression for $r_1^* - r_2^*$ suggests that size matters. Even if policymakers believe that the only difference between D_1 and D_2 is a matter of scale, then differential reserve ratios are employed. If $\sigma_{x_1}(= \sigma_{x_2}/f)$ is small relative to σ_z, then r_1^* is greater than r_2^*; and if σ_z is small relative to σ_{x_1}, then r_2^* is greater than r_1^*. Of course, if $f = 1$ and, therefore, $D_2 = D_1$, then the optimal reserve ratios for demand deposits are uniform.

[9] The square root of the loss function values were taken since it is more convenient to have the measurement of variation in dollars, the standard deviation, rather than squared dollars, the variance.

Losses were also calculated for the reserve scheme of $r_1 = r_2 = t = 0$. Some critics of the Fed's attempts to have equivalent member bank requirements imposed on state chartered institutions in the DIDMC, argue that the Fed should have reduced the burdens of membership to avoid losing member banks. One method of reducing the burdens of membership is to drop reserve requirements entirely. Zero reserve requirements are not necessarily unreasonable, since the money supply can still be manipulated by Fed open market operations.

Examining the losses for the M_1 target, it is clear that even though optimal reserve ratios exist, the additional losses attributable to suboptimal reserve schemes are small. For instance, with the poorest suboptimal reserve regime $r_1 = r_2 = t = 0$, the standard deviation of M_1 from its mean is just \$3.3 billion, less than 1 percent of the current magnitude of M_1. It is especially interesting to note that the standard deviation of narrowly defined money is just \$.08 and \$.13 billion larger ($\sigma_{x_2} = 1$) for the old dual reserve scheme than the new universal reserve ratios, suggesting, contrary to the Fed's promulgations, that the existence of dual reserve ratios were not and are not a substantial complication of the Fed's ability to control M_1. Another major point is that all uniform rates for federal and state banks are not necessarily superior to nonuniform rates. For example, if reserve requirements on demand deposits are reduced to produce uniformity, then instability of the target increases. However, keep in mind that $r_1 = r_2 = 1$ is the optimal. From Table IIIA we see that uniform rates on demand deposits eliminate the impact of varying assumptions about ρ_{ux_2} (or ρ_{vx_2}) upon the instability of the target. This is the case since the loss function can be written such that the covariance terms involving x_2 with the other disturbances drop out when $r_1 = r_2$;

Table IIIA

Square Root of Loss Function Values (in billions \$)

	r_1^* r_2^* t^*	$r_1^* = r_2^* = t^*$	$r_1 = 0$ $r_2 = 0$ $t = 0$	$r_1 = .12$ $r_2 = 0$ $t = .03$	$r_1 = .12$ $r_2 = .12$ $t = .03$	$r_1 = .12$ $r_2 = .12$ $t = .12$
			M_1 Target			
$\rho_{ux_1} = -.25$, $\rho_{ux_2} = -.125$	0	1.82	3.33	1.96	1.88	1.85
$\rho_{ux_1} = -.125$, $\rho_{ux_2} = -.25$	0	1.82	3.33	2.01	1.88	1.85
			M_2 Target			
$\rho_{ux_1} = -.25$, $\rho_{ux_2} = -.125$	0	0	9.15	6.29	6.24	4.20
$\rho_{ux_1} = -.125$, $\rho_{ux_2} = -.25$	0	0	9.15	6.29	6.24	4.20
			M_1 Target with $\sigma_{x_2} = 5$			
$\rho_{ux_1} = -.25$, $\rho_{ux_2} = -.125$	0	1.82	3.33	2.72	1.88	1.85
$\rho_{ux_1} = -.125$, $\rho_{ux_2} = -.25$	0	1.82	3.33	2.89	1.88	1.85

see Equation (4a). If dropping reserve requirements entirely was ever considered as a strategy to offset decreasing Federal Reserve membership, it would have resulted in the most instability for M_1 as pointed out above.

The calculations of losses for the M_2 target generally confirm the M_1 results. The magnitude of the differences in the standard deviation of M_2 under the optimal scheme and the various suboptimal ratios increases from the M_1 case. But the significance of the increases remains small and the loss functions flat, since for even the worst case, σ_{M_2} = \$9.15 billion represents about a 1 percent deviation of M_2 from its mean. The relative attractiveness of the suboptimal schemes change. The reserve scheme with $r_1 = r_2 = t = 12\%$ becomes increasingly desirable since $t = 12\%$ is closer to the optimal of 100 percent than any of the other suboptimal schemes. The notion of dropping reserve ratios altogether becomes increasingly unattractive.

Table IIIA records the instability of narrowly defined money, M_1, under the alternative reserve schemes with $\sigma_{x_2} = 5$. The standard deviation of demand deposits at nonmember commercial banks was increased to see if the loss functions remain relatively flat with increases in uncertainty of x_2. The loss functions do remain flat but the results in Table IIIA provide some support for the recently implemented universal reserve requirements on demand deposits, since the increase in σ_{x_2} has no absolute impact on the losses associated with any of the uniform reserve ratio schemes while it did marginally increase the instability of M_1 when $r_1 = 12\%$, $r_2 = 0\%$, and $t = 3\%$.

Analyzing Table IIIB, it is clear that many of the conclusions drawn from Table IIIA are substantiated in Table IIIB.[10] Again, the range of losses for the target is small across reserve schemes and across assumptions about the correlation of the error terms. The largest standard deviation of output is recorded for the case where reserve requirements are dropped. However, the largest σ_Y (= \$11.62 billion) is not even .6 percent of the current level of GNP and is not significantly different from σ_Y of the other reserve schemes. By definition, the unconstrained optimal reserve ratios do the best job of stabilizing the target but the constrained optimals produce standard deviations of Y which are only marginally inferior. Comparing the losses of optimal reserve ratios with those of the universal scheme suggests that attaining the optimal reserve ratios is not of paramount importance for controlling output. In addition, damaging evidence to the Fed's argument that differential reserve requirements detracted from its ability to stabilize the macro aggregates appears in Columns (4) and (5). The Fed's new universal reserve regime for national and state banks, $r_1 = r_2 = 12\%$, generates σ_Y's which are only slightly superior to those of the old dual reserve scheme (\$.3 billion smaller on average). This indicates that the new membership requirements for state banks will not substantially enhance the Fed's ability to stabilize output.[11]

[10] More losses were simulated for the output target than the monetary targets since (4c) is written in such a way that it involves $\rho_{x_1 x_2}$, in contrast to Equations (4a) and (4b). The correlation between the two demand deposit disturbances was then allowed to vary across simulations.

[11] As a technical observation, the variation of the output target increases with increases in the magnitude of $\rho_{x_1 x_2}$. If the demand deposit equations of member and nonmember banks have disturbances which are positively correlated, then economic instability is greater than if the errors are negatively correlated and, consequently, offsetting.

Table IIIB

Square Root of Loss Function Values (in billions $)

	r_1^* r_2^* t^*	$r_1^* = r_2^* = t^*$	$r_1 = 0$ $r_2 = 0$ $t = 0$	$r_1 = .12$ $r_2 = 0$ $t = .03$	$r_1 = .12$ $r_2 = .12$ $t = .03$	$r_1 = .12$ $r_2 = .12$ $t = .12$
			Y Target			
$\rho_{x_1x_2} = -.25$, $\rho_{ux_1} = -.25$, $\rho_{ux_2} = -.125$	6.44	7.18	10.51	8.46	8.08	7.47
$\rho_{x_1x_2} = -.25$, $\rho_{ux_1} = -.125$, $\rho_{ux_2} = -.25$	6.50	7.55	10.85	8.90	8.41	7.86
$\rho_{x_1x_2} = 0$, $\rho_{ux_1} = -.25$, $\rho_{ux_2} = -.125$	7.20	7.76	10.91	8.87	8.60	8.03
$\rho_{x_1x_2} = 0$, $\rho_{ux_1} = -.125$, $\rho_{ux_2} = -.25$	7.30	8.11	11.24	9.29	8.91	8.39
$\rho_{x_1x_2} = .25$, $\rho_{ux_1} = -.25$, $\rho_{ux_2} = -.125$	7.80	8.30	11.30	9.27	9.09	8.55
$\rho_{x_1x_2} = .25$, $\rho_{ux_1} = -.125$, $\rho_{ux_2} = -.25$	7.96	8.62	11.62	9.67	9.38	8.89

Simultaneously examining Tables II and III, we find that the constrained optimum scheme of $r_1^* = r_2^* = t^*$ seems to be of more interest than might at first have been thought. There are several reasons for this. First, as noted before, the optimal levels in the constrained case do not vary nearly so much for the various targets and correlations. Second, the optimal levels are, with the exception of the M_2 target case, not so far removed from actual reserve ratios on demand deposits as to be totally unrealistic. Third, the losses for the constrained optimal cases are lower than those for the new universal scheme, and they are not substantially higher than the unconstrained optimal case. Finally, and quite apart from the considerations of this paper, with the introduction of explicit interest payments on NOW accounts and electronic access to savings accounts, it seems plausible and possibly desirable that reserve requirements on demand deposits and time deposits should become more equal over time.

Another major point concerns the relation between monetary target losses and income target losses. Tables IIIA and IIIB indicate there is no significant change in the amount of additional uncertainty generated by nonoptimal reserve ratios as we move from monetary targets to real sector targets. Although it seems plausible that extra uncertainty in the monetary sector caused by inappropriate reserve schemes might have substantial multiplicative effects on the overall economy, as measured by increased uncertainty in income, this is not the case.

VI. Summary

Recently, testimony of prominent economists to the Committee on Banking, Finance, and Urban Affairs on the proposed (at that time) DIDMC Act has been published [6]. Generally, the economists agreed that the differential reserve requirements for federal and state banks do not adversely affect the Fed's ability to control monetary aggregates. Consequently, the economists maintained that the universal reserve ratios provided by the proposed DIDMC Act were not imperative since their enactment would not enhance stabilization. Presumably their testimony drew heavily on existing empirical research and, by the nature of their views, their own intuition. Essentially, this paper provides an appropriate framework to evaluate the impact of the new universal reserve requirements on stabilization policy.

We have derived the optimal reserve ratios for a dual banking system under the objective of controlling the monetary aggregates and the level of output. The optimal level of reserve requirements was found to be independent of the desired level of the target. Thus, from a monetary policy standpoint, reserve ratios are not to be used as countercyclical tools. Optimal reserve requirements were then calculated from illustrative money market and macroeconomic parameters, since the usual comparative statics were not useful. The results, generally, suggested optimal reserve ratios which were significantly higher than the old dual or the new universal reserve regimes for all targets. However, the calculation of values for the loss functions under various reserve regimes suggests that attainment of r_1^*, r_2^*, and t^* may not be imperative, since the discrepancy between losses for optimal and various nonoptimal reserve schemes were not large. The major result of this paper, observed for both monetary and real targets, is that the differences in the instability of the targets for the old dual reserve ratios and the Fed's new universal reserve scheme are small. This result clearly suggests that although the new DIDMC Act of 1980 may solve the Federal Reserve's membership problem, it will not significantly enhance the Fed's effectiveness in controlling monetary or real sector aggregates. This conclusion is consistent with testimony given to the Reuss Committee by economists and with the existing literature on the impact of state chartered banks on monetary stability; see [10], [15], and [17].

APPENDIX A

Derivation of Loss Function

Deriving the first two loss functions (4a) and (4b) is straight forward. However, obtaining (4c) is tedious and will be outlined below. Substituting (2c) and (2d) into (3) and then solving alternatively for D_1 and D_2 yields:

$$D_2 = \frac{B - (r_2 + tn + c)D_2 - (c_0 + tn_0) - (u + tv)}{r_1 + tn + c} \tag{A.1}$$

$$D_2 = \frac{B - (r_1 + tn + c)D_1 - (c_0 + tn_0) - (u + tv)}{r_2 + tn + c} \tag{A.2}$$

Equation (A.1) is a partially reduced supply side equation of demand deposits at member banks and Equation (A.2) is a partially reduced supply side equation of demand deposits at nonmember banks.

M_1 is $C + D_1 + D_2$ or

$$M_1 = (1 + c)\left\{\frac{B - (r_2 + tn + c)D_2 - (c_0 + tn_0) - (u + tv)}{r_1 + tn + c} + \frac{B - (r_1 + tn + c)D_1 - (c_0 + tn_0) - (u + tv)}{r_2 + tn + c}\right\} + c_0 + u \tag{A.3}$$

Equating the supply of money to the demand, and using the partially reduced form equations for D_1 and D_2, results in the LM schedule:

$$i = \frac{[B - (r_1 + tn + c)(m_{10} + x_1) - (r_2 + tn + c)(m_{20} + x_2) - (c_0 + tn_0) - (u + tv)]}{k_1(r_1 + tn + c) + k_2(r_2 + tn + c)} - \frac{(m_1(r_1 + tn + c) + m_2(r_2 + tn + c))Y}{k_1(r_1 + tn + c) + k_2(r_2 + tn + c)}. \tag{A.4}$$

Equating the IS, Equation (1), and the LM schedules we have for the equilibrium level of income:

$$Y = \frac{(K - z)[k_1(r_1 + tn + c) + k_2(r_2 + tn + c)] + j[B - (r_1 + tn + c)(m_{10} + x_1) - (r_2 + tn + c)(m_{20} + x_2) - (c_0 + tn_0) - (u + tv)]}{(Ak_1 + jm_1)(r_1 + tn + c) + (Ak_2 + jm_2)(r_2 + tn + c)}. \tag{A.5}$$

The mean level of income exists when all uncertainty terms are zero. Thus, subtracting the mean of income from (A.5), squaring, and taking the expected value of the result yields (4c).

APPENDIX B

Discussion of Macroeconomic and Money Market Parameters Presented in Table I

The money market parameters c and n reflect the size of currency and time deposits relative to total demand deposits. The parameters k_1 and k_2 are based on textbook values of the elasticity of the demand for monetary balances with respect to the rate of interest and then chosen in such a fashion that balances at federally chartered commercial banks are more responsive to changes in the rate of interest. The terms m_1 and m_2 were picked in a similar fashion. The macroeconomic parameters A and j are class room selections.

The remaining assumptions involve the variance and covariance terms. In the monetary sector we have assumed that the standard deviations of currency, demand, and time deposit demands are roughly proportional to the relative size of the variables themselves. In the same spirit, since investment is roughly of the same order of magnitude as demand deposits, one estimate of real sector uncertainty is that it is equal to demand deposit uncertainty. We do not need to assign absolute values to these uncertainty terms, since it is only their relative size which determines r_1^*, r_2^*, and t^*.

Mainly for simplicity, but also because there is little reason to believe otherwise, we assume that ρ_{ux_i} equals ρ_{vx_i}, implying that the error in each of the demand deposit equations is equally correlated with the currency and time deposit errors. Similarly, we assume that $\rho_{uz} = \rho_{x_1z} = \rho_{x_2z} = \rho_{vz}$ so that product market disturbances equally affect currency, demand deposit, and time deposit disturbances. Given these assumptions, it is still difficult to determine the size and direction of the other correlation terms. However, it is clear that the correlations, ρ_{ux_i} and ρ_{vx_i} will be negative, because of strong substitution effects.

The correlations, ρ_{uz}, ρ_{x_1z}, ρ_{x_2z}, and ρ_{vz}, should be characterized by a very weak positive covariation. An increase in z contracts the IS schedule, and in an environment characterized by sluggish aggregate demand, people will hold more in financial balances signaling that u, x_1, x_2, and v have increased. Hence, the correlations are positive. However, we believe that this intersector covariation is so weak that we assigned the correlations the value zero. In regard to $\rho_{x_1x_2}$, our a priori notions are not very well estabished and since this correlation coefficient is central to the analysis of dual reserve ratios, a range of values were specified. Finally, the correlation coefficient, ρ_{uv}, between the stochastic errors in the currency and time deposit equation is set equal to zero. The correlation between the two errors is weak and probably very near zero. Our assumptions represent what we hope are reasonable ranges of values. We leave, for further research, a more empirical approach to obtaining the hypothesized relationships between the relevant variables.

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