83-6

A Series of Occasional Papers in Draft Form Prepared by Members of the Research Department for Review and Comment.

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BANK RESERVE ADJUSTMENT PROCESS AND THE USE OF RESERVE CARRYOVER PROVISION AND THE IMPLICATIONS OF THE PROPOSED ACCOUNTING REGIME

Vefa Tarhan

FEDERAL RESERVE BANK OF CHICAGO

Bank Reserve Adjustment Process and the Use of Reserve Carryover Provision and the Implications of the Proposed Accounting Regime

Vefa Tarhan*
Loyola University of Chicago
Department of Finance

*This paper was written while I was a summer research fellow at the Federal Reserve Bank of Chicago. I have benefited from the helpful comments of George Kaufman, and Harvey Rosenblum. Special thanks go to Steven Strongin for the detailed discussions I had with him about the various aspects of the proposed reserve accounting regime.

1. INTRODUCTION

In June 1982 the Board of Governors of the Federal Reserve voted to abandon the lagged reserve accounting (LRA) in favor of a concurrent system of reserve accounting. The implementation period for the new regime as well as some of its details are yet to be determined. It will be a while before the new system generates enough data to conduct an empirical analysis on how banks adjust their reserves. However, it is possible that the process of reserve adjustment is invariant with respect to the reserve accounting system in effect. This being the case, this study will analyze the reserve adjustment process under the current regime. However, possible implications of the proposed regime is also discussed.

The purpose of this study is to build a weekly model describing the individual bank reserve adjustment behavior and to empirically determine the parameters of this process. Special attention will be paid to the use of the carryover provision as a reserve adjustment tool, and the possible implications of the use of this provision on the variability of the federal funds rate is examined. The reserve adjustment problem is discussed by specifying a system of equations which describe the environment in which banks make their decisions. Furthermore, a "reserves balance sheet constraint" is introduced. The relevant variables of the reserve adjustment process are identified as being either a "source" or a "use" of reserves. The specification acknowledges the fact that the optimal planned level of reserve tools are chosen

subject to the condition that sources of reserves be equal to the uses of reserves. This allows us to examine the relative importance of the different instruments in question.

Section 2 provides an analytical framework for the reserve adjustment problem. Section 3 analyzes the implications of the use of the carryover provision. Empirical results are discussed in Section 4, the proposed reserve accounting regime and its possible implications for both the individual bank and the system, are discussed in Section 5, and our conclusions are presented in section 6.

2. THE RESERVE ADJUSTMENT MODEL

Under lagged reserves accounting, the individual bank knows at the start of reserve week t the level of its required reserves which is determined by its level of deposits in week t-2 (RR_t^{t-2}). The bank also knows its vault cash balances from week t-2 that count as reserves in period t(VC_t^{t-2}). Lastly, the bank knows the amount of reserves carried over from the previous week (CO_t^{t-1})[1]. Because required reserves are pre-determined in period t, LRA eliminates one source of uncertainty for the bank. However, another source of uncertainty remains: As a result of the interactions of its depositors with the other banks and the Fed the bank's reserve balances change.[2] This uncertainty may be summarized in the variable (Z) which is defined as

$$Z_t = RBAL_t - NFF_t - BOR_t$$

where RBAL is the reserve balances, NFF is its net Federal funds purchases (federal funds purchases - sales) and BOR represents its discount window borrowings. In this model it is assumed that the

bank forecasts Z_t in order to reduce this source of uncertainty. 5 other variables it forecasts are the current and future costs of obtaining reserves represented by the forecasted level of the discount rate (DR_t) and the forecasted spread between next week's and current week's fed funds rate.

The bank's problem is to satisfy its required reserves in week t given its inherited carryover position, and the forecasts for Z_t and the cost of obtaining funds. This can be accomplished by obtaining reserves in the federal funds market and/or from the discount window, or the bank may chose to carryover deficit or surplus reserves to the next week (CO_{t+1}^{t}) provided that the amount in question does not exceed 2 percent of its required reserves.[3] The bank also has to decide on a level of excess reserves. In this study the definition of excess reserves is modified for the reserves carried over from the previous week. Thus the adjusted excess reserves (AER) is

$$AER_t = RBAL_t + VC_t^{t-2} - RR_t^{t-2} - CO_t^{t-1}.$$

The bank's choice of optimal adjustment paths for the control variables falls out of its attempt to minimize the cost of adjustment subject to the constraint that sources of reserves be equal to the uses of reserves. The relevant variables and their descriptions are summarized in Table 1.

In this framework, the sources of reserves are NFF_t, BOR_t, VC_t^{t-2}, Z_t, and CO_t^{t-1}. The uses of reserves, on the other hand, are represented by RR_t^{t-2}, AER_t and CO_{t+1}^{t}. Thus both sources and uses of reserves contain endogenous as well as exogenous variables.

Furthermore we differentiate between the ex-post and ex-ante values of the variables

$$R_{1t} = \tilde{R}_{1t} + e_{1t} \qquad (1)$$

$$R_{2t} = \hat{R}_{2t} + e_{2t} \qquad (2)$$

Where R_{1t} is a vector of the ex-post values of the endogenous variables and $\tilde{R}_{1t}$ the vector of ex-ante or planned values of the same variables. R_{2t} represents the vector of exogenous and predetermined variables (ex-post) and $\hat{R}_{2t}$ includes the forecasted values of $Z_t(\hat{Z}_t)$ and the predetermined exogenous variables. The disturbance terms e_{1t} and the forecast errors e_{2t} have the usual properties. The error terms in question are correlated

$$i_1' e_{1t} + i_2' e_{2t} = 0 \qquad (3)$$

The ex-post, "reserves balance sheet" constraint is

$$i_1' R_{1t} + i_2' R_{2t} \equiv 0 \qquad (4)$$

where i_1 and i_2 are unit vectors of appropriate order and the use of reserves variables are indexed negatively. This constraint has no behavioral content; it is solely an accounting identity. The behavioral constraint applicable to the problem at hand is

$$i_1' \tilde{R}_{1t} + i_2' \hat{R}_{2t} = 0 \qquad (5)$$

In other words, it is assumed that the bank chooses the optimal path for its control variables subject to the forecast of the exogenous variable and the constraint that the uses of reserves equals the sources of reserves.

The bank faces a penalty function that has two components: 1) The bank incurs a cost of adjustment when it changes the level of its control variables and 2) there are costs for being away from

the desired levels of these variables. The desired levels are a function of the forecasted value of Z_t as well as the forecasts of current and future costs of reserves. Minimizing this penalty function subject to the behavioral constraint (5) results in the following constrained optimal adjustment plans.[4]

$$\tilde{R}_{1t} = KR_{1t-1} + L\hat{r}_t + M\hat{R}_{2t} \qquad (6)$$

Substituting (2), the equations to be estimated are given by

$$R_{1t} = KR_{1t-1} + L\hat{r}_t + M\hat{R}_{2t} + e_{1t} \qquad (7)$$

where $\hat{r}_t$ represents the vector of forecasted interest rates: Current discount rate and the intertemporal spread on the funds rate. Equation by equation OLS estimates of the parameter matrices necessarily satisfy

$$i'K = 0 \quad i'L = 0 \quad \text{and} \quad i'M = -i'_2 \qquad (8)$$

The estimates of (7) are presented in section 4. Before discussing these results we would like to elaborate on the role played by the carryover provision in this process and analyze its potential implications for the variability of the Federal funds rate.

3. USE OF RESERVE CARRYOVER AND FEDERAL FUNDS RATE VARIABILITY

Banks use carryover for two purposes: 1. as a buffer against unexpected changes in their reserve balances just as an individual would use overdraft protection in his checking account and 2. as a "futures in reserves" instrument. If the latter is the case, one would expect banks to carryover a surplus when they expect the future funds rate to go up and a deficit when they expect a decline in the funds rate. In all probability carryover use satisfies both purposes. The analysis presented below shows that if banks use carryover as a hedge against future costs of

reserve adjustment this tends to smooth out the week to week variability in the funds rate. A priori it can be argued that use of this instrument for hedging purposes may be sporadic. However what is important here is whether or not banks use it at the margin when they forecast a change in the next periods funds rate.[5] We will attempt to determine this empirically in the context of a model described in Section 2.

In the following analysis it is assumed that there are two types of commercial banks; the first group of banks are net buyers of federal funds and the second group consists of banks which have a net selling position. It is further assumed that both groups of banks form forecasts regarding the future level of federal funds rates and make full use of the carryover provision as a futures instrument in reserves, based on the comparison of the current federal funds rate with the federal funds rate they expect to prevail during the next period. Furthermore, all banks are assumed to have homogeneous expectations with respect to the direction of funds rates movements, and also a two period (week) horizon.

Figure 1a shows that an individual bank makes its carryover decision by comparing the current fed-funds rate (FR_t) with the funds rate that is expected for the next period $E(FR_{t+1})$. If the current rate exceeds the expected rate for next period, the bank decides to make full use of its carryover provision by carrying over a deficit which is equal to two percent of its required reserves. On the other hand, if the funds rate is expected to rise compared to the current rate, the bank decides to carryover two percent of its required reserves as a surplus. If no change in the

funds rate is expected, the bank is indifferent between having a zero, positive or negative carryover. Figure 1a can be made more "realistic" by making two modifications. 1. Recognizing that banks will have a bias towards negative carryovers. Since, even when the funds rate is expected to remain unchanged, a profit maximizing bank will have an incentive to carryover a deficit both to avoid a penalty and because a negative carryover amounts to an interest free loan from the Fed to the bank when the federal funds rate remains unchanged from one week to the next week. Only when $E(FR_{t+1})$ exceeds FR_t by a sufficient amount would the bank be willing to have a zero carryover. Thus, section AB in Figure 1a should intersect the vertical axis below $E(FR_{t+1})$. 2. In addition, when uncertainty is introduced, it is likely that section AB will not be horizontal but downward sloping meaning that full use of the carryover will be made only when the likelihood of discrepancy between current and future funds rates is strong. Figure 1b is the modified version of Figure 1a. However, for the sake of simplicity the following analysis will ignore the uncertainty issue.

Now we will examine the implications of the above analysis for the banking system in the context of an intertemporal arbitrage model where storage is allowed. To examine the effects of carryover, we will compare the equilibrium levels of the fed-funds rate (FR) under a carryover regime (CO) with that of a no carryover system (NCO) over a two week period. Figure 2 shows that the funds rate in period t is determined by demand and supply of federal funds in the same period. Both D (D_{nct}) and S (S_{nct}) are primarily

Figure 1a

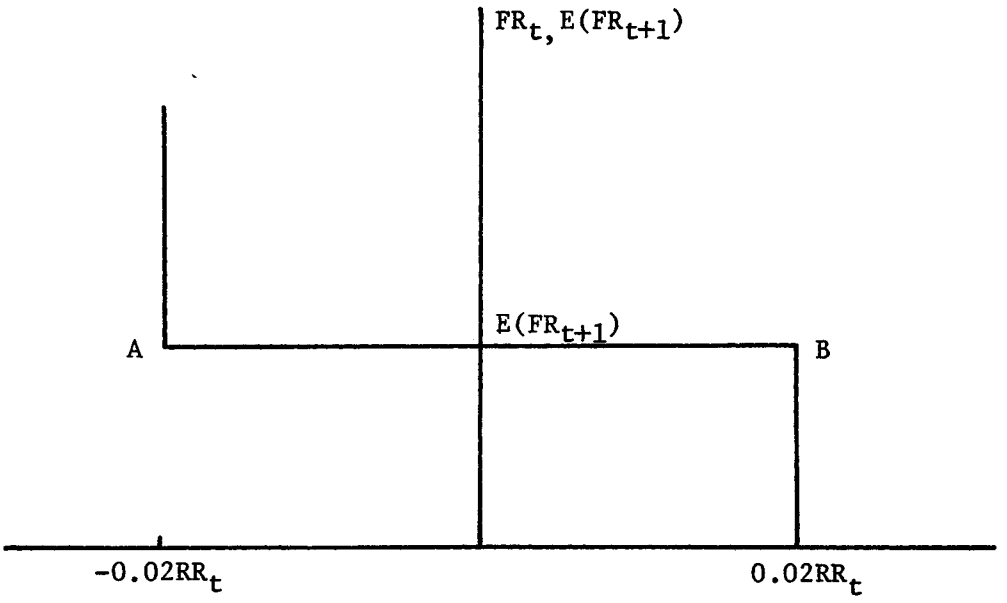
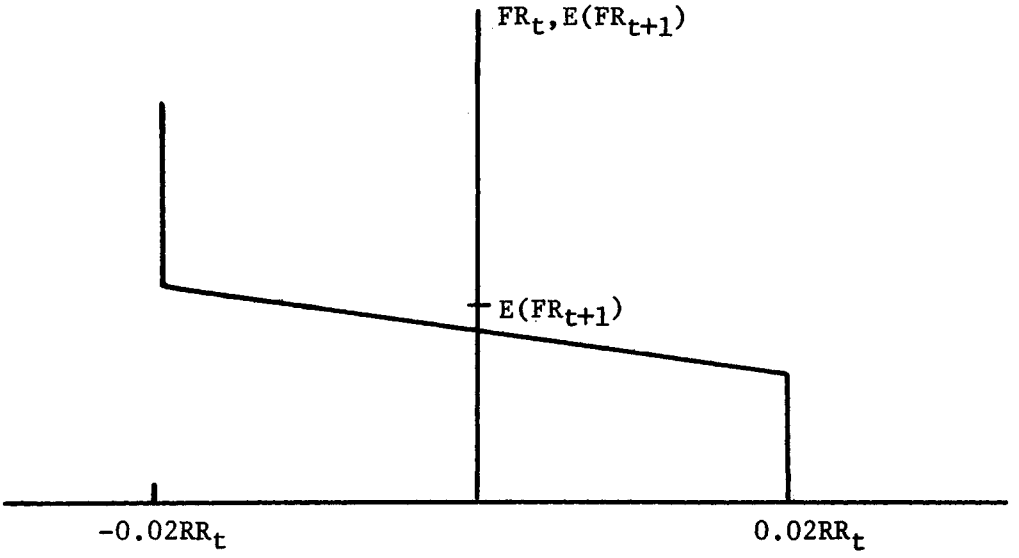


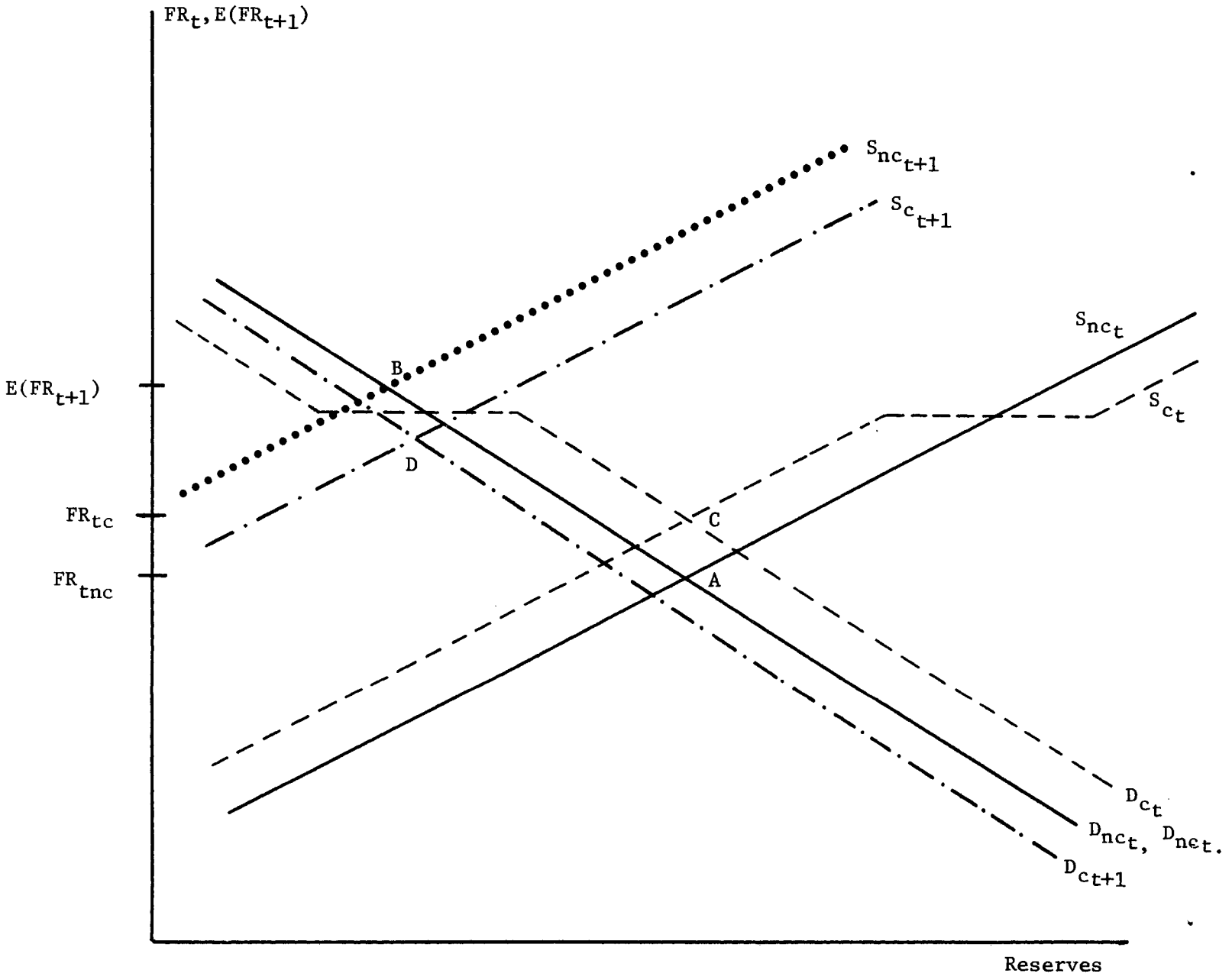
Figure 1b



determined by the required reserves implied by the level of deposits two periods ago. Other factors that determine the D for and S of reserves include bank behavior regarding the excess reserves, the discount rate and the Fed's administration of the discount window, the federal funds rate, and open market operations in the current week. We will assume that the banks expect the federal funds rate to increase in period t+1 and by construction the source of this increase is that the Fed is expected to withdraw reserves from the system during the next period, thus causing the supply curve to shift to the left. The D curve is assumed to remain unchanged. Thus, in period t+1 the new equilibrium for the funds rate is at point B (the intersection of D_{nct+1} (which is same as D_{nct}) and S_{nct+1}. Thus, the expectation that future funds rate will be higher than the current level (A) is realized. When there is no carryover, there is little that banks can do to smooth the variations in the funds rate.

Superimposed on the same diagram is the D and S curves for periods t and t+1 when banks use the carryover provision in the manner described above. Under a CO regime the current federal funds rate will be above the NCO level (A) when the FR for next period is expected to be higher. The expected funds rate for next period is denoted $E(FR_{t+1})$ (realized level under a NCO regime). The demand curve for reserves in the current period when CO is possible is labeled D_{ct}. The schedule is to the right of the D schedule with NCO up to almost point B. Slightly below point B, the level of indifference between negative and positive carryover is reached; above that level the D_{ct} shifts to the left of D_{nct}.

Figure 2



This is so because when current funds rate is below expected, the banks which are net buyers of fed-funds will demand more funds so as to be able to carryover a surplus of reserves to the next period. If the current FR is below next period's FR on the other hand, they will desire to have a negative carryover, thus, they demand less reserves at the same prices compared with the NCO regime. The banks which are net sellers of federal funds also make use of the carryover provision in the same manner. Hence, the supply curve (S_{ct}) will be to the left of S_{nct} up to the next week's expected rate and to the right of S_{nct} above $E(FR_{t+1})$. The equilibrium position with NCO available is thus at C. Thus, in the current period a higher funds rate is attained under a carryover system.

The D and S curves with CO in period t+1 are D_{ct+1} and S_{ct+1}. D_{ct+1} is to the left of D_{nct+1} by the amount of the carryover. S of reserves is again assumed to shift to the left as a result of the Fed's actions but S_{ct+1} will be to the right of S_{nct+1} by the amount of the carryover. The reason why D_{ct+1} is to the <u>left</u> of D_{nct+1} and S_{ct+1} is to the <u>right</u> of S_{nct+1} is that in period t both net purchasers and net sellers of federal funds have carried a surplus of reserves into period t+1 and thus they are in a position to offset their surplus positions. The equilibrium in period t+1 under a carryover regime is reached at point D. Thus, when funds rate is expected to increase the variation in the funds rate is A to B when carryover is not available and C to D under a system where banks can make use of the carryover provision. Furthermore, the above analysis implies that the variation will be smaller the

larger the amount that can be carried over. To the extent loan rates are affected by the funds rate, depending on the price elasticities of D and S of loans it can be argued that even the variation in bank assets may also be less as a result of the carryover provision.

Empirical verification of whether or not the carryover provision dampens the volatility of the funds rate is made very difficult by the fact that CO was introduced simultaneously with the lagged reserve accounting (LRA), and it is agreed that the initial impact of LRA, combined with CO, was to increase the variability in the funds rate.[6] The issue is whether the variability would have been more in the absence of CO. In the absence of possibility of a direct test, one can empirically examine the impact of CO in either of two ways: 1.) using a simulation approach, 2.) building a model of bank reserve adjustment where CO is an endogenous variable and examine its use in conjunction with other reserve adjustment tools, especially in response to expected increases in the FR. We chose the latter approach, and furthermore decided to use individual bank data since when CO is aggregated across banks there will be offsetting positions.

4. FINDINGS

The four equation system (7) was estimated for one large money center bank using not seasonally adjusted weekly data. The data spans the period from January 8, 1969 to September 26, 1979. The "use" items are indexed negatively, thus OLS automatically satisfies the parameter restrictions (8). Estimates of the

parameter matrices L and M are reported in Table 2. The estimated coefficients of the lagged endogenous variables are by and large both small and insignificant. These results are not reported here and are available upon request. The size and the insignificant nature of the lagged endogenous variables indicate there is almost no momentum in the system. In other words the variables in question absorb the reserve pressure in the same week it occurs. Thus any disequilibrium is not transmitted to the next week. This, of course, is not surprising since the reserve adjustment decision by its nature is constrained to be accomplished in one week.

The direction of responses to shocks in $\hat{Z}_t$, RR_t^{t-2} and VC_t^{t-2} are as expected.[7] Judging by the sizes of the estimated coefficients, the net fed funds purchases variable seems to be the most important reserve adjustment tool. When the forecasted level of the change in banks reserve balances due to the actions of the rest of the system increases by one dollar federal funds purchases decline by $1.02. When required reserves increase by one dollar fed-funds purchases increase by $1.04 and discount window borrowings decline by 4 cents.[8] A one dollar increase in vault cash results in decreased fed-funds purchases and discount window borrowings by 81 cents and 9 cents, respectively, and adjusted excess reserves increase. Again the sum of such responses add up to the shock of a dollar increase in vault cash two periods ago. One interpretation of why net fed-funds purchases increase by even more than the size of the shock may be due to the fact that a shock creates an environment where other adjustments have to be made. For example when required reserves increase, the bank finds

it necessary to increase its excess reserves somewhat too. The negative sign on the lagged carryover position in the CO equation captures the relationship that banks cannot have two deficits in a row.

The significant responses to an increase in the forecasted spread between next week's and current fed-funds rate are an increase in the reserves carried over and a decrease in adjusted excess reserves. Thus there is strong evidence that at least the sample bank uses the carryover provision to hedge reserves adjustment costs over time. Additional evidence is provided in Table 3. The highest correlation between the forecast errors on the spread and the residuals are found to be in the carryover equation. Whereas the correlation between the residuals of the equations and the forecast error of the variable Z on the other hand is highest for the NFF equation. This combined with the previous results, indicates that, the bank in question uses the carryover provision more in response to forecasted changes in the funds rate than as an "overdraft" protection against the exogenous changes in its reserve balances.

5. THE PROPOSED RESERVES REGIME AND ITS IMPLICATIONS

The new proposed reserve accounting regime (PRA) combines elements of both the concurrent reserve accounting (CRA) which was in effect prior to 1968 and lagged reserve accounting which has been in effect since then. The reserve computation period is 15 days (Monday to Monday). Reserve maintenance period is from the first Wednesday after the start of the reserve computation period to Wednesday of two weeks later for transaction deposits. Actual

reserves for other reservable liabilities will be posted in the two week maintenance period beginning 17 days later. We will confine our discussion to the transaction deposits.

Under this system the first two days (Days 1 and 2) and the last two days (Days 16 and 17) are very similar to the LRA in the sense that an individual bank's concern is to meet its predetermined required reserves. The 13 day period in between is a CRA regime since the level of an individual bank's deposits during that time period have implications for its required reserves. However, the bank has two more days to satisfy its required reserves. Those two days will be very crucial for the individual bank and the Fed. It will be important for the bank because its decision regarding what proportion of the adjustment to postpone to the very end might prove to be very costly, as the funds rate on days 16 and 17 might turn out to be drastically different than what the individual bank expected. This might be the case initially when the implementation of the new system starts, but in time the banks will probably become adept in forecasting the funds rate for those two days. In a way banks have unlimited carryover from the first 13 days to the last two days and this should eventually eliminate wide first 13 days last 2 days variation in the funds rate if forecasts are accurate.

However, the ability of banks to forecast will depend greatly on what the Fed does as opposed to what the banks expect the Fed to do during the last two days. The Fed will have to give out very unambiguous signals regarding both its discount window

administration policy as well as its intended open market operations. The last 2 days may at first seem similar to the current situation. However, the dimension of the problem is drastically different for two reasons: 1. Compared with the current LRA system, banks will have much less information about the system's demand for required reserves thus their funds rate forecast may be less accurate and 2. There are only two days to adjust and not a week. Thus the funds rate might change drastically during the last 2 days compared to the first 13 days unless the Fed is successful in conveying its intentions.

For an individual bank a crucial question regarding the PRA is how the new regime affects the uncertainty surrounding its reserve adjustment environment. The issue can be thought of having two components: uncertainty about the size of disequilibria the bank is likely to face, and uncertainty concerning the price of adjustment to a given disequilibrium. It seems that on both accounts there are forces working at opposite directions making it necessary for the issue to be settled empirically. However, any empirical attempt to resolve the problem has to be interpreted with caution due to the fact that the data in question is generated by the LRA system. Below, a preliminary test on the first component of uncertainty an individual bank faces is presented, the appropriate procedure for the analysis of the second component is also discussed.

The unanticipated portion of exogenous changes in an individual bank's reserve balances (errors on $\hat{Z}_t$) represent the

only source of uncertainty regarding the size of reserve disequilibria under LRA. But when subjected to a CRA type regime, the bank in question will also have to be concerned with the unanticipated component of its required reserves (forecast errors on RR_t). However, the uncertainty under PRA is less than the sum of the two error terms in question.[9] This follows since a one dollar change in Z_t is likely to produce a reserve imbalance which is less than one dollar due to the fact that RR_t is likely to change in the same direction by a fraction of the amount determined by the relevant required reserve ratio. Thus there is a positive correlation between changes in Z_t and RR_t. But the correlation coefficient is less than one because it is possible for changes in Z_t not to have any effect on RR_t and likewise changes in RR_t may not have any implications for Z_t. An example for the former case is the bank engaging in open market transaction with the Fed (Z_t changes but not RR_t). Factors like changes in the composition of the bank's deposits, on the other hand affect its required reserves but not its reserve balances.

For the sample bank, the uncertainty concerning the size of reserve disequilibria is estimated to be 6 percent less in a concurrent reserve accounting regime with a one week settlement period than it is under the lagged reserves system currently in effect.[10] This result occurs largely because the variance of residuals associated with $\hat{Z}_t$ is substantially larger than the variance of residuals of $\hat{RR}_t$ (In fact the correlation coefficient between the two error terms is only 0.25). In all probability, factors like knowledge of its depositors (for example the

redeposition rate of its loan customers) will enable the bank to produce better forecasts of Z_t compared with the simple auto-regressive procedure used here. If this is the case, the new regime may mean more, not less uncertainty for an individual bank. It is unlikely however, that in light of the factors discussed above, the uncertainty involved is substantially different between the two regimes.

The issue of whether or not funds rate will become more volatile is more difficult to analyze. One approach to this question is to compare the frequency of reserve disequilibria individual banks face in the two regimes under the assumption that funds market acts as the "shock-absorber" for any reserve discrepancies. The variance of reserve discrepancies under the LRA system is equal to variance of Z_t. In a CRA regime it is equal to the sum of the variances of Z_t and RR_t minus twice the covariance between the two. However, it should be noted that a change in Z_t for one bank has no implications for the funds rate if it involves another bank (since the two banks will be at opposite ends of the funds market, their activities will cancel each other out with no impact on the funds rate). Therefore it is only the changes in Z_t which result from the Fed's actions that is relevant for the analysis. The comparison is between the variance of open market operations under LRA and the sum of $\text{var}(OMO) + \text{var}(RR_t) - 2\ \text{cov}(OMO, RR_t)$ under CRA. Thus, how the Fed intends to conduct its OMO when PRA is implemented becomes a crucial factor. The issue of uncertainty regarding the price of adjustment will probably not be resolved until after the proposed system is implemented.

It is possible banks will have larger forecast errors in their attempts to predict the funds rate when PRA is introduced compared with the current situation since now they have information on the most important component of demand for reserves (the required reserves for the banking system). This information will not be available under the new regime.[11]

A more fundamental issue is whether or not bank earning asset behavior (the portfolio of loans and investments) will change with the introduction of PRA. This is a very important issue because one of the main criticisms against LRA is that it can potentially create an environment where the Fed has no choice but to validate the deposits created by the banking system with a two week lag. Thus this argument amounts to the contention that a reserve accounting regime potentially can change bank earning asset behavior. As far as individual bank behavior is concerned, a conclusion of a study which comparès bank behavior under CRA and LRA is that bank earning asset and reserve position adjustment is no different before and after the change to LRA took place.[12] This result is not entirely unexpected if one believes that what governs bank earning asset expansion is the expected costs and returns from these assets over a multi-period horizon. Unless a reserve accounting regime changes these expected costs there is no reason to think banks will create more or less deposits because of a particular reserve accounting regime. The impact of PRA on bank asset expansion will partially depend on whether or not funds rate volatility changes. Even if there is a change in volatility, the effect of this is likely to be one which changes the terms of

banks' asset acquisitions rather than the size of their portfolios.[13]

Finally, the use of the carryover provision and its potential under the proposed system needs to be addressed. In order to achieve a reduction in the funds rate variability via carryover use, it is crucial that future funds rate forecasts on the average be accurate. As discussed above, under LRA this may not be as complex as it will be under PRA. Thus, when PRA is implemented the forecasts of the future funds rate may turn out to be less accurate. Under such conditions the carryover provision can potentially have a destabilizing effect on the funds rate. In this regard, the Fed can increase the accuracy of such forecasts by giving clear signals about its policy stance and future course of actions.

Carryover should not be viewed as "another loophole" for the banks to get around the objectives and implications of monetary policy. First of all a deficit in any reserve settlement period is offset during the succeeding period. A deficit represents a limited amount of interest free loan, by the Fed to the bank in question. This loan has a maturity of one week and a provision that it cannot be repeated next week. Furthermore the interest-free nature of the loan should not be dwelled on so much since carryover historically has been more frequently a surplus on which no interest is earned than a deficit.[14] The importance of CO is that it is a tool which may enable the banks to arbitrage away the inter-period variability of the funds rate. Alternatively the Fed can smooth out the funds rate variability as it has done in the

past instead of letting the banks do it. But the potential pitfalls of this approach is that monetary policy becomes procyclical and the causation which is suppose to run from reserves to money may be reversed.[15] If the banks are allowed to act on their forecasts of the future course of the funds rate, and if the Fed sends clear signals about its actions increasing the accuracy of such forecasts, the week to week variability of both the funds rate and monetary aggregates is likely to be reduced without any undesirable side effects. It should be noted however that at times the amount of excess or deficits necessary to smooth out the funds rate may run into the 2 percent constraint. The issue of whether or not the constraint becomes binding deserves to be studied carefully, and if it is found to be the case the Fed could consider, after PRA is implemented, a more liberalized carryover provision.

6. CONCLUDING REMARKS

An individual bank's reserve adjustment behavior was examined in the context of a model which takes into account the interrelations between the reserve adjustment tools. It was found that in response to various shocks these tools are used in an expected manner. Among our conclusions is that net federal funds purchases is by far the most important variable in adjusting to disequilibria affecting the reserve positions of an individual bank. Another conclusion is that the sample bank in question uses the carryover provision to hedge its intertemporal costs of reserve adjustment. If all banks make use of their reserve carryovers in a similar way this will tend to reduce the inter-week volatility of

the funds rate provided their forecasts are on the average accurate.

The possible implications of the proposed regime was also discussed. The claim that the proposed regime will increase the uncertainity surrounding individual bank reserve adjustment was found to be exaggerated. The impact of PRA on Fed-funds rate volatility on the other hand remains to be resolved. One possible context to analyze this issue was discussed.

It is also hypothesized that the role of discount window administration will become more important especially during the last two days of the reserve settlement period. In this regard, if the Fed uses a nonborrowed reserves target, it is essential that the borrowing function is studied extensively. Additionally, bank behavior in response to the change in the composition of reserves needs to be examined.

Bank earning asset behavior is not likely to change as a result of the new regime since the proposed system is not expected to alter the intertemporal costs/returns of bank sources and uses of funds. PRA may result in an improvement in short-run monetary control. However, it is unrealistic to expect the improvement in question to be substantial. Besides, even if the Fed is able to control total reserves on a weekly basis, to the extent total reserves multiplier is not predictable at a weekly level, money targets will not be realized.

One final conclusion is that in order to achieve a reduction in funds rate volatility as a result of banks' actions, it is essential that the Fed convey clear signals about its intentions.

This will enable banks to forecast the funds rate more accurately and acquire earning assets in a smooth manner. In this regard, the Fed should also consider liberalizing the carryover provision if it is found that the current two percent rule imposes a binding constraint on the system.

Table 1

Variable		Definition	Status
NFF_t^t	=	Net federal funds purchases	endogenous
$BORH_t^t$	=	Discount window borrowings	endogenous
CO_{t-1}^t	=	Reserve carryover from period t to t+1	endogenous
AER_t^t	=	Adjusted excess reserves	endogenous
VC_{t+2}^t	=	Vault cash from t to t+2	endogenous
RR_t^{t-2}	=	Required reserves	Pre-determined
CO_t^{t-1}	=	Reserves carried over from t-1 to t	Pre-determined
Z_t	=	Change in reserve balances caused by the rest of the system	exogenous
DR_t	=	Discount rate	exogenous
$FR_{t+1}-FR_t$	=	Federal funds rate spread	exogenous

Table 2

Selected Coefficient Estimates and Summary Statistics

Variable	C	VC_t^{t-2}	CO_t^{t-1}	RR_t^{t-2}	$\hat{Z}_t^t$	$(FR_{t+1}\hat{-}FR_t)$	$\hat{DR}_t$	R^2	D-W
NFF_t^t	-308 (-0.26)	-0.81 (-1.90)	0.68 (0.65)	1.047 (-9.70)	-1.02 (13.35)	-528 (-0.53)	-42.3 (-0.39)	0.70	2.01
BOR_t^t	396 (2.78)	-0.087 (-1.65)	-0.006 (-0.04)	-0.0412 (-3.07)	0.02 (2.17)	-11.77 (-0.09)	22.07 (1.73)	0.038	1.99
CO_{t+1}^t	-19.79 (-0.37)	-0.024 (-1.22)	-0.1095 (-2.27)	0.0046 (0.92)	-0.002 (-0.58)	115.7 (2.53)	8.63 (1.73)	0.44	1.79
AER_t^t	107 (0.52)	0.124 (1.62)	0.78 (4.20)	0.0012 (0.068)	-0.004 (0.32)	-656 (-3.70)	-28 (-1.43)	0.22	1.96

NOTE: t-statistics are reported in parenthesis below the coefficient estimates.

Table 3

Correlation Coefficients

	Forecast errors current-future funds rate spread	Forecast errors discount rate	Forecast errors exogenous reserve balances
NFF residuals	0.0048	-0.0597	0.9812*
BOR residuals	0.0054	-0.0450	0.1275*
CO residuals	0.2401*	-0.0238	-0.0157
AER residuals	-0.2329*	0.0011	0.1166*

*indicates significance at one percent

Footnotes

[1]Before 1968 banks were able to carry forward into the next settlement week only deficits provided 2 percent limit is not violated. Since September 1968 as a result of an amendment to Regulation D banks can carryover surplus reserves as well as deficits again subject to 2 percent constraint.

[2]Typically, a bank has information on its level of reserve balances with a one day lag. Thus, in any reserve accounting regime uncertainty about the reserve adjustment is not completely resolved until one day after the reserve settlement period ends. Furthermore, additional adjustments regarding the past current and future reserve positions continue in the form of as of adjustments (ASOF). For a discussion of use of ASOF see Beek (1981).

[3]Other instruments that a bank may use include government securities, CDs, Eurodollar purchases, RPs, loans to security dealers. However, some of these instruments are not used for reserve adjustment purposes in any consistent manner. For example liquidation of government securities may involve capital losses and/or the bank may be using them as collateral against Government deposits or in RP transactions. CDs are basicly used to finance earning assets. Loans to securities dealers were excluded due to data restrictions. RPs are already included as part of federal funds transactions.

[4]A rigorous derivation of the equations to be estimated is presented in Spindt and Tarhan (1978).

[5]In our private discussions with some bankers we have found this to be the case, i.e., other things being equal they stated that they use CO when they expect future funds rate to be different than the rate prevailing in the current week.

[6]See Coats (1976). However Jones (1982) reports that by 1974 the intraweekly volatility of the funds rate was reduced by enlarging the volume of defensive open market operations.

[7]The interest rate forecasts are generated by autoregressive models fit to each time series. Forecast of Z_t on the other hand incorporates information on all the exogenous variables of the model in addition to past values of Z_t. Thus forecasts for Z_t are orthogonal to all the righthand side variables of the regression equations which allows the use of single equation OLS. Under these conditions, single equation OLS estimates the model parameters and automatically respects the balance sheet adding up constraint.

[8]It is interesting to note that even though the decline in discount window borrowings is small, the coefficient in question is significant at the five percent level. One criticism against the LRA is that such borrowings for the system may increase in response to deposit expansion two periods ago, in effect forcing the Fed to validate the asset expansion of the banks. However, at least for this individual bank this does not seem to be the case since the relationship between RR_t^{t-2} and BOR_t^t is actually negative.

[9]Reserve disequilibrium for an individual bank can be defined as

$$RD = Z_t - RR_t$$

Under LRA RR_t is predetermined. Thus uncertainty in this regime can be described by the variance of the forecast errors associated with Z_t. But under PRA the bank also has to be concerned with the unanticipated component of RR_t as well as the relationship between the two forecast errors.

$$\text{Let } Z_t = \alpha_o + \alpha_1 X + e_{Z_t}$$

$$RR_t = \beta_o + \beta_1 Y + e_{RR_t}$$

Where X and Y are the vector of independent variables that enter into the forecast of Z_t and RR_t respectively. Then, uncertainty in a LRA regime equals

$$\text{var } (\hat{e}_{Z_t}).$$

whereas under PRA it is

$$\text{var } (\hat{e}_{Z_t}) + \text{var } (\hat{e}_{RR_t}) - 2\text{COV } (\hat{e}_{Z_t}, \hat{e}_{RR_t}).$$

[10]The variance of forecast errors associated with Z_t and RR_t is estimated to be 5344024 and 224056 respectively, and the covariance between the two residuals is 279972 making the reserve disequilibria variance of forecast errors 5344024 under LRA and 5008036 under CRA.

[11]Money supply figures are announced with a 10-day lag thus on Fridays the banks have complete information about the amount of required reserves that the system needs for the reserve settlement week which has started the previous day. It is conceivable that the announcements will cause them to revise their forecasts of the system's demand for RR, and thus the funds rate they expect for the next settlement period. Under a CRA type regime since they have no deposit figures to base their forecasts on such forecasts are likely to have wider confidence intervals.

[12]See Spindt and Tarhan (1982).

[13]If funds rate become more volatile this will imply increased volatility for other short-term interest rates as well. It is expected that banks will respond to the increase in their interest rate exposure by continuing the trend of increasing the proportion of floating rate loans in their portfolios and/or accelerating their efforts to use financial futures instruments. Their response is more likely to be the latter in light of the fact that the use of the former approach seems to have decreased the profitability of their loan portfolios. See Rose (1981).

[14]David Beek (1981) has calculated that for the system excess carryover in 1980 averaged about $225 million a week, while the average deficit carryover was in the order of $125 million.

[15]Under a funds rate target an increase in demand for bank credit will result in increased funds rate as banks increase their fed-funds purchases. Provided the increase is sufficient to push the funds rate above the upper limit, the Fed will supply reserves. See Spindt and Tarhan (1980) and (1982).

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