

Working Paper 73-1

SIMULATIONS OF MARGINAL RESERVE REQUIREMENTS
ON LARGE DENOMINATION CERTIFICATES
OF DEPOSIT IN THE FRB MODEL

Philip H. Davidson

Federal Reserve Bank of Richmond

May 10, 1973

The views expressed here are solely those of
the author and do not necessarily reflect the
views of the Federal Reserve Bank of Richmond.

SUMMARY

As a substitute for Regulation Q ceilings, Regulation D may be used to control the volume of bank credit stemming from the issuance of large denomination, negotiable certificates of deposit. The effects of the use of Regulation D, through the vehicle of marginal reserve requirements, would be to increase the quantity of required reserves and to raise the effective cost to the bank of acquiring funds via CD's beyond some base level. The effectiveness of marginal reserve requirements would primarily depend on the interest elasticity of demand for bank loans. That is, the higher effective cost of CD's would force the bank to raise its commercial loan rate, which to some degree would tend to reduce the demand for commercial loans. The behavior of these financial variables may be examined by conducting some simulations of the FRB model.

Three simulations were conducted. The first was a simple matching of history, including Regulation Q ceilings on CD's. The second simulation removed these ceilings, allowing the quantity of CD's to expand in response to prevailing economic and financial conditions. The third simulation imposed marginal reserve requirements on the banking system. Marginal reserve requirements on CD's were introduced by raising the average required reserve ratio against CD's and by raising the value of the CD interest rate in the commercial loan rate equation.

The results of these simulations were largely as expected. CD volume increased substantially with the removal of Regulation Q ceilings, but then decreased slightly with the imposition of marginal reserve requirements. In the second simulation, the commercial loan rate fell somewhat, which, coupled with the increase in CD's, expanded the quantity of commercial loans outstanding. Commercial loan volume fell sharply in the third simulation as was expected because of the higher required reserves and higher cost of CD funds that forced banks to raise the interest rate charged on commercial loans. The decrease in

commercial loans between the first and third simulations closely followed the decrease in total deposits between these two simulations. The larger volume of CD's outstanding, plus the higher level of required reserves, and the decline in commercial loans resulted in an overall decrease in both demand deposits and other time deposits.

In general, the results of these simulations suggest that marginal reserve requirements would have been more effective in controlling bank credit than Regulation Q ceilings were. These results must be qualified by several factors, however. The FRB model, in its current version, does not explicitly identify alternative sources of credit to borrowers. Also, the behavior of some of the variables examined was affected undesirably by certain structural aspects of the model. Finally, the marginal reserve requirements were implemented in a necessarily arbitrary manner that may have biased the results. On balance, however, the results of these simulations appear to provide a basic understanding of the role that marginal reserve requirements on CD's might serve in our banking system.

SIMULATIONS OF MARGINAL RESERVE REQUIREMENTS
ON LARGE DENOMINATION CERTIFICATES OF DEPOSIT IN THE FRB MODEL*

Introduction

Recently, a suggestion has been made that the Federal Reserve utilize Regulation D (reserve requirements) rather than Regulation Q (deposit interest rate ceilings) to control the volume of bank credit stemming from the issuance of large denomination, negotiable certificates of deposit (CD's). Using the authority granted under Regulation D to establish reserve requirements, the Fed could develop a set of marginal reserve requirements to be applied against outstanding CD's that are in excess of some predetermined base level. Marginal reserve requirements would have a two-part effect on a bank's loans and investments. First, the quantity of required reserves that would be released because of a shift from demand deposits into CD's would be reduced if there were a marginal reserve requirement against CD's. Thus a bank would have fewer excess reserves to loan or invest. Second, a marginal reserve requirement would raise the effective cost to the bank of selling additional CD's, which would cause the banks to raise the interest rate on loans made with such funds. Presumably, the bank's willingness to incur this added cost would depend upon the interest elasticity of demand for commercial loans experienced by the bank. Again, the bank's ability to make loans would most likely be impaired.

Given the well-specified markets appearing in the FRB model for commercial loans, CD's, and other deposits, a series of simulations of the model designed to test the impact of marginal reserve requirements on bank credit appears feasible. The remaining sections of this paper will explain the details of the simulations and the results obtained therefrom.

*The author acknowledges considerable help from Joe Crews in the specification of simulations on the FRB model and from Cathy Gaffney in the operation of the model.

Structure of the Loan and Deposit Markets in the FRB Model

Although the financial sector of the FRB model is not in general well specified, the markets for bank loans and deposits are constructed in sufficient detail for our purposes. The commercial loan market is represented by the following two equations:

$$\text{commercial loan rate} = f(\text{deposits}, \text{bond rate}, \text{rate}, \text{lagged value of commercial loan rate}, \text{dummy for introduction of negotiable CD's}, \text{CD interest rate})$$

$$\text{demand for commercial loans} = f(\text{inventory investment}, \text{inventory valuation adjustment}, \text{expenditures on producers' durables}, \text{Treasury bill rate} - \text{commercial loan rate}, \text{corporate bond rate} - \text{commercial loan rate}, \text{lagged value of commercial loans}).$$

In the rate equation, the CD interest rate used is the secondary market rate, and it only comes into use when it exceeds the Regulation Q ceiling on CD rates payable by banks.

The market for CD's contains the following equations:

$$\text{demand for CD's} = f(\text{CD interest rate}, \text{Treasury bill rate}, \text{commercial paper rate})$$

$$\text{supply of CD's} = f(\text{CD interest rate}, \text{Treasury bill rate}, \text{deposits}, \text{loans}).$$

In the operation of the model, the CD demand equation is solved for the CD interest rate. The coefficients for these two equations were estimated only during periods when Regulation Q ceilings on CD rates were not binding.

The equations for demand deposits and time deposits are specified as follows:

$$\text{demand for demand deposits} = f(\text{Treasury bill rate}, \text{time deposit rate}, \text{lagged value of demand deposits}, \text{discount rate})$$

$$\text{demand for time deposits} = f(\text{disposable personal income} - \text{consumption}, \text{household net worth}, \text{time deposit rate}, \text{savings and loan share rate}, \text{mutual savings account rate}, \text{Treasury bill rate}, \text{disposable personal income}).$$

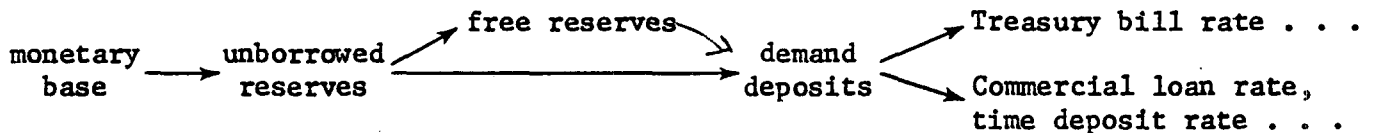
In the operation of the model, the demand deposit equation is solved for the Treasury bill rate. Further, the behavior of each of these deposit variables is at least partially constrained by the reserve structure of the model, which may be seen in the following identities:

unborrowed monetary base = unborrowed reserves + currency outside banks

free reserves = excess reserves - borrowed reserves

unborrowed reserves - free reserves = demand deposits (required reserve ratio) + time deposits (required reserve ratio).

In order to permit demand deposits to respond to shifts of other deposits and changes in required reserves, the model was simulated using the monetary base as the exogenous instrument variable.¹ The transmission process using the monetary base as the instrument variable is as follows:



Under this regime the unborrowed monetary base is held constant and unborrowed reserves may fluctuate only to the extent that the allocation of currency between the banks and the public changes. Thus, because the supply of unborrowed reserves is not unlimited, an increase in CD's, for example, would most likely lead to a decrease in demand deposits, other time deposits, or both.

Changes in the Structure of the Model

A system of marginal reserve requirements may be introduced into the model by making adjustments in two equations. First, required reserves must be altered to reflect the higher reserve ratio against CD's that are issued in excess of some base level. This change may be effected in the reserve equation containing

¹All other simulations of the model at this bank have used the money supply (M_1) as the exogenous instrument variable. That regime severely constrains the behavior of demand deposits, which would not have produced meaningful results for the simulations we have planned.

the required reserve ratios by splitting the reserve ratio for time deposits into two components, one for CD's and another for other time deposits. / Thus, given a specific marginal reserve requirement for CD's, as they increase beyond some base level, the average reserve requirement against CD's will rise.

The second adjustment in the model will be made in the commercial loan interest rate equation. Because the marginal reserve requirement against CD's will raise the cost of this source of funds to the bank, some upward adjustment in the rate charged for commercial loans will be likely. The higher loan rate, which appears in the demand for loans equation, should tend to slow the rate of growth of loans made by commercial banks.

Three Simulations of the FRB Model

The role marginal reserve requirements might play in controlling the volume of bank credit may be tested with three simulations of the FRB model. Initially, a control solution must be determined as a reference point for evaluating the results of the other simulations. This first simulation will be a simple historical match for the period 1969I - 1972IV.² The purpose of this simulation is to observe the actual behavior of the variables in which we are interested when they were influenced by Regulation Q ceilings on CD rates.

The second simulation will differ from the first only in that Regulation Q ceilings on CD rates will be completely removed. The purpose of this change will be to observe the behavior of CD's, CD rates, commercial loans, and deposits under a system of relative interest rate freedom. It is expected that the volume of CD's will increase sharply during those periods when the ability of a bank to issue CD's was sharply curtailed by the presence of market interest rates in excess of

²Technically, a historical match is a rather complex process involving a set of adjustment factors determined by the difference between the results produced from the initial step in solving the model and the actual historical values of the variables.

ceiling rate levels. An increased quantity of CD's should put upward pressure on CD rates, provide more funds for commercial loans, and decrease demand deposits and other time deposits. The decrease in deposits is attributable to the limited supply of reserves.

The third simulation will introduce marginal reserve requirements on CD's as described in the preceding section. Marginal reserve requirements should have the effect of reducing the quantity of CD's below the quantity appearing when there were no CD rate ceilings, but not nearly as low as the quantity appearing with rate ceilings. Both the higher level of required reserves and the higher cost to the bank of issuing CD's when marginal reserve requirements are in effect should put downward pressure on the quantity of CD's outstanding. Marginal reserve requirements should not be nearly as stifling as CD rate ceilings, however.

The reduced quantity of CD's and the effects of higher required reserves and higher CD costs should raise the commercial loan rate and lower the volume of commercial loans outstanding as compared to a system of unlimited CD rate ceilings. A priori, it is difficult to specify the effects of marginal reserve requirements as compared to Regulation Q ceilings. Essentially, the Federal Reserve would be substituting a price rationing mechanism (marginal reserve requirements) for a quantity rationing mechanism (Regulation Q rate ceilings). Under the latter system the quantity of CD's was tightly controlled, forcing banks to develop alternative sources of funds such as Eurodollars and commercial paper. Moreover, borrowers rationed by banks found alternative sources of credit in the open market and from other financial intermediaries such as commercial finance companies.

If marginal reserve requirements were to be implemented, however, banks could still obtain funds in the CD market, although they would be costlier, which would put upward pressure on loan rates. The crucial question regarding the

effectiveness of marginal reserve requirements in controlling bank credit hinges on the interest elasticity of demand for bank loans. The more elastic the relationship, the more effective marginal reserve requirements would be in reducing loan demand and bank credit. Reducing bank credit is only a necessary, not a sufficient condition, however, for controlling the rate of growth of total credit. Borrowers who consider bank loan rates unattractively high may well turn to alternative sources of credit, as they have in the past under a system of Regulation Q ceilings. Until the interest rate elasticity of commercial loans can be specified, the effectiveness of marginal reserve requirements on CD's will be difficult to ascertain. The results of the third simulation should shed some light on this question. The problem of borrowers seeking alternative sources of credit outside the banking system must remain unresolved at this juncture, however, because the markets for such credit are unspecified in the FRB model.

Changes in the Structure of the FRB Model

Marginal reserve requirements will be introduced into the model by specifying a separate required reserve ratio for CD's in the reserve equation set forth above. All CD's issued in excess of some base level will be subject to a higher reserve requirement in addition to the basic reserve requirement specified in Regulation D. The quantity of CD's determining the marginal reserve requirement will be the difference in each quarter between the quantity of CD's appearing in the second simulation (no CD rate ceilings) and the first simulation (history match with CD rate ceilings). A marginal reserve requirement of 25 percent will be used. This ratio was chosen using two guidelines. First, we felt that the average reserve ratio for CD's should about equal the reserve ratio for demand deposits at large banks (17 percent) during that period when the largest quantity of CD's appeared in the second simulation. Second, we felt that the effective cost to the bank of issuing additional CD's should fall within a range of about 10 percent

to 13 percent. This range appeared to be commensurate with the costs of alternative funds obtained by banks during those periods when they were subject to binding Regulation Q ceilings on CD rates.

Admittedly, these guidelines are rather arbitrary, but probably no more so than any others we might have used. Given the preliminary status of marginal reserve requirements, it was difficult to specify any one method of implementing them that appeared to be absolutely "correct."

The 25 percent marginal reserve requirement produced the following average reserve requirements on CD's and effective interest rate cost to the bank:

		<u>Average Reserve Requirement</u>	<u>Effective Interest Cost</u>
1969	I	11%	9.72%
	II	11%	10.53%
	III	15%	11.36%
	IV	17%	11.76%
1970	I	14%	11.16%
	II	14%	10.74%

The commercial loan rate was adjusted to reflect the above cost increases to the bank of issuing CD's subject to a marginal reserve requirement. These six quarters constitute the longest consecutive period during which Regulation Q ceilings on CD's were binding. We have assumed that marginal reserve requirements would have been implemented during such periods.

Simulation Results

The results for the three simulations are set forth in Table I. For the most part, each of the variables behaved as we expected. The most noteworthy exception was the behavior of the commercial loan variable in the third simulation, which included marginal reserve requirements on CD's. The decreases in commercial loans in the third simulation were much larger than we anticipated.

Scanning the numbers in Table I, we observe that the volume of CD's increased sharply with the removal of interest rate ceilings, but then decreased

TABLE I

SIMULATION RESULTS

Year, by quarters	1969				1970	
	I	II	III	IV	I	II
CD VOLUME						
Control	18.847 ^a	16.656	13.313	12.165	14.296	16.793
No interest rate ceilings	27.246	28.731	27.856	28.808	27.164	30.766
Marginal Reserve Requirements	26.765	26.857	26.409	26.076	24.030	27.624
CD INTEREST RATE						
Control	6.525 ^b	6.878	7.536	7.720	7.685	7.307
No interest rate ceilings	7.286	7.765	8.517	8.817	8.367	8.058
Marginal Reserve Requirements	8.861	8.764	10.920	9.804	7.465	7.893
COMMERCIAL LOAN VOLUME						
Control	99.506 ^a	103.555	106.777	108.467	110.575	113.034
No interest rate ceilings	100.700	105.191	108.849	110.385	112.235	114.699
Marginal Reserve Requirements	96.403	98.825	100.578	101.386	102.712	102.870
COMMERCIAL LOAN RATE						
Control	7.257 ^b	7.657	8.400	8.298	8.314	8.059
No interest rate ceilings	6.773	7.009	7.484	7.191	7.324	7.239
Marginal Reserve Requirements	9.279	10.507	11.564	11.549	11.692	11.592
DEMAND DEPOSITS IN M₁						
Control	156.296 ^a	157.407	157.285	158.182	160.053	161.663
No interest rate ceilings	155.265	156.090	155.759	156.364	158.397	159.729
Marginal Reserve Requirements	149.442	148.847	144.477	144.991	149.575	149.289
TIME DEPOSITS (OTHER THAN LARGE CD's)						
Control	143.149 ^a	142.929	140.836	139.903	141.905	144.503
No interest rate ceilings	143.139	142.443	139.967	138.642	140.605	143.084
Marginal Reserve Requirements	138.388	136.355	130.995	129.021	131.954	134.440

^abillions of dollars^bpercent

slightly with the imposition of marginal reserve requirements. This decrease was not large enough to lower CD volume to anywhere near its Regulation Q levels. As might be expected, the increase in CD volume in the second simulation put upward pressure on CD rates. That is, banks had to raise the rate offered on CD's to induce the market to absorb the higher quantity of CD's. In the third simulation, CD rates again increased, which was not in line with our expectations. Because CD volume had decreased and because of the increased cost of CD's to banks, we expected CD rates to decline. A detailed examination of the model helped to explain this anomalous result. Noticing that demand deposits decreased sharply in the third simulation, which was at least partially expected because of the increase in required reserves and decline in commercial loans, we checked the role of demand deposits in the model and discovered that they influence the Treasury bill rate, which appears in the CD rate equation. Thus, the decrease in demand deposits put upward pressure on the bill rate, which tended to raise the CD rate.

The quantity of commercial loans increased in the second simulation and then fell off dramatically in the third simulation. We expected a larger increase in the second simulation, but the effect on loans of the increase in CD's was partially offset by the rise in the CD rate. Also, we might perhaps conclude that loan demand was largely satisfied during these periods with funds that the banks obtained via alternative sources. The decrease in loans in the third simulation appears to stem for the most part from the increase in the loan rate, which, of course, was caused by the higher effective cost to banks of issuing CD's. Apparently, the demand for bank loans is rather interest elastic, at least more so than most observers seem to think.

Demand deposits and time deposits moved in the general directions that were expected in each of the simulations, although somewhat more sharply than was

expected. The total deposits of the banking system, including CD's, decreased between the first and third simulations by an amount that was roughly equal to the decrease in commercial loans, as can be seen in Table II. This result was encouraging because it suggested the presence of some sort of balance sheet constraint that helped to provide simulation results that were internally consistent.

Evaluation of the Results

In general, we might conclude that a system of marginal reserve requirements is more effective in controlling bank credit, especially loans, than is a system of Regulation Q ceilings. Several qualifications to this generalization are in order, however. Foremost is the narrow focus of these simulations. Because the financial sector of the FRB model is not specified in detail beyond the markets examined here, it is difficult to draw conclusions regarding these results. That is, because the model does not specify what is happening outside the banking sector in these simulations, the sharp decrease in loans in the third simulation reveals only part of the overall effects of the marginal reserve requirements. For example, what alternative sources of funds might banks employ if issuing CD's becomes too costly, or what alternative sources of credit might borrowers turn to if bank borrowing becomes too costly? The current version of the FRB model is not capable of answering these questions.

Another qualification is that we are not fully comfortable with the elasticity of the interest rate-loan demand relationship. At this juncture we are unable to identify a completely satisfactory explanation of the sharp decrease in loans. One problem may lie in the adjustment of the loan rate. Since CD's are a marginal source of funds, it would probably be more appropriate to adjust only the interest rate on loans made with such funds. Further research in this area might incorporate this suggestion.

TABLE II

DIFFERENCES BETWEEN FIRST AND THIRD SIMULATIONS

		<u>Change in Total Deposits*</u>	<u>Change in Commercial Loans*</u>
1969	I	- 2.510	- 3.103
	II	- 3.339	- 4.730
	III	- 7.259	- 6.199
	IV	- 8.201	- 7.081
1970	I	- 8.747	- 7.863
	II	- 9.114	- 10.164

*billions of dollars

The magnitude of the feedback effects of the decrease in demand deposits on the Treasury bill rate and ultimately on the CD rate are disturbing. Naturally, during periods of tight credit conditions an increase in market interest rates would be expected. But the increase in the bill rate in the third simulation is much too large. Again, further research efforts might find a way to produce a milder increase in the bill rate.

On balance, these simulations provide us with some empirical insight into the effects that marginal reserve requirements might have on commercial banks. Although we are not fully confident of the precision of some of the results, they do suggest a direction and order of magnitude that are believable.