Reserve Requirements and the Structure of the CD Market: A Note
Author(s): Thomas A. Lawler
Source: *The Journal of Finance*, Vol. 36, No. 4 (Sep., 1981), pp. 935-940
Published by: Blackwell Publishing for the American Finance Association
Stable URL: http://www.jstor.org/stable/2327557
Accessed: 27/11/2009 08:33

THE JOURNAL OF FINANCE • VOL. XXXVI, NO. 4 • SEPTEMBER 1981

Reserve Requirements and the Structure of the CD Market: A Note*

THOMAS A. LAWLER*

THIS NOTE EXAMINES the effect that reserve requirements on bank negotiable certificates of deposit (CDs) of different maturities may have on the term structure of CD interest rates. The analysis shows that when reserve requirements are imposed on CD issues, the forward rate implied by the term structure of CD rates may not equal the corresponding expected future short-term CD rate that equates the expected borrowing cost over some period of issuing long-term CDs with that of issuing short-term CDs. For purchasers of CDs, however, the implied forward CD rate does equal the expected future CD rate that equates expected holding-period returns. The note then discusses the implications of this analysis for the relative yields and quantities of CD with different maturities, and looks at recent data.

Forward Rates

To begin with, suppose there exist negotiable CDs with maturities of both one period and two periods. Let

$_0R_1$ = the nonannualized yield on a one-period CD;

$_0R_2$ = the nonannualized yield on a two-period CD;

$_1F_1$ = the one-period forward yield on a one period CD;

$E(_1R_1)$ = the expected one-period CD yield one-period hence

By definition, the forward yield equals

$$_1F_1 = [(1 + {}_0R_2)/(1 + {}_0R_1)] - 1 \tag{1}$$

Assuming no transactions costs, this forward yield equals the one-period CD yield that must prevail one-period hence if the two-period return from purchasing a two-period CD is to equal the two-period return from purchasing a one-period CD and rolling it over at maturity. The forward yield also equals the one-period CD rate that must prevail one period in the future if the two-period borrowing costs of issuing a two-period CD is to equal the two-period borrowing cost of issuing a one-period CD and reissuing it at maturity.

Reserve Requirements

Now suppose that the monetary authorities force banks to hold r_1% of the face value of one-period CDs issued and r_2% of the face value of two-period CDs issued

* The views expressed here are the author's and do not necessarily represent those of the Chase Manhattan Bank.

in noninterest-bearing accounts, where $0 < r_1, r_2 < 1$. When such reserve requirements exist, the interest received per \$1 of CDs purchased by investors will not equal the total cost to banks of raising \$1 of loanable funds. The two-period borrowing costs per \$1 of loanable funds raised by issuing two-period CDs will now equal ${}_0R_2/(1 - r_2)$, while the expected two-period borrowing costs per \$1 of loanable funds raised by issuing one-period CDs and reissuing them at maturity will equal

$$[1 + ({}_0R_1/(1 - r_1))][1 + (E({}_1R_1)/(1 - r_1))] - 1$$

If expected borrowing costs of these two methods are to be equal, and if the future value of r_1 is known with certainty, then the expected future one-period yield one period hence must be:

$${}_1F_1^B = [[1 + ({}_0R_2/(1 - r_2))]/[1 + ({}_0R_1/(1 - r_1))] - 1](1 - r_1) \tag{2}$$

Stated yields do, however, still reflect actual rates of returns to investors. Consequently, the forward yield in Equation (1) still equals the expected future yield that equates the expected two-period rate of return from purchasing a two-period CD with that from purchasing a one-period CD and rolling it over at maturity.

The expression in Equation (2) will not equal that in Equation (1) except for a specific set of combinations of r_1 and r_2. In other words, the future yield that equates two-period borrowing costs will not in general equal the future yield that equates two-period rates of return. In fact, as is shown in the Appendix, if $0 < r_1$, $r_2 < 1$, then the relationship between the expression in Equation (2) for borrowers (${}_1F_1^B$) and Equation (1) for investors (${}_1F_1$) will be:

$${}_1F_1^B = {}_1F_1 \quad \text{iff} \frac{(1 - r_1)}{(1 - r_2)} = \frac{(1 - r_1)[{}_0R_2 + {}_0R_1 \cdot {}_0R_2] + r_1[{}_0R_1 \cdot {}_0R_2 - {}_0R_1^2]}{(1 - r_1)[{}_0R_2 + {}_0R_1 \cdot {}_0R_2]} \tag{3a}$$

$${}_1F_1^B > {}_1F_1 \quad \text{iff} \frac{(1 - r_1)}{(1 - r_2)} > \frac{(1 - r_1)[{}_0R_2 + {}_0R_1 \cdot {}_0R_2] + r_1[{}_0R_1 \cdot {}_0R_2 - {}_0R_1^2]}{(1 - r_1)[{}_0R_2 + {}_0R_1 \cdot {}_0R_2]} \tag{3b}$$

$${}_1F_1^B < {}_1F_1 \quad \text{iff} \frac{(1 - r_1)}{(1 - r_2)} < \frac{(1 - r_1)[{}_0R_2 + {}_0R_1 \cdot {}_0R_2] + r_1[{}_0R_1 \cdot {}_0R_2 - {}_0R_1^2]}{(1 - r_1)[{}_0R_2 + {}_0R_1 \cdot {}_0R_2]} \tag{3c}$$

Before going on to the implications for the term structure, it is useful to observe what relationship between one-period and two-period reserve requirements is necessary to make such requirements "neutral," i.e., to make them such that both expected two-period returns to investors and expected two-period borrowing costs to banks are independent of whether one-period or two-period CDs are purchased/issued. For the relationship in (3a) to hold when ${}_0R_2 > {}_0R_1$ (or ${}_1F_1 > 0$), r_2 must exceed r_1, since in this case the LHS of (3a) is always greater than one.[1] Equation

[1] That equal reserve requirements for CDs of all maturities are not neutral can be seen in the following example. Suppose a bank makes a two-period loan of \$100, and that $r_1 = r_2 = 5\%$. To raise \$100 of loanable funds by issuing two-period CDs, the bank must issue \$100/(1 − .05) = \$105.26 of two-period CDs, and must hold \$5.26 in reserves over the life of the loan. To raise \$100 of loanable funds by issuing one-period CDs, it must also initially issue \$105.26 of one-period CDs and hold \$5.26 in reserves. In one period, however, this CD matures. If ${}_0R_1$ equals, say, 5%, then \$105.26 × .05 = \$5.26 of interest must be paid out. To replenish its cash balances, the bank must now issue \$105.26/(1 − .05) = 110.80 of one-period CDs, and must hold \$110.80 × .05 = \$5.54 in reserves for one-period. Thus, the

(3a) also illustrates that the neutral combinations of r_1 and r_2 change with the level of interest rates. However, the equation suggests that for low values of r_1 and r_2 and "normal" levels of interest rates, the difference between neutral reserve requirements and reserve requirements which do not vary with CD maturity will be quite small.[2]

An Implication for the Term Structure

Expectations of future interest rates play a major role in the theory of the term structure of interest rates. Indeed, according to the pure expectations hypothesis, such expectations are the sole determinant of the shape of the yield curve.

Most of the literature on the expectations hypothesis has focused on the behavior of investors (lenders). According to the hypothesis, investors maximize their expected return over some holding period. The hypothesis also applies to borrowers, in that borrowers are assumed to minimize their expected borrowing cost over some period. Assuming no transactions costs or differential tax treatment, such behavior will force the forward yields implied by spot yields on securities of different maturities to equal the market's expectations of future short-term interest rates.

The imposition of reserve requirements, however, is equivalent to the imposition of a tax on borrowers (i.e., banks) only. And, as illustrated in the previous section, when reserve requirements are introduced, the future one-period CD rate that equates the two-period borrowing costs of issuing two-period CDs with that of issuing one-period CDs will not in general equal the future one-period CD rate that equates the two-period return from investing in two-period CDs with that from investing in one-period CDs.

If reserve requirements are such that this inequality exists, then if banks minimize expected two-period borrowing costs and purchasers of CDs maximize expected two-period returns, either: (a) banks' expectations of the future one-period CD rate must be different from that of the purchasers of CDs; or (b) the market for either one-period or two-period CD will disappear (depending on whether (3b) or (3c) holds).

Of course, this latter conclusion is only true if all of the assumptions of the pure expectations hypothesis are valid, i.e., no other transactions costs exist and borrowers and/or lenders are on the margin risk-neutral.

Even if these latter assumptions are violated, however, the above analysis may still be useful. For example, suppose that the difference between expected two-period costs/returns simply affects, but is not the sole determinant of, borrowers' and lenders' decisions to go "long" or "short." In this weak version of the expectations hypothesis, the demand for two-period CDs relative to one-period CDs would be positively related to the difference between ${}_1F_1$ and $E({}_1R_1)$. The supply of two-period CDs relative to one-period CDs, however, would be negatively related to the difference between ${}_1F_1^B$ and $E({}_1R_1)$.

average amount of reserves held over these two-periods when one-period CDs are issued is (\$5.26 + \$5.54)/2 = \$5.40, which exceeds the average amount of reserves held when two-period CDs are issued (\$5.26).

[2] For example, suppose $r_1 = r_2 = 5\%$, ${}_0R_1 = 6\%$, and ${}_0R_2 = 12\%$. Plugging these values into Equation (1) and Equation (2) yields values of 5.66% for ${}_1F_1$ and 5.64% for ${}_1F_2^B$, or a difference between the two of only 2 basic points.

In such a model, a change in the relative reserve requirements on one-period and two-period CDs would, by affecting ${}_1F_1^B$ relative to ${}_1F_1$, change the equilibrium quantity of two-period CDs relative to that of one-period CDs. Specifically, an increase in r_1 relative to r_2 would, by lowering ${}_1F_1^B$ relative to ${}_1F_1$, cause the quantity of two-period CDs to rise relative to that of one-period CDs.[3]

Moreover, a change in relative reserve requirements may affect the relationship between the forward rate and the expected future rate in such a model. The possible effect of reserve requirements on this relationship should be recognized when trying to gauge market expectations of short-term CD rates from the yield curve.

Empirical Evidence

Casual empiricism suggests that the existence of a higher reserve requirement on two-period CDs than on one-period CDs has not resulted in the disappearance of the market for one-period CDs. In December 1974, the Federal Reserve lowered the reserve requirement on CDs with a maturity of exceeding 179 days to 3 percent, while the reserve requirement on CDs with a maturity of 30 to 179 days was set at 6 percent. Prior to 1974, reserve requirements were uniform for all CDs. The market for shorter-term CDs after this change remained quite active. Thus, if the behavioral assumptions of the pure expectations hypothesis were valid for both banks and CD purchasers, then banks' expectations of future short-term CD rates must have been below those of CD purchasers—a not particularly intuitively appealing conclusion.

If the weaker form of the expectations hypothesis discussed in the previous section were valid, however, then the market for one-period CDs would not necessarily disappear. All the analysis can predict is that this reserve requirement change would, *ceteris paribus*, be expected to have increased the volume of "long-term" (≥180 days maturity) CDs issued relative to the volume of "short-term" CDs issued. Indeed, the Federal Reserve initiated this change in the hopes that banks would increase the maturity of their outstanding liabilities.

Unfortunately, estimating such an effect is difficult, since in such a model other forces, such as changing liquidity premia or changes in banks' asset maturities, may also affect the demand for or supply of longer-term versus shorter-term CDs. It is worth noting, however, that from December 1974 to 1978, the average remaining maturity of large CDs at weekly reporting banks did increase from about two months to over three months. This over 50 percent increase provides support for the above hypothesis.

Even if relative changes in reserve requirements affect the average maturity of CDs, it is not clear whether they have any significant effect on the relationship between forward and expected future CD rates. In trying to estimate such an effect, the fact that the reserve "tax" imposed on banks is not imposed on issuers of other short-term securities which are close substitutes for CDs (such as commerical paper) would have to be taken into account. An interesting topic for future research would be to test if reserve requirements changes have affected the relationship between forward and expected future CD rates.

The existence of a relative supply effect does suggest, however, that recent

[3] That is, $\partial_1 F_1^B/\partial r_1 < 0$ (from Equation (2)) and $\partial_1 F_1/\partial r_1 = 0$ (from Equation (1)).

changes in reserve requirements may affect the maturity structure of CDs in coming years. On 15 August 1980, the Federal Reserve revised its regulations on reserve requirements to carry out the provisions of the Monetary Control Act of 1980. One of the changes is that reserve requirements on all negotiable CDs with original maturities of less than four years will, after a phase-in period, be 3 percent, while those on CDs with original maturities of four years or more will be zero. Previously, the reserve requirement on CDs with maturities of 30–179 days was 6 percent; of 180 days to 4 years, 2½ percent; and of 4 years or more, 1 percent. Thus, for CDs with maturities of up to 4 years, this change will raise ${}_1F_1^B$ relative to ${}_1F_1$, and thus should, *ceteris paribus*, lower the quantity of 180-day to 4-year CDs relative to that of shorter-term CDs. And since reserve requirements on CDs with original maturities of 4 years or more go to zero, the relative quantity of such CDs should increase, at least relative to 180-day to 4-year CDs.

APPENDIX

This appendix examines the relationship between Equations (1) and (2) in the text.

The expected future one-period CD rate which equates the expected two-period borrowing costs of issuing two-period CDs with that of issuing one-period CDs when reserve requirements exist is

$${}_1F_1^B = [[1 + ({}_0R_2/(1 - r_2))]/[1 + ({}_0R_1/(1 - r_1))] - 1](1 - r_1) \tag{A.1}$$

This can be written to obtain

$${}_1F_1^B = \left[\frac{(1 - r_1)[{}_0R_2(1 - r_1) - (1 - r_2){}_0R_1]}{(1 - r_2)[{}_0R_1 + 1 - r_1]}\right] \tag{A.2}$$

The one-period forward CD rate, which equates the expected two-period rate of return from investing in two-period CDs with that of investing in one-period CDs, can be written as

$${}_1F_1 = \left[\frac{{}_1R_2 - {}_0R_1}{(1 + {}_0R_1)}\right] \tag{A.3}$$

The question is: what is the relationship between ${}_1F_1^B$ in (A.2) and ${}_1F_1$ in (A.3)? ${}_1F_1^B$ will be greater than, less than, or equal to ${}_1F_1$ if the product of the numerator of the LHS of (A.2) and the denominator of the RHS of (A.3) is greater than, less than, or equal to the product of the denominator of the LHS of (A.2) and the numerator of the LHS of (A.3). Calculating these products, and simplifying, yields

$$\begin{aligned}(1 - r_1)[{}_0R_2(1 - r_1) + {}_0R_1 \cdot {}_0R_2(1 - r_1)]& \\ - (1 - r_1)(1 - r_2){}_0R_1^2 &\gtreqless (1 - r_2)[{}_0R_2 \cdot {}_0R_1 + (1 - r_1){}_0R_2 - {}_0R_1^2]\end{aligned} \tag{A.4}$$

Adding $(1 - r_1)(1 - r_2){}_0R_1^2$ to both sides yields

$$\begin{aligned}(1 - r_1)[{}_0R_2(1 - r_1)& \\ + {}_0R_1 \cdot {}_0R_2(1 - r_1)] &\gtreqless (1 - r_2)[{}_0R_2 \cdot {}_0R_1 + (1 - r_1)[{}_0R_2 + {}_0R_1^2] - {}_0R_1^2]\end{aligned} \tag{A.5}$$

Dividing both sides by $[{}_0R_2(1 - r_1) + {}_0R_1 \cdot {}_0R_2(1 - r_1)](1 - r_2)$ (which, since it is positive, does not affect the direction of the equality signs) and rearranging yields

$$\frac{(1 - r_2)}{1 - r_2)} \gtreqless \frac{(1 - r_1)[{}_0R_2 + {}_0R_1 \cdot {}_0R_2] + r_1[{}_0R_1 \cdot {}_0R_2 - {}_0R_1{}^2]}{(1 - r_1)[{}_0R_2 + {}_0R_1 \cdot {}_0R_2]} \tag{A.6}$$

Thus we get the relationships shown in Equations (3a–c) in the text.