An Early Look at the Volatility of Money and Interest Rates under CRR

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ON February 2, 1984, the Federal Reserve enacted a system of contemporaneous reserve requirements (CRR) to replace the system of lagged reserve requirements (LRR) that had been in effect since September 1968. The Fed made this change in response to widespread criticism that, under a reserve target operating procedure, LRR made it more difficult to control the monetary aggregates and contributed to the volatility of money and, perhaps, interest rates. Thus, critics believed a return to CRR would reduce the volatility of money and might reduce the volatility of interest rates as well.[1]

The purpose of this article is to determine whether the return to CRR has had, so far, any significant impact on the variability of money and interest rates. The article begins with a concise review of the arguments bearing on the presumed effects of the change from LRR to CRR on the volatility of money or interest rates. The actual behavior of these variables is then examined to see whether arguments in favor of the return to CRR have been supported.

WHAT CRR IS SUPPOSED TO ACCOMPLISH: THE STANDARD ANALYSIS

The rationale for returning to CRR rests primarily on the argument that LRR weakens the contemporaneous link between reserves and deposits of depository institutions. For example, it was argued that depository institutions would have no incentive to curtail their lending activities under LRR because they are not required to hold reserves against the deposits that these activities create until the following week. Consequently, an increase in loan demand would be more readily transmitted into a change in the money stock in the short run under LRR.

At a more formal level, the case for CRR was usually presented in terms of the supply of and demand for

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[1]See Thornton (1983b) and the references cited there.

Figure 1
Demand-Side Variability under CRA and LRA

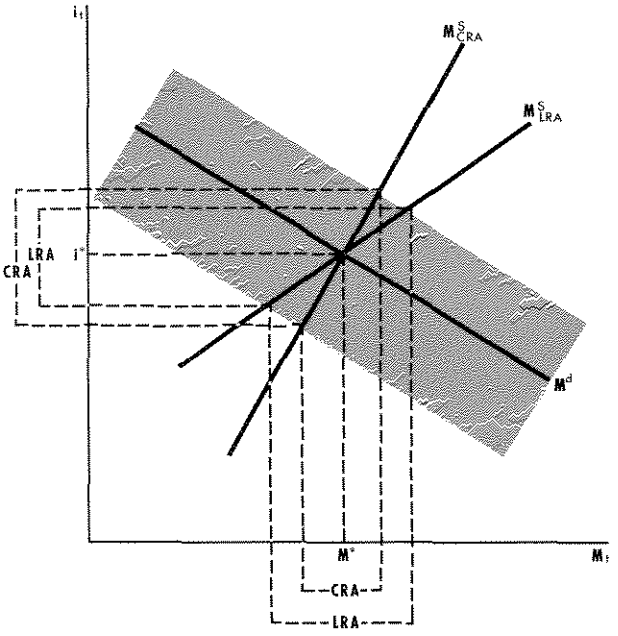
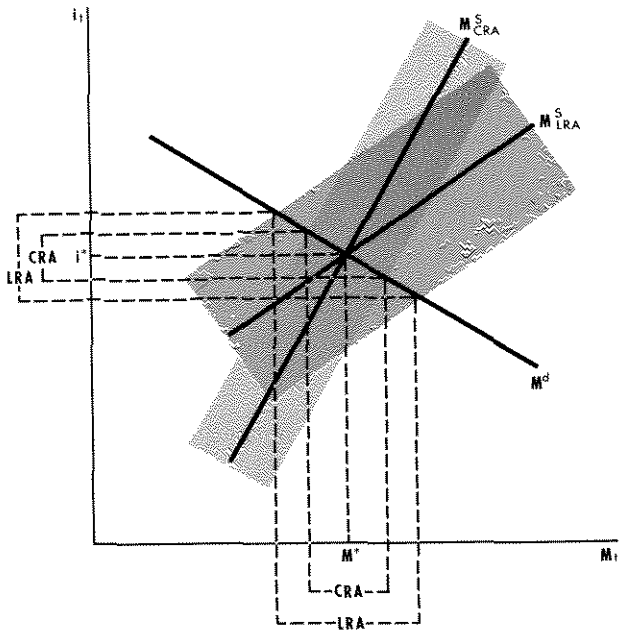


Figure 2
Supply-Side Variability under CRA and LRA



money. Within this framework, the proponents of CRR argued that the money supply schedule is flatter under LRR than under CRR. This is illustrated in figures 1 and 2. Consequently, random variation in the demand for money (represented by the shaded area in figure 1) results in more variability in the stock of money and less variability in the interest rate under LRR, as illustrated in figure 1. Also, random variation in the supply of money (represented by the shaded areas in figure 2) results in more variability in money and interest rates under LRR. Thus, compared with CRR, LRR produces greater variation in the money stock. Whether interest rates are also more variable depends on the relative magnitude of the variance of the supply-side and demand-side disturbances.[2]

An Alternative Analysis of What to Expect under CRR

There are two reasons why the result predicted above need not occur. First, depository institutions' behavior may not be as sensitive to the reserve accounting system in effect as this analysis suggests. Consequently, the switch from LRR to CRR may not significantly alter the week-to-week variability of money and interest rates, at least in the short run. Second, the suggested outcome is predicated on the assumption that the Federal Reserve is targeting on a reserve aggregate. If the Federal Reserve is not targeting explicitly on money or a reserve aggregate in the short run, the variability of money and interest rates will not necessarily be related to the reserve accounting system.

The first view argues that the short-run contemporaneous link between depository institutions' decisions to make additional loans and investments and their holdings of reserves need not be close *even under a system of CRR.*[3] In the short run, depository institutions can obtain additional reserves by borrowing from the Federal Reserve or holding temporarily fewer excess reserves than they would hold otherwise. These factors may be sufficient to accommodate most short-run, week-to-week supply- and demand-side disturbances. Consequently, the slopes of the money supply schedules under LRR or CRR may be similar. Unless the adoption of CRR fundamentally changes the way that depository institutions adjust their reserve positions, there may be no dramatic change in the volatility of money and interest rates in the short run.

[2]There are other factors, not considered here, that also affect the outcome; see Thornton (1983b) and the references cited there.

[3]See Thornton (1983b) for a more detailed explanation of the arguments presented in this section.

This conjecture is likely to be even more valid given that the new CRR system lengthened the reserve settlement period from one to two weeks.[4] Depository institutions may now make loans early in the accounting period, waiting to settle (through the discount window, the money market or changes in excess reserves) toward the end of the period. By accommodating loan demand at the first part of the period and settling later in the period, week-to-week variability in money and interest rates could be similar under the new system of CRR and the old system of LRR.[5]

The Role of Federal Reserve Operating Procedures

Expectations of differential effects in the variability of money and interest rates under CRR and LRR are based on the assumption that the Federal Reserve is attempting to hit a monetary target by manipulating a reserve aggregate. If this is not the case, there is little reason to expect differential effects associated with a change in the reserve accounting system. For example, week-to-week variability of money and interest rates are unaffected by the choice of reserve accounting system under an interest rate targeting procedure.[6]

This point is important because the Federal Reserve changed operating procedures in the fall of 1982, about a year and a half before the implementation of CRR. The Federal Open Market Committee (FOMC) followed a reserve aggregate targeting procedure that placed greater emphasis on movements in M1 as a policy guide from October 6, 1979, to early October 1982.[7] Since then, the FOMC has placed less emphasis on the behavior of M1 in the short run, aiming instead at longer-run monetary and credit aggregate objectives. This policy has been implemented in the short run through a "flexible nonborrowed-reserves path."[8] As a result of this procedural change, the variability of money and interest rates immediately before and after the implementation of CRR may reveal little change.

HAS THE VARIABILITY OF MONEY AND INTEREST RATES CHANGED SINCE CRR?

Before a comparison of the weekly variability of money and interest rates for periods before and after the adoption of CRR can be made, one must decide what measure of variability to use. The measure used here is the average absolute percentage change (AAPC).[9] This is preferable to two more commonly cited measures, the standard deviation and the coefficient of variation, as a measure of the short-run, week-to-week variability that this article is concerned with (see the insert on page 30).

Data are presented for various subperiods to reflect both the move from LRR to CRR *and* the change in Federal Reserve operating procedures. Data for the two weeks immediately before and after the implementation of CRR were excluded to guard against the possibility that they were contaminated by expectations or other problems associated with the implementation of the new procedure.

Results for the money stock, M1, are presented in table 1. The AAPC of seasonally adjusted M1 appears to have increased significantly in the 28-week period following the implementation of CRR, compared with that of the 28-week period immediately before CRR. The AAPC of seasonally adjusted M1 increased from about 0.13 percent to 0.43 percent, a difference that is significant at the 5 percent level.[10] When the most recent period is compared with a similar period in 1983, the increase is much smaller; nevertheless, it is statistically significant.[11]

These comparisons, however, are deceptive because revised seasonally adjusted data is "smoother" than preliminary seasonally adjusted data. Thus, the significant increase in the variability of seasonally ad-

[4]For a discussion of the new system, see Gilbert and Trebing (1982). For an interesting analysis of the carryover provision of the new system of CRR, see Spindt and Tarhan (1984).

[5]Some have suggested that the Federal Reserve has no choice but to accommodate this credit expansion, since the additional reserves needed to support the new deposits can only come into the system via the discount window. This argument comes perilously close to saying that the Federal Reserve must accommodate credit demand completely under LRR. This position, however, ignores the dynamics of these long-run adjustments. For another view of this process, see Thornton (1982), p. 29.

[6]The short-run money supply schedule is completely flat (interest-elastic). Thus, the variability of money would be completely determined by the random variation in the demand for money, and this would be unaffected by the reserve accounting system.

[7]For a discussion of the issues surrounding the decision to deemphasize M1 as an intermediate target, see Thornton (1983a).

[8]Wallich (1984), p. 26. Also, see Solomon (1984).

[9]The AAPC is defined as $AAPC(X) = (1/(T-1)) \sum_{t=1}^{T} (|X_t - X_{t-1}|/X_{t-1})100$. It is a measure of relative variability in that AAPC (kX) = AAPC(X), where k is an arbitrary constant.

[10]The t-statistic is 5.20.

[11]The t-statistic is 3.15.

Table 1
The Variability of M1

Period	Seasonally adjusted	Not seasonally adjusted	First-published seasonally adjusted
2/27/84 — 9/03/84	0.43%	1.61%	0.44%
7/13/83 — 1/18/84	0.13	1.46	0.36
3/02/83 — 9/07/83	0.24	1.57	0.44

Table 2
The Variability of M1 and Selected Interest Rates

Period	Revised seasonally adjusted	First-published seasonally adjusted	Federal funds	Treasury[1] bill	Commercial[1] paper
10/17/79 — 9/29/82	0.22%	.50%	4.48%	3.91%	4.11%
10/06/82 — 9/28/83	0.24	.43	2.52	1.90	1.81

[1]For week ending two days later than date shown.

justed M1 with the implementation of CRR may be a statistical artifact of the seasonal adjustment revision.[12]

This is investigated by a comparison of the AAPC over the three periods using either not seasonally adjusted or first-published seasonally adjusted data. If the increased variability is primarily the result of the seasonal adjustment revision rather than the change in the reserve accounting system, then the AAPC for the first-published or not seasonally adjusted M1 should be essentially the same over these periods.[13] Likewise, a comparison of not seasonally adjusted data for the 28-week period since the implementation of CRR and the corresponding period a year earlier should reveal no change in the AAPC. The data are consistent with both of these conditions. Thus, there appears to be no change in the variability of M1 between the pre- and post-CRR periods.

It is indeterminant, however, whether this result stems from depository institutions not changing their behavior following the enactment of CRR or from a change in the operating procedure in the fall of 1982. In order to determine which explanation is more consistent with the facts, the AAPC was calculated for M1 and three interest rates — the federal funds rate, the three-month Treasury bill rate and the commercial paper rate — for the three-year period of reserve aggregate targeting (October 17, 1979, to September 29, 1982) and for the year immediately following the change in the Federal Reserve's operating procedure (October 6, 1982, to September 28, 1983). These results are presented in table 2. The data indicate a decline in the AAPC for both revised and first-published M1 after the fall of 1982; however, this decline is not statistically significant at the 5 percent level.[14] Thus, it appears there was no significant change in the week-to-week variability of M1 following the change in the operating procedures.

The AAPCs for all three interest rates, however, decrease significantly after the fall of 1982. Thus, it appears that the change in operating procedure had some impact on the behavior of interest rates. Hence,

[12]For example, see Hein and Ott (1983).

[13]A comparison of these data is perhaps more relevant because these are the figures that economic agents and policymakers use to make their decisions.

[14]The relevant t-statistics for first-published and not seasonally adjusted data are 0.91 and 0.15, respectively.

The Limitations of Two Common Measures of Variability

Both the standard deviation (SD) and the coefficient of variation (CV) measure the variability of the data relative to an average. For the SD the average is the mean of the raw data; for the CV the mean is unity, that is, the average of the raw data divided by the mean. Thus, the SD is a measure of absolute variability and the CV is a measure of relative variability.[1]

Because both of these statistics average squared deviations from their respective means, they may give relatively small weight to large weekly changes and relatively large weight to small weekly changes. This is illustrated in the accompanying charts, which show the level of seasonally adjusted M1, by itself and relative to its mean level for the 28-week period following the implementation of CRR.

Charts 1 and 2 show that the largest (in absolute and relative terms) one-week change in M1 occurred on May 7, when the money supply *increased* by $5.3 billion. Because the absolute and relative (i.e., mean-adjusted) levels are only slightly above their respective means for the period, their respective contributions to the SD and the CV are small. Moreover, the smallest one-week change in M1 occurred on March 19. Because the levels are further from their mean, their contribution to the SD and the CV is larger than that of the largest change.

The average absolute percentage change (AAPC) is a measure of *relative* variability that avoids the problem of inappropriate weighting. Thus, it is a better measure of the week-to-week variability with which this article is concerned.[2]

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[1] The $SD = \left(\sum_{t=1}^{T} (X_t - \bar{X})^2/(T-1)\right)^{1/2}$ and the

$CV = \left(\sum_{t=1}^{T} (X_t^* - \bar{X}^*)^2/(T-1)\right)^{1/2}$,

where $\bar{X}$ is the mean of the raw series,

i.e., $\bar{X} = \sum_{t=1}^{T} X_t/T$, and $X_t^* = X_t/\bar{X}$,

so that $\bar{X}^* = \sum_{t=1}^{T} ((X_t/T)/\bar{X}) = 1$. Furthermore, while the SD depends on the scale of the data, the CV does not; i.e., the $SD(kX) = kSD(X)$, while the $CV(kX) = CV(X)$, where k is a constant.

[2] Of course, if the growth rate is constant across time periods, then the AAPC will not necessarily be preferable to the SD of the growth rate. If there is variable growth or short periods of rapid growth preceded and followed by periods of approximately equal growth, as in the charts above, then the AAPC is likely to be a better measure of week-to-week variability. If the growth rates were constant over these periods, however, the CV of the growth rate might be a useful measure.

it is possible that the lack of a significant change in the variability of money after the implementation of CRR was due to the earlier change in operating procedures. Unfortunately, these results cannot rule out the possibility that the short-run reserve management behavior by depository institutions is simply insensitive to changes in the reserve accounting system.[15]

The Variability of Interest Rates

The AAPC was calculated for the federal funds, the three-month Treasury bill and the 30-day commercial paper rate for comparable 28-week periods before and after the implementation of CRR. The results, which are reported in table 3, indicate a slight increase in the AAPC for the federal funds rate for periods immediately before and after the implementation of CRR and a slight decrease for both the Treasury bill rate and the commercial paper rate; however, none of these were

Table 3

The Variability of Selected Interest Rates

Period	Federal[1] funds	Treasury bills	Commercial paper
2/24/84 — 8/31/84	2.55%	1.13%	1.13%
7/15/83 — 1/20/84	2.33	1.21	1.27
3/04/83 — 9/09/83	1.99	1.58	1.56

[1] For week ending two days earlier than date shown.

[15] Neither of these, however, rules out other potential gains from CRR. See Goodfriend (1984).

Chart 1

Levels of M1

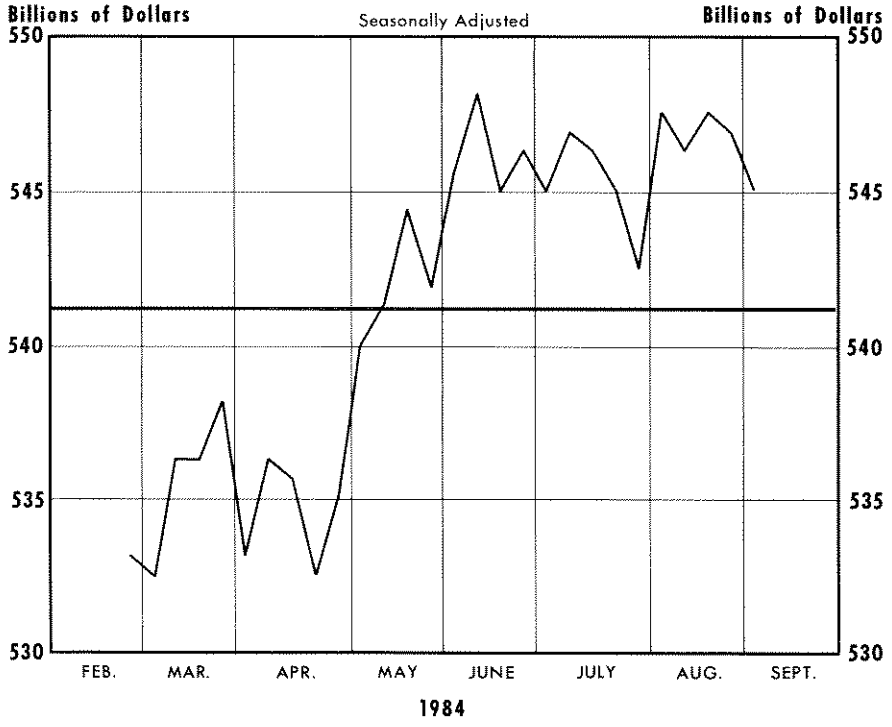
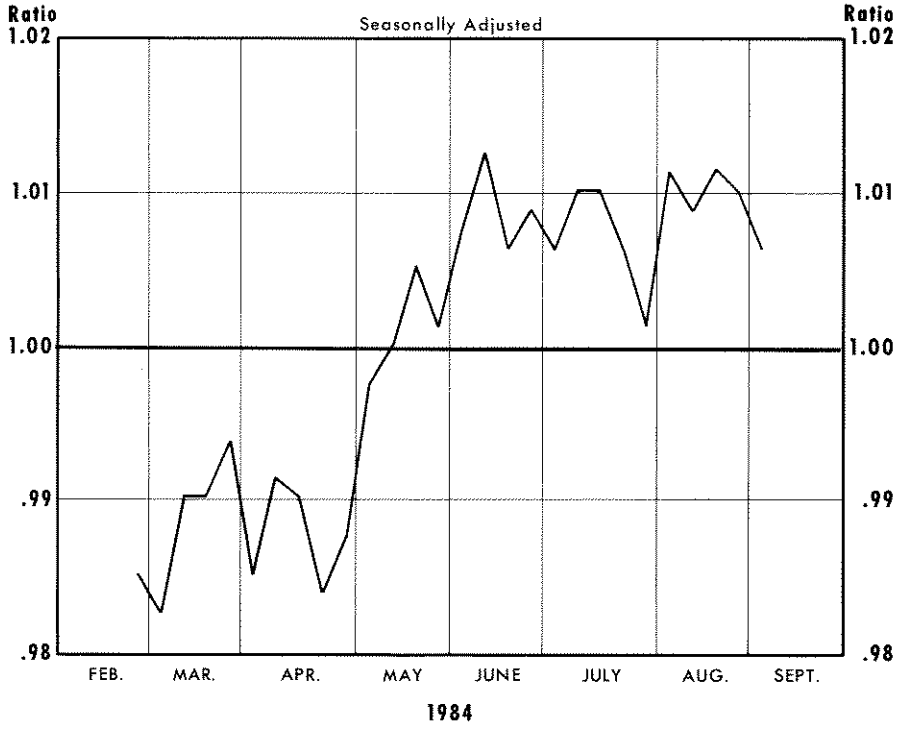


Chart 2

Ratio of M1 to Sample Mean



significant at the 5 percent level.[16] Thus, the results suggest that the implementation of CRR had little effect on the variability of money or interest rates. The significant reduction in interest rate variability appears to correspond with the earlier change in operating procedures, not with the implementation of CRR.

CONCLUSIONS

The purpose of this article was to take an early look at the effect of the Federal Reserve's new system of contemporaneous reserve accounting on the variability of money and interest rates. Although the CRR system was adopted with the expectation that it would reduce the variability of money under a reserve targeting procedure, it may not have that effect for two reasons. First, depository institutions may behave in ways that reduce the short-run contemporaneous link between aggregate reserves and deposits even under CRR. Second, the change in operating procedures in October 1982 may have preempted any potential benefits from the switch in accounting systems.

The data for M1 indicate that there was no significant change in week-to-week variability following either the change in operating procedure in October 1982 or the adoption of CRR. The variability of short-run interest rates declined significantly after the change in operating procedures, but has been unaffected by the implementation of CRR. Thus, the change in the reserve accounting procedure had no statistically significant impact on the variability of money either because depository institutions' lending and investment decisions are insensitive to the reserve accounting system, or because of the change in operating procedures that occurred some year and a half earlier. Consequently, CRR's potential usefulness in reducing the variability of money can be determined for certain only if the Federal Reserve implements a strict reserve aggregate or monetary base target.

[16]The relevant t-statistics for a comparison of periods immediately before and after the implementation of CRR for the federal funds rate, the three-month Treasury bill rate and the commercial paper rate are 0.30, 0.39 and 0.53, respectively.

REFERENCES

Gilbert, R. Alton, and Michael E. Trebing. "The New System of Contemporaneous Reserve Requirements," this *Review* (December 1982), pp. 3–7.

Goodfriend, Marvin. "The Promises and Pitfalls of Contemporaneous Reserve Requirements for the Implementation of Monetary Policy," Federal Reserve Bank of Richmond *Economic Review* (May/June 1984), pp. 3–12.

Hein, Scott E., and Mack Ott. "Seasonally Adjusting Money: Procedures, Problems, Proposals," this *Review* (November 1983), pp. 16–25.

Spindt, Paul A., and Vefa Tarhan. "Bank Reserve Adjustment Process and the Use of Reserve Carryover as a Reserve Management Tool: A Microeconometric Approach," *Journal of Banking and Finance* (March 1984), pp. 5–20.

Solomon, Anthony M. "Unresolved Issues in Monetary Policy," Federal Reserve Bank of New York *Quarterly Review* (Spring 1984), pp. 1–6.

Thornton, Daniel L. "Simple Analytics of the Money Supply Process and Monetary Control," this *Review* (October 1982), pp. 22–39.

_____. "The FOMC in 1982: De-emphasizing M1," this *Review* (June/July 1983a), pp. 26–35.

_____. "Lagged and Contemporaneous Reserve Accounting: An Alternative View," this *Review* (November 1983b), pp. 26–33.

Wallich, Henry C. "Recent Techniques of Monetary Policy," Federal Reserve Bank of Kansas City *Economic Review* (May 1984), pp. 21–30.