WHAT WAS BEHIND THE M2 BREAKDOWN?

by

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ABSTRACT

A deterioration in the link between the M2 monetary aggregate and GDP, along with large errors in predicting M2 growth, led the Board of Governors to downgrade the M2 aggregate as a reliable indicator of monetary policy in 1993. In this paper, we argue that the financial condition of depository institutions was a major factor behind the unusual pattern of M2 growth in the early 1990s. By constructing alternative measures of M2 based on banks' and thrifts' capital positions, we show that the anomalous behavior of M2 in the early 1990s disappears. Specifically, after accounting for the effect of capital constrained institutions on M2 growth, we are able to explain the unusual behavior of M2 velocity during this time period, obtain superior M2 forecasting results, and produce a more stable relationship between M2 and the ultimate goals of policy. Our work suggests that M2 may contain useful information about economic growth during periods of time when there are no major disturbances to depository institutions.

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1. INTRODUCTION

There has been a long-running debate over the usefulness of monetary aggregates as intermediate targets or information variables in the conduct of monetary policy.   This issue has remained timely. The European Central Bank, for example, is reviewing whether to target a monetary aggregate or inflation in its implementation of monetary policy (Svensson, 1999).   In the U.S., most recently Feldstein and Stock (1994) argued that the Federal Reserve should use the M2 monetary aggregate as an intermediate target. On the other hand, there has been a fair amount of work suggesting that M2 is not reliable as either a target or an indicator of monetary policy. Friedman and Kuttner (1992) argued that by the early 1990s the relationship between M2 and GDP had weakened, and Estrella and Mishkin's (1998) work provided further support for this finding.

In this paper, we show that depository institutions' capital difficulties during the late 1980s and early 1990s can account for a substantial part of the deterioration in the link between M2 and GDP. With these problems now behind us, the link between M2 and economic growth has strengthened. An implication of our findings is that it may be premature to abandon M2 as an indicator of aggregate real activity. In particular, in the absence of financial sector difficulties, a monetary aggregate such as M2 could possibly provide useful information about the future direction of economic growth.

As the link between M2 and GDP deteriorated, the forecasting ability of M2 money demand equations also suffered. The difficulties in forecasting M2 spurred a fair amount of research examining whether the deterioration in the M2 equation's forecasting ability was

temporary, or whether more fundamental factors -- such as flaws in the construction of the opportunity cost, the M2 aggregate, or both -- were at work. Carlson and Parrott (1991), and Duca (1992) first argued that the existence of troubled thrifts and the length of time it took the Resolution Trust Corporation to resolve the thrifts' difficulties helped explain the weakness in M2. In particular, Duca found that the change in the volume of cumulated deposits at resolved thrift institutions accounted for a large part of the M2 weakness, although he suggested his findings be viewed cautiously because of the short time period of the analysis. In the same article, as well as in one subsequent to it, Duca (1995) also examined whether some of the weakness in M2 reflected substitution by households away from M2-type deposits and into bond and equity mutual funds. He found that this substitution effect appeared to account for only a small part of the M2 weakness.

More recently, Koenig (1996a, 1996b) notes that attributing the M2-growth slowdown to the thrift resolution process has largely been abandoned. The focus instead has shifted to an examination of the competitiveness problems of financial intermediaries in the face of tighter regulations and stricter capital standards. Koenig proposes an alternative strategy for empirically modeling M2 by altering the opportunity cost measure to include a long-term Treasury bond rate. This addition improves the forecast ability of M2 substantially until 1995, when large prediction errors once again appear.

To provide support for our hypotheses that the substantial prediction errors exhibited by M2 equations during the early 1990s, and the deterioration in the long-run relationship between M2 and GDP, can be explained by depository institutions' financial difficulties, our work takes a different approach from the prior research. Rather than add additional, and in some cases

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temporary, explanatory variables to the money demand equation, we construct alternative

monetary aggregates in an attempt to pinpoint the sources of difficulty in predicting money

growth. This approach allows us to show that both stricter capital requirements and the

difficulties that confronted banks and thrifts during this time period played a role in the

unpredictable M2 weakness.[1] These alternative monetary aggregate measures are also used to

show how financial sector difficulties affected the long-run relationship between M2 and GDP.

The remainder of the paper proceeds as follows. In the next section, we provide some

background on the breakdown in the predictive ability of the M2 equation. We then discuss in

some detail how we construct the various alternative M2 series, and we show how these

alternatives appear to provide a good explanation for the deterioration in the forecasting equation.

In section three, we use our alternative measures of M2 to re-estimate the demand for M2.

Although our data are fairly limited, we find that the money demand equation's out-of-sample

forecast performance does show improvement when using our alternative measures. In section

four, we review how the long-run relationship among M2, real GDP, prices and interest rates has

changed over time. We show that relationships among these variables are consistent with our

results concerning the forecasting ability of the M2 equation in that the strength of the

cointegrating relationship improves considerably after accounting for the effect of bank and thrift

difficulties on M2 growth. Section five concludes.

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[1]The work presented in this paper builds on the earlier work of Peek and Rosengren
(1992), and Hilton and Lown (1994). These papers used bank level data to document a
statistically significant cross-sectional link between bank capital-asset ratios and deposit growth in
the early 1990s.

2. ALTERNATIVE MEASURES OF M2 BASED ON BANK

AND THRIFT CAPITAL POSITIONS

Prior to the early 1990s, the money demand equations forecast M2 growth fairly well. For example, Chart 1 shows actual M2 growth and predicted M2 growth using a model developed by staff at the Federal Reserve Board of Governors (staff model).[2] As the chart also shows, from mid-1989 until late 1993 large forecast errors appeared. This breakdown in the ability to forecast M2 led in part to the de-emphasis of M2 in the policy process (Greenspan, 1993). Perhaps because of this de-emphasis, little attention has been given to the fact that since late 1993, the staff model has again forecasted M2 fairly well (with the exception of a large under prediction of M2 growth in the second quarter of 1995).[3]

A large part of the breakdown in the M2 equation stems from the deterioration in the relationship between M2 velocity (defined as nominal GDP/M2) and its opportunity cost. As Chart 2 shows, from 1959 until 1989 these two series tracked each other fairly closely. Since that time, however, the two series have diverged considerably. This divergence suggests that, given the historical relationships with its opportunity cost, M2 should have grown at a much faster pace during the early 1990s. Or alternatively, given the weak growth in M2 during this time period, one would have expected the opportunity cost to be larger during this time period. We explore

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[2] For more on the M2 money demand equation used here, see Small and Porter (1989), and Feinman and Porter (1992). The staff model was not the only money demand equation to exhibit large overprediction errors. See Koenig (1996a).

[3] In its mid-year 1998 monetary policy report to the Congress, the Board stated that "...since 1994, the velocities of M2 and M3 have again moved roughly in accord with their pre-1990 experience, although their levels remain elevated," (Board of Governors, 1998, p. 5).

the former in this section and section three by examining the role of depository institutions' capital

positions in affecting observed money growth. We briefly discuss the behavior of the M2

opportunity cost measure at the end of section three.

A. Defining Capital Adequacy Positions

Current capital requirements on banks and thrifts, based on the Basel risk-based capital

standards, were phased in beginning in 1990. However, even before this time, regulators imposed

capital requirements on insured financial institutions. In December 1981, the bank regulatory

agencies first announced specific capital requirements applicable to insured commercial banks.

Initially, these requirements were based on the size of the institution, with larger institutions

required to hold a smaller percentage of assets as capital. In 1985, bank regulators then decided

to impose the same capital requirements on all banks, regardless of size. A uniform 5.5-percent

minimum primary capital to asset ratio was adopted in June 1985.[4]

The thrift industry's capital requirements were substantially weakened throughout the

1980s, as reflected in a number of redefinitions of what constituted capital, as well as reductions

in the actual amount of capital required.[5] In response to the resulting thrift industry meltdown,

Congress passed the Financial Institutions Reform, Recovery, and Enforcement Act of 1989

(FIRREA) which imposed significantly tougher capital requirements on thrift institutions. Under

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[4] Primary capital is defined mainly as common equity plus the sum of loan loss reserves
and perpetual preferred stock. A minimum total capital ratio of 6 percent was also adopted.
Total capital consists of primary capital, plus the sum of limited life preferred stock and
subordinated notes and debentures.

[5] For more on thrifts' capital requirements, see Barth (1991), Appendix D.

FIRREA, thrifts were required to meet a minimum leverage ratio of three percent. FIRREA also required that thrifts meet a minimum tangible-capital-to-assets ratio of 1.5 percent.[6]

Utilizing these capital requirements to classify banks and thrifts based on their capital positions, we define a bank as capital constrained if it fails to meet a primary capital ratio of 5.5 percent. A thrift is classified as capital constrained if it fails to meet both the 3-percent leverage ratio and the 1.5-percent tangible capital ratio.[7] While thrifts were not subject to these requirements over some of our sample period, we feel that utilizing the FIRREA capital requirements more closely matches the requirements imposed on banks, and also that these standards more closely approximate the economic value of the institutions.[8] For every quarter over the time period 1984:Q1 -1998:Q2, capital levels for each bank and thrift are calculated, and an institution is classified as either nonconstrained or constrained. These calculations are based

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[6] The leverage ratio is defined as the ratio of "core capital" to total assets. Core capital is the sum of common equity, noncumulative perpetual preferred stock, and minority interests in consolidated subsidiaries, less most intangibles (with the exception of purchased mortgage servicing rights and qualifying supervisory goodwill). Tangible capital is core capital minus supervisory goodwill and all other intangibles except qualifying purchased mortgage servicing rights. FIRREA also imposed risk-based capital requirements on the nation's thrift industry.

[7]The data necessary to calculate an institution's risk-based capital position are not generally available prior to 1990, making it impossible to use the risk-based criteria in defining capital constrained institutions.

[8] Calculations for both banks and thrifts are made using book value capital measures. As such, they are not representative of the economic or market value of the institution. However, given that bank capital requirements (as well as the definition of what constitutes capital) were more stringent than thrifts' capital requirements, we feel it is appropriate to use the stricter FIRREA capital standards for thrifts, even though they were not imposed until 1989.

on data found in individual bank *Reports of Condition and Income*, and from thrift institutions'

Thrift Financial Reports (call reports).[9]

Using these capital classifications, money supply measures can be constructed based on

the capital positions of individual banks and thrifts in an effort to determine if the unusual

behavior of M2 might be the result of depository institutions' financial difficulties.

B. *Money Supply Measures and Capital Positions*

Individual bank and thrift call reports contain most of the items needed to construct the

M2 measure of the money supply, based on capital positions.[10] It is not possible, however, to

collect the currency, travelers checks, or retail money market mutual funds components of M2

from call reports. Our measure of M2, constructed from data on individual banks and thrifts,

consists of demand deposits, other checkable deposits, savings deposits (including money market

deposit accounts), and small time deposits. These components capture, on average, 81 percent of

M2 over the time period of our analysis. However, for purposes of estimating money demand

equations, the growth rate of the monetary aggregate is the variable of interest. A simple

comparison of the growth rates of actual M2 and our M2 measure constructed from bank and

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[9] While call report data are available prior to 1984, we chose this as our starting point because of the substantial revisions made to the call reports beginning in 1984. Moreover, the individual deposit account data needed to construct the M2 series are not generally available prior to 1984.

[10] The bank and thrift deposits that are included in the actual money supply measures reported in the Board of Governors H(6) statistical release are not obtained from bank and thrift call reports, but rather from what is known as the FR2900. Depending on their size, institutions file the FR2900 weekly, quarterly, or annually. All banks and thrifts must file a call report at the end of each quarter. Credit unions also file the FR2900, and their deposits are part of the money supply. While credit unions also complete a call report, we did not include them in our calculations. Most credit unions only file their call report semi-annually, and more important for our analysis, they are not required to maintain a minimum level of capital like banks and thrifts.

thrift call reports shows a close association. Although the M2 measure constructed from individual banks and thrifts is more choppy, the correlation coefficient between the two series is 78 percent, indicating that our measure of M2 is a reasonable proxy for movements in actual M2.[11]

The separate categories of M2 constructed from nonconstrained banks and thrifts and from constrained banks and thrifts, highlight the relative importance of the deterioration in the thrift industry's financial condition compared to banks. For every deposit category (e.g., demand deposits, savings deposits, small time deposits), the level of constrained thrift deposits exceeds the level of constrained bank deposits (until the early 1990s, when most of the troubled thrifts had been resolved), while the opposite is true for all nonconstrained deposit categories. Within individual deposit categories, the most interesting development is what occurred with small time deposits. Nonconstrained banks and thrifts were almost equal in their offerings of small time deposits until 1989. Then, despite the subsequent improvement in the thrifts' capital profile, small time deposits began to decline steadily even at nonconstrained thrifts. While small time deposits also declined at nonconstrained banks from 1992 through 1994 (in response to lower interest rates), they recovered in late 1994, while nonconstrained thrift time deposits continued to decline.[12]

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[11] Our measure of M2 indicated no seasonal pattern, and therefore this measure is not seasonally adjusted.

[12] Overall, the importance of thrift industry small time deposits in M2 reached a peak of 21.6 percent in 1985 and declined to a low of 8.7 percent in mid 1994. At the end of 1996, small time deposits at thrifts accounted for 9.2 percent of M2. For banks, small time deposits as a percent of M2 reached a peak of 18.7 percent in the first quarter of 1991, and declined to 13.2 percent in early 1994. Small time deposits at banks accounted for 15.4 percent of M2 at the end of 1996.

Based on these comparisons of the M2 components between banks and thrifts, it appears that the thrift industry accounted for a proportionately larger share of constrained deposits, especially when considering small time deposits. By 1993, the difficulties at financial institutions had largely been resolved, as evidenced by the virtual disappearance of deposits in the constrained category. Previous researchers have suggested that the unprecedented increase in the velocity of M2 during the early 1990s (as shown in Chart 2) might be related to the unusual financial difficulties faced by banks and thrifts. Our findings also suggest that the difficulties plaguing the nation's bank and thrift industry during the late 1980s and early 1990s might have been an important factor behind the breakdown in the M2 money demand equation, and that the influence of thrifts might have been greater than that of the banking industry.

C. Adjusted M2 Money Supply Measures

Beginning in 1989, M2's opportunity cost began to decline while M2 velocity began a steady increase. Consequently, models of M2 demand began to over-predict money growth by larger and larger margins. In an effort to provide empirical support for our hypothesis on the role of bank and thrift difficulties in explaining the M2 overprediction, we construct several alternative measures of M2 that attempt to eliminate the distortions resulting from financial-sector difficulties. We first construct an M2 series that uses actual M2 from 1959 until 1983. Then, beginning in 1984, this series is constructed by assuming that it grew at the rate of M2 that was observed at all nonconstrained banks and thrifts. We refer to this series as NCM2. Next, in an effort to judge the relative importance of the thrift industry's decline, we construct an M2 series that, once again, uses actual M2 from 1959 through 1983, and then assumes that M2 grew at a rate equal to the growth rate of M2 that was observed at all banks. We refer to this series as

BANKM2. Finally, we construct an M2 series that uses actual M2 from 1959 through 1983, and then assumes M2 grew at a rate equal to the M2 components observed at all nonconstrained banks beginning in 1984. We refer to this series as NCBANKM2. This final series is intended to account for the effects of capital constrained banks on movements in M2.

D. Adjusted M2 Velocity Measures

Using these different measures of M2, we calculate M2 velocity series. The movements in the different velocity measures can then be compared with movements in the opportunity cost of M2 in an effort to determine if the recent bank and thrift difficulties might have played a role in affecting the relationship between M2 velocity and its opportunity cost. The three different panels in Chart 3 show these different velocity measures and how they track with M2's opportunity cost. The sharp divergence between the velocity of M2 and its opportunity cost that began in 1989 is apparent (upper panel). However, in the top panel, our NCM2 measure of velocity now shows a much closer relationship with the opportunity cost. In fact, the anomalous up drift in velocity is mitigated considerably when M2 is constructed by assuming that it grew at the rate observed at all nonconstrained banks and thrifts.

The movements in M2's velocity show even more promise when the effects of the entire thrift industry are excluded (middle panel). The velocity of BANKM2 also fails to exhibit a sharp increase, and tracks the opportunity cost fairly closely. A similar pattern is observed if the velocity of NCBANKM2 is compared with the opportunity cost, as indicated in the bottom panel. The sharp run-up in velocity disappears, and this measure of velocity and the opportunity cost bear a much closer relationship than that found using actual M2.

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From this evidence, the breakdown in the relationship between M2 and its opportunity cost, and the concomitant difficulties in accurately predicting movements in M2, appear to be related to the financial-institution difficulties experienced during the 1980s and early 1990s. When M2 is adjusted to account for these difficulties, the anomalous relationship between M2 and its opportunity cost disappears. More formal statistical evidence from money demand regressions using these alternative M2 measures provides additional support for the role of financial-sector difficulties in the recent breakdown of the M2 money demand equation.

3. MONEY DEMAND EQUATIONS

A. *Estimates and Forecasts*

Given the relationships indicated in Charts 3, money demand regressions that are estimated with M2 measures that eliminate the influence of troubled financial institutions should produce superior forecasting performance than models using the actual measure of M2. In an effort to test this assertion, we use the staff M2 money demand model to compare the forecasting performance of our alternative monetary aggregate measures. Although other M2 equations likely produce similar results, we focus on this model for several reasons. First, it was developed in the late 1980s and hence incorporates recent time series developments. Second, until the early 1990s this equation was relatively accurate in forecasting M2. Third, previous research into the issue of the money demand breakdown has also made use of this equation. Due to data limitations in constructing our alternative measures of M2, we are only able to estimate the following equation beginning in 1984.

$$
\begin{aligned}
\Delta \ln M_t = \beta_0 + \beta_1 \tau_t + \beta_2 \ln OPCOST_{t-1} + \beta_3 \ln V_{t-1} + \beta_4 \Delta \ln C_t + \beta_5 \Delta \ln C_{t-1} \\
+ \beta_6 \Delta \ln C_{t-2} + \beta_7 \Delta OPCOST_t + \beta_8 \Delta \ln M_{t-1} + \epsilon_t
\end{aligned}
\tag{1}
$$

Data for the opportunity cost ($OPCOST$), velocity (V), consumption (C), and M2 (M) are obtained from the Board of Governors. The variable (τ_t) represents a deterministic trend. For each of the M2 aggregates that lie behind the velocity measures in Chart 3, we estimate the staff M2 demand equation from 1984-1990. We then conduct an out-of-sample dynamic forecast from 1991-1994, which covers the time period when the largest forecast errors in predicting M2 occurred (see Chart 1). Table 1 shows the results of estimating these equations. As Table 1 shows, judging from the statistical fit of the equation, the results using M2 from all banks (BANKM2) and M2 from all nonconstrained banks (NCBANKM2) are not as strong as those obtained when using actual M2, and M2 from all nonconstrained banks and thrifts (NCM2). More important for our analysis, however, is the forecasting ability of the different measures of M2.

Table 2 compares two measures of forecast performance -- the root mean square error and Theil's bias proportion coefficient -- for the forecasts made with the four equations. As the table shows, the root mean square forecast error for actual M2 in this model is 3.3 percent, with a bias proportion coefficient of 0.87. When the estimated equation is based on the measure of M2 constructed from nonconstrained banks and thrifts (NCM2), the generated forecasts show an improvement. In this case, the root mean square forecast error is 2.7 percent, with a bias proportion coefficient of 0.54.

The final two forecast evaluation measures indicate that excluding the thrift industry's influence on M2, as well as the influence of capital constrained banks, also improves the forecasting ability of the M2 money demand equation. Forecasting M2 with a series that grows at the rate of all banks (BANKM2) decreases the root mean square forecasting error to 2.6 percent

and results in a bias proportion coefficient of only 0.09. Finally, eliminating the effect of capital constrained banks on M2's growth improves the forecasting ability a bit further. Under this specification, the average forecast error is now 2.1 percent, with a bias proportion coefficient of 0.24.[13]

Given the limited time period over which to estimate our money demand equations, these findings should be viewed with caution. Overall, though, our results from estimates of various specifications of the M2 money demand equation provide evidence consistent with the velocity movements shown in Chart 3. The sharp increase in the velocity of M2, and it's unusual divergence from the path of the opportunity cost appear to reflect the influence of financial-sector difficulties. After adjusting M2 to account for these developments, the forecasting ability of the M2 equation improves considerably.

B. Opportunity Cost

In searching for explanations for why the M2 forecast errors were so large in the early 1990s, we also examined the behavior of the opportunity cost in the M2 equation. Presumably, if banks and thrifts were experiencing financial difficulties that contributed to weak deposit growth, we should have observed differences in the behavior of the opportunity cost between capital constrained and nonconstrained institutions. Unfortunately, this examination did not prove fruitful when examining an important component of the M2 opportunity cost. The difference

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[13] F-tests of whether these differences in the root mean square error are statistically significant indicate that only the difference between M2 and NCBANKM2 is statistically significant as evidenced by an F-statistic of 2.47. Testing for the difference between M2 and NCM2 yields an F-statistic of 1.49, while testing for the difference between M2 and BANKM2 yields an F-statistic of 1.61. These test statistics are not significant given a critical value of 1.98 at the five-percent significance level.

between time deposit rates offered by capital constrained and nonconstrained institutions during this time period was, at most, 50 basis points. Such a small difference can not explain the large divergence in deposit growth across these two types of institutions.

An alternative explanation is that the nonprice terms associated with bank deposits, such as charges for withdrawals, service charges, advertising costs, etc., were less favorable at capital constrained institutions. Unfortunately, we have no data on these terms over the time period in question in order to prove or disprove this hypothesis. A recent paper by Stavins (1999) offers some results consistent with our hypothesis, however. Using 1997 survey data, she provides evidence that interest rates on checking accounts are not an important determinant for the supply of checking account deposits. Instead, bank customers appear to be more responsive to various fees and restrictions imposed on the use of checks.

4. RE-EXAMINING THE COINTEGRATING RELATIONSHIP

The money demand equation used in our analysis in the previous section consists of two parts: a long-run cointegrating relationship between money, income, and the opportunity cost, and a short-run dynamic relationship among these variables. The assumption of a long-run cointegrating relationship among the variables implies that any disturbance to the relationship is short-lived; the variables eventually return to their long-run equilibrium relationship. The existence of such a long-run relationship is a primary factor motivating a focus on the monetary aggregates as an intermediate target of policy. As Chart 2 shows, it is not difficult to observe that M2 velocity and the opportunity cost appear to move together, although their co-movement seems to break down in the late 1980s and early 1990s. In this section, we explore the long-run relationship among money, income, prices, and interest rates in some detail using our alternative

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measures of M2. Such an exploration allows us to investigate whether the breakdown in our ability to predict M2 and the breakdown in the relationship between M2 and the ultimate goals of policy are related. And as with M2's predictive ability, examining the long-run relationship embedded in the M2 money demand equation allows us to consider whether the breakdown between M2 and the ultimate goals of policy was a temporary or a more permanent phenomenon.

In the most general setting, recent studies investigating the long-run relationship among money, income, prices and interest rates assert the following linear relationship:

$$lnM_t = \beta_0 + \beta_p lnP_t + \beta_y \ln y_t + \beta_r lnr_t + \beta_\tau \tau_t + u_t, \qquad\qquad (2)$$

where M_t represents a nominal measure of money (in our case M2), P_t is the price level, y_t is real output, and r_t denotes a nominal interest rate. The variable τ_t represents the deterministic trend, which is typically included in the cointegrating equation. Finally, u_t represents a white noise random error.

This cointegrating relationship has been examined extensively by several previous empirical studies (see for example, Hafer and Jansen (1991), Miller (1991), Stock and Watson (1988, 1993), Friedman and Kuttner (1992); a brief survey of the literature is given by Miyao (1996)). This prior research explores the existence of a cointegrating relationship as defined by equation (2).[14] In addition to different specifications, these studies employ a wide variety of measures of interest rates and monetary aggregates, and test the hypothesis of no cointegration over different sample periods using different statistical tests. Overall, these studies find that

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[14]Actually, these studies investigate different forms of the cointegrating system given by equation (2) by restricting some of the linear parameters to be one or zero.

evidence for cointegration is inconsistent and sensitive to different specifications or statistical tests. However, although the results are somewhat inconclusive, the papers do confirm that there exists at least a weak form of cointegration among the variables.

While the evidence for cointegration is at best tentative for subsamples before 1990, Miyao (1996) also points out that the null of no cointegration is always accepted when the 1959:1 -1992:1 time period -- including the early 1990's -- is used. This is an interesting finding because it agrees with our result that the ability to predict M2 was quite weak over the same period. At the same time, this result raises some important questions. If the M2 equation is back "on track" as of the mid-1990s, as our analysis in the previous section suggests, does this portent that the strength of the cointegrating relationship among M2 and the other variables in the equation has also improved over this period? Second, if alternative measures like NCBANK2 appear to move more closely with M2's opportunity cost, do these measures provide more robust cointegration results? We address both of these issues in the analysis below.

We begin by estimating the linear relationship specified by equation (2). As in the other studies, we measure M_t by the nominal seasonally adjusted M2 monetary aggregate, y_t is real gross domestic product, and P_t represents the implicit price deflator. We utilize four different measures of the interest rate variable r_t: the three-month Treasury bill rate (TBILL), the six-month commercial paper rate (CP), the ten-year Treasury bond rate (TBOND), and finally the M2 opportunity cost measure (OPCOST). Clearly, the choices of variables and specifications are fairly large, however, we believe that our findings are representative.

We test for the presence of cointegration using the standard augmented Dickey-Fuller (ADF) test. The choice of test statistic has generated some controversy in the literature because

results from these different statistical procedures are somewhat inconsistent. The discrepancy is most evident when we compare the standard ADF test to Johansen's eigenvalue test. A number of studies (Friedman and Kuttner (1992), Miyao (1996), Hafer and Jansen (1991)) have shown that the null of no cointegration is rejected more often by the Johansen test. Recent simulation studies attribute this disparity to the poor small sample properties of Johansen's tests (Miyao (1996), and Toda (1994)). In light of these findings, our analysis focuses on the ADF method to test for cointegration. We should emphasize that our objective here is not to present an absolute test for cointegration. Instead, we view the ADF statistic as a broad measure of the strength of cointegration among the variables in question.

Table 3 reports the findings for the ADF cointegration tests. In addition to M2, the null is tested using our three adjusted measures of M2 — NCM2, NCBANKM2, and BANKM2 — which were described in Section 2. Similar to previous studies, we also examine three sample periods. Initially, we estimate the strength of the cointegrating relationship for the period 1959:1-1988:4. This period replicates the analysis of previous studies (such as Miller (1991) and Miyao (1996)). More importantly, we use this sample period to establish a baseline for the ADF statistics. Subsequently, the equation is estimated for the periods 1959:1-1992:4 and 1959:1-1998:2.

The top panel in Table 3 presents the ADF statistics for the M2 monetary aggregate. Similar to previous studies, we find that the hypothesis of no cointegration cannot be rejected for any of the interest rate measures during 1959:1-1988:4 (ADF t-statistics range in absolute value from 3.10 to 3.70, smaller than the 4.2 ten-percent significance threshold). Our empirical estimates then reveal a noticeable drop in the significance level of ADF statistics during the

1959:1-1992:4 period, a result others have also found. This outcome signifies a deterioration in the cointegrating relationship among the variables. More important, however, the last column of the first panel confirms a resurgence in the level of significance of the ADF statistics, although the t-statistics are still not statistically significant at conventional levels. As of 1998:2, the ADF t-statistic value for the three month Treasury bill rate (TBILL) rose to 4.07 (which achieves approximately a 12.5 percent p-value), the closest it has ever been to statistical significance. In sum, these results demonstrate that the "degree" of cointegration among M2, income, prices, and interest rates has strengthened and is currently the strongest it has ever been.

Our prior analysis showed that the adjusted M2 measures provide more accurate forecasts of monetary growth during the early 1990s. One might therefore expect that these alternative measures may also yield a more consistent cointegrating relationship. The remaining three panels in Table 3 examine the cointegrating capacity of the three alternative measures of M2. According to the table, ADF statistics for these alternative M2 measures, especially BANKM2, are somewhat larger and more significant over the 1959:1-92:4 period than is the case for M2. The evidence for cointegration is strongest when we assume that M2 has grown at the rate of M2 at all banks (BANKM2). The more significant ADF statistics for this period support the view that the financial problems among depository institutions likely contributed to the observed decline in cointegration among these variables. In particular, it appears that eliminating the drag created by thrift industry deposits uncovers a more stable long-run relationship among the M2 monetary aggregate, income, prices, and interest rates.

Although some of our alternative M2 measures appear to do better during the 1959:1-1992:4 period, the calculated test statistics are markedly lower during the 1959:1-1988:4 period.

In fact, ADF scores for the actual M2 monetary aggregate are much stronger during this earlier time period. This result likely signifies the importance of capturing the timing of the onset of the financial difficulties of depository institutions. We constructed the various M2 alternatives beginning in 1984. The findings in Table 3, however, suggest that M2 was probably affected more adversely by financial problems after 1988. In other words, our proxies for M2 might overcompensate for deposit growth between 1984 and 1988 so that these proxies do worse than actual M2 in the earlier time period. Similarly, by 1992, most depositories resolved their financial difficulties so that growth in M2 returned to a more normal pattern. As a result, the test statistics for our constructed M2 measures over the 1959:1-1998:2 period are generally similar, and are smaller than those associated with M2.

Overall then, the cointegration tests reported in this section are consistent with the results of the previous section suggesting that depository institutions' capital problems of the late 1980s and early 1990s played a role in affecting movements in M2. The cointegration tests suggest that capital problems also played a role in the deterioration of the relationship between M2 and the ultimate goals of policy. When considering an estimation period that encompasses the peak years of bank and thrift difficulties, a strong cointegrating relationship is found when using an M2 measure that accounts for these difficulties. With these problems behind us, the relationship among money, interest rates, prices, and income has returned to its pre-difficulties stance.

5. CONCLUSION

The debate over the efficacy of monetary aggregates as intermediate targets or indicators continues. Forecasting M2 growth proved increasingly problematic in the late 1980s and early 1990s, and M2's relationship with inflation and economic growth deteriorated as well. In this

paper, we argue that capital constraints at banks and thrifts were an important factor behind both of these events. After constructing alternative measures of the M2 monetary aggregate that adjust for these financial difficulties, we show that the anomalous relationship between M2 velocity and its opportunity cost disappears. We also show that using these M2 measures in money demand equations yield more accurate forecasts of monetary aggregate growth, and that these adjusted measures indicate an improvement in the relationship between M2 and the ultimate goals of policy during the early 1990s. Our hypothesis of financial-sector difficulties as a primary factor behind the breakdown in the M2 forecasting equation is consistent with the improvement in the forecast errors for M2 beginning in 1994, since capital constrained banks and thrifts virtually disappeared by that time. Finally, our hypothesis is consistent with the results of a stronger cointegrating relationship among money, income, prices, and interest rates for an adjusted measure of M2 around the time that financial difficulties peaked, and with a return to cointegrating relationships observed before the onset of these difficulties.

Our work identifies a main factor behind the decreased reliability of M2 as an indicator of monetary policy in the late 1980s and early 1990s, and shows that in all likelihood the decreased reliability was temporary. In particular, our findings suggest that during periods of time when there are no disturbances to financial institutions, the M2 monetary aggregate might very well contain useful information about the future direction of the economy. At a minimum, attempts to completely dismiss M2 as a useful indicator of economic activity may be overstated.

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TABLE 1. Estimates of M2 Money Demand Equations Using Various Measures of M2, 1984:I - 1990:IV

Independent Variables	Dependent Variables			
	ln(M2)	ln(NCM2)	ln(BANKM2)	ln(NCBANKM2)
Constant	-0.1361***	-0.2209***	-0.2985*	-0.2306**
	(0.0579)	(0.0388)	(0.0870)	(0.0870)
τ_t	-0.0009***	-0.0012*	0.0016	0.0008
	(0.0002)	(0.0006)	(0.0011)	(0.0012)
$\ln OPCOST_{t-1}$	-0.0150***	-0.0325*	-0.0027	-0.0071
	(0.0045)	(0.0159)	(0.0184)	(0.0246)
$\ln V_{t-1}$	0.3472***	0.6520***	0.5127	0.7047***
	(0.0793)	(0.1115)	(0.2993)	(0.1783)
$\Delta \ln C_t$	-0.3609*	0.9734	1.8955	0.7492
	(0.1978)	(0.7757)	(1.4515)	(1.4308)
$\Delta \ln C_{t-1}$	-0.4470*	0.1887	-0.4105	-0.7739
	(0.2129)	(0.7739)	(1.4642)	(1.3129)
$\Delta \ln C_{t-2}$	-0.1803	0.2094	0.0419	-0.4844
	(0.2125)	(0.7140)	(1.2341)	(1.2233)
$\Delta OPCOST_t$	-0.0016	-0.0226	-0.0458	-0.0472
	(0.0049)	(0.0191)	(0.0316)	(0.0335)
Lagged Dependent Variable	0.0805	-0.2103	-0.0407	-0.0473
	(0.1701)	(0.1217)	(0.2673)	(0.1810)
Adjusted R^2	0.72	0.78	0.24	0.57

NOTES: The full specification is given by equation (1). V_t = velocity, defined as GDP divided by the level of the dependent variable. C_t = nominal personal consumption expenditures. Data for GDP and C are from the National Income and Product Accounts. M2 = actual M2, from the Federal Reserve Board's H.6 release, *Money Stock and Debt Measures*; NCM2 = M2 measure derived by assuming that M2 grew at the same rate as the M2 components at all nonconstrained banks and thrifts; BANKM2 = M2 measure derived by assuming that M2 grew at the same rate as the M2 components at all banks; NCBANKM2 = M2 measure derived by assuming that M2 grew at the same rate as the M2 components at nonconstrained banks. NCM2, BANKM2, and NCBANKM2 were constructed from bank and thrift call reports from 1984-96. OPCOST = opportunity cost, the three-month Treasury bill rate less a weighted average of interest rates on M2 deposits; the Treasury bill rate is from the Federal Reserve Board's G.13 release; the M2 components used to construct the weights are from the H.6 release; the deposit rates are from the monthly supplementary table of the H.6 release. Standard errors are in parentheses. The symbols (***), (**), (*) indicate statistical significance at the one, five, and ten percent level, respectively.

TABLE 2. Summary Measures of M2 Forecasts (Models Estimated 1984:I - 1990:IV and
Dynamic Forecasts from 1991:I - 1994:IV)

	Forecast Evaluation Measures	
M2 Measure	Root Mean Square Error	Theil Bias Proportion
M2	0.033	0.87
NCM2	0.027	0.54
BANKM2	0.026	0.09
NCBANKM2	0.021	0.24

NOTES: Evaluation measures are based on results obtained from estimates using equation (1). See notes
following Table 1 for definitions of the M2 measures.

TABLE 3. Testing the long-run stability of the cointegrating relationship

$$Model \ : \ lnM_t = \beta_0 + \beta_p lnP_t + \beta_y lnY_t + \beta_r lnr_t + \beta_\tau \tau_t + u_t$$

Money Aggregate	Interest Rate	59:1-88:4	59:1-92:4	59:1-98:2
M2	TBILL	-3.48	-2.77	-4.07
	CP	-3.70	-2.80	-3.89
	TBOND	-3.10	-2.86	-3.87
	OPCOST	-3.61	-2.70	-3.86
NCM2	TBILL	-2.83	-2.26	-2.65
	CP	-3.03	-2.40	-2.58
	TBOND	-3.66	-2.17	-2.22
	OPCOST	-2.95	-2.67	-2.70
NCBANKM2	TBILL	-2.97	-3.06	-2.87
	CP	-3.18	-3.09	-2.81
	TBOND	-3.61	-3.15	-2.02
	OPCOST	-3.09	-3.23	-3.09
BANKM2	TBILL	-3.78	-4.53**	-3.12
	CP	-3.89	-4.50**	-2.93
	TBOND	-3.14	-4.17*	-2.62
	OPCOST	-4.07	-4.69**	-3.10

NOTES: We test for cointegration using the augmented Dickey-Fuller(ADF) method. Stationarity tests are based on the error equation

$$\Delta \hat{u}_t = \rho \hat{u}_{t-1} + \sum_{i=1}^{4} \alpha_i \Delta \hat{u}_{t-i} + \epsilon_t$$

The symbols (**) and (*) indicate statistical significance at the five-and ten-percent level, respectively. Critical values for the ADF test are given in Hamilton (1994) or Phillips and Ouliaris (1990). TBILL = three-month Treasury bill rate, TBOND = ten-year Treasury bond rate, CP= six-month Commercial Paper rate, all from the Federal Reserve Board G.13 release. See notes following Table 1 for other variable definitions and sources.

Chart 1
Actual and Forecasted M2
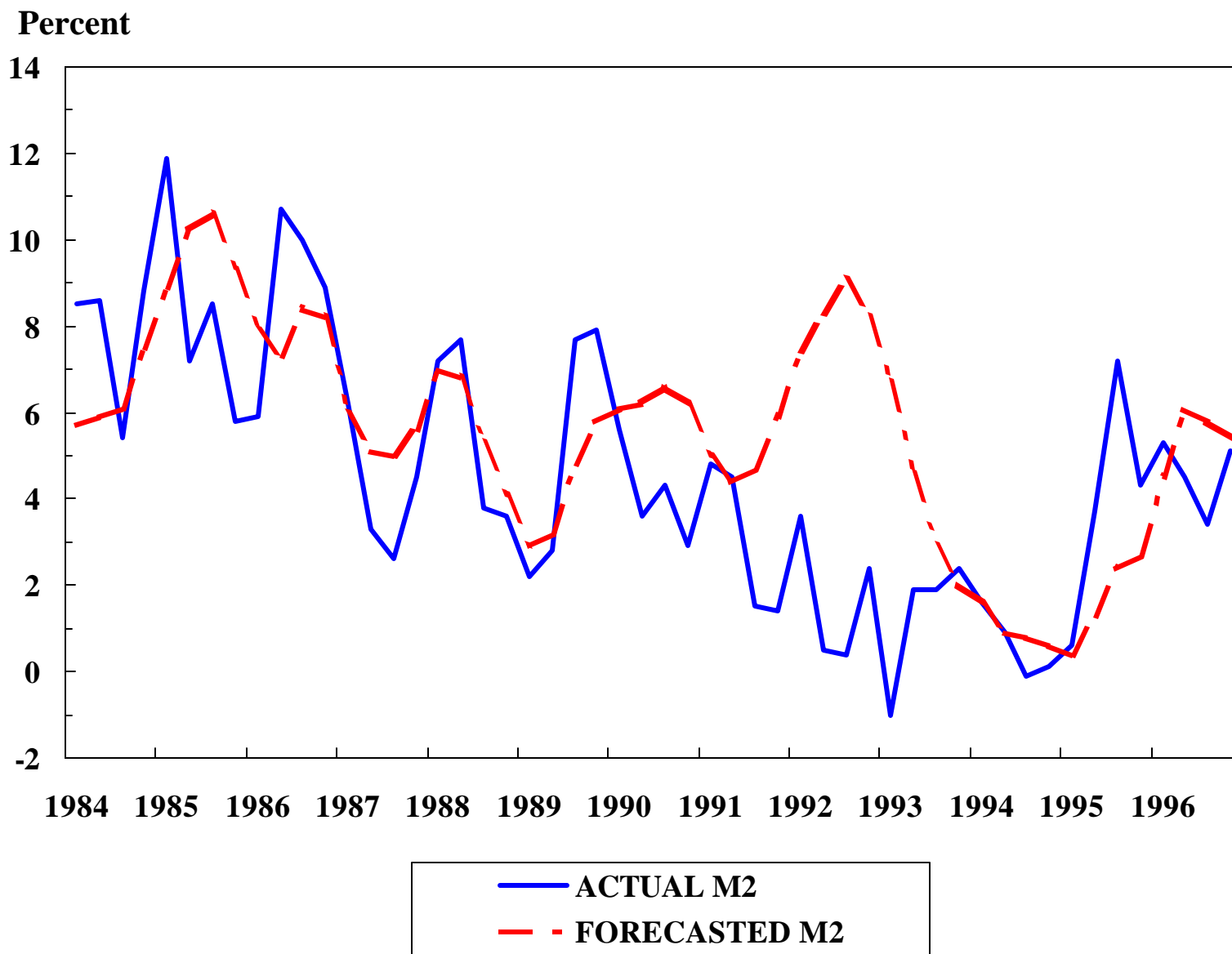(Quarter-to-Quarter Annualized Growth Rates)

Chart 2
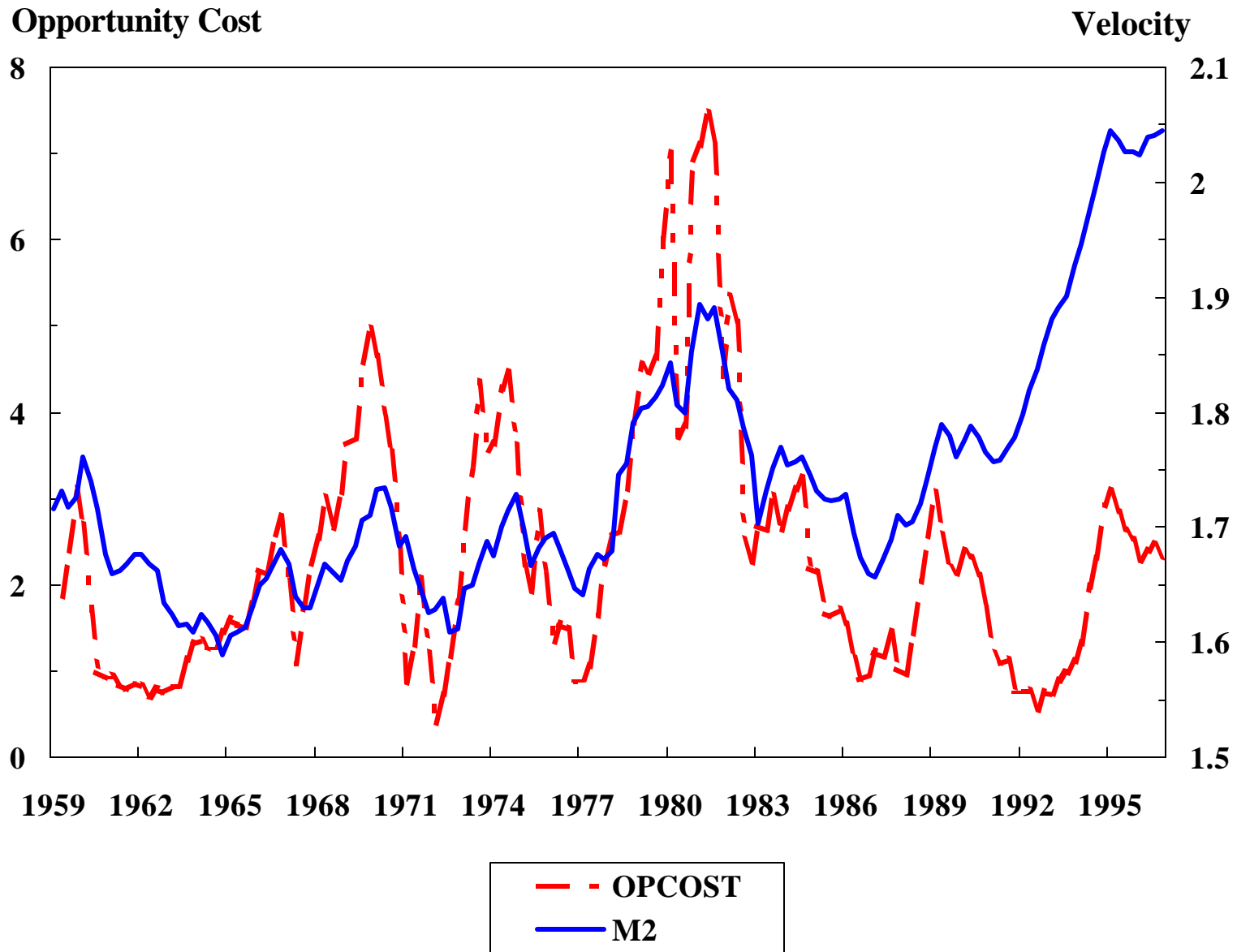## M2 Velocity and Opportunity Cost

Chart 3
M2 Velocity Comparisons and Opportunity Cost