Can the monetary models be fixed?

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For years M1 has been regarded as the single most reliable tool for the formation and execution of monetary policy. Serving as both compass and rudder, it forecast future rates of economic growth and inflation, while providing the Federal Reserve with a powerful mechanism to affect those rates. Simple single-equation money/income models provided forecasts of comparable accuracy to the forecasts of multiple-equation commercial models.[1] But after 1980, the M1 models suddenly lost their forecasting ability and they have not recovered it since. Many suggestions have been made to improve the performance of the M1 models in the 1980s. Most have recommended changes in the measures of money or income used in the models.

In this paper we apply some of these suggestions to a monetary model to see if they improve its performance in the 1980s. Our approach differs from that of previous studies in that our model separately analyzes the money/real income and money/inflation relationships rather than focusing only on the money/nominal income relationship. The two relationships break down so differently in the 1980s that separate analysis is necessary to understand the large changes in the money/income relationship that have occurred.

The collapse of the money/income relationship is most often attributed to changes in the behavior of the monetary aggregates brought about by the financial deregulation and innovation of the 1980s. Following the passage of the Depository Institutions Deregulation and Monetary Control Act in 1980, the financial sector went through an extended series of fundamental changes. New types of accounts were created. The rules governing old accounts were revised. Nonbank institutions continued to innovate to better compete with banks. These changes significantly altered the individual and corporate patterns of money usage.

From the beginning, many hoped that adjusting the definition of money to account for all of these changes would improve the performance of the money/income models. The suggestions for new definitions ran the gamut from redefining money in the narrowest possible fashion, using only accounts that existed before deregulation, to using credit measures that include every conceivable financial asset. Others suggested sophisticated weighting schemes in which the "moneyness" of each component of the money supply is separately estimated and those estimates are used to produce a functional money measure.

Other proposals have focused on the income side of the equation. Most money/income models are estimated using GNP, which measures production, as the income variable. Some have argued that GNP is inappropriate for the money/income models because money is held primarily to finance purchases of goods and services. The relationship between money and domestic demand is thus thought to be closer than the relationship between money and GNP. Recent changes in the international sector have widened the difference between domestic demand and GNP. A number of demand variables which adjust GNP for imports and changes in inventories have been suggested to correct this problem.

Our tests of several alternative money and income measures yield the following conclusions: 1) The observed problems persist no matter what money and income measures are used, casting doubt on the strategy of definition changes. 2) The breakdowns in the money/real income and money/inflation relationships are fundamentally different and attempts to analyze only the nominal income relationship obscure the problems. 3) The money/inflation relationship seems to have changed in a simple, and potentially predictable, fashion. Changes in the rate of money growth still seem to affect the inflation rate much as they did in the past. However, the rate of inflation that would exist in the absence of money growth, i.e. the constant term in the inflation equation, is now significantly lower. 4) The breakdown of the

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money/real income model is very erratic, apparently reflecting real economic shocks which are not included in the model. A pure monetary model is simply not sufficient to explain real growth in the 1980s.

Recent history of the money/income relationship

The money/income relationship has been one of the major tools of macroeconomic analysis in this century. It was used to explain everything from the Great Depression of the 1930s to the stagflation of the 1970s. Its reliability in the postwar period, even in the simple velocity ratio of nominal GNP to M1, caused it to become increasingly important for policy decisions. This importance was codified in the Humphrey-Hawkins bill of 1978, which required the Federal Reserve to target the aggregates and report those targets to Congress twice a year. In 1979, the Federal Reserve revamped its operating procedures to improve its control of the aggregates. In 1980, Congress passed the Monetary Control Act which was intended to aid monetary control by subjecting a broader range of financial institutions to reserve requirements. And even as late as 1984, the Federal Reserve revised its entire method of reserve accounting in order to further improve monetary control.

But, as laws and institutional arrangements were being changed to take better advantage of the money/income relationship, the monetary aggregates were becoming less and less reliable as policy guides. In 1982, M1 velocity growth strayed seriously from its three percent historical trend rate, actually falling 2½ percent, as the recession exceeded expectations in depth and length. In 1983, with the recovery underway, real growth returned to historical patterns and ended the apparently short-term anomaly in the money/real income relationship. Inflation, however, had fallen significantly below what historical patterns would have predicted. As a result, the nominal velocity measure continued to fall, now at a 3¼ percent rate. Again, the velocity decline was widely thought to be temporary. It was attributed to an increase in money demand following the introduction of NOW accounts and a rapid decline in interest rates.

In 1984, inflation continued below predictions based on historical precedents, but real income began to grow faster than historical relationships would have indicated. This combination of anomalies brought the nominal velocity ratio back near its three percent trend growth rate, and analysts began to talk about a shift in the trade-off between real income and inflation. Imports, the value of the dollar, and fiscal policy were frequently cited factors for the new trade-off. This shift was viewed as a minor problem, especially since it was considered a favorable development.

Unfortunately, in 1985 the real side of the economy cooled off and the "good" inflation news just kept coming, causing another major fall in velocity, again at a 2½ percent rate. These constant runs of new and different behavior finally took their toll. Many economists and policymakers lost faith in the monetary models and began to take a more skeptical view of the post hoc explanations that had been used to explain the models' behavior in the 1980s.

Methodology

This paper uses the FRB Chicago-Gittings money/income model[2] to test some of the money and income measures that have been proposed to improve the performance of the money/income relationship. The model is similar to most monetary models with the one exception that it divides the relationship into two equations which explain inflation and real income growth separately.[3] Both equations include money growth in the current and 20 preceding quarters, three lags of the endogenous variable, and the rate of growth of real energy prices in the previous two quarters.

Earlier work—Siegel (1986)—has shown that both the real growth and inflation equations lost their forecasting ability in the 1980s, but that the deterioration took a very different course in each case. This suggests that different factors may be causing the breakdowns of the two relationships. To explore the possibility that different solutions are required for the two equations, we apply the suggested money/income corrections to each one.

The effectiveness of the various proposals is judged by comparing the forecasting accuracy of the equations when they are estimated with the suggested money and income measures. The two equations are estimated over 50 samples which begin in the second quarter of 1964 and end in every quarter from the fourth quarter of 1973 through the first quarter of 1986. Forecasts from these estimations are constructed for the first quarter following the sample periods. This produces forecasts one quarter ahead of each of the 50 samples for every quarter from 1974 through the second quarter of 1986.

The errors from these forecasts are cumulated over time and graphed in order to highlight the development of trends in the estimated money/income relationship. Periods of stability and change in the relationship can be easily identified by the slope of the cumulative forecast error graph. If an equation is performing well, its cumulative error graph will be fairly level as positive and negative errors offset each other over time. If the relationship shifts so that estimations based on past experience consistently overpredict either inflation or real growth, the resulting run of negative forecast errors will cause the cumulative error graph to decline steeply. If a shift causes an equation to underpredict persistently, the cumulative error graph will increase steeply.

The money measures tested on the FRB Chicago-Gittings equations include the standard aggregates[4] M1A, M2, M3, and L as well as three weighted indexes, MQ, MSI1, and MSI2, which have been proposed to improve the measurement of assets that provide monetary services. Data on the three experimental, or functional, indexes do not begin until 1970, so the current and 20 past quarters of money growth required to estimate the model are not available for these indexes until the second quarter of 1975. Thus, the equations with these variables are estimated over expanding samples which begin in the second quarter of 1975 and end in every quarter from the fourth quarter of 1979 through the first quarter of 1986. This yields one-quarter-ahead forecasts beginning in 1980.

We compare the performance of the aggregates which are narrower than M1 with that of those which are broader to see if the problems of the money/income model can be attributed in part to the range of assets included in M1. The aggregates in the narrow category are M1A and the MQ and MSI1 experimental indexes. M1A does not include the other checkable deposits of M1. MSI1 covers the same asset categories as M1, and MQ includes slightly more assets than M1, but they both give the greatest weight to the currency and demand deposit components. The M2, M3, L, and MSI2 aggregates all cover a broader range of liquid assets than M1.

In addition to comparing the impact of the assets covered by the money measure, we examine the effectiveness of different approaches to money measurement through the performance of the three functional indexes. The three indexes focus on the qualities which have long been associated with the theoretical concept of money. They are designed to include only assets which appear to perform the services expected of money. The MQ index attempts to directly identify those assets which are strictly used for transactions purposes. It includes the M1 components, money market fund shares, savings accounts subject to telephone transfer, and MMDAs, but weights each by its net rate of turnover in purchasing final products.[5]

The MSI1 and MSI2 indexes estimate the degree of monetary services offered by the components of M1 and M2 by the rate of return which people sacrifice to hold each asset. The components which pay the lowest rates of interest are inferred to be the greatest providers of monetary services. The indexes weight the components by the interest cost of holding them, so that those with the most monetary characteristics will have the most influence. The interest cost of each type of asset is estimated as the difference between its interest rate and the maximum of the rates paid on Baa bonds and the components of L.[6]

The equations estimated with the different money aggregates are then compared to an estimation which excludes money growth entirely (the no money model) but still includes the lagged endogenous variables and the growth of real energy prices. The purpose of this comparison is to determine if the money aggregates add any explanatory power to the model in the 1980s. If the forecasts are better when money growth is included in the equations, then money has apparently contributed information to the model. If the forecasts are worse with money growth in the equations, then the monetary aggregates have apparently detracted from the model's predictive power.

The real growth equation is also used to test two alternative income variables. The first is a measure of domestic demand for final goods and services. Wenninger and Radecki (1985) argue that since people are thought to hold money to finance transactions, money growth may have greater effect on the growth of total domestic purchases than on the growth of the GNP production measure. The disparity between the production and domestic demand measures has grown in recent years as imports have increased in importance. Domestic purchases of foreign goods are part of final demand but not GNP. The final demand variable tested in this paper is GNP plus imports, minus exports, and minus the inventory changes of business and the Commodity Credit Corporation. This includes all purchases for current consumption within the U.S. but eliminates transactions made either outside the U.S. economy or for consumption in another period.

The second real growth measure tested excludes real government spending in order to test an assumption implicit in the GNP and final demand models concerning such expenditures. Both GNP and final demand include government expenditures, even though money growth is only thought to affect the private spending of consumers and businesses. The employment of these two variables to estimate money/income models is thus based on the premise that government spending is a perfect substitute for private spending; that is, a rise in government spending will cause an equal decline in private spending.

In the more likely case that some government expenditures are substitutes for private spending and some are not, only the substitutable expenditures should be included in the income variable. Failure to make this correction is not a serious problem as long as the composition of government spending is fairly steady over time. The coefficients of the money/income model would merely adjust somewhat to compensate for such a constant misstatement of the income variable. But the dramatic changes in government spending patterns since 1980 could have changed the mix of expenditures which are substitutable for private expenditures. The inclusion of government spending in the money/income models should therefore be considered as one possible source of the breakdown of such models in the 1980s.

We attempt to correct for this distortion by eliminating real government spending entirely from real final demand. This measure is equivalent to the sum of real consumption and real fixed investment. We also estimate two specifications of the equation with real government spending included directly as an independent variable. In one case the dependent variable is real final demand growth, and in the other it is real final demand growth less real government spending growth.

The following two sections present the results of the estimation of the inflation equation with the various monetary aggregates and the estimation of the real growth equation with the aggregates and the two alternate income measures.

Money/inflation: Performance of the broad aggregates

The inflation equation's cumulative forecast errors follow essentially the same pattern whether the model is estimated with M1 or the broader aggregates (see Figure 1). There are few significant trends through 1981, although the cumulative errors of the M1 equation do rise sharply in 1974 and 1975.[7] The relatively good performance of the inflation equations in the latter 1970s does not continue in the 1980s. In the second quarter of 1981, the cumulative errors of *all* the equations in Figure 1 begin a steady linear descent. This evidence suggests it is unlikely that the money/inflation relationship can be repaired in the 1980s simply by broadening the definition of money. The failure of the MSI2 equation to produce superior forecasts is an indication that the efforts to construct a functional money measure also may not lead to an improved money/inflation model.

The severity of the money/inflation relationship's breakdown is further dramatized by the equation which excludes money growth, for its forecasts in the 1980s are better than those of all the equations estimated with monetary aggregates. This suggests that M1 and the broader aggregates may actually be providing misleading information about the future course of inflation.

Both Figure 1 and the average forecast errors in Table 1 indicate that the M1 and the broader aggregate equations all overpredict inflation at a remarkably constant rate over the 1980s. Table 1 splits the 1980s breakdown period into two subperiods which appear in Figure 1 to have somewhat different rates of descent, but the average overprediction of inflation in the two periods is still found to be

Figure 1
Cumulative forecast errors of inflation equation—M1 and broader aggregates

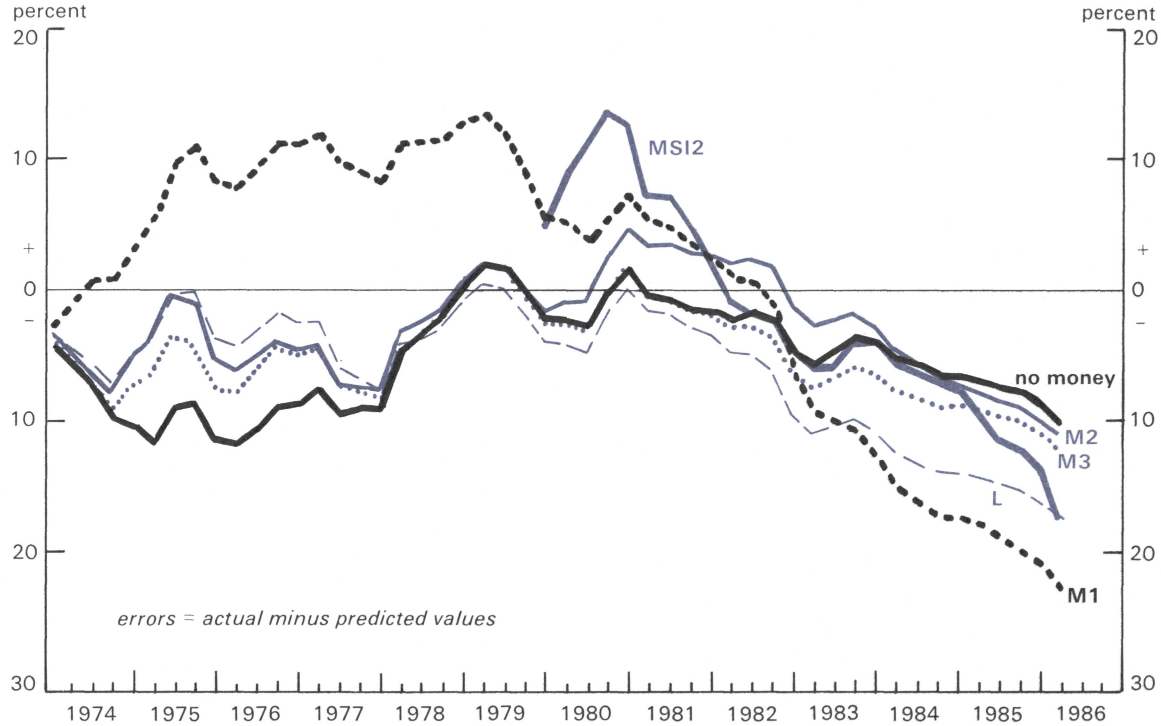
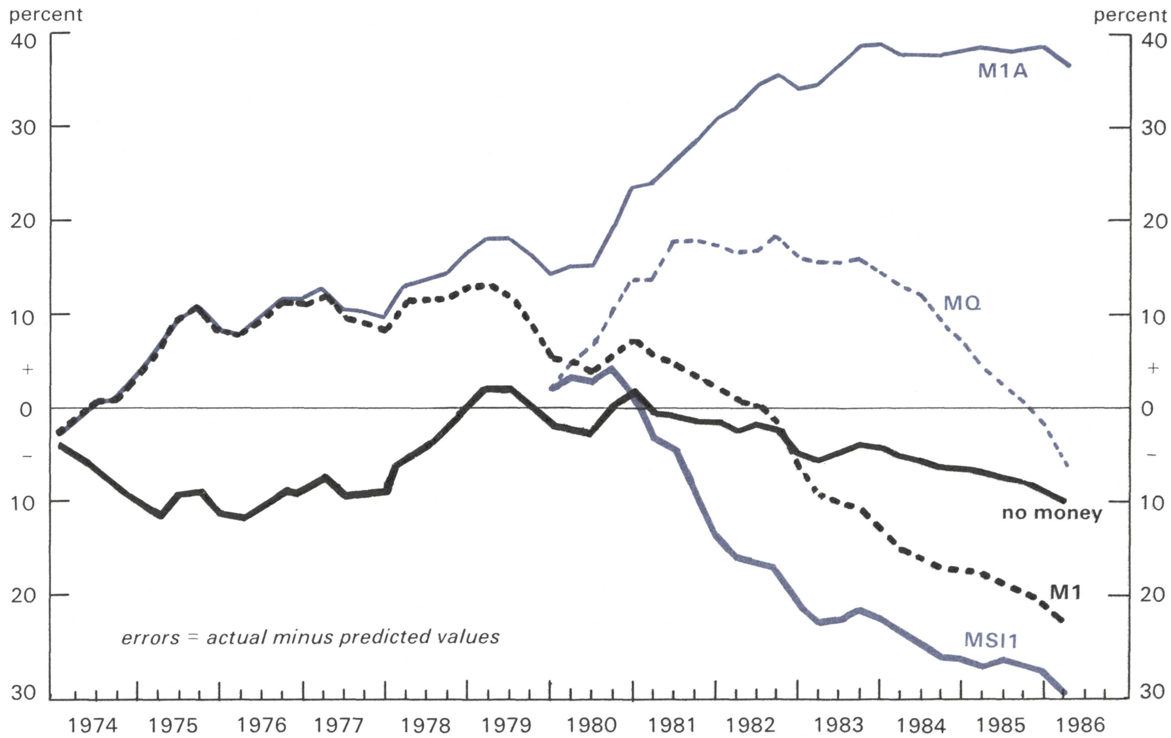


Figure 2
Cumulative forecast errors of inflation equation—M1 and narrower aggregates



very similar. The constant rate of overprediction suggests two conclusions about the breakdown of the money/inflation relationship. First, there may have been a simple change in the constant term of the regression. Such a shift would cause a constant bias in the forecasts and thus lead to the steady linear descent which we observe in the cumulative errors. Second, the change may be permanent. If the model were simply making a one time adjustment to financial deregulation, we would expect the slope of the cumulative errors to flatten over time, not to maintain a constant downward course as it does for 5½ years.

This suggests that a simple adjustment to the constant term after 1980 might allow a money-based model to outperform the no money model. In estimations of several such models, money growth does contribute positive information in the 1980s.

Simulation of these adjusted models indicates that the shift in the constant term lowers the long run inflation rate by roughly five percent. But the overall pattern of inflation's response to money growth in the adjusted model is very similar to that of the money/inflation model before the 1980s. Thus, a change in the rate of M1 growth will have a similar effect on inflation as in the past. One caveat is that this adjusted model is a post hoc explanation and must therefore be viewed with skepticism. In fact, attempts to include a constant correction in a dynamic estimation of the model failed to produce an estimation superior to the no money model.

Table 1
Average forecast errors of inflation equations during 1980s breakdown

	81Q2-83Q4	84Q1-86Q2
M1	−1.6	−1.2
Broader aggregates		
MSI2	−1.5	−1.3
M2	−.6	−.9
M3	−.7	−.6
L	−.9	−.7
Narrower aggregates		
M1A	1.4	−.1
MQ	.2	−2.2
MSI1	−2.1	−.8
No money	−.5	−.6

Money/inflation: Performance of the narrower aggregates

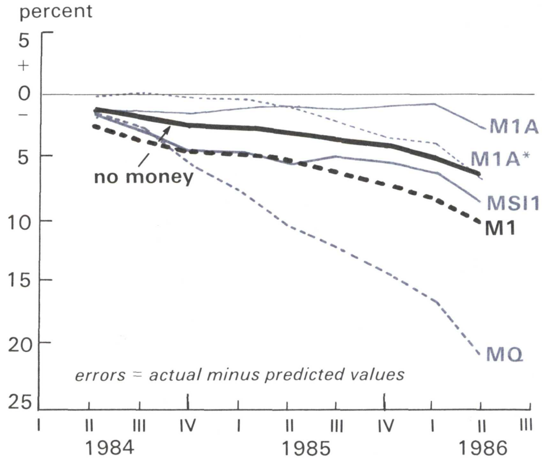
The experience of the equations estimated with the narrow aggregates is more diverse than that of the broader aggregate equations (see Figure 2). The cumulative errors of the MSI1 equation slope steadily downward throughout the 1980s just like the cumulative errors of the M1 and broader aggregate equations. This general pattern is not followed, however, by the narrowest aggregates, M1A and MQ. Instead of overpredicting inflation throughout the 1980s, they both have a period of consistent underprediction beginning in 1980. This underprediction could be due to depressed growth of the two aggregates as funds shifted out of demand deposits and into the NOW accounts which were authorized on a national basis at the end of 1980.

In the case of the MQ equation, the adjustment to the NOW accounts appears to have been completed by late 1981. At that point, the equation stops underforecasting inflation, and by 1984 its behavior begins to resemble that of the broader aggregate equations. From 1984 through early 1986, the MQ equation has a downward sloping cumulative error graph just like the broader aggregate equations.

The portfolio adjustment appears to have had a more prolonged effect on the M1A equation, for the M1A cumulative errors continue climbing through 1983. The errors are then flat through early 1986, suggesting that the M1A equation was so affected by the period of portfolio adjustment that it cannot return later to the same behavior as the other equations. The M1A cumulative errors do behave more like those of the other equations when the episode of underprediction, the fourth quarter of 1980 through the fourth quarter of 1983, is removed from the sample. Figure 3 shows that with this adjustment, the M1A equation overforecasts inflation in every quarter from the fourth quarter of 1984 through the second quarter of 1986.

None of the standard or experimental narrow aggregates provides significantly better forecasts in the 1980s than the M1 equation. Furthermore, the no money equation again seems to have the lowest forecast errors in the 1980s. Thus, it does not appear that the performance of the money/inflation model can be

Figure 3
Cumulative forecast errors of inflation equation after 1984 Q2—M1 and narrower aggregates



*1980 Q4-1983 Q4 excluded from sample.

significantly improved by narrowing the aggregate or estimating it with functional weights. In addition, it appears that deregulation has further complicated the interpretation of the money/inflation equation when the narrow aggregates are used.

Money/real income: Performance of different aggregates

The FRB Chicago-Gittings real income equation performs much the same whether it is estimated with M1 or aggregates with broader or narrower asset coverage. The cumulative forecast errors produced when the equation is estimated with M1, the broader aggregates, and without any money variable are plotted in Figure 4. Table 2 gives the average forecast errors between the apparent turning points of these equations. The equations all have fairly constant cumulative errors from 1974 through 1980, but they begin to break down seriously in early 1981 just as the inflation equations also start to go off track. In 1981 and 1982, all the cumulative error graphs fall sharply, indicating persistent overprediction of real growth. The majority of the error graphs then rise steadily from 1983 through early 1984 before flattening out or falling into a slow decline through the second quarter of 1986.

This error pattern is so consistent across the equations that the only apparent deviations are in cases where the general pattern is merely more pronounced. The M1 equation experiences two periods of substantial decline and increase in the latter 1970s which are much milder for the other equations. The general increase that begins in 1983 lasts longer for the M1 equation, extending all the way through mid-1984, and the slight decline of late 1985 and early 1986 is more marked. The MSI2 equation has a much larger increase in late 1980 than the other equations, and it falls more steeply after 1983.

The close similarity between the error patterns of M1 and the broader aggregates strongly suggests that broadening the aggregate will not put the money/real growth equation back on track in the 1980s. The poor forecasting record of the MSI2 equation suggests that the weighted index approach does not offer the solution either. In fact, the forecasting performance of the equation that does not include money growth is often better or comparable to that of the equations estimated with the aggregates. Its cumulative error graph follows the same pattern as that of the equations which include money growth, but the slope is not as steep in many cases. This suggests that M1 and the broad monetary aggregates are contributing very little or even misleading information to the real economic growth equations in the 1980s.

Very similar results are obtained when the real growth model is estimated with the aggregates that are narrower than M1. The cumulative errors of those equations conform quite closely to the error pattern of the broader aggregate equations. (See Figure 5 and Table 2.) Thus, the performance of the money/real growth relationship in the 1980s is not improved by either narrowing or weighting the aggregate measure. Again, the no money equation often has the best forecasting record in the 1980s, indicating that in some cases the narrower aggregates also reduce the model's predictive power.

The alternation of the equations between episodes of overprediction and underprediction indicates that a single adjustment such as the constant term shift in the inflation case will not salvage the money/real income model. The erratic forecasting performance in the 1980s suggests that the equations were thrown off

Figure 4
Cumulative forecast errors of real income models—M1 and broader aggregates

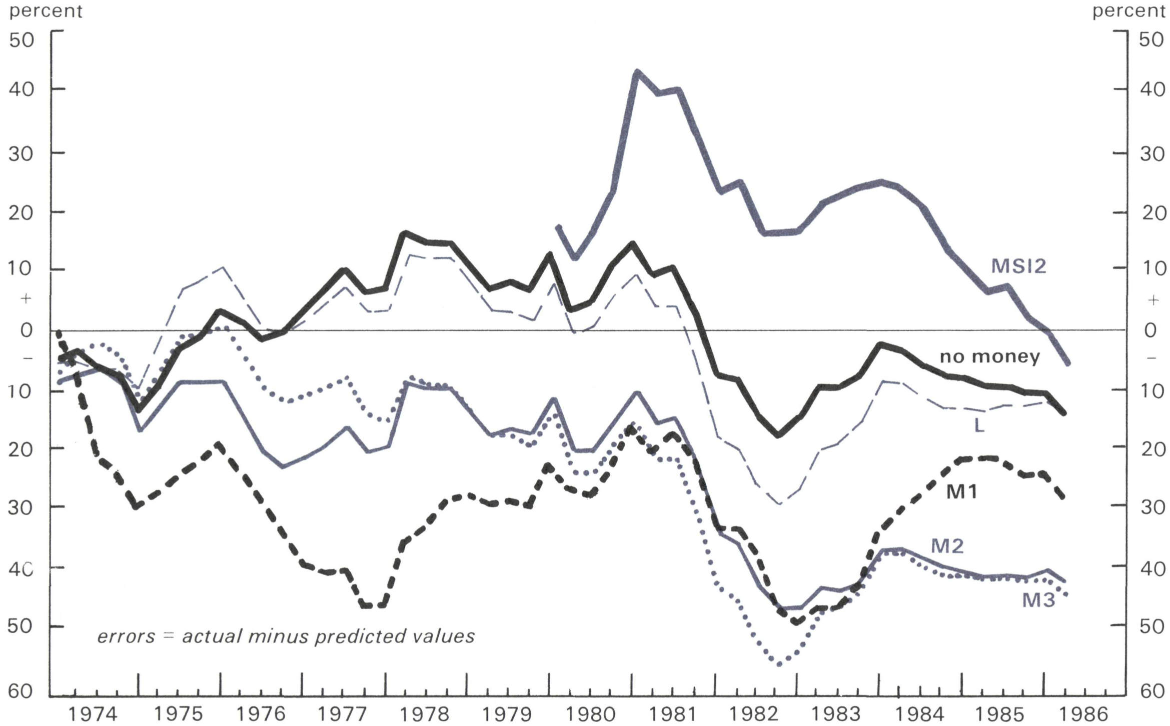


Figure 5
Cumulative forecast errors of real income models—M1 and narrower aggregates

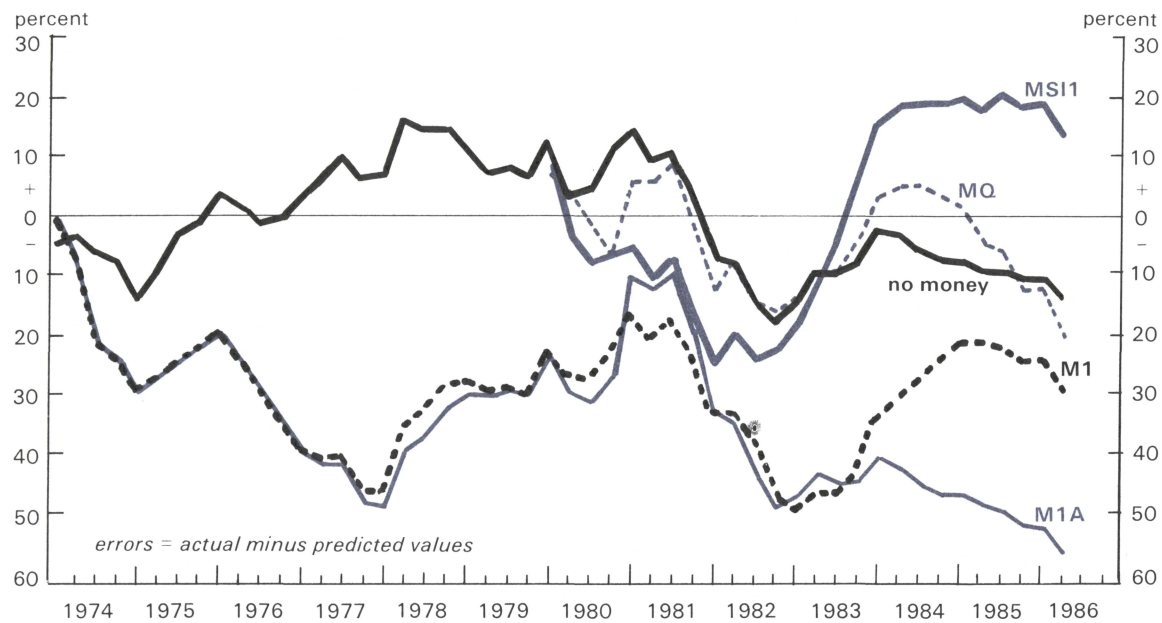


Table 2
Average forecast errors of real growth equations during 1980s breakdown

	81Q2-82Q4	83Q1-84Q1	84Q2-85Q1	85Q2-86Q2
M1	−4.4	2.5	3.2	−1.5
Broader aggregates				
MSI2	−4.0	1.9	−3.8	−3.1
M2	−5.2	2.0	−1.0	−.3
M3	−5.9	3.8	−.9	−.7
L	−5.6	4.2	−1.2	−.2
Narrower aggregates				
M1A	−5.6	1.8	−1.6	−2.0
MQ	−3.2	3.9	−.4	−4.5
MSI1	−2.5	7.7	1.0	−1.3
No money	−4.7	3.2	−1.4	−1.3

course by economic shocks not included in the model. Further research should attempt to identify such shocks and incorporate them into the money/real income models.

There have been many recent economic events which could have seriously disrupted the real growth process. Likely candidates include the deregulation of the financial sector, the rapid oil price increase of 1979, the oil price decline of 1985-86, the tax law changes in 1981, the large increase in the value of the dollar and subsequent deterioration of the U.S. trade position, and finally the very large fiscal deficits.

Additional evidence in favor of the unmodeled shock explanation is provided by the puzzling finding that the equation that excludes money growth often produces better forecasts in the 1980s than the aggregate equations. Shocks external to the model will reduce the forecasting ability of the aggregates if the Federal Reserve responds to them by changing the money growth rate. For example, suppose the Fed increased money growth in response to a shock which produced unexpectedly low growth. As long as the shock is not explicitly included in the model, the higher money growth would lead to predictions of greater economic growth just as actual growth falls due to the shock. In such a case, inclusion of money growth in the model actually reduces the accuracy of the forecasts, and money growth appears spuriously to be a misleading indicator.

Money/real income: Performance of different income measures

The real income equation's performance in the 1980s also is not significantly improved by changing the income variable. Figure 6 charts the cumulative forecast errors when the equation is estimated with M1 as the monetary aggregate and the real growth rates of GNP, final demand, and consumption plus fixed investment as alternative dependent variables.

The real final demand variable improves the equation's forecasting accuracy a little in 1981 and 1982, but makes it slightly worse in 1983 and 1984. The cumulative error graph of the real final demand equation drops less sharply than that of the real GNP model in the 1981-82 period, but it rises more steeply in 1983-84. The real consumption plus fixed investment variable produces an equation which behaves much like the real GNP equation in the 1980s. Its decline in 1981-82 is almost identical to that of the real income equation, and its rise in 1983-84 is a little steeper. The two specifications that include real government spending as an independent variable also follow the same cumulative error pattern as those of the three estimations shown in Figure 6.

It is somewhat surprising that these alternative estimations produce poorer forecasts than the real GNP equation after 1983, for this is when the importance of imports and the changed patterns of government spending should have been greatest. Our results show that the deterioration of the money/real income relationship in the 1980s is not caused primarily by GNP's failure to accurately measure either domestic transactions or private spending.

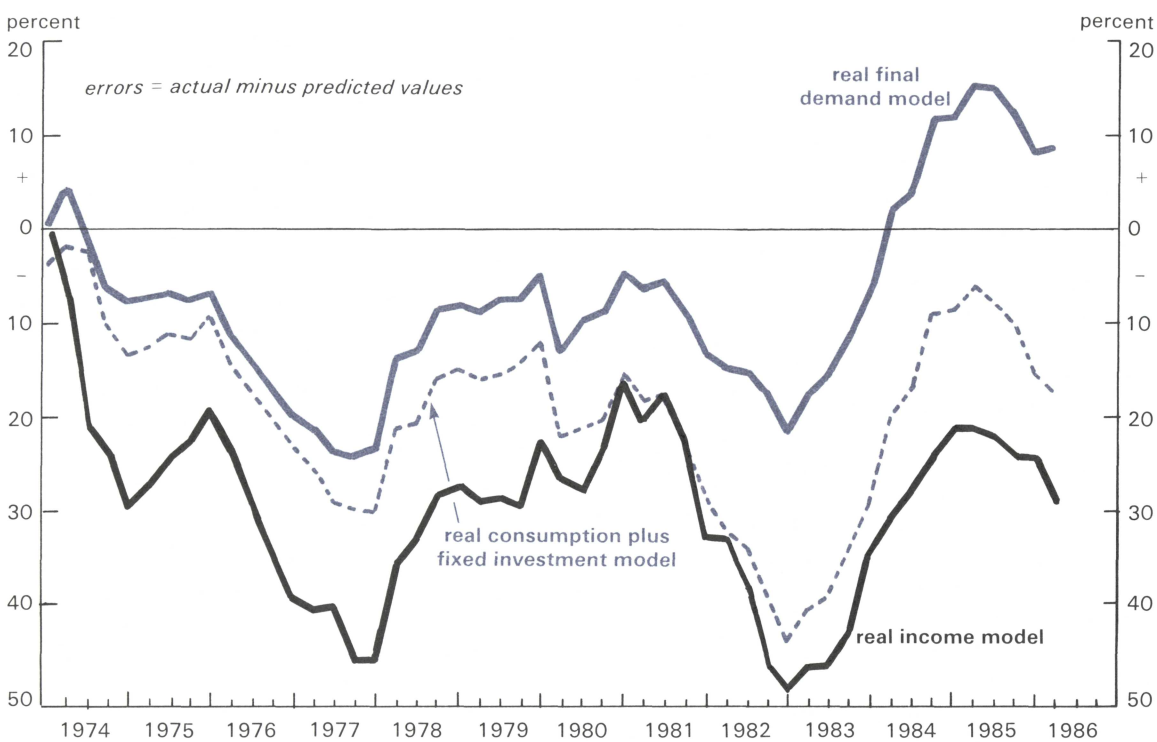
Conclusion

The money/income relationship broke down severely after 1980, prompting some economists to suggest that different money and income measures might improve its performance. In this paper, we estimate the inflation and real growth equations of the FRB Chicago-Gittings money/income model using a range of money and income measures in order to test some of these suggestions. We find that none of the alternative measures significantly improves the two equations' forecasting accuracy in the 1980s. In fact, the patterns of the equations' poor performance are very consistent no matter which monetary aggregates and income measures are used. As the breakdown appears unrelated to the component mix of the aggregates, it is not surprising that the experimental indexes, which assign functional weights to the components, are unable to provide significantly better results.

All our estimations clearly indicate that the inflation and real growth equations experience very different types of deterioration in the 1980s. The inflation equation overpredicts inflation at a remarkably constant rate from 1981 through early 1986. This suggests that a single constant adjustment to the money/inflation equation may be sufficient to correct the problem of the 1980s. The real growth equation, on the other hand, has a very erratic error pattern in the 1980s, with long periods of both overprediction and underprediction. This could have been caused by economic shocks which affected real growth but are not explicitly included in the model.

These findings have several implications for monetary policymakers. First, increases in the rate of money growth should not be entirely ignored as an indicator of possible future in-

Figure 6
Cumulative forecast errors of real growth models with M1 and alternative income measures



creases in inflation. Second, the money/real income model needs significant revision before it can be relied on for policy purposes. Pure monetary models cannot adequately explain the path real economic growth has taken in the 1980s.

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[1] For comparisons of the St. Louis model with several large structural models see: Leonall C. Andersen and Keith M. Carlson, "A Monetarist Model for Economic Stabilization," Federal Reserve Bank of St. Louis *Review*, vol. 52 (April 1970), pp. 7-25; Gary Fromm and Lawrence R. Klein, "A Comparison of Eleven Econometric Models of the United States," *American Economic Review*, vol. 63 (May 1973), pp. 385-393; and Yoel Haitovsky and George Treyz, "Forecasts with Quarterly Macroeconometric Models, Equation Adjustments, and Benchmark Predictions: The U.S. Experience," *The Review of Economics and Statistics*, vol. 54 (August 1972), pp. 317-325.

[2] See Thomas Gittings and Steven Strongin, "The Current FRB Chicago-Gittings Model," *Economic Perspectives*, Federal Reserve Bank of Chicago, (July/August 1986), pp. 10-12, for a description of the model used in this paper. The model explained in that article is estimated with two restrictions which force it to behave as if money has a neutral impact on economic growth. We do not impose these restrictions in this paper because we feel many of the aggregates tested are too broad to conform to the assumption of neutrality.

[3] There is some evidence that the specification of the monetary model does not greatly affect its performance in the years examined here. The FRB Chicago-Gittings model and a recent version of the St. Louis equation were found to have very similar forecasting records from 1974 through early 1986 in Diane F. Siegel, "The Relationship of Money and Income: The Breakdowns in the 70s and 80s," *Economic Perspectives*, Federal Reserve Bank of Chicago, (July/August 1986), pp. 3-15.

[4] M1A is currency plus demand deposits at commercial banks minus demand deposits at foreign banks and official institutions; M2 is M1 plus savings and small denomination time deposits at all depository institutions, overnight repurchase agreements issued by commercial banks, overnight Eurodollars held by U.S. residents at foreign branches of U.S. banks, Money Market Deposit Accounts, and money market fund shares; M3 is M2 plus large denomination time deposits at all depository institutions, term repurchase agreements issued by commercial banks and thrifts, term Eurodollars held by U.S. residents at foreign branches of U.S. banks and at all banking offices in the United Kingdom and Canada, and institutional money market mutual funds; L is M3 plus bankers acceptances, commercial paper, Treasury bills, other liquid Treasury securities, and U.S. savings bonds.

[5] See Paul A. Spindt, "Money Is What Money Does: Monetary Aggregation and the Equation of Exchange," *Journal of Political Economy*, vol. 93 (February 1985), pp. 175-204, for a description of the MQ index.

[6] See William A. Barnett, "Economic Monetary Aggregates: An Application of Index Number and Aggregation Theory," *Journal of Econometrics*, vol. 14 (September 1980), pp. 11-48 and William A. Barnett and Paul A. Spindt, "Divisia Monetary Aggregates: Compilation, Data, and Historical Behavior," Staff Studies 116 (Board of Governors of the Federal Reserve System, May 1982) for further description of the MSI1 and MSI2 indexes.

[7] In 1974 and 1975, money growth was much lower relative to economic growth than people expected. At the time this episode was called the "missing money phenomenon." Of the many explanations offered for the low money growth, the most likely attributed it to increased business use of overnight repurchase agreements for transactions purposes. See Gillian Garcia and Simon Pak, "Some Clues in the Case of the Missing Money," *American Economic Review*, vol. 69, (May 1979), pp. 330-334.

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