Are Money Growth and Inflation Still Related?

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A S NOTED ECONOMIST ALLAN MELTZER HAS OBSERVED, "MOST WORKING ECONOMISTS, MOST CENTRAL BANK STAFFS, AND MARKET PRACTITIONERS DO NOT USE MONEY GROWTH TO PREDICT INFLATION. MANY RELY ON THE PHILLIPS' CURVE OR ATHEORETICAL RELATIONS" (MELTZER 1998, 25).[1] THERE IS SUBSTANTIAL SUPPORT FOR MELTZER'S CLAIM. FOR EXAMPLE, FREDERIC MISHKIN, AN ECONOMICS PROFESSOR AND A FORMER DIRECTOR OF RESEARCH AT THE FEDERAL RESERVE BANK OF NEW YORK, HAS BEEN QUOTED AS SAYING, "THE AMOUNT OF INFORMATION IN THE MONETARY AGGREGATES IS ESSENTIALLY ZERO" (MANDEL 1999). RELIANCE ON THE PHILLIPS CURVE OR ATHEORETICAL RELATIONS IS NOT UNIVERSAL, THOUGH. FOR INSTANCE, *THE ECONOMIST* SUGGESTS THAT "THE FED WOULD BE FOOLISH TO IGNORE RAPID MONEY GROWTH COMPLETELY" ("FOLLOW THE MONEY" 1998, 68) IN ITS POLICY DELIBERATIONS.

At one level, the view that money growth is largely, if not entirely, irrelevant for inflation is surprising. The idea that persistent changes in the price level are associated with changes in the supply of money is one of the oldest and most established propositions in economics. An early and influential analysis appeared almost 250 years ago: David Hume's 1752 essay "Of Money" analyzes the link between increases in money and the subsequent increase in prices. Economists since Hume repeatedly have observed that prolonged increases in prices are associated with increases in the nominal quantity of money. Summing up the evidence, Milton Friedman in 1963 coined the aphorism "Inflation is always and everywhere a monetary phenomenon" (1992, 262). In recent years Lucas (1980), Dwyer and Hafer (1988), Friedman (1992), Barro (1993), McCandless and Weber (1995), Dewald (1998), Rolnick and Weber (1997), Dwyer (1998), and others have found that changes in the nominal quantity of money and the price level are closely related.

Despite its long history and the substantial evidence, the predicted association between money and inflation remains disputed. One possible explanation for this seeming paradox is that the empirical relationship between money growth and inflation holds only over time periods that are so long that the relationship is uninformative for practitioners and policymakers, who

are more concerned about inflation next month or next year. Some of the evidence above is based on average inflation rates and money growth rates over thirty years. If it takes a generation for the relationship between money growth and inflation to become apparent, perhaps it is not surprising that central bankers and practitioners put little weight on recent money growth.

It is not clear, though, that it takes a generation for the relationship between money growth and inflation to become apparent. Dwyer and Hafer (1988), for example, find that inflation and the growth rate of money are closely related over periods as short as five years. While the five-year average inflation rate does not have the same immediacy as next month's inflation rate, it is not a generational inflation rate either. On a monthly or quarterly basis in the United States, it is difficult to find variables that improve a forecast of next month's or next quarter's inflation rate using only past inflation (see, for example, Dwyer 1998). This finding indicates that policymakers in the United States have little effect on inflation next month. Such a forecast may be of little value for monetary policymakers other than in its relationship to inflation rates further in the future that their policies may affect.[2]

This article reconsiders the link between money growth and inflation, using two types of evidence. The first is based on the behavior of five countries' price levels and money stocks over much of the twentieth century. This evidence provides a perspective on the relationship between inflation and money growth over time and in countries that differ widely in terms of economic and political developments. Collecting comparable data for such long periods is not feasible for many countries, however. Hence, the second analysis of the relationship between inflation and money growth uses two recent five-year periods for a large number of countries.

The Quantity Theory

Inflation sometimes is defined informally as "too much money chasing too few goods." This statement captures important aspects of why money growth is related to inflation. Still, it is better to define inflation as increases in the general level of prices rather than in terms of why increases in the general price level occur.

The relationship between inflation and money growth ultimately is based on the demand for money and the supply of money. There are many different empirical measures of money, and the best measure is a matter of dispute.[3] Still, money today generally is measured as the sum of currency and deposits in financial intermediaries that are used in exchange and also may include deposits that are close substitutes for currency or for deposits that are directly usable in exchange. For example, the commonly used measure of money in the United States is called M2, estimated to be $4.4 trillion for February 1999 (Board of Governors 1999).

The Supply of Money. Historically, changes in the quantities of certain commodities such as gold affected the supply of money. That relationship is no longer true.

At least since the early 1970s, central banks have affected the nominal quantities of money in modern economies, whether intentionally or not, through their policy actions. These policy actions may include buying and selling government securities, changing reserve requirements, or changing the interest rate at which the central bank provides reserves to financial intermediaries.

> **The idea that persistent changes in the price level are associated with changes in the supply of money is one of the oldest and most established propositions in economics.**

How does the Federal Reserve affect the nominal quantity of money in the United States? The basic principles are simple, but details can blur them. Suppose that all money in the United States were currency. The Federal Reserve could buy and sell government securities as it does now in open market operations, using currency rather than deposits to pay for the securities. When the Federal Reserve bought government securities with currency, the amount of currency held by the public would increase. When the Federal Reserve sold government securities and received currency in exchange, the amount of currency held by the public would decrease. These changes in the amount of currency would be changes in the nominal quantity of money in the economy. While simplified, this example of such purchases and sales

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1. *The Phillips curve relates the unemployment rate and the rate of inflation. In its most common form, it suggests that there is a negative relation between the two series: higher rates of inflation are associated with lower unemployment rates. Basing inflation forecasts on such a relation has been subject to much criticism. Chang (1997) discusses how the Phillips curve is interpreted as a theory of inflation and critiques this use.*
2. *Dwyer (1998) shows that averaging over longer periods for the United States does produce a closer relationship, with three-to five-year averages providing visual evidence of the relationship.*
3. *Friedman and Schwartz (1970, part 1) probe the issues. Anderson, Jones, and Nesmith (1997a, 1997b) provide a recent analysis.*

illustrates how the Federal Reserve affects the nominal quantity of money.[4]

The Demand for Money. The public's demand for money is another fundamental part of the relationship between money growth and inflation. People hold money in order to buy goods and services. As a consequence, firms' and households' demand is for a real quantity of money. If prices increase, then people want to hold more dollars so that the money will buy the same amount. If M is the nominal quantity of money and P is the price level, the real quantity of money is M/P. The price level commonly is measured by general price indexes such as the consumer price index and the gross domestic product deflator. Loosely speaking, the real quantity of money is the nominal quantity of money adjusted for inflation.

The single most important factor affecting the demand for money is real income. A higher income is associated with more spending, and more spending is facilitated by holding more money. A proportional relationship between the real quantity of money demanded and real income is a convenient form of the dependence of demand for money on income. This relationship can be written as

$$M/P = ky, \qquad (1)$$

where y is real income and k is the factor of proportionality.[5] The factor of proportionality is not a constant. Most importantly, changes in the opportunity cost of holding money affect the quantity of money demanded.[6] The opportunity cost of holding money can be summarized by the forgone interest income from holding money instead of other assets. If the opportunity cost of holding money increases, the demand for money decreases; if the opportunity cost of holding money decreases, the demand for money increases. Other factors also can affect the demand for money, such as payments practices and technological innovations in financial intermediation.

The Price Level. Neither the demand for money, the supply of money, nor the two together completely explain the price level. If the nominal quantity of money supplied equals the quantity demanded, equation (1) summarizes the relationship among several variables. Those variables are the nominal quantity of money, the price level, and real income as well as all of the other factors that affect the demand for money and are reflected in the factor of proportionality, k.

If real income, y, were constant and factors reflected in k other than real income also were constant, equation (1) would provide a direct relationship between the nominal quantity of money and the price level. An informative way of rewriting equation (1) is

$$P = k^{-1}(M/y). \qquad (2)$$

This equation highlights the relationship between the price level and factors that determine it.[7] It also makes clear that the nominal quantity of money is not the only factor affecting the price level.

If real income were constant and other factors did not affect the demand for money or were constant, then there would be a proportional relationship between the price level and the nominal quantity of money relative to real income. If the nominal quantity of money M changed, then P would change by the same proportion because k and y were constant.

While patently unrealistic, this supposition is a useful starting point for thinking about what has to be true for the nominal quantity of money and the price level to be proportionally related. Further analysis and assumptions about what is more or less important create a proportional connection between the nominal quantity of money and the price level.

First, consider real income. Real income changes over time and affects the demand for money. The factors that determine real income, though, are largely if not entirely unrelated to the demand for money and the supply of money, especially over longer periods.[8] The major factors affecting the growth of real income over time are growth of resources available to produce goods and services and technological change. Printing money does not create more labor or real capital to produce goods and services or affect technological change. Hence, at least over longer periods, real income is independent of the nominal quantity of money and the price level. As a result, changes in real income do affect the price level, but there is a proportional relationship between the price level and the nominal quantity of money relative to real income.

If variation in the demand for money for reasons other than real income, indicated by the k in equations (1) and (2), is relatively unimportant, then equation (2) indicates that the price level and money relative to real income are proportionally related. There need not be such a close relationship between the price level and the nominal quantity of money relative to income. If variation in the demand for money for reasons other than real income is substantially more important than variation in the money supply relative to real income, this variation in the demand for money can result in no observable relationship between the price level and money relative to

> The relationship between inflation and money growth ultimately is based on the demand for money and the supply of money.
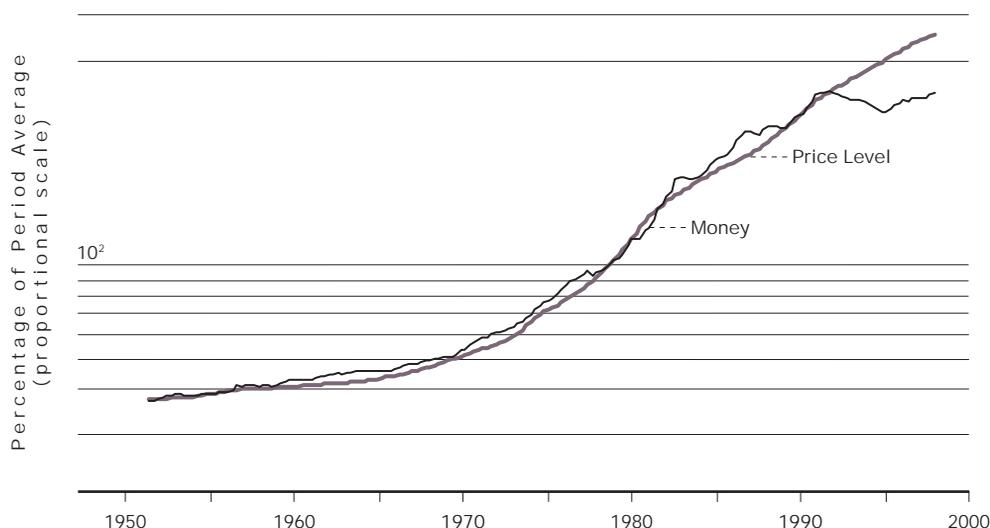
Source: See data appendix.

real income.[9] Changes in the price level will be associated with changes in the demand for money, k in equations (1) and (2), and not money relative to real income. The relative importance of variation in the supply of money and the demand for money for explaining the price level is therefore an empirical issue.

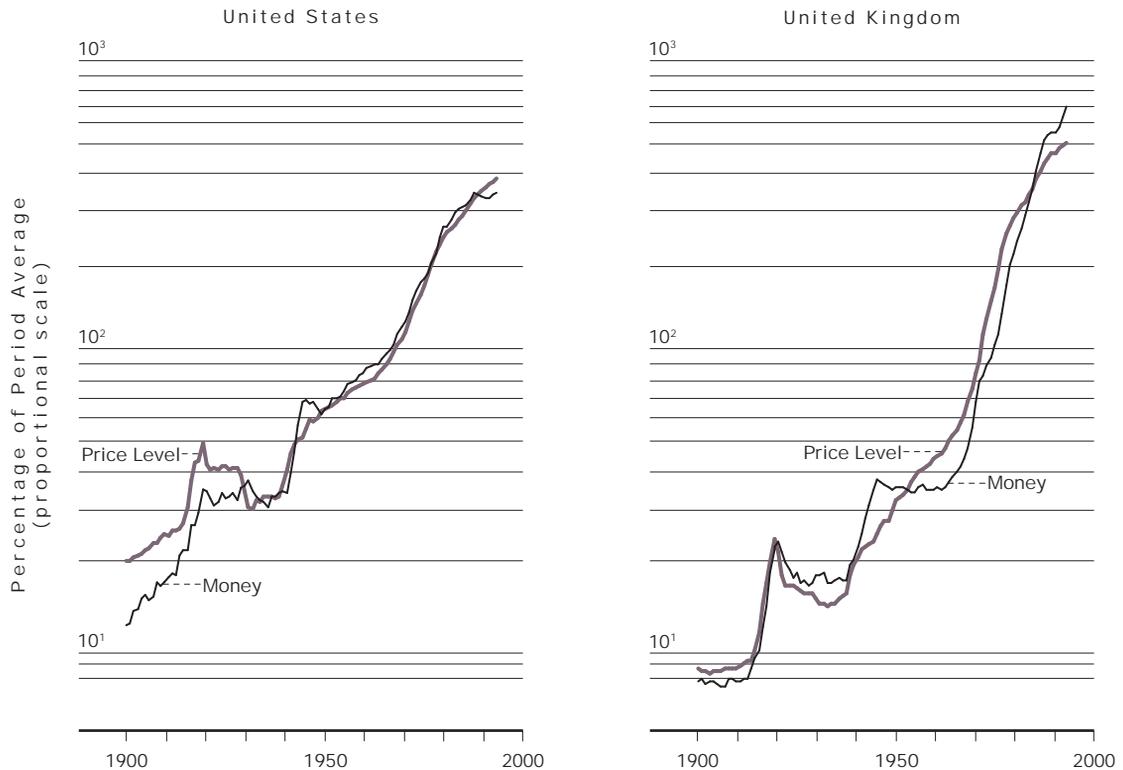**Money and Prices in the United States since 1953.** Chart 1 shows the relationship between the price level and money relative to real income for the United States from the first quarter of 1953 through the end of 1997.[10] The vertical axis uses a proportional scale for the values of money relative to real income and the price level. With a proportional scale, the proportional and percentage changes in the price level and in money relative to income are represented by the slopes of the respective lines. The inflation rate is represented by the slope of the line for the price level. The growth rate of money relative to real income is represented by the slope of the line for money relative to real income.

The average values of the price level and of money relative to income are set to 100 in Chart 1. As a result, the graph shows the percentage deviations of the price level from its average and the percentage deviations of money relative to real income from its average. Nothing in the construction of the graph forces any coincidence of the lines. A strictly proportional relationship would be indicated by the coincidence of the two lines. A positive but less than perfectly proportional relationship is indicated by the two lines' general agreement in terms of direction and rate of change.[11]

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4. This illustration leaves out details that are helpful for understanding discussions of monetary policy in the United States but are not crucial for understanding the principles of how the Federal Reserve can affect the nominal quantity of money. Friedman (1992), Board of Governors (1994), and many money and banking textbooks provide more details.

5. The factor of proportionality sometimes is called the Cambridge k because Cambridge University economist A.C. Pigou (1917) first used it in an article on the value of money and the quantity theory.

6. If the demand for money is not proportional to income, changes in real income will be associated with changes in the factor of proportionality.

7. This equation also can be written in terms of the income velocity of money, V, where $V = k^{-1}$.

8. Technically, then, the real income elasticity of the real quantity of money demanded must be 1. Many empirical estimates of the demand for money, although not all, are consistent with this restriction. (Hoffman and Rasche 1996 provide a recent survey.) In addition, technological change affecting payments may well be related to growth of real income. Over short periods, increases in the nominal quantity of money are associated with increases in real income. Espinosa-Vega (1998) provides a recent discussion of how inflation may affect the long-run growth of real income. There is no evidence, though, that such effects are an important part of the variance of real income growth.

9. Changes in the expected inflation rate affect the opportunity cost of holding money, implying that the inflation rate affects the demand for money and hence the relationship between the price level and the nominal quantity of money.

10. The data series used and sources are discussed in the appendix.

11. If the income elasticity of the demand for money is not unity, the lines would have similar changes in slope, but the trends of the price level and money relative to real income would not be the same.

C H A R T   2
**Price Level and Money Relative to Real Income in the United States
and the United Kingdom, 1900–1997**

United States

United Kingdom

Source: See data appendix.

Chart 1 shows that, generally speaking, more money relative to income is associated with a higher price level in the United States since 1953. The upward trend in money relative to income is matched by a similar trend in the price level. Changes in the growth rate of money relative to real income also are matched by similar changes in the inflation rate. There generally is a close relationship between the two series.

There is, however, one noticeable exception to this generalization. An apparently unprecedented deviation appears in the 1990s: money relative to income falls, and the price level does not. This divergence between the price level and money relative to income suggests that money growth can be misleading. For the first half of the decade the behavior of money relative to real income suggests virtually no inflation. Although the actual inflation rate during this period is substantially lower than in the 1970s and 1980s, it is not zero on average. After a relatively brief period of time the slopes of the two lines do appear to agree for later years in the decade. This subsequent parallel movement suggests that the different growth rates may be specific to the early 1990s. Is this recent divergence for the United States unusual?

Inflation and Money Growth
in the Twentieth Century

This section takes a broader look at the relation between money and prices to answer this question. The historical behavior of the price levels and money relative to real income in several selected countries can be used to illustrate how well money relative to real income tracks the price level. The countries represent a wide range of economic and institutional conditions over time. The United States and the United Kingdom are representative of relatively low-inflation, high-income economies. In contrast, Brazil and Chile are countries that have experienced substantially higher average inflation in the twentieth century. Even though the average inflation rate has been higher in these two countries, both have had different experiences and incidences of inflation over time. Japan has a substantially different history than any of the other countries and a substantially different time pattern of inflation.

United States and United Kingdom. Chart 2 shows the relationship between the price level and money relative to real income in the United States and the United Kingdom since 1900. The United Kingdom has experi-

enced substantially more inflation than the United States in the twentieth century. This higher inflation is associated with a much larger increase in money relative to real income in the United Kingdom than in the United States. In both countries substantial inflations and deflations are associated with corresponding changes in money relative to real income. Still, there are deviations between prices and money relative to real income, and sometimes these departures are persistent.

The deviation of the price level from money relative to real income in the United States in the 1990s is not the only one in the century, nor is it the largest. For instance, in the early years of the century, money relative to real income grew more rapidly than the price level. One explanation for this phenomenon is the increased financial development of the United States (Friedman and Schwartz 1982). Even so, the rapid increases in money relative to real income after World War I are associated with increases in the price levels in both countries.

The decreases in money relative to income in the Great Depression in the 1930s are associated with decreases in the price levels.[12] Even the pattern during the Great Depression, with all its turmoil, is consistent with the long-run relationship between money and prices. More recently, the sustained inflation since World War II is associated with a sustained increase in money relative to real income. The higher inflation in the 1970s and the slowing since the 1980s are associated with similar movements in the growth of money relative to real income, as the quantity theory suggests. Although both countries had a wide range of experiences during the past century, the common link between increases in the price level and increases in money relative to income is clear.

Brazil and Chile. Chart 3 shows the relationship between the price level and money relative to real income in Brazil and Chile. Unlike for the United States and the United Kingdom, data are not available for each country for the entire century. The time spans are reasonably long, though. The data for Brazil start in 1912, and the data for Chile start in 1940. As in the preceding charts, the graphs show the price level and money relative to real income with average values of 100. In this chart, however, the vertical and horizontal scales of the two graphs are not the same.

The very high inflation rates in these countries compared with the United States and the United Kingdom stand out in Chart 3. The price level in Brazil has risen from

being on the order of 10^{-12} in 1912 to 1,000 in the 1990s. The implied change in prices is hard to contemplate. In terms of dollars, such an increase would mean that a good with a price of \$1 in 1912 would have a price of \$1,000 trillion in the 1990s. This is a large increase in prices by any standard. Brazil's average inflation rate was 43.6 percent per year from 1912 to 1996. Chile also had relatively high inflation. Chile's average inflation rate was 33.2 percent per year from 1940 to 1997. This high average rate of inflation in Chile stems in large part from the increases in the price level in the 1970s when the inflation rate averages 90 percent per year.

More informative than just money relative to real income tracking the price level, changes in the rate of increase in the price level are associated with changes in the rate of increase in money relative to real income in Chart 3. The slope of the line for the price level is the inflation rate. In Brazil the inflation rate increased in the 1980s and declined dramatically in recent years. This

> **As in low-inflation countries, there is a positive association between inflation and growth of money relative to real income in high-inflation countries.**

change in inflation is associated with a like change in money relative to real income. Similarly, in Chile the inflation rate increased in the 1970s and fell in the 1980s and 1990s. This decrease in the inflation rate also is associated with a decrease in the growth of money relative to real income. As in low-inflation countries, there is a positive association between inflation and growth of money relative to real income in high-inflation countries.

Japan. Japan has a very different history in the twentieth century than the other countries discussed. Japan was occupied after World War II, and many of its political institutions were forcibly changed. Chart 4 shows that World War II also is reflected in the history of Japan's price level. Both before and after the war, Japan had relatively low inflation rates and relatively low growth of money relative to income. As for the United States, money relative to real income increased more rapidly than the price level in the early years of the twentieth century, possibly also because of increasing monetization and financial development of its economy.

12. This episode is an important reason why the analysis in this article uses broader measures of money rather than the monetary base. Broader measures of money fall in the Great Depression and prices fall, although the monetary base actually increases. The monetary base may well be an adequate measure of money for some purposes, as evidence in Lothian (1976) and Rolnick and Weber (1997) indicates, but it is not obvious that it is the best measure in banking panics. Fortunately, banking panics are rare in the twentieth century.

Price Level and Money Relative to Real Income in Brazil, 1912–87, and Chile, 1940–97

Brazil, 1912–87

Chile, 1940–97
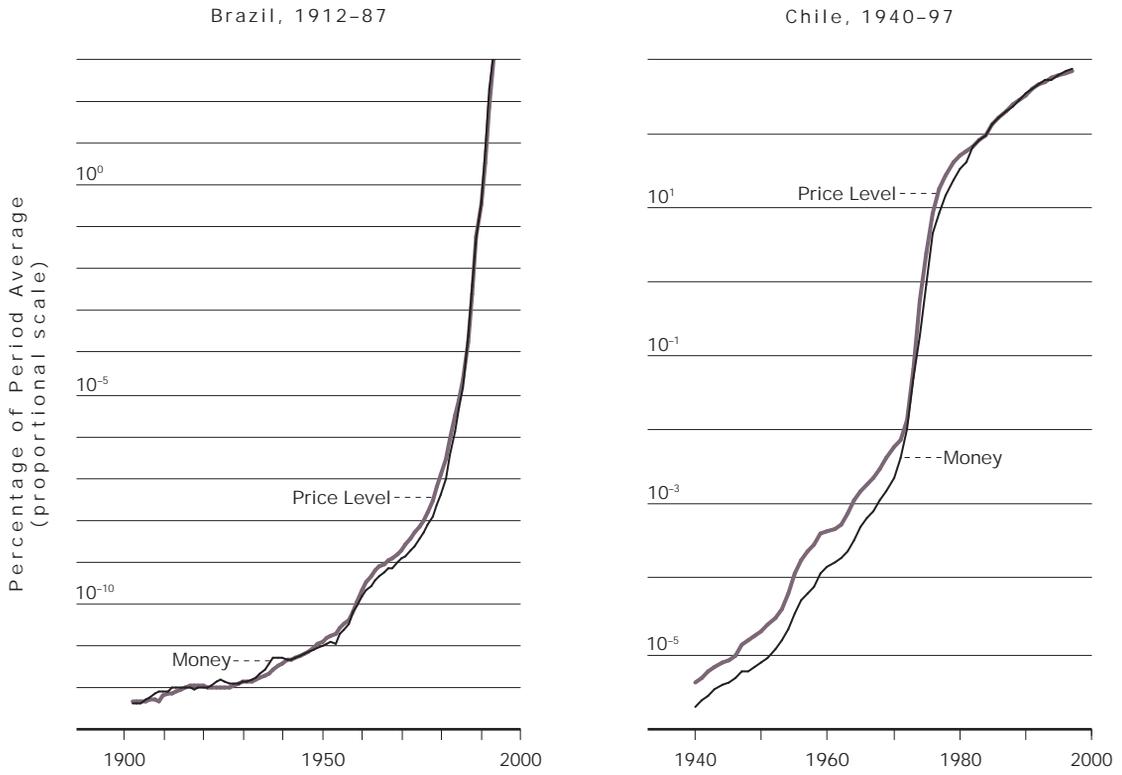
Source: See data appendix.

C H A R T 4 Price Level and Money Relative to Real Income in Japan, 1900–1994
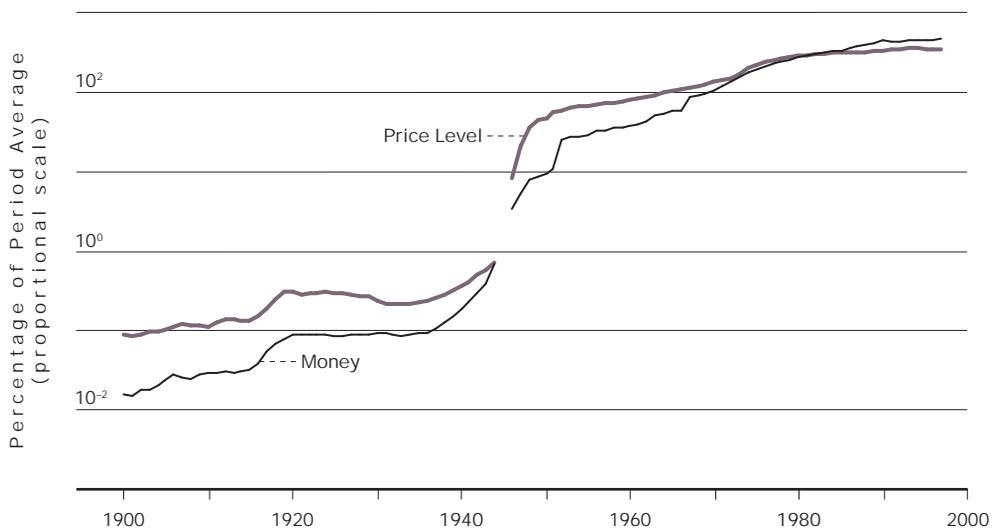
Source: See data appendix.

Summary. Inflation is associated with growth of money relative to real income. This relationship holds across countries with quite different economic and political experiences. Moreover, substantial changes in inflation in a country are associated with changes in the growth of money relative to real income. These charts indicate that there is not a perfect correspondence between inflation and the growth of money relative to real income. Divergences can occur and have occurred, as in the United States in the 1990s. Even so, the evidence in the charts is inconsistent with any suggestion that inflation is unrelated to the growth of money relative to real income. On the contrary, there appears to be substantial support for a positive, proportional relationship between the price level and money relative to income.

Inflation and Money Growth across Countries

The relationship between the price level and money relative to income also can be examined using data for a large number of countries, albeit for a shorter period of time. The quantity theory is informative about the long-run movements of variables. The last section uses data on the levels of prices and on money relative to income, which are dominated by persistent long-run movements. There is no obvious relationship between price levels across countries because the level of the demand for money in different countries may well be different. Across countries, though, the quantity theory predicts that countries with higher money growth relative to income will have higher inflation rates.

The analysis in this section uses the inflation rate and the growth rate of money relative to real income. Prior studies, including Dwyer and Hafer (1988), use the inflation rate and the growth rate of money. Using the growth rate of money relative to income rather than the growth rate of money by itself is more consistent with the analysis of individual countries and with the quantity theory. If, as the evidence in Dwyer and Hafer (1988) indicates, there is no relationship between the growth rates of money and real income, the quantity theory indicates a closer relationship when the growth rate of money relative to income is used instead of the growth rate of money by itself. The data used in this section indicate the same thing.[13]

Growth rates must be calculated over some time period, raising the question of how long a period to use. Over very short periods, there is no relationship between the inflation rate and the growth rate of money relative to

income. Dwyer (1998) finds that the relationship between a quarter's growth rate of money and that quarter's inflation rate is, at best, loose in the United States. Dwyer and Hafer (1988) find little correlation of inflation and money growth across countries on an annual basis. How much averaging is necessary before there is a proportional relation between money growth and inflation? Some researchers average over decades. McCandless and Weber (1995) and Rolnick and Weber (1997), for example, use thirty-year or longer averages of inflation and money growth rates. Barro (1993) uses growth rates for the period since World War II, with an average period of thirty-two years. Using a different approach, Dewald (1998) compares the inflation rate with a ten-year moving-average growth rate of money. All these studies find a close link between the average growth rate of money and inflation.

This section focuses on five-year averages of inflation and the growth of money relative to income. This shorter

> **Substantial changes in inflation in a country are associated with changes in the growth of money relative to real income.**

time interval has more immediacy and is likely to be of more interest to some people, perhaps especially policymakers, than averages over decades.[14] The data set used here includes observations on money growth relative to income and inflation for all countries for which data are available from the International Monetary Fund. This study examines the data for two adjoining five-year periods: from 1987 to 1992 and from 1992 to 1997.[15] Examining these consecutive periods makes it possible to determine whether changes in countries' inflation rates over these two periods are related to changes in their growth of money relative to income.

The relation between average annual rates of inflation and average annual rates of growth in the money supply relative to real income for the two five-year periods appear in the two panels of Chart 5. Each point in the graphs shows the average growth rate of the money supply relative to income and the average rate of inflation for a specific country. The 45-degree lines show where the data would lie if there were a perfect proportional

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13. Because the variance of real income growth across countries is small relative to the variance of money growth, the results differ little using the growth rate of money alone instead of the growth rate of money relative to real income.

14. A closer relationship is likely if the growth rates are computed over longer time periods.

15. The data appendix includes details. Because data are not available for 1997 for some countries, the growth rates for a few countries are for 1986 to 1991 and 1991 to 1996.

1987–92

1992–97
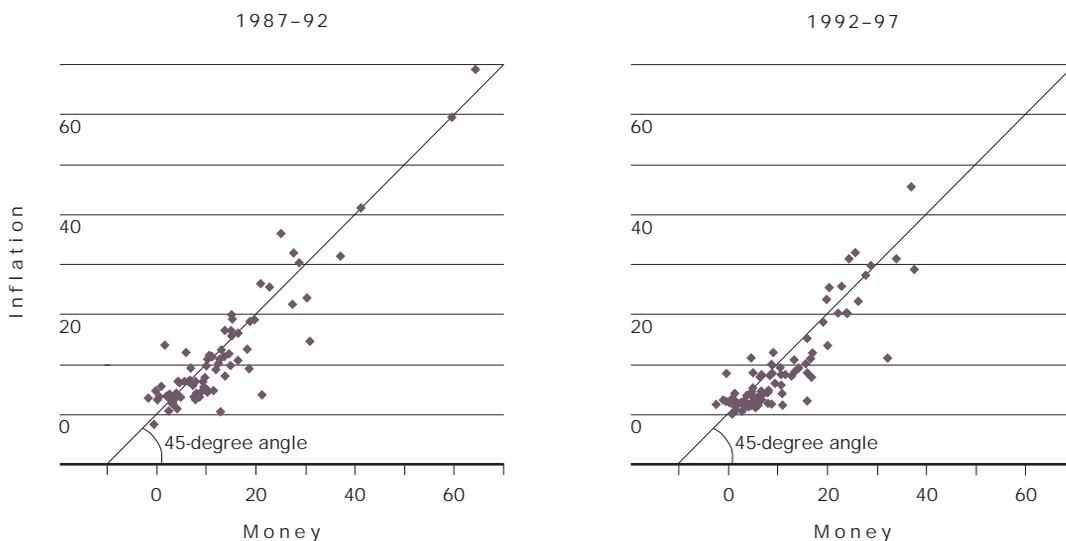
Source: See data appendix.

relationship between the price level and money relative to real income.[16] Each 45-degree line shows the relationship if a 1 percentage point increase in the growth rate of money relative to income is associated with a 1 percentage point increase in the inflation rate.

The left panel shows the data for 1987 to 1992. The data reveal a positive relationship between average money growth rates relative to income and inflation rates across countries.[17] The visual evidence in this panel indicates that the points cluster around the 45-degree line: on average, higher rates of money growth relative to income are associated with roughly the same increases in inflation.

The right-hand panel in Chart 5 shows data for the more recent period, from 1992 to 1997. As in the preceding five-year period, higher rates of money growth relative to income are associated with higher inflation rates. The points again cluster around the 45-degree line.[18]

There are substantial changes in inflation across countries from the first to the second period. Are these changes in inflation associated with similar changes in the growth of money relative to income? Even though both panels in Chart 5 show a positive relationship between inflation and the growth of money relative to income, there need not be a positive relationship between the changes. Because changes emphasize short-run movements over five-year periods, the uncertainty about such a relationship is significant.

The data from Chart 5 are used to examine this question. The changes in each country's inflation rate and growth rate of money relative to income are measured by the growth rate from 1992 to 1997 minus the growth rate from 1987 to 1992. These changes are shown in Chart 6.

The observed changes will cluster around the 45-degree line if there is a proportional relationship between the price level and money relative to real income. The results shown in Chart 6 reveal just that: the points lie around the 45-degree line. Generally speaking, Chart 6 suggests that a 1 percentage point higher growth of money relative to income is associated with a 1 percentage point higher rate of inflation. Conversely, lower inflation is associated with lower growth of money relative to income.

In addition to visual inspection, simple correlations can be used to measure how close the observations are to the 45-degree line. The correlations between inflation and the growth of money relative to income are 0.92 for 1987–92 and 0.84 for 1992–97. These correlations would be unity if the only factor affecting the price level were money relative to income. The correlations are not unity, but the correlations are substantial and are not likely to have resulted from chance. The correlation between changes in inflation and changes in the growth of money relative to income is a slightly lower 0.78. While that figure is smaller than either correlation of inflation with the growth of money relative to income, on average, countries with a higher growth rate of money relative to income have higher rates of inflation between the two five-year periods. Countries with a lower growth rate of money relative to income have lower inflation rates.

Conclusion

Does the behavior of inflation justify ignoring money growth when attempting to estimate future inflation? The evidence in this article indicates that it does not. A positive, proportional relation-
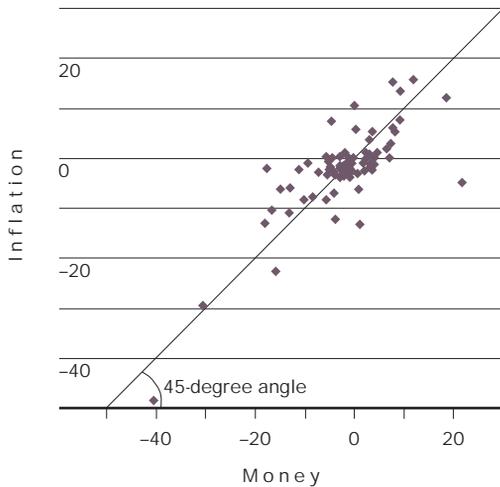
Source: See Chart 5. Difference computed between both time periods.

ship between the price level and money relative to real income is quite consistent with the evidence. This relationship between inflation and money growth is evident in data over long periods of time and over shorter periods for many countries. The divergence between inflation and the growth of money relative to income in the United States during the early 1990s appears to be transitory and is not that unusual when viewed in a longer context. Such divergences do not nullify the substantial amount of evidence showing that inflation and money growth are related over time. Statements to the contrary or assertions that there is no information content in monetary aggregates are misguided at best.

16. The 45-degree line is the predicted relationship if the demand for money is proportional to real income.

17. One country with data available is not included in the graph. Argentina has sufficiently high inflation and money growth rates that other countries would be obscured if Argentina were included in the chart. From 1987 to 1992, Argentina's inflation rate is 182 percent per year and the growth rate of money relative to income—179 percent—is almost the same as the inflation rate.

   Nicaragua is a clear outlier in the graph, with an average annual inflation rate of 11.2 percent from 1992 to 1997 and an average growth rate of money relative to income of 32.3 percent. A notation in International Financial Statistics Yearbook 1998 indicates an unexplained break in the series for the nominal quantity of money between 1995 and 1996.

18. Brazil has relatively high inflation in this period and is not included in the chart. Brazil has a growth rate of money relative to income of 138 percent per year and an inflation rate of 140 percent per year from 1992 to 1997. Just as for Argentina, this relatively high inflation country would lie quite close to the 45-degree line and is excluded only because its inclusion would obscure the data for other countries.

Data Appendix

Data for Selected Countries for the Twentieth Century

In all cases, splicing of data series is done by the simple expedient of multiplying the later series by the ratio of the earlier to the later series in an overlapping year.

United States. The annual data for the United States cover the years from 1900 through 1997. From 1900 through 1948, the nominal quantity of money is measured by M2 as in Friedman and Schwartz (1982, Table 4.8, 122–29). These data are spliced to M2 for 1948 through 1958, computed as indicated in Rasche (1987), and to M2 for 1959 through 1997 from the Federal Reserve Bank of St. Louis. For 1900 through 1959, nominal and real income are nominal and real net national product (NNP) from Friedman and Schwartz (1982, Table 4.8, 122–29). Nominal and real NNP for 1959 through 1997 are from the Bureau of Economic Analysis, Table 1.9, "Relation of Gross Domestic Product, Gross National Product, Net National Product, National Income, and Personal Income" at http://www.stat-usa.com on April 22, 1998.

The quarterly data on the United States include data from 1953 through 1997. The data on M2 for 1953 through 1958, from Rasche (1987), are spliced to seasonally adjusted M2 supplied by the Federal Reserve Bank of St. Louis. The monthly data are averaged to produce quarterly average values of M2. Real income is real GDP, and the price

level is the GDP deflator, both from the Federal Reserve Bank of St. Louis.

United Kingdom. For the years from 1900 through 1975, the money stock is measured by M2 as in Friedman and Schwartz (1982, Table 4.9, 130–37). For the purposes of this article, these data are not noticeably different from the data on M3 for 1871 to 1969 in Capie and Webber (1985, Table 1.[3] 76–77). Data on M2 are not available for later years. For 1975 through 1983, monthly values of M3 are available from the Bank of England (1977–86). These values are used to compute annual averages, which then are spliced to the M2 data for earlier years by their ratio in 1975. For 1983 through 1997, monthly data on M4 are available from the Bank of England (1998). Annual averages of these M4 values are spliced to the series for the earlier years.

The price index is computed from the ratio of nominal to real income. Nominal and real income for 1900 through 1975 are NNP as in Friedman and Schwartz (1982, Table 4.9, 130–37). Nominal and real gross domestic product (GDP) data for 1975 through 1997 are available from the International Monetary Fund (IMF) (1999). These data are spliced to the earlier national product data in 1975. The ratios of the resulting nominal to real income are the value of the price index used.

Brazil. The data for 1912 through 1980 are those documented in Rolnick and Weber (1995, data appendix). Real income is "Renda Real" for 1912 through 1962 and real GDP for 1962 through 1980. The price level is the "Indice do Custo de Visa no Brasil" for 1912, the "Deflator" for 1913 through 1959, and the GDP deflator for 1960 through 1980. The nominal quantity of money is "M2." These data are spliced to real GDP, the GDP deflator, and money plus quasi money from the IMF (1996, 1998) for 1966 through 1996. Changes in the currency are from the IMF (1996).

Chile. The data from 1940 through 1966 are those documented in Rolnick and Weber (1995, data appendix). Real income is real GDP, the price level is the GDP deflator, and the nominal quantity of money is M2. These data are spliced to real GDP, the GDP deflator, and money plus quasi money from the IMF (1996, 1998) for 1966 through 1997. Changes in currencies are from Behrman (1976).

Japan. The data for 1900 through 1944 and 1946 through 1966 are those documented in Rolnick and Weber

(1995, data appendix). Real income is real GDP for 1900 through 1940, real gross national expenditure for 1941 through 1960, and real GDP for 1961 through 1966. These data are spliced to real GDP, the GDP deflator, and money plus quasi money from the IMF (1996, 1998) for 1966 through 1997.

Data across Countries for 1987 to 1992

The data across countries are from the IMF (1999). Real income for each country is measured by GDP in base-period prices. The price level for each country is measured by the GDP deflator. The nominal quantity of money is the sum of money and quasi money. This sum is called the nominal quantity of money and the money stock in this part of the article. The IMF (1999) CD provides the nominal quantity of money only at the end of the calendar year for many countries. Real income is an integral of a flow over the year, and its average date is in the middle of the year. To line up the money stock more closely with real income, the nominal quantity of money in a year is the average of the level at the end of the prior year and that year. For example, the nominal quantity of money in 1997 is the average of the value at the end of 1997 and the end of 1996. This calculation provides a reasonable estimate of the annual average for the year dated at the middle of the year.

Growth rates are measured using continuously compounded growth rates computed from the difference between the logarithms of variables, converted to annual growth rates by dividing by five and to percentage growth rates by multiplying by 100. For example, the average growth rate of prices from 1992 to 1997 is computed from ($\ln P97 - \ln P92$) (100/5), where $P97$ is the price level in 1997 and $P92$ is the price level in 1992. The growth rates for 1992 to 1997 are computed using data for 1992 and 1997, and the growth rates for 1987 to 1992 are computed using data for 1987 and 1992. Data on money, quasi money, GDP, and the GDP deflator are available for eighty countries for 1987 to 1992 and for eighty-one countries for 1992 to 1997. Seventy-nine countries appear in both sets of data for which it is possible to compute the change in inflation and the change in the growth rate of money relative to real income.

REFERENCES

ANDERSON, RICHARD G., BARRY E. JONES, AND TRAVIS D. NESMITH. 1997a. "Introduction to the St. Louis Monetary Services Index Project." Federal Reserve Bank of St. Louis *Review* 79 (January/February): 25–29.

———. 1997b. "Monetary Aggregation Theory and Statistical Index Numbers." Federal Reserve Bank of St. Louis *Review* 79 (January/February): 31–51.

Bank of England. 1977–86. "Money Stock: Amounts Outstanding, Components of M1, £M3, and M3." Table 11.1, *Quarterly Bulletin,* various issues.

———. 1998. "Break-Adjusted Levels: M0, Retail Deposits and Cash in M4, M4, and M4 Lending." Table 10. *Statistical Abstract*, part 2. Available online at <http://www.bankofengland.co.uk/mfsd/abst/part2.htm> [April 29, 1999].

BARRO, ROBERT J. 1993. *Macroeconomics*. 4th ed. New York: Wiley.

BEHRMAN, JERE R. 1976. *Foreign Trade Regimes and Economic Development: Chile*. New York: Columbia University Press for the National Bureau of Economic Research.

BOARD OF GOVERNORS OF THE FEDERAL RESERVE SYSTEM. 1994. *The Federal Reserve System: Purposes and Functions*. 8th ed. Washington: Board of Governors of the Federal Reserve System. Available online at <http://www.bog.frb.fed.us/pf/pf.htm> [March 30, 1998].

———. 1999. *Money Stock and Debt Measures*. Release H.6. Washington: Board of Governors of the Federal Reserve System, March 25.

CAPIE, FORREST, AND ALAN WEBBER. 1985. *A Monetary History of the United Kingdom, 1870–1982*. Vol. 1 of *Data, Sources and Methods*. London: George Allen & Unwin.

CHANG, ROBERTO. 1997. "Is Low Unemployment Inflationary?" Federal Reserve Bank of Atlanta *Economic Review* 82 (First Quarter): 4–13.

DEWALD, WILLIAM G. 1998. "Money Still Matters." Federal Reserve Bank of St. Louis *Review* 80 (November/December): 13–24.

DWYER, GERALD P., JR. 1998. "Is Money a Leading Indicator of Inflation?" Unpublished paper, Federal Reserve Bank of Atlanta.

DWYER, GERALD P., JR., AND R.W. HAFER. 1988. "Is Money Irrelevant?" Federal Reserve Bank of St. Louis *Review* (May/June): 3–17.

ESPINOSA-VEGA, MARCO A. 1998. "How Powerful Is Monetary Policy in the Long Run?" Federal Reserve Bank of Atlanta *Economic Review* 83 (Third Quarter): 12–31.

"Follow the Money." 1998. *The Economist,* August 8, 68.

FRIEDMAN, MILTON. 1992. *Money Mischief: Episodes in Monetary History*. New York: Harcourt Brace Jovanovich.

FRIEDMAN, MILTON, AND ANNA J. SCHWARTZ. 1970. *Monetary Statistics of the United States*. New York: Columbia University Press for the National Bureau of Economic Research.

———. 1982. *Monetary Trends in the United States and the United Kingdom: Their Relation to Income, Prices, and Interest Rates, 1867–1975*. Chicago: University of Chicago Press.

HOFFMAN, DENNIS L., AND ROBERT H. RASCHE. 1996. *Aggregate Money Demand Functions*. Boston: Kluwer Academic Publishers.

HUME, DAVID. [1752] 1970. "Of Money." Reprinted in *David Hume: Writings on Economics*, edited by Eugene Rotwein. Madison, Wisconsin: University of Wisconsin Press.

INTERNATIONAL MONETARY FUND. 1996. *International Financial Statistics Yearbook 1996*.

———. 1998. *International Financial Statistics*. September.

———. 1999. *International Financial Statistics*. Compact disk. March.

LOTHIAN, JAMES. 1976. "The Demand for High-Powered Money." *American Economic Review* 66 (March): 56–68.

LUCAS, ROBERT E., JR. 1980. "Two Illustrations of the Quantity Theory of Money." *American Economic Review* 70 (December): 1005–14.

MANDEL, MICHAEL J. 1999. "Rivers of Cash Won't Swamp the Economy." *Business Week*, March 8, 34.

McCANDLESS, GEORGE T., JR., AND WARREN E. WEBER. 1995. "Some Monetary Facts." Federal Reserve Bank of Minneapolis *Quarterly Review* 19, no. 3:2–11.

MELTZER, ALLAN H. 1998. "Monetarism: The Issues and the Outcome." *Atlantic Economic Journal* 26 (March): 8–31.

PIGOU, A.C. [1917] 1951. "The Value of Money." *Quarterly Journal of Economics* 32:38–65. Reprinted in *Readings in Monetary Theory*, edited by Friedrich A. Lutz and Lloyd W. Mints. Homewood, Illinois: Richard D. Irwin, Inc.

RASCHE, ROBERT H. 1987. "M1—Velocity and Money Demand Functions: Do Stable Relationships Exist?" Carnegie-Rochester Conference Series on Public Policy 27 (Autumn): 9–88.

ROLNICK, ARTHUR J., AND WARREN E. WEBER. 1995. "Inflation, Money, and Output under Alternative Monetary Standards." Federal Reserve Bank of Minneapolis Research Department, Staff Report 175.

———. 1997. "Money, Inflation, and Output under Fiat and Commodity Standards." *Journal of Political Economy* 105, no. 6:1308–21.