Some Monetary Facts

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Abstract

This article describes three long-run monetary facts derived by examining data for 110 countries over a 30-year period, using three definitions of a country's money supply and two subsamples of countries: (1) Growth rates of the money supply and the general price level are highly correlated for all three money definitions, for the full sample of countries, and for both subsamples. (2) The growth rates of money and real output are not correlated, except for a subsample of countries in the Organisation for Economic Co-operation and Development, where these growth rates are positively correlated. (3) The rate of inflation and the growth rate of real output are essentially uncorrelated.

The Federal Reserve System was established in 1913 to provide an elastic currency, discount commercial credit, and supervise the banking system in the United States. Congress changed those purposes somewhat with the Employment Act of 1946 and the Full Employment and Balanced Growth Act of 1978. In these acts, Congress instructed the Federal Reserve to "maintain long run growth of the monetary and credit aggregates commensurate with the economy's long run potential to increase production, so as to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates" (FR Board 1990, p. 6). Implicit in these instructions from Congress is the assumption that the Fed has the ability, through its monetary policy, to control these economic variables. Does it? Clearly, it does have a measure of control over some definitions of money. But the links between money and the other economic variables have yet to be conclusively established. The facts about those links can help determine how well the Fed can do its job. The purpose of this study is to improve upon past attempts to determine what the facts are.

A central bank's major instrument of monetary policy is the growth rate of the money supply, targeted either directly or indirectly through some nominal target like an interest rate or the exchange rate for the country's currency. Different central banks choose to adjust different definitions of money, whichever they deem appropriate for their direct instrument. The target for price stability is typically some measure of the country's inflation rate, and the target for real economic activity, or production, is typically the growth rate of national output.

A natural way to start to analyze the ability of changes in money growth to affect the rate of inflation or output growth is to examine the statistical correlations between these variables. To do that, we need to make some choices. Do we look for correlations in data over the short run—during a quarter or a year, for example—or do we concentrate on much longer time periods? Do we look for correlations within or across countries? For reasons explained below, we here examine long-run correlations over a large cross section of countries, although we do check the robustness of our results by determining how sensitive they are to the choice of countries included in the cross section.

Our findings about these correlations indicate that over the long run the Fed has more ability to follow Congress' mandate about inflation than its mandate about production. Specifically, the correlations that we compute reveal these long-run monetary facts:

- There is a high (almost unity) correlation between the rate of growth of the money supply and the rate of inflation. This holds across three definitions of money and across the full sample of countries and two subsamples.

- There is no correlation between the growth rates of money and real output. This holds across all definitions of money, but not for a subsample of countries in the Organisation for Economic Co-operation and Development (OECD), where the correlation seems to be positive.

- There is no correlation between inflation and real output growth. This finding holds across the full sample and both subsamples.

Studying long-run, cross-country correlations like those we consider is, of course, not new. What is new here is threefold: we consider a larger number of countries than have been used before, we consider more definitions of money, and we consider how sensitive the results are to the choice of subsamples of countries.

Methodology

In this article, we examine long-run correlations between money growth and other variables because many economists and policymakers have strong reservations about the ability of monetary policy to hit short-run targets for either inflation or output. Milton Friedman is perhaps the best-known exponent of this view. He has said, "I don't try to forecast short-term changes in the economy. The record of economists in doing that justifies only humility" (quoted in Bennett 1995).

We study a cross section of countries rather than just a single country because we want our results to be independent of policy rules. If we were to study a single country, the correlations we obtained could be an artifact of the particular policy rule or rules being followed there. For example, suppose a central bank were to follow a constant growth rate rule for the money supply. If we examined the time series for the growth rate of money and the inflation rate for that economy, we would observe no correlation between these two variables. If, instead, the central bank chose to follow a feedback rule, where the growth rate of money was determined by the inflation rate, then we would observe a perfect correlation between money growth and inflation.

We hope that the range of policy rules in our cross section of countries is so broad that the correlations we observe are independent of the policy rules. Even if all central banks were following a constant money growth rule, we doubt that they'd all be following the same one. That's true for feedback rules too. So, by using a large cross section of countries, we hope our correlations will be free of policy rule influences.

Independence of correlations from policy rules is important because we want the correlations we find to be useful for determining whether causal relationships exist. While correlations are not direct evidence of causality, they do lend support to causal hypotheses that yield predictions consistent with the correlations. Consider, for example, the hypothesis that a monetary policy with a higher growth rate of money will result in a higher inflation rate than a policy with a lower rate of growth in an otherwise identical economy. That hypothesis would be supported (though by no means conclusively) by observed positive correlations between money growth and inflation.

This study is based on time series data for 110 countries. For each country, we calculate the long-run (up to 30-year) geometric average rate of growth for the standard measure of production, gross domestic product adjusted for inflation (real GDP); a standard measure of the general price level, consumer prices; and three commonly used definitions of money (M0, M1, and M2). We also look for correlations over two specific subsamples of countries. One of the subsamples consists of 21 OECD countries; the other consists of 14 Latin American countries.[1] The countries within each of the two subsamples are more homogeneous than those in the full sample in terms of avail-

able technology, education, and level of development of financial (and other) institutions. We consider the findings from these subsamples as a crude test of robustness of our full sample facts.

The data we use come from the CD-ROM version of the International Monetary Fund's *International Financial Statistics* (*IFS*). The time period we consider is from 1960 to 1990. For each country with 10 or more years of data (110 countries), we calculate the geometric rate of growth for consumer prices (line 64 of the *IFS* tables); three definitions of money—M0, currency plus bank reserves (line 14); M1, money easily used in transactions (line 34); and M2, money easily used in or converted into use for transactions (the sum of lines 34 and 35)—and real GDP. The growth rate of real GDP is calculated by subtracting the growth rate of consumer prices from that of nominal GDP (line 99b).

The Facts

Now we will restate each of the three results of our study, describe each in detail, and discuss how our results compare with those of previous studies.

Money Growth and Inflation

> In the long run, there is a high (almost unity) correlation between the rate of growth of the money supply and the rate of inflation. This holds across three definitions of money and across the full sample of countries and two subsamples.

The evidence on the long-run relationship between the rate of money growth and the rate of inflation from our sample of 110 countries is presented in Table 1. It shows a high correlation between money growth and inflation for both narrow and broad definitions of money. For the full sample, for each of the three definitions of money we consider, the correlation coefficient between the rate of change of the money definition and the rate of change of consumer prices is 0.925 or higher.

The evidence from our sample also suggests that the growth rates of M1 and M2, which are broader definitions of money, are slightly more highly correlated with inflation rates than is the growth rate of M0, which is a narrow definition. The correlation coefficients for the broader definitions are both approximately 0.95, whereas that for the narrower definition is slightly lower, 0.925.

The evidence from the subsamples of OECD and Latin American countries, also shown in Table 1, confirms the robustness of the high correlation between money growth and inflation. For these subsamples, the correlation coefficients between money growth and inflation are always higher than 0.89, and the relation is always weaker for M0 than for the broader monetary aggregates.

The high correlation between money growth and inflation suggests that the relationship between these two variables is very close to linear. The natural question is, What is the slope of the relationship? Here the slope is very close to unity, as is illustrated in Chart 1, where we plot average rates of change of the M2 definition of the money supply and average rates of change of consumer prices for the full 110-country sample. Each point in the chart represents the observations on money growth and inflation for a particular country. In the chart we have also drawn a 45-degree line through the grand means of the observations. Inspec-

tion shows that the individual country observations lie on or very close to such a line.

The finding that money growth and inflation have a linear relationship with a slope very close to unity brings to mind the quantity equation. The quantity equation is

$$(1) \qquad M \times V = P \times Y$$

where M is the money supply, V is the velocity of money (roughly, how many times each dollar in the money supply is spent each year), P is the price level, and Y is real output. Written in terms of growth rates, the quantity equation becomes

$$(2) \qquad m + v = p + y$$

where the lowercase letters in (2) refer to the growth rates of the variables represented by the uppercase letters in (1). The growth rate version of the quantity equation implies that there should be a linear relationship between money growth and inflation with a slope coefficient of unity when v and y are treated like constants.

The evidence in Chart 1 seems to support the quantity equation, at least as a long-run constraint on the effects of monetary policy. That the 45-degree line through the grand means does not go through the origin of the graph suggests that a central bank cannot generate a particular long-run rate of inflation by choosing an equal long-run growth rate for the money supply. The long-run inflation rate is influenced by the growth rates of real output and velocity as well as by the growth rate of money. However, a central bank can be confident that over the long run a higher growth rate of the money supply will result in a proportionally higher inflation rate.

Our finding is consistent with what other studies have found. A sampling of them we summarize in Table 2. This table shows that the existence of a high correlation between money growth and inflation has been found in many studies, but these studies have focused almost exclusively on broad definitions of money. Lucas (1980), for example, applies filters that progressively emphasize the long-run relationship in U.S. data between M1 and the consumer price index. He finds that the relationship becomes more regular, with a coefficient closer to one, the more the filter stresses the low frequencies (the long-run relationships). Lucas (1980, p. 1005) claims that the low-frequency relationship he finds represents "one way in which the quantity-theoretic relationships can be uncovered via atheoretical methods from time-series which are subject to a variety of other forces."

Other evidence for the long-run relationship between money growth and inflation has come from studies using cross-sectional data. In general, these studies include fewer countries and cover a shorter time period than does our study. For example, using a pooled time series–cross-sectional regression, Vogel (1974, p. 112) finds that "an increase in the rate of growth of the money supply causes a proportionate increase in the rate of inflation within two years." The coefficients Vogel gets sum to close to one and behave like a filter that stresses low frequencies. These low-frequency results can be interpreted as representing long-run relationships. Dwyer and Hafer (1988, p. 9) find that "countries with higher money growth on average simi-

larly have higher rates of inflation." However, we doubt that the five-year averages Dwyer and Hafer use are long enough to reflect the steady-state relationships as they claim. Studies by Barro (1990) and Poole (1994) are also consistent with the fact of a high correlation between money growth and inflation. Barro (1990, p. 155) finds a "strong positive association across countries between the average rates of price change and the average rates of monetary growth." Poole finds a strong positive relationship between the rate of inflation and the average annual change in a broad measure of money per unit of real GDP. Pakko (1994) examines the relationship between money growth and inflation for 13 countries that were formerly Soviet republics. He finds that countries "with the highest rates of inflation tend to be those with the most rapid money growth rates."

Rolnick and Weber (1994) use long-run average rates of growth to study the relationship between money and inflation under commodity and fiat monetary regimes. They find that the correlation between money growth and inflation is almost unity for fiat money regimes, but much lower, 0.61 or less, for commodity money regimes.

Sargent (1982) and Smith (1985) present some empirical evidence that seems inconsistent with the fact that money growth and inflation are highly correlated. Specifically, Sargent (1982) shows that in several European countries in the 1920s, inflation rates fell far more than did money growth rates after the monetary reforms that followed the ends of four hyperinflations. Smith (1985) presents evidence that during the colonial period in the United States, prices did not increase at the same rate as did money. Taken together, the Sargent and Smith studies show that rates of money growth can exceed, perhaps significantly, rates of inflation.

On closer examination, however, their evidence is not inconsistent with that presented here. We find a few data points that do not lie close to the 45-degree line in Chart 1. Almost exclusively, these fall below the line—which is consistent with the Sargent and Smith observations.

Money Growth and Real Output Growth

In the long run, there is no correlation between the growth rates of money and real output. This holds across all definitions of money, but not for a subsample of OECD countries, where the correlation seems to be positive.

The evidence on the long-run relationship between money and real output growth from our sample of 110 countries is shown in Table 3. It shows no correlation between money growth and real output growth. Although the coefficients for the correlations between the growth of money, however defined, and real output are negative, all of the coefficients are lower than −0.05. Since the standard deviation away from zero is 0.097, none of these correlation coefficients is statistically different from zero at any reasonable significance level for the full sample.[2] Chart 2 plots the average rates of change of the M2 definition of money and the average rates of change of real output for the full 110-country sample. The lack of any relationship between the two variables is also clearly shown here.

Our finding of no correlation between money growth and real output growth appears to be robust across the subsample of Latin American countries (Table 3). While the

correlation might seem to be more negative for this subsample than for the sample as a whole—the correlation coefficients for the subsample are between −0.17 and −0.25 for all three definitions of money—none of the correlation coefficients is significantly different from zero at any reasonable significance level.

However, the fact of no correlation between money growth and real output growth does not appear to be robust across the subsample of OECD countries (Table 3). For these countries, there is a positive and relatively high correlation between average rates of growth of money and real output. For these countries, the correlation coefficients between money and real output growth are always higher than 0.5 and range between 0.51 and 0.71. This indicates that within the group of OECD countries, those with higher rates of growth of the money supply tend to have higher rates of real output growth. The correlation is highest for M0 growth; the correlations for M1 and M2 growth are lower and approximately equal to each other, which is to be expected since they are so highly correlated themselves.[3]

While correlation coefficients indicate the direction of a relationship, they do not indicate its magnitude. That is, while the positive correlation coefficients for the OECD subsample indicate that increases in money growth tend to be associated with increases in real output growth for these countries, they do not tell whether the money growth increases are associated with real output growth increases that are large or small. To obtain some idea of the magnitudes involved, we regressed real output growth on money growth for the OECD countries and measured the slope of the regression line. We obtained slope coefficients approximately equal to 0.1 for all three definitions of money. These results indicate that increases in money growth are associated with increases in real output growth about one-tenth as large. The positive relationship between the growth rates of M0 and real output for OECD countries is shown in Chart 3. In that chart we have also drawn a line through the grand means with a slope of 0.1.

Some might be led to conclude from these results that the central banks of OECD countries should embark on rapid money growth in order to achieve high rates of long-term real output growth. This is not necessarily so. As was suggested above, the positive correlations in the data may reflect not a causal relationship, but rather a similarity in central bank policy; the central banks of the OECD countries may all be following similar feedback rules from real output growth to money growth, increasing or decreasing money growth as real output growth increases or decreases. Further investigation is required to determine what is going on.

Nonetheless, that qualification does not mean that the correlation for the OECD subsample of countries must be dismissed. It is a reminder that results based on select subsamples of the world's countries cannot necessarily be interpreted as representing global relationships. Institutional or policy differences among countries may be an important feature in explaining how each country's real output relates to its money supply process. For example, our finding may reflect the fact that the financial institutions of the OECD countries permit a separation of fiscal and monetary policies that is not seen in the rest of the world.

Table 4 summarizes some previous studies of the relationship between money growth and real output growth. The studies do not agree on what that relationship is. This is not surprising given our finding about the sensitivity of the results to the subsample chosen. Some studies find a negative relationship. For Kormendi and Meguire (1985), the average rate of growth of the money supply and the standard deviation of money supply shocks are both negatively correlated with real output growth. For Dwyer and Hafer (1988), the growth rate of money is negatively correlated with that of real output, but money growth is not statistically significant for explaining real output growth. Some studies get ambiguous results. Poirier (1991) finds that money is neutral in some countries and not in others. For Poirier (1991, p. 137), "the data provide little discrimination between neutrality . . . and nonneutrality." Other studies find no relationship. Geweke (1986) finds money "superneutral," implying no correlation between money growth and real output growth. His result is not consistent with our finding of a positive relationship between these variables for the subsample of OECD countries.

Inflation and Real Output Growth

In the long run, there is no correlation between inflation and real output growth. This finding holds across the full sample and both subsamples.

For the inflation–real output relationship, the evidence from our sample of 110 countries is shown in Table 5 and plotted in Chart 4. The correlation between inflation and real output growth is −0.243. Since the standard deviation away from zero is 0.097, this correlation coefficient is significantly different from zero at a reasonable level for the full sample.

This seems to indicate that there is at least a weak negative relationship between the rate of inflation and the rate of growth of real output, but further investigation contradicts that. The correlation coefficients for the entire sample are distorted by one unusual country. The plot of the individual country observations in Chart 4 demonstrates that the data include a definite outlier, a data point that seems very different from the rest. This data point is for Nicaragua, which had real output growth of −12 percent and an inflation rate of 52 percent. (Nicaragua was engaged in a civil war during much of the sample period.) With Nicaragua eliminated from the sample, the correlation coefficient (for the remaining 109 countries) is −0.101, which is not significantly different from zero.

Further, although the inflation–real output growth results for the Latin American and OECD subsamples look different from those for the full sample, all the results are consistent. For the Latin American subsample, the correlation is negative, at −0.342, but since the standard deviation from zero is 0.302, this not significantly different from zero at the 0.1 level. Rather interestingly, for the OECD subsample, the correlation is positive, but it is not significantly different from zero at the 0.1 level either.

Our finding about inflation and real output growth is somewhat different from much of what has already been reported in the literature. Table 6 summarizes some of the other studies. Kormendi and Meguire (1985) find that the average inflation rate is negatively correlated with average output growth. Fischer (1983, 1991); Altig and Bryan (1993); Ericsson, Irons, and Tryon (1993); and Barro (1995) all find a negative correlation between the inflation rate and the growth rate of output.

The difference between our results and those of the studies listed in Table 6 and the difference between our results for the full sample and the Latin American subsample and those for the OECD subsample suggest that the true relationship between inflation and real output growth is still uncertain. This conclusion is supported by the work of Levine and Renelt (1992). They find that the relationship between inflation and output is not robust to the inclusion of additional variables in regression equations explaining real output growth. The types of variables Levine and Renelt include are the average rate of inflation, the growth rate of domestic credit, and the standard deviations of both of those variables.

Conclusion

Here we present three principal long-run monetary facts derived from an examination of 110 countries over a 30-year period, using three definitions of a country's money supply. First, growth rates of the money supply and the general price level are highly correlated, with a correlation coefficient close to one, for three money definitions. Second, the growth rates of money and real output are not correlated. This fact is not robust, however. For a subsample of OECD countries, growth rates of money and real output are positively correlated. Third, the rate of inflation and the growth rate of real output are essentially uncorrelated.

To the extent that we can interpret the long-run relationships we get here as causal relationships, what do they suggest about the ability of central banks to hit policy targets? First, the fact that the correlation between money growth and inflation is close to one implies that we can adjust long-run inflation by adjusting the growth rate of money. However, that does not mean that we can hit specific inflation targets. To do that requires accurately predicting the growth rates of real output and velocity, something that has not been done well. This should cause concern about the type of inflation targets that have been adopted by some countries recently. Further, our results do not argue either for or against a constant money growth rule. We find a relationship between long-run rates of money growth and inflation. On the short-run relationship between these variables, this study can say nothing.

Second, the fact that the growth rates of money and real output are not correlated suggests that monetary policy has no long-run effects on real output. Of course, this does not rule out the possibility that it might have short-run effects. On the ability of monetary policy to hit any short-run real output targets, this study, again, is silent. However, if the long-run effect of monetary policy on real economic activity is truly zero, then any short-run successes in reducing downturns can only come about at the expense of reducing upturns.

[2]We compute the standard deviation of the correlation coefficient using the approximation due to Fisher (as described in Brownlee 1965, p. 414). According to this approximation, the standard deviation is $(n–3)^{-1/2}$, where n is the number of observations. Thus, for the full 110-country sample, the standard deviation is 0.097; for the OECD subsample, it is 0.236; and for the Latin American subsample, it is 0.302.

[3]Note that our findings about the relationship between money growth and real output growth have implications for the relationship between money growth and velocity growth. This is because the quantity equation restricts the pairwise correlations between the four variables that appear in it. Specifically, if we take the pairwise correlations of the variables in equation (2) with respect to the growth rate of money, we obtain

$$(*) \qquad 1 + \rho(m,v)s(m,v) \equiv \rho(m,p)s(m,p) + \rho(m,y)s(m,y)$$

where $\rho(x,y)$ denotes the correlation between the variables x and y and $s(x,y)$ denotes the ratio of the standard deviation of x to the standard deviation of y. Since we showed above that the relationship between m and p is linear with a slope coefficient of unity, we know that $\rho(m,p)s(m,p) = 1$. Substituting that into equation $(*)$ and subtracting 1 from both sides yields

$$(\dagger) \qquad \rho(m,v)s(m,v) = \rho(m,y)s(m,y).$$

According to equation $(\dagger)$, once the correlation between money growth and real output growth is known, so is the correlation between money growth and velocity growth. The two correlations must be equal up to the ratio of their standard deviations. Since the correlation between the growth rates of money and real output seems to be zero, equation $(\dagger)$ implies that the correlation between the growth rates of money and velocity must be zero as well.

References

Altig, David E., and Bryan, Michael F. 1993. Policy and long-run output: A sensitivity analysis. Manuscript. Federal Reserve Bank of Cleveland.

Barro, Robert J. 1990. *Macroeconomics.* 3rd ed. New York: Wiley.

_____. 1995. Inflation and economic growth. *Bank of England Quarterly Bulletin* 35 (May): 166–76.

Bennett, Amanda. 1995. Inflation calculus: Business and academia clash over a concept: 'Natural' jobless rate. *Wall Street Journal,* January 24: 8.

Brownlee, K. A. 1965. *Statistical theory and methodology in science and engineering.* 2nd ed. New York: Wiley.

Dwyer, Gerald P., Jr., and Hafer, R. W. 1988. Is money irrelevant? *Federal Reserve Bank of St. Louis Review* 70 (May/June): 3–17.

Ericsson, Neil R.; Irons, John S.; and Tryon, Ralph W. 1993. Output and inflation in the long run. Manuscript. Division of International Finance, Board of Governors of the Federal Reserve System.

Federal Reserve Board of Governors (FR Board). 1990. *Federal Reserve Act and other statutory provisions affecting the Federal Reserve System.* Washington, D.C.: Board of Governors of the Federal Reserve System.

Fischer, Stanley. 1983. Inflation and growth. Working Paper 1235. National Bureau of Economic Research.

_____. 1991. Growth, macroeconomics, and development. *NBER Macroeconomics Annual 1991,* Vol. 6, ed. Olivier Jean Blanchard and Stanley Fischer, pp. 329–64. Cambridge, Mass.: MIT Press/National Bureau of Economic Research.

Geweke, John. 1986. The superneutrality of money in the United States: An interpretation of the evidence. *Econometrica* 54 (January): 1–21.

Kormendi, Roger C., and Meguire, Philip G. 1985. Macroeconomic determinants of growth: Cross-country evidence. *Journal of Monetary Economics* 16 (September): 141–63.

Levine, Ross, and Renelt, David. 1992. A sensitivity analysis of cross-country growth regressions. *American Economic Review* 82 (September): 942–63.

Lucas, Robert E., Jr. 1980. Two illustrations of the quantity theory of money. *American Economic Review* 70 (December): 1005–14.

Pakko, Michael R. 1994. Inflation and money growth in the former Soviet Union. *International Economic Conditions* (February): 1. Research and Public Information Division, Federal Reserve Bank of St. Louis.

Poirier, Dale J. 1991. A Bayesian view of nominal money and real output through a new classical macroeconomic window. *Journal of Business & Economic Statistics* 9 (April): 125–48.

Poole, William. 1994. Keep the M in monetary policy. *Jobs & Capital* 3 (Winter): 2–5. Milken Institute for Job & Capital Formation.

Rolnick, Arthur J., and Weber, Warren E. 1994. Inflation, money, and output under alternative monetary standards. Research Department Staff Report 175. Federal Reserve Bank of Minneapolis.

Sargent, Thomas J. 1982. The ends of four big inflations. In *Inflation: Causes and effects,* ed. Robert Hall, pp. 41–97. Chicago: University of Chicago Press.

Smith, Bruce D. 1985. Some colonial evidence on two theories of money: Maryland and the Carolinas. *Journal of Political Economy* 93 (December): 1178–1211.

Vogel, Robert C. 1974. The dynamics of inflation in Latin America, 1950–1969. *American Economic Review* 64 (March): 102–14.

Table 1

Correlation Coefficients for Money Growth and Inflation*

Based on Data From 1960 to 1990

Sample	Coefficient for Each Definition of Money		
	M0	M1	M2
All 110 Countries	.925	.958	.950
Subsamples			
21 OECD Countries	.894	.940	.958
14 Latin American Countries	.973	.992	.993

*Inflation is defined as changes in a measure of consumer prices.

Source of basic data: International Monetary Fund

Table 2

Previous Studies of the Relationship Between Money Growth and Inflation

Author (and Year Published)	Study Characteristics					
	Time Series		Countries	Time Period	Data Frequency	Finding
	Money	Inflation				
Vogel (1974)	Currency + Demand deposits	Consumer prices	16 Latin American countries	1950–69	Annual	Proportionate changes in inflation rate within two years of changes in money growth
Lucas (1980)	M1	Consumer prices	United States	1955–75	Annual	Strong positive correlation: Coefficient closer to one the more filter stresses low frequencies
Dwyer and Hafer (1988)	n.a.	GDP deflator	62 countries	1979–84	Five-year averages	Strong positive correlation
Barro (1990)	Hand-to-hand currency	Consumer prices	83 countries	1950–87	Full-period averages	Strong positive association
Pakko (1994)	Currency + Bank deposits	Consumer prices	13 former Soviet republics	1992 and 1993	Four-quarter averages	Positive relationship
Poole (1994)	Broad money	n.a.	All countries in World Bank tables	1970–80 and 1980–91	Annual averages	Strong positive correlation
Rolnick and Weber (1994)	Various	Various	9 countries	Various	Long-period averages	Strong positive correlation for fiat money regimes

n.a. = not available

Table 3

Correlation Coefficients for Money Growth and Real Output Growth*

Based on Data From 1960 to 1990

Sample	Coefficient for Each Definition of Money		
	M0	M1	M2
All 110 Countries	−.027	−.050	−.014
Subsamples			
21 OECD Countries	.707	.511	.518
14 Latin American Countries	−.171	−.239	−.243

*Real output growth is calculated by subtracting changes in a measure of consumer prices from changes in nominal gross domestic product.

Source of basic data: International Monetary Fund

Table 4

Previous Studies of the Relationship Between Money Growth and Real Output Growth

Author (and Year Published)	Study Characteristics		Countries	Time Period	Data Frequency	Finding
	Time Series					
	Money	Output				
Kormendi and Meguire (1985)	M1	Real GDP	47 countries	1950–77	Period averages	Negative correlation
Geweke (1986)	M2, M1	NNP, industrial production	United States	1870–1978, Postwar period	Annual, monthly	Money superneutral
Dwyer and Hafer (1988)	n.a.	Real GDP and GNP	62 countries	1979–84	Five-year averages	Slight negative correlation (not statistically significant)
Poirier (1991)	M1	Real GDP	47 countries	1873	Annual	Money neutral in some countries, not in others

n.a. = not available

Table 5

Correlation Coefficients for Inflation
and Real Output Growth*

Based on Data From 1960 to 1990

Sample	Coefficient With Outlier**	
	Included	Excluded
All 110 Countries	−.243	−.101
Subsamples		
21 OECD Countries	.390	.390
14 Latin American Countries	—	−.342

 *Inflation is defined as changes in a measure of consumer prices. Real output
  growth is calculated by subtracting those inflation rates from changes in nominal
  gross domestic product.
**The outlier is Nicaragua.
  Source of basic data: International Monetary Fund

Table 6

Previous Studies of the Relationship Between Inflation and Real Output Growth

Author (and Year Published)	Study Characteristics		Number of Countries	Time Period	Data Frequency	Finding
	Time Series					
	Inflation	Output				
Fischer (1983)	n.a.	n.a.	53	1961–73, 1973–81	Annual	Negative contemporaneous relationship; positive correlation with one lag
Kormendi and Meguire (1985)	Consumer prices	Real GDP	47	1950–77	Period averages	Negative correlation
Fischer (1991)	GDP deflator	GDP	73	1970–85	Annual	Negative relationship
Altig and Bryan (1993)	GDP deflator	Per capita GDP	54 and 73	1960–88	Annual	Negative correlation
Ericsson, Irons, and Tryon (1993)	GDP deflator	GDP	102	1960–89	Annual	Weak negative correlation
Barro (1995)	Consumer prices	Per capita real GDP	78, 89, and 84	1965–90	Five- or ten-year averages	Negative correlation

n.a. = not available

Chart 1

Money Growth and Inflation:
A High, Positive Correlation

Average Annual Rates of Growth in M2 and in Consumer Prices
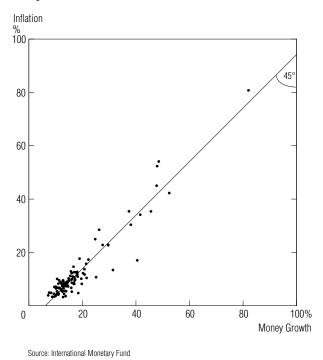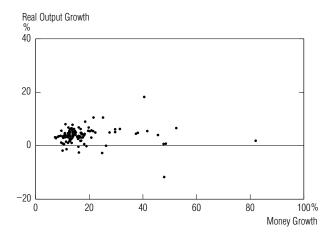During 1960–90 in 110 Countries

Inflation
%

Money Growth

Chart 2

Money and Real Output Growth:
No Correlation in the Full Sample . . .

Average Annual Rates of Growth in M2
and in Nominal Gross Domestic Product, Deflated by Consumer Prices
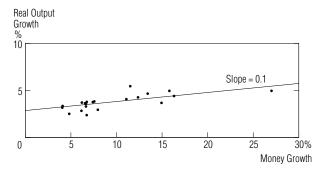During 1960−90 in 110 Countries

Real Output Growth
%

Money Growth

Chart 3

. . . But a Positive Correlation in the OECD Subsample

Average Annual Rates of Growth in M0
and in Nominal Gross Domestic Product, Deflated by Consumer Prices
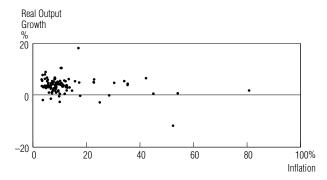During 1960–90 in 21 Countries

Real Output
Growth
%

Slope = 0.1

Money Growth

Chart 4

Inflation and Real Output Growth: No Correlation

Average Annual Rates of Growth in Consumer Prices
and in Nominal Gross Domestic Product, Deflated by Consumer Prices
During 1960–90 in 110 Countries