On the Correlations of Nominal Money and Real Output: A Simple Cross-Country Analysis

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Abstract

This study examines correlations of nominal monetary aggregates (the monetary base, M1, and M2) and real output in a broad sample of countries in the 1975-2000 period. On average we typically observe small but statistically significantly positive correlations. For the monetary base and M1, there is a tendency of money changes to precede output changes since the half lag in money is more strongly correlated with output than the half lead in money. M1 and M2 is more strongly associated with real output than the monetary base. In high-inflation countries, the given correlations are typically negative.

JEL classification: E32, E51, E52, N10

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1. Introduction

A fundamental problem in macroeconomics is a possible connection of nominal variables (such as the nominal monetary base, M1, and M2) and real variables (such as the real output, industrial production, and unemployment). Most economists believe that money affects real variables in the short run. However, the general belief is that in the long run the economy's product converges to the potential product, while the unemployment rate converges to the natural rate of unemployment. It is not possible to speed up the long-run growth of the economy by monetary expansions; money does not influence real output in the long run (see, for example, Kormendi and Meguire, 1984, and Barro, 1997, Chapter 18). This phenomenon is called the *long-run neutrality of money*. If we regress the long-run growth rate of real product on the long-run growth rate of money in a broad sample of countries, we typically find no significantly positive relationship (see Duczynski, 2001). Nevertheless, frequent

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monetary contractions (declines in the monetary base or the money supply) are connected with low long-run growth of real output. This observation somewhat weakens the concept of long-run neutrality.

In the economic literature, there are two major techniques examining the impact of money on output, namely the *statistical approach* and the *narrative approach*. Some studies using statistical techniques are based on regressions of output on money and lagged values of money. These are the St. Louis equations (see, for example, Romer, 1996, p. 232). The problem with these studies is that they cannot identify *causality* from money to output. A similar problem arises in studies of the effects of unanticipated money (developed, for example, by Attfield and Duck, 1983) and in studies using vector autoregressions (VAR). The narrative approach can better address the problem of causality. This approach uses the historical record and identifies cases of large shifts in monetary policy that were not driven by the real economy (Friedman and Schwartz, 1963a; Romer and Romer, 1989).

The present paper uses the statistical approach. It examines correlations of the growth rates of the monetary base (M0), money (M1), and money plus quasi money (M2), and the growth rates of real product in a broad sample of countries in the 1975-2000 period. We consider all the countries for which the *International Financial Statistics Yearbook* (2002) presents data; we have around 100 observations. Average correlations are close to zero – they are around 0.1. Albeit small in absolute value, they are statistically significantly positive (we observe this using t-tests for means). We obtained similar results in Duczynski (2005), where we examined a sample of developed countries in the 1951-1990 period. Thus, there exists at least some association between nominal money and real product; nevertheless, money is not likely to be the most important driving force of business fluctuations. For high-inflation countries, money-output correlations are even negative. It is possible that rapid money growth is harmful for the real economic activity, although it is also likely that low output leads to high money growth (in recessions there are high seignorage needs since the tax base is low). We also observe that for the whole sample of countries, the growth rates of M0 and M1 precede the growth rates of output (lagged money is more connected with output than lead money). M1 and M2 is more strongly associated with output than M0.

The paper is organized as follows. Section 2 briefly describes the channels of monetary policy. Section 3 is devoted to the problem of endogenous money. Section 4 introduces the notion of half lags and half leads of money changes. Section 5 presents the results, and Section 6 concludes the paper.

2. The channels of monetary policy

Money can affect real output via the interest rate channel, the exchange rate channel, the equity channel, the bank lending channel, and the balance sheet channel. A monetary expansion (growth of M1 or M2) increases the demand for bonds (people want to have balanced portfolios of money and bonds and want to change a part of the additional money for bonds). The prices of bonds increase, and interest rates go down (there is a negative association between bond prices and market interest rates). This is a standard *liquidity effect* (see Mankiw, 2000, p. 273). Some components of the aggregate demand (namely investment and to some extent consumption) depend negatively on the real interest rate – they are stimulated by lower rates (the interest rate channel). The Mundell-Fleming model predicts that in an open economy with flexible exchange rates, lower interest rates induce a financial capital outflow and an exchange rate depreciation, which leads to higher net exports and higher output (the exchange rate channel). Lower interest rates increase asset prices. The wealth of households is positively affected, and consumption and output go up (the equity channel). A monetary contraction can affect the real economy via the decline in the supply of credit (a credit crunch); small firms typically do not have easy substitutes for bank loans (the bank lending channel). A monetary contraction also diminishes cash flows and the net worth of firms; this leads to problems with asymmetric information in credit markets (the balance sheet channel).

3. The endogeneity of money

It is important to realize that positive correlations of money and output do not necessarily imply causality from money to output. This is the well-known problem of endogenous money; practically all studies relying on the statistical approach face this difficult problem. One example of endogenous money is a banking panic (see Barro, 1997, p. 712). In this situation the amounts of deposits and the money supply decrease, and also the real output is negatively affected. In this case, there is no direct causality from money to output. Because the reaction of the real economy to the banking panic may take some time, changes in output may follow changes in money. Classic examples of monetary endogeneity are situations in which the central bank accommodates the money supply to changes in the demand for money. For example, a negative supply shock leads to low output and a low money demand and to high

prices. The central bank combats inflation and decreases the supply of money. There is a positive correlation of money and output, but money does not cause output. The money supply is typically an endogenous variable in open economies with fixed exchange rates. If the money demand in such economies goes up, interest rates increase (this follows from the money market), and there is an inflow of foreign financial capital. There is a surplus in the financial account of the balance of payments, and foreign reserves and the domestic money supply increase. If the initial change in the money demand was connected with a change in output in the same direction, there is again causality from output to money. For more details concerning endogenous money, see, for example, King and Plosser (1984).

Despite the difficulty regarding the endogeneity of money, presenting correlations of money and output has its advantages. The problem of the neutrality (non-neutrality) of money is a fundamental, extremely important problem, and any piece of evidence concerning it is valuable. The given approach is quite simple and clear; it is frequently the best strategy to keep the analysis as simple as possible. We consider a large sample of countries; this is an advantage over studies focusing only on one country – random effects existing in individual countries are averaged out in the present study. The data used (the data of the IMF) are believed to be of high quality. We can address some important problems, for example, whether broader monetary aggregates (M1 and M2) are more strongly associated with the real product than narrower monetary aggregates (M0), or whether money changes precede output changes.

4. Half-lag and half-lead money changes

The present paper introduces half-lag and half-lead money changes relative to output changes (see also Duczynski, 2005). The main idea is that the growth rate of output between two subsequent years (T and T+1) is not directly comparable to the growth rate of money between T and T+1. Output is a flow variable, whereas money is a stock variable. The growth rate of output between T and T+1 reflects the average growth performance both in T and T+1. For example, if output grows continually within T and stays constant within T+1, we still observe a positive change of output between T and T+1. The situation is different for money, for which the growth between T and T+1 reflects only a change in T+1 (the stock of money is derived from end-of-year estimates). We call the growth rate of money between T and T+1 a half-lead growth rate relative to the output growth rate between T and T+1. Similarly, the

growth rate of money between T-1 and T is called a half-lag growth rate relative to the output growth rate between T and T+1.

Examining correlations of half-lag money changes and output changes, and half-lead money changes and output changes can shed light on the problem of whether money changes precede output changes. Most economists believe that there are lags in the effects of monetary policy on the real economy (see, for example, Friedman, 1961, and Friedman and Schwartz, 1963b). If half-lag money is more strongly correlated with output than half-lead money, then there is a tendency of money changes to precede output changes. This is an important fact which would otherwise be difficult to document. Although this fact still does not imply causality from money to output, it constitutes an important rule concerning the association of money and output. In the present paper we observe that money changes tend to precede output changes for M0 and M1 in a broad sample of countries.

5. The results

We have considered all the countries for which the *International Financial Statistics Yearbook* (2002) presents data. Table 1 shows average correlations of half-lag money changes and output changes, r[m(-1),g], and average correlations of half-lead money changes and output changes, r[m,g], for various groups of countries. Table 2 presents corresponding standard deviations. Table 3 illustrates corresponding t-statistics for differences of the means presented in Table 1 from zero. Table 4 shows the numbers of observations for each group of countries and each indicator.

Figure 1 shows the dependence of r[m,g] on r[m(-1),g] for M1 for 21 developed countries. This figure is quite similar to Figure 1 in Duczynski (2005), where we examined correlations between the real output *per capita* and nominal money in the group of developed countries in 1951-1990. Clearly positive values of r[m,g] and r[m(-1),g] prevail. As indicated by Table 1, both half lags and half leads of all monetary aggregates are on average positively correlated with output in the group of developed countries; nevertheless, the average correlations are small; the mean of the six averages (r[m(-1),g] and r[m,g] for M0, M1, and M2) is only 0.127. Table 3 implies that half lags of all monetary aggregates are statistically significantly correlated with output in developed countries since all the corresponding t-statistics exceed 2. Since the half lags of money are more strongly correlated with output than the half leads of money, money changes precede output changes. This is consistent with Duczynski (2001, 2005) but inconsistent with Duczynski (2004). Broader monetary aggregates are not more

strongly connected with real output than narrower monetary aggregates, which is to some extent inconsistent with Duczynski (2001, 2004, and 2005).

Figure 2 illustrates the dependence of r[m,g] on r[m(-1),g] for M1 for 26 African countries. Again, positive values of r[m,g] and r[m(-1),g] dominate. Table 1 shows that all the average correlation coefficients are positive for these countries; the mean of the six averages is 0.119, which is quite similar to the mean in developed countries. For M1 and M2, the average correlation coefficients are significantly positive (the t-statistics in Table 3 are 2 or higher). As opposed to developed countries, in Africa changes in money are preceded by changes in output – correlations r[m,g] are higher than correlations r[m(-1),g]. African countries are structurally different from developed countries, and they have a correspondingly different monetary transmission. A precise explanation of why product changes precede money changes is left for future research. In African countries broader monetary aggregates are more strongly connected with real output than narrower aggregates, which supports some of the findings in our previous research. (Out of the aggregates considered, M0 is the narrowest aggregate, while M2 is the broadest one.)

Figure 3 presents M1-output correlations for 15 Asian countries. Again, positive values prevail. As described in Table 1, there is practically no average correlation between M0 and output in Asia. The averages for M1 and M2 are positive but small. The mean of the six indicators – r[m(-1),g] and r[m,g] for M0, M1, and M2 – is just 0.072 for the countries in Asia, which is less than for developed countries or countries in Africa. The only significant association is for r[m,g] for M1, where the t-statistic exceeds 2. We observe a certain tendency of the product changes to precede money changes (for M1 and M2), similarly to the African countries. It is of some interest to present the behavior of monetary aggregates in the countries affected by the Asian crisis in 1998. In Indonesia, there was a dramatic fall of output (-13.1%) and relatively fast growth of money. In Korea, output fell by 6.7%, and there was a decline of M0, very slow growth of M1, and relatively rapid growth of M2. In Malaysia, the product went down by 7.4%, while monetary aggregates also declined. In Thailand, the decrement of output was 10.5%, while M0 fell, and M1 and M2 grew slowly.

Figure 4 shows M1-output correlations for 3 developing countries in Europe (Cyprus, Malta, and Turkey) and 7 countries in the Middle East. Again, positive values occur the most frequently. Table 1 indicates that all the average correlation coefficients are positive in this case. The mean of the six indicators is 0.196, which is higher than the means in the previous groups of countries. Changes in M0 precede changes in output, but changes in M2 follow changes in output. M1 is more strongly connected with real output than M0. There is at least

some evidence that M2 is more closely associated with output than M0: there is a large difference for r[m,g].

Figure 5 presents r[m,g] and r[m(-1),g] for 29 countries in the Western Hemisphere, which are Latin-American countries. Positive values prevail, but an important group of observations is negative (these are mainly the observations corresponding to high-inflation countries, discussed below). Except for r[m,g] for M0, the average correlation coefficients are positive, as indicated in Table 1. Statistically significant values are achieved for r[m(-1),g] for M1 and M2, where the t-statistics exceed 2 (see Table 3). The average of the six means – r[m(-1),g] and r[m,g] for M0, M1, and M2 – is 0.071, which is below the average in developed countries; it is similar to the average achieved in Asian countries. Changes in money precede changes in output – be it for M0, M1, and M2. The connection of M1 and M2 with real output is stronger than the association between M0 and output (consistently with Duczynski, 2004).

Probably *the most important lesson* can be learned from averages in the group of *all countries*. There are 100 observations for M0, and 101 observations for M1 and M2. All the six average correlation coefficients are positive, and they are strongly statistically significantly different from zero (except for r[m,g] for M0). The average of these six means is, however, only 0.108, which is a low number. Thus, there exists a statistically significant association between nominal money and real output; nevertheless, money is not likely to be the most important driving force of output fluctuations. In Duczynski (2005) we made a similar observation. Both M1 and M2 is more strongly connected with real output than M0; this corresponds to our findings in Duczynski (2001, 2004). M2 is not observed to be more tightly associated with output than M1; this stands in contrast to our previous results (Duczynski, 2001, 2005). Money changes precede output changes for M0 and M1, but not for M2.

Figure 6 examines M1-output correlations for 8 high-inflation countries (Democratic Republic of Congo, Israel, Argentina, Bolivia, Brazil, Mexico, Nicaragua, and Peru). These are the countries in which the growth of M1 exceeded 100% in at least two years in the 1975-2000 period. In all of these countries, the behavior of money was countercyclical (with the exception of Brazil, where it was acyclical). The average behavior of the product growth in the years in which M1 grew by more than 100% was g=-0.34%, with the standard deviation of s=5.40%, and the number of observations n=56. All the six average correlation coefficients are statistically significantly negative, as indicated by the t-statistics in Table 3. Product changes have a tendency to precede money changes, which was also observed for 5 high-inflation Latin-American countries in Duczynski (2005). The mean of the six averages of

correlation coefficients is -0.220, which is in absolute value higher than the corresponding mean in developed countries (0.127) or all countries (0.108). This is again consistent with Duczynski (2005), where we considered earlier data and output *per capita* (based on the Summers-Heston data set) instead of the total product. The negative money-output association in high-inflation countries indicates that it is likely that very high money growth rates are harmful for the economic growth, although it is also possible that slow or negative product growth induces monetary expansions – in recessions the tax base is lower and there are higher seignorage needs.

6. Conclusion

This paper has examined money-output correlations in a broad sample of countries in the 1975-2000 period. Average correlations are quite small – around 0.1, but they are statistically significantly positive. We have evidence that M1 and M2 is more strongly connected with real output than the monetary base (M0). We observe that money changes precede on average output changes for M0 and M1, but not for M2. Almost all average money-output correlations are positive in all the regional groups of countries, but they are negative in high-inflation countries. To summarize, the present paper has provided important pieces of evidence concerning the non-neutrality of money, which is a fundamental problem in macroeconomics.

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Table 1: Arithmetic averages of correlation coefficients between money and output

Group of countries	M0		M1		M2	
	r[m(-1),g]	r[m,g]	r[m(-1),g]	r[m,g]	r[m(-1),g]	r[m,g]
Developed	0.142	0.101	0.236	0.069	0.145	0.071
Africa	0.050	0.109	0.095	0.161	0.105	0.196
Asia	-0.002	0.013	0.109	0.167	0.043	0.104
Developing in Europe and Middle East	0.227	0.070	0.229	0.230	0.166	0.254
Western Hemisphere	0.085	-0.015	0.131	0.054	0.117	0.053
All countries	0.090	0.054	0.150	0.119	0.113	0.121
High-inflation countries	-0.166	-0.321	-0.143	-0.271	-0.150	-0.269

Table 2: Standard deviations of correlation coefficients between money and output

Group of countries	M0		M1		M2	
	s(-1)	s	s(-1)	s	s(-1)	s
Developed	0.17	0.22	0.23	0.28	0.27	0.25
Africa	0.22	0.30	0.24	0.25	0.24	0.28
Asia	0.31	0.29	0.31	0.26	0.27	0.27
Developing in Europe and Middle East	0.35	0.39	0.36	0.40	0.37	0.43
Western Hemisphere	0.28	0.32	0.30	0.34	0.25	0.36
All countries	0.26	0.30	0.28	0.30	0.27	0.32
High-inflation countries	0.18	0.19	0.15	0.18	0.14	0.17

Table 3: t-statistics testing the statistical significance of the difference of averages of money-output correlations from zero.

Group of countries	M0		M1		M2	
	t(-1)	t	t(-1)	t	t(-1)	t
Developed	3.85	2.10	4.68	1.14	2.47	1.28
Africa	1.15	1.88	2.00	3.31	2.19	3.63
Asia	-0.02	0.17	1.37	2.53	0.62	1.49
Developing in Europe and Middle East	2.05	0.57	2.00	1.83	1.43	1.86
Western Hemisphere	1.64	-0.25	2.39	0.85	2.50	0.80
All countries	3.44	1.81	5.38	3.97	4.29	3.84
High-inflation countries	-2.62	-4.86	-2.61	-4.33	-2.99	-4.48

Table 4: The numbers of observations of money-output correlations

Group of countries	M0	M1	M2
Developed	21	21	21
Africa	26	26	26
Asia	14	15	15
Developing in Europe and Middle East	10	10	10
Western Hemisphere	29	29	29
All countries	100	101	101
High-inflation countries	8	8	8

Figure 1. The dependence of correlations of half-lead money and output on correlations of half-lag money and output for developed countries

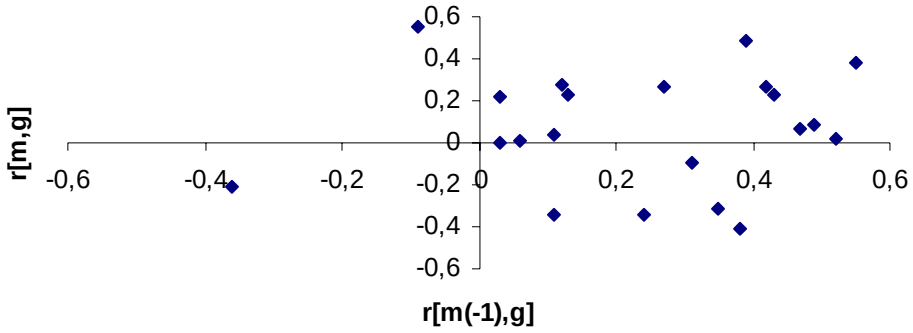

Figure 2. The dependence of correlations of half-lead money and output on correlations of half-lag money and output for countries in Africa

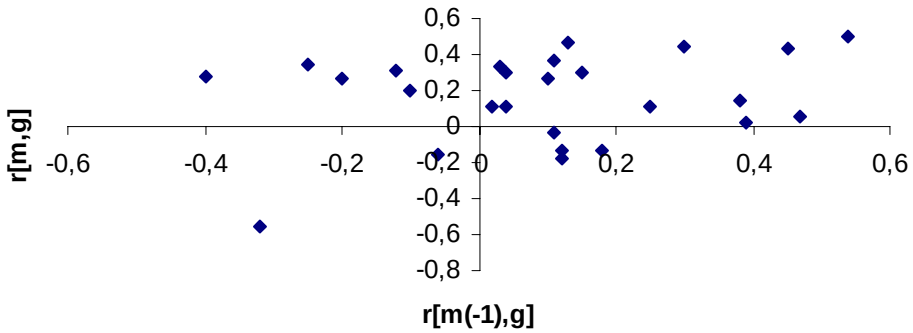

Figure 3. The dependence of correlations of half-lead money and output on correlations of half-lag money and output for countries in Asia

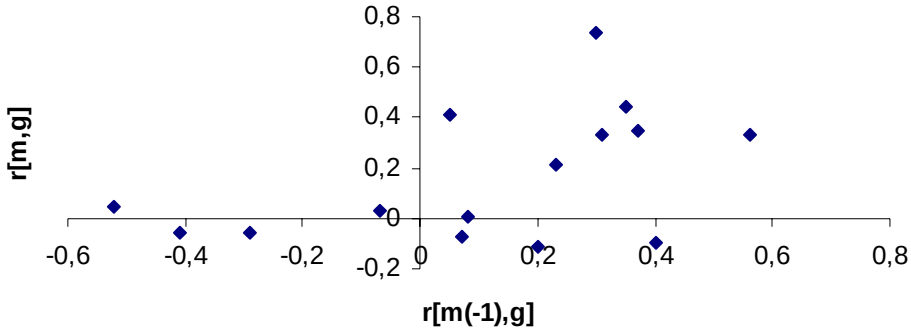

Figure 4. The dependence of correlations of half-lead money and output on correlations of half-lag money and output for developing countries in Europe and the Middle East

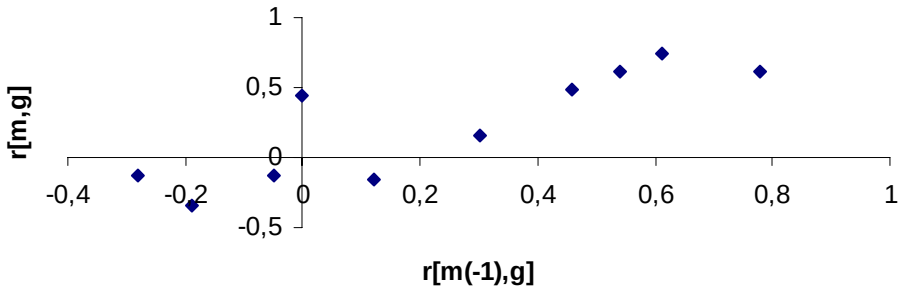

Figure 5. The dependence of correlations of half-lead money and output on correlations of half-lag money and output for countries in the Western Hemisphere

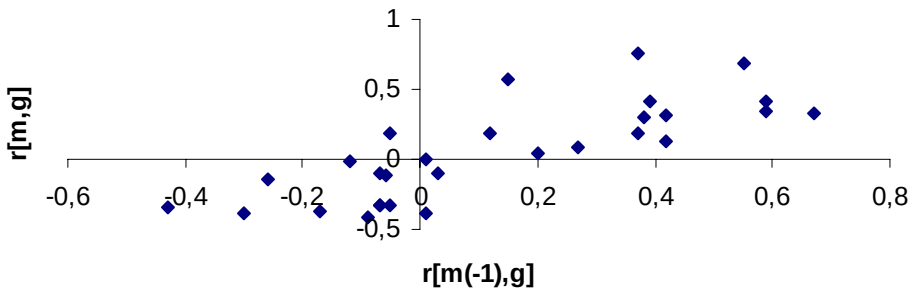

Figure 6. The dependence of correlations of half-lead money and output on correlations of half-lag money and output for high-inflation countries