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On the Empirics of the Non-neutrality of Money: Evidence from Developed Countries

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1. Introduction

One of the most important problems in macroeconomics is whether money has real effects. Most economists believe that money is neutral in the long run but non-neutral in the short run. The long-run neutrality of money is documented, for example, in (Kormendi – Meguire, 1984) and (Barro, 1997, Chapter 18). The short-run effects of money on income have been examined in a number of studies. In their classic work, Friedman and Schwartz (1963a) provide ample evidence that money mattered in the United States in the period before World War II. Apart from banking panics, they identify four periods of monetary shocks (January–June 1920, October 1931, June 1936–January 1937, and, in general, the passivity of the Fed in the Depression years 1929–1931) in which the monetary movement was unusual given economic conditions. They document that these monetary shocks were associated with declines in the real economic activity. Romer and Romer (1989) use a somewhat different criterion for monetary shocks. Following the narrative approach of Friedman and Schwartz, they add a relevant analysis for the postwar period. In their analysis the Romers study cases in which the Fed intended to cause a recession (or at least a slowdown) in order to decrease inflation (October 1947, September 1955, December 1968, April 1974, August 1978, and October 1979). They show that these contractionary measures really had significant effects on unemployment and industrial production. Several other studies have examined the impact of unanticipated money changes – for the United States, see (Barro, 1978); for the United Kingdom, see (Attfield et al., 1981); for Canada, see (Wogin, 1980); for a cross-country analysis, see (Attfield – Duck, 1983), and (Kormendi – Meguire, 1984). Some monetary studies use regressions of output on money and lagged values of money; these regressions are known as the St. Louis equation – see (Romer, 1996, p. 232). Granger-causality tests and vector autoregressions (VAR) are important tools in studying the impact of money on output.

The present paper complements the existing literature by providing evi-

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dence from a sample of 21 developed countries (Canada, United States, Japan, Western European countries, Australia, and New Zealand), which had (with the exception of Iceland) a stable monetary policy, and also from a sample of 5 Latin-American countries (Argentina, Bolivia, Brazil, Chile, and Peru) with highly volatile monetary policies. The data source for money and prices is the *International Financial Statistics* (IFS) of the International Monetary Fund, various issues. The data source for real output per capita is the Summers-Heston data set, Mark 5.6 – see (Summers – Heston, 1991), and the web site http://pwt.econ.upenn.edu/, RGDPCH variable.[1] The paper examines the series of data on the real output per capita growth, the growth of the monetary base (high-powered money, code 14 – reserve money[2] – in the IFS), money (code 34 in the IFS), money plus quasi money (code 35l in the IFS),[3] and the price level (code 64 – consumer prices – in the IFS) in the period from 1951 to 1990 (whenever the data are available).

The present study works with nominal monetary aggregates and real output per capita. There are, of course, two possible alternatives to this approach. First, we could have considered real monetary aggregates. We follow the approach of, for example, Attfield and Duck (1983), and Kormendi and Meguire (1984), who use nominal money. Since the price level is found to be countercyclical, real money would have been more procyclical than nominal money. Second, we could have worked with total real output (Attfield – Duck, 1983); (Kormendi – Meguire, 1984); (Duczynski; 2004) instead of output per capita. However, changes in output per capita better reflect changes in the standard of living. We also believe that output per capita better corresponds to the economic situation; the total output is influenced by the size of the population, which is to some extent a non-economic factor. Definitely, we are not interested in whether monetary policy affects the size of a population. We should also note that the quality of the underlying Summers-Heston data on real output per capita is believed to be high.

For two reasons, the paper does not work with unanticipated monetary changes. The first reason is practical – it is probably difficult to implement a reliable procedure that separates unanticipated and anticipated changes. The second reason hinges on a macroeconomic theory. Although the rational expectations literature – (Lucas, 1972, 1973), (Barro, 1976) – suggests that only unexpected changes in money matter, Fischer (1979) discusses a model with the Tobin effect (anticipated inflation induces capital accumulation) in which anticipated monetary changes (as well as transitory unanticipated monetary changes) are non-neutral, whereas permanent unanticipated monetary changes are neutral.

For each developed country, it is computed how the growth rates of real output per capita are correlated with the growth rates of nominal monetary aggregates, and how the price level growth rates are correlated with per capita output growth rates. Additionally, the paper shows how the growth

[1] This research started before the new Summers-Heston data for 2000 were available. For this reason, the time period considered ends in 1990.

[2] Reserve money also includes currency outside deposit money banks.

[3] Money is approximately M1 and money plus quasi money is approximately M2.

of nominal money and the price level behaved during output contractions and booms. If money really matters in the short run, the correlation coefficient of the growth of output and the growth of money can be expected to be positive, as well as the correlation of the growth of output and the growth of the price level. Of course, the price level can be countercyclical if the effects of money are more than offset by the effects of supply shocks. Examining the cyclical behavior of the price level can shed light on the relative importance of real and monetary shocks in the business cycle.

It is widely believed that monetary policy is effective with a lag – see, among other studies, (Friedman, 1961), (Friedman – Schwartz, 1963b). To address this issue, the paper examines how the lagged values of the growth rates of nominal money are correlated with the growth rates of real output per capita. It is important to realize that there is a conceptual difference in measuring the growth rate of money and the growth rate of output (output is a flow variable, whereas money is a stock variable).[4] The growth rate of output between two subsequent years (T and $T + 1$) reflects the average growth performance both in T and $T + 1$. On the other hand, the growth rate of money between T and $T + 1$ relates only to the behavior of money in $T + 1$ (the growth rate is computed from end-of-year estimates). Thus the growth of money between T and $T + 1$ follows in some sense the growth of output between T and $T + 1$. In this paper 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 $T + 1$. The paper formally tests whether the correlation between the half-lag growth rate of money and the growth rate of output per capita is higher on average than the correlation between the half--lead growth rate of money and the growth rate of output per capita. This tendency may be a relevant indication that money changes precede output changes, an important fact which may otherwise be difficult to document.

In addition, the paper studies how one-and-half-lead money changes (changes between $T + 1$ and $T + 2$) are correlated with per capita output changes (between T and $T + 1$). If these correlations are positive, it could be some indication that money endogenously responds to the previous real economic activity. The issue of the endogeneity of money is important. Definitely, one should be aware that a positive correlation of money (or even lagged values of money) and output does not imply causality from money to output. Barro (1997, p. 712) provides some examples of endogenous money: If there is a banking panic,[5] the amounts of deposits and the money supply are negatively affected, and there is a decline in the real economy. Money does not cause output in this situation. In addition, changes in money may precede changes in output since the response of the real economy to the banking panic may take some time. Endogenous money also arises in situations in which the central bank accommodates the money supply to

[4] This difference does not apply for the price level because consumer prices are computed as period averages.

[5] We believe, however, that banking panics were not very relevant for developed countries in 1951–1990.

changes in the money demand. If there is a negative supply shock, output and the money demand decline, while prices increase. In order to reduce inflation, the central bank decreases the supply of money. Money and output are positively correlated in this situation, although causality is directed from output to money. We typically have endogenous money in open economies with fixed exchange rates. If there is an increase in the demand for money in such economies, interest rates go up, and there is an inflow of foreign 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 money demand reflects a change in output, there is again causality from output to money. For more details concerning the endogeneity of money and related topics, see, for example, (Tobin, 1970), (Black, 1972), and (King – Plosser, 1984).

The paper also examines how one-and-half-lag money changes (changes between $T-2$ and $T-1$) are correlated with per capita output changes (between T and $T+1$). These correlations are found marginally significantly negative, which supports the idea that money is neutral in the long run.[6]

Additionally, it is examined whether broader monetary aggregates are on average more significantly associated with the real economy than narrower monetary aggregates. An expected outcome is that the correlation of output and money plus quasi money is higher than the correlation of output and money, which is in turn higher than the correlation of high-powered money and output. This expectation is confirmed only partially.

As suggested by the rational expectations literature (Lucas, 1972, 1973), and (Barro, 1976), the effectiveness of monetary policy should depend negatively on the variability of the monetary policy. This important implication of the literature stems from the basic assumption of the underlying models – the inability of individuals to distinguish between real and nominal shocks. If a shock occurs in a country with a stable monetary tradition, individuals rationally derive that it is likely that the shock is real; if the shock is positive, they supply more goods and the output increases. On the other hand, if a shock occurs in a country with a traditionally volatile monetary policy, individuals infer that the shock is probably nominal and they practically do not react. Empirical studies of this effect include (Lucas, 1973), (Attfield – Duck, 1983), and (Kormendi – Meguire, 1984). In order to address this issue in the present paper, correlation coefficients are computed between money and per capita output growth rates for high-inflation countries in South America. A somewhat surprising observation is that the given correlations are always negative. This finding goes beyond the standard neutrality implication of the rational expectations literature. It may be that dramatic monetary expansions are harmful for growth, although reverse causality cannot be excluded.

To summarize, the paper addresses the following fundamental questions:

1. Is there a statistically significant association between nominal money and real output in the short run?

[6] On the contrary, Duczynski (2001) finds some evidence that money may be long-run nonneutral. Frequent monetary contractions are connected with slow long-run growth.

2. Is there a tendency of money changes to precede output changes?
3. Is the association of broad monetary aggregates with output more important than the association of narrow monetary aggregates with output?
4. Is the price level procyclical or countercyclical?
5. Is there a tendency for the long-run neutrality of money?
6. What is the correlation between the per capita output growth rate and the one-and-half-lead growth rate of money? This correlation can provide at least some information concerning the endogeneity of money.
7. How is the output growth rate correlated with the money growth rate in high-inflation countries?

As stated above, the present paper's goal is oriented towards a statistical description. The paper tries to address a number of important questions, although it cannot provide absolutely convincing evidence that changes in money cause changes in real output. We cannot fully address the problem of endogenous money. We believe that providing correlations between money and output is still useful: The problem of whether money matters is extremely important and any piece of evidence concerning this problem is valuable. It is definitely useful to know if money changes precede output changes or if broader monetary aggregates (M2) are more strongly associated with real output than narrower aggregates (M1, M0), among other things studied in the paper. We believe that the present simple framework can better address these important issues than more sophisticated approaches would do. It is sometimes better to keep the analysis as simple as possible. The evidence from 21 developed countries and 5 Latin-American countries is in some sense more reliable than the evidence in studies examining only one country: random effects are averaged out in the present study.

2. Evidence from Developed Countries

The sample contains 21 countries. We focus on developed countries because the theory of rational expectations predicts that monetary policy should be effective in stable countries. At the end of this paper we will examine less stable countries (Latin-American countries), for which the rational expectations literature practically implies monetary neutrality. Thus we will be able to compare stable and less stable countries. We will also compare European and non-European developed countries.

Table 1 shows the averages and standard deviations for the growth rates of output per capita and consumer prices for developed countries in 1951–1990. This table also presents the correlation coefficients of the growth rates of output per capita and consumer prices. The given correlation coefficients are always negative. The average correlation coefficient makes –0.31 (standard deviation 0.15). The absolute value of the t-statistic for the difference of the mean correlation coefficient from zero is 9.63. Thus there exists a strongly significant countercyclical pattern of the price level.[7] *Table 2* examines the average behavior of the growth rate of CPI in recessions[8] and booms. This behavior is again typically countercyclical. This ob-

TABLE 1 The Averages and Standard Deviations of the Growth Rates of Output per capita and Consumer Prices in 1951–1990. The Correlation Coefficient of the Growth of Output per capita and Consumer Prices

Country	g_y	s_y	g_π	s_π	r
Australia	2.0	3.5	6.8	4.9	–0.54
Austria	3.8	2.8	4.7	4.6	–0.09
Belgium	2.8	2.2	4.2	3.3	–0.23
Canada	2.5	2.9	4.8	3.5	–0.09
Denmark	2.5	3.1	6.3	3.5	–0.50
Finland	3.6	3.6	7.0	4.7	–0.28
France	3.2	1.9	6.5	4.6	–0.37
Germany	3.7	3.0	3.1	2.1	–0.37
Iceland	3.3	4.8	21.8	18.9	–0.16
Ireland	3.1	2.8	7.5	5.7	–0.26
Italy	3.9	2.7	7.7	6.1	–0.35
Japan	6.0	3.6	5.3	4.6	–0.13
Netherlands	2.7	3.0	4.3	3.1	–0.16
New Zealand	1.4	3.9	7.9	5.0	–0.30
Norway	3.1	1.9	6.3	3.5	–0.21
Portugal	4.7	4.1	10.2	9.3	–0.40
Spain	4.2	4.3	9.1	5.7	–0.44
Sweden	2.4	1.7	6.4	3.6	–0.63
Switzerland	2.3	3.1	3.3	2.3	–0.28
United Kingdom	2.3	2.1	7.0	5.3	–0.47
United States	1.9	2.7	4.4	3.3	–0.31

Notes: g_y and s_y (in %) are the average and the standard deviation of the annual growth of output per capita. g_π and s_π (in %) are the average and the standard deviation of the growth of consumer prices. Coefficient r is the correlation coefficient of the given growth rates.

servation provides relevant information concerning the relative importance of real and monetary shocks in the business cycle. In particular, it seems that supply shocks were more important than monetary shocks in determining real output fluctuations.[9]

Table 3 shows the averages and standard deviations of the growth rate of money. It also presents correlation coefficients between the one-and-half-

[7] Studies examining correlations between detrended output and detrended prices typically find a countercyclical pattern of the price level in the postwar period – see (Backus – Kehoe, 1992), (Chadka – Prasad, 1994), and /with the expection of the 1950s and the 1960s/ (Smith, 1992). Nevertheless, Chadka and Prasad find that inflation (as opposed to a detrended price level) was positively correlated with detrended output. This stands in contrast to the present finding that inflation is negatively correlated with the output growth rate.

[8] In this paper, recessions are defined as declines in real output per capita in a given year relative to the previous year.

[9] Duczynski (2001) examines the average output performance in all countries (developed and developing) for the years between 1970 and 1990 in which the CPI declined. In these years, the average output growth was significantly below the long-run cross-country average. Duczynski (2004) observes a similar fact in the data from the 1990s. This procyclical character of the price level contrasts with the present finding.

TABLE 2 The Cyclical Behavior of CPI (1951–1990)

Country	$g_{\pi R}$	$\Delta g_{\pi R}$	DEF BOOM	$g_{\pi B}$	$\Delta g_{\pi B}$	cyclical behavior
Australia	9.8	+3.0	4.0	3.5	–3.3	cc
Austria	8.1	+3.4	5.0	6.7	+2.0	ac
Belgium	7.3	+3.1	5.0	4.2	0.0	w-cc
Canada	3.9	–0.9	5.0	3.9	–0.9	ac
Denmark	9.4	+3.1	5.0	3.8	–2.5	cc
Finland	10.1	+3.1	6.0	4.8	–2.2	cc
France	11.4	+4.9	5.0	6.7	+0.2	cc
Germany	5.2	+2.1	6.0	2.1	–1.0	cc
Iceland	17.8	–4.0	7.0	10.2	–11.6	cc
Ireland	6.1	–1.4	6.0	5.8	–1.7	ac
Italy	17.0	+9.3	6.0	6.7	–1.0	cc
Japan	7.8	+2.5	10.0	6.5	+1.2	ac
Netherlands	6.2	+1.9	5.0	3.4	–0.9	w-cc
New Zealand	9.0	+1.1	4.0	6.8	–1.1	w-cc
Norway	7.6	+1.3	5.0	5.8	–0.5	w-cc
Portugal	24.9	+14.7	7.0	6.6	–3.6	s-cc
Spain	12.7	+3.6	7.0	4.9	–4.2	cc
Sweden	10.3	+3.9	4.0	3.0	–3.4	cc
Switzerland	3.7	+0.4	4.0	2.1	–1.2	w-cc
United Kingdom	12.7	+5.7	4.0	4.5	–2.5	cc
United States	5.6	+1.2	4.0	3.2	–1.2	w-cc

Notes: $g_{\pi R}$ and $g_{\pi B}$ (in %) denote the average growth rates of CPI in recessions and booms, respectively. $\Delta g_{\pi R}$ and $\Delta g_{\pi B}$ (in %) denote their deviations from the long-run average growth rate for a given country. The growth rate of output per capita is considered a boom if it exceeds the value indicated in DEF BOOM (in %). For Japan, recessions also include slow growth of output per capita (below 3 %).

ac = acyclical; cc = countercyclical; pc = procyclical; s = strongly; w = weakly
This notation also applies to Table 6.

-lag money growth rate and the per capita output growth rate, $r[m(-2), g]$, between the half-lag money growth rate and the per capita output growth rate, $r[m(-1), g]$, between the half-lead money growth rate and the per capita output growth rate, $r[m,g]$, and between the one-and-half-lead money growth rate and the per capita output growth rate, $r[m(+1), g]$. The notation $m(-2)$ reflects the fact that the change in money occurs between $T - 2$ and $T - 1$ if the change in output occurs between T and $T + 1$. Since money is a stock variable and output is a flow variable, the actual lag of money relative to output is less than two in this case. *Figure 1* illustrates the dependence of $r[m,g]$ on $r[m(-1), g]$ for money. We have 12 observations in the first quadrant, two observations in the second quadrant, two observations in the third quadrant, one observation between the third and fourth quadrants, and four observations in the fourth quadrant. Clearly positive values of correlation coefficients prevail.

Table 4 shows the correlation coefficients between the half-lag growth rate of high-powered money and the growth rate of output per capita, and the correlation coefficients between the half-lead growth rate of high-powered

FIGURE 1 The Dependence of Correlations of Half-lead Money and Output on Correlations of Half-lag Money and Output

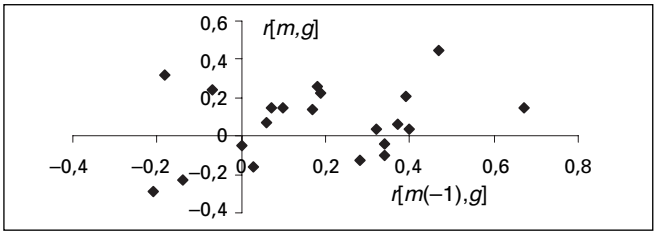

TABLE 3 Money and Output (1951–1990)

Country	g_M	s_M	r[m(–2),g]	r[m(–1),g]	r[m,g]	r[m(+1),g]
Australia	7.9	7.7	–0.38	–0.18	0.32	–0.19
Austria	8.0	6.2	0.08	0.17	0.14	0.09
Belgium	5.3	4.0	0.12	0.28	–0.13	0.26
Canada	7.5	7.1	0.05	0.40	0.04	0.12
Denmark	9.7	6.6	–0.31	0.37	0.06	–0.09
Finland	11.0	10.3	–0.42	0.19	0.22	–0.07
France	10.6	5.3	–0.13	0.00	–0.05	0.09
Germany[a]	8.8	4.1	0.29	0.67	0.15	0.12
Iceland[b]	26.4	18.2	–0.09	0.06	0.07	–0.10
Ireland	8.6	5.9	0.03	0.18	0.26	0.08
Italy	14.4	5.7	–0.17	0.07	0.15	–0.05
Japan[c]	12.2	7.5	0.14	0.47	0.45	0.50
Netherlands	7.6	4.8	0.34	0.34	–0.10	0.06
New Zealand	9.3	11.6	–0.32	0.10	0.15	–0.20
Norway	11.0	8.6	–0.09	–0.14	–0.23	0.28
Portugal	12.5	8.5	–0.20	0.03	–0.16	–0.19
Spain	14.8	5.6	–0.29	–0.07	0.24	0.22
Sweden[a]	7.6	3.7	–0.35	–0.21	–0.29	–0.36
Switzerland[d]	5.3	6.3	0.33	0.34	–0.04	0.05
United Kingdom[b]	8.5	7.9	0.05	0.39	0.21	–0.04
United States	5.4	4.1	–0.20	0.32	0.04	0.13
Mean			–0.07	0.18	0.07	0.03
Deviation			0.24	0.23	0.19	0.20
|*t*-statistic|			1.40	3.57	1.73	0.80

Notes: g_M and s_M (both in %) denote the average and the standard deviation of the annual growth rates of money. r[m(–2),g] is the correlation coefficient between the one-and-half-lag money growth rate and the per capita output growth rate. r[m(–1),g] is the correlation coefficient between the half-lag money growth rate and the per capita output growth rate. r[m,g] is the correlation coefficient between the half-lead money growth rate and the per capita output growth rate. r[m(+1),g] is the correlation coefficient between the one-and-half-lead money growth rate and the per capita output growth rate.

[a] data between 1951–1989
[b] data between 1952–1990
[c] data between 1954–1990
[d] There were frequent monetary contractions in the 1970s and the 1980s.

money and the growth rate of output per capita. *Table 5* presents similar correlation coefficients for money plus quasi money.

TABLE 4 Correlation Coefficients between High-powered Money Changes and per capita Output Changes (1951–1990)

Country	$r[m(-1),g]$	$r[m,g]$
Australia	–0.19	0.50
Austria	0.16	–0.02
Belgium	0.12	0.12
Canada	0.32	0.34
Denmark	0.22	–0.01
Finland	–0.04	0.27
France	–0.10	0.25
Germany[a]	0.29	0.47
Iceland	0.21	0.08
Ireland	0.00	0.10
Italy[b]	0.02	–0.32
Japan[c]	0.17	0.55
Netherlands	0.20	0.10
New Zealand	0.33	0.11
Norway	0.47	0.30
Portugal[c]	0.12	–0.00
Spain[d]	–0.34	–0.08
Sweden	–0.05	–0.04
Switzerland	0.11	0.03
United Kingdom	0.01	0.45
United States	0.25	0.03
Mean	0.11	0.15
Deviation	0.19	0.22
$\lvert t\text{-statistic}\rvert$	2.63	3.18

Notes: [a] data between 1952–1989
[b] data between 1956–1990
[c] data between 1954–1990
[d] data between 1953–1990

Table 6 examines the behavior of money in recessions and booms. A procyclical pattern of money prevails; the procyclical pattern is somewhat stronger for half-lag money changes than for half-lead money changes.

Tables 3, 4, and 5 also present average correlation coefficients of changes in monetary aggregates with per capita output changes, corresponding standard deviations of correlation coefficients, and t-statistics for differences of the means from zero. For money, the average correlation coefficient $r[m(-2), g]$ is marginally significantly negative (the critical t-value at a 10% level in a one-tail test is 1.33). This observation provides at least partial support for the idea that money is neutral in the long run. The average coefficients $r[m(-1), g]$ and $r[m,g]$ are significantly positive for high-powered money and money plus quasi money; for money, coefficient $r[m(-1), g]$ is significantly positive and coefficient $r[m,g]$ is marginally significantly positive. Thus there exists a statistically significant association between nominal monetary aggregates (M0, M1, and M2) and real output in the short run. This observation is important and tells us at least something about the non-neu-

TABLE 5 Correlation Coefficients between Money plus Quasi Money Changes and per capita Output Changes (1951–1990)

Country	$r[m(-1),g]$	$r[m,g]$
Australia	0.09	0.15
Austria[a]	0.60	0.22
Belgium	0.39	0.05
Canada	–0.02	0.19
Denmark	0.35	0.14
Finland	0.20	0.44
France	0.02	0.02
Germany[b]	0.67	0.46
Iceland[c]	0.02	0.03
Ireland	0.13	0.22
Italy[a]	0.29	–0.09
Japan	0.25	0.34
Netherlands	0.32	0.11
New Zealand	0.03	0.02
Norway	0.21	0.16
Portugal[a]	–0.08	–0.13
Spain[d]	0.09	0.25
Sweden	0.05	–0.10
Switzerland	0.43	–0.15
United Kingdom[c]	0.20	0.23
United States	0.36	0.05
Mean	0.22	0.12
Deviation	0.20	0.17
$\lvert t$-statistic$\rvert$	4.99	3.30

Notes: [a] data between 1954–1990
[b] data between 1952–1989
[c] data between 1952–1990
[d] data between 1953–1990

trality of money. Nevertheless, since the average correlation coefficients are small (they range from 0.07 to 0.22), it is likely that money is not the most important driving force of output fluctuations. For money, the average coefficient $r[m(+1), g]$ is significantly positive at a 25% level in a one-tail test (the critical t-level is 0.69). The value of the average of this coefficient is very low, thus indicating that there may be a very weak association between the output growth and the lead of the money growth. It is possible that a part of monetary movements endogenously responds to previous output movements.[10]

For money and for money plus quasi money, the mean of $r[m(-1), g]$ is higher than the mean of $r[m,g]$. In other words, half-lag growth rates of money (money plus quasi money) are more strongly associated with per capita output growth rates than half-lead growth rates of money. This is

[10] The positive value of $r[m(+1), g]$ may also reflect that money causes output and that money is autocorrelated over time.

TABLE 6 The Cyclical Behavior of Money (1951–1990)

Country	$\Delta g_{M(-1)R}$	Δg_{MR}	$\Delta g_{M(-1)B}$	g_{MB}	*M*(–1)	*M*
Australia	+0.3	–5.3	–3.2	+0.9	w-cc	pc
Austria	+4.3	–1.4	+3.4	+5.0	ac	pc
Belgium	–2.7	+2.8	+1.8	–1.1	pc	cc
Canada	–5.6	–1.2	+1.6	+2.1	pc	w-pc
Denmark	–3.8	–0.2	+2.6	–1.0	pc	ac
Finland	–1.9	–2.4	+0.7	+3.9	w-pc	pc
France	–0.2	+1.8	+2.3	+0.7	w-pc	ac
Germany	–5.5	–0.7	+4.0	+0.8	s-pc	w-pc
Iceland	–9.7	–7.4	–6.2	–5.5	ac	ac
Ireland	–4.1	–4.2	+1.6	+3.5	pc	pc
Italy	–1.9	+0.2	–0.6	+0.9	ac	ac
Japan	–1.6	–0.8	+6.1	+4.3	pc	pc
Netherlands	–5.7	+1.2	+0.3	–0.5	pc	w-cc
New Zealand	+0.8	+0.2	+4.1	+0.4	w-pc	ac
Norway	+18.2	+6.2	+2.2	+3.2	cc	w-cc
Portugal	–0.7	+3.9	+0.6	–1.5	w-pc	cc
Spain	+0.7	–3.1	–3.2	–0.5	w-cc	w-pc
Sweden	0.0	+2.4	–1.2	–1.5	w-cc	w-cc
Switzerland	–5.4	+2.1	+0.8	+0.8	pc	ac
United Kingdom	–1.5	–1.1	+8.5	+4.4	s-pc	pc
United States	–2.5	–1.1	+0.8	–0.7	w-pc	ac

Notes: $\Delta g_{M(-1)R}$ (in percentage points) is the deviation of the average of half-lag money changes in recessions from the long-run growth rate of money for a given country. Δg_{MR} is a similar variable for half-lead money changes. $\Delta g_{M(-1)B}$ and Δg_{MB} are similar variables for booms. *M*(–1) denotes the cyclical behavior of half-lag money changes, while *M* denotes the cyclical behavior of half-lead money changes (see the notation used in Table 2). For Japan, recessions also include years with slow growth of output per capita (below 3 %).

some evidence that money (money plus quasi money) changes precede output changes.[11] The *t*-statistic for the difference in the means of $r[m(-1), g]$ and $r[m,g]$ is 1.68 for money and 1.65 for money plus quasi money. In comparison, the critical value for a 10% significance level in a one-tail test is 1.30, and for a 5% level 1.68. However, for high-powered money, the average of $r[m(-1), g]$ is below the average of $r[m,g]$. In this case, the absolute value of the *t*-statistic for the difference in means is 0.71, which is well below the *t*-statistics for money and for money plus quasi money.

An interesting question is whether broader monetary aggregates are more strongly associated with real output than narrower monetary aggregates. High-powered money is the narrowest aggregate. The average of $r[m(-1), g]$ for high-powered money is really below the average for money. The corresponding *t*-statistic for the difference in means is 1.09, which is significant at a 25% level in a one-tail test. Nevertheless, the average of $r[m,g]$ for high-powered money is above the corresponding average for money. The value of the *t*-statistic for the difference in means is 1.31 in this case, which is

[11] Additional evidence that money changes precede output changes is provided in (Duczynski, 2001). However, money changes are not observed to precede output changes in (Duczynski, 2004).

significant at a 10% level. If we pool the observations for $r[m(-1), g]$ and $r[m,g]$, the average is 0.13 both for high-powered money and money. Thus there is no evidence that money is more strongly associated with real output than high-powered money or vice versa.[12] We can also compare high-powered money with money plus quasi money. The average of $r[m(-1), g]$ for money plus quasi money is above the average of $r[m(-1), g]$ for high-powered money, and the corresponding t-statistic for differences in means is 1.82, which is significant at a 5% level. However, the average of $r[m,g]$ for money plus quasi money is below the corresponding average for high-powered money. The t-statistic for differences in means is -0.49 in this case, which is insignificant. If we pool the observations for $r[m(-1), g]$ and $r[m,g]$, the average is 0.17 for money plus quasi money. The t-statistic for the difference in means in the pooled samples (comparing 0.13 with 0.17) is 0.95, which is significant at a 25% level in a one-tail test. Similar results are obtained if money is compared with money plus quasi money. The averages of $r[m(-1), g]$ and $r[m,g]$ are higher for money plus quasi money than for money. The corresponding t-statistics for differences in means are 0.58 for $r[m(-1), g]$ and 0.95 for $r[m,g]$. The critical value for a 25% significance level in a one-tail test is 0.68. If we pool the observations for $r[m(-1), g]$ and $r[m,g]$, the t-statistic for the difference in means (comparing 0.13 with 0.17) is 1.04, which is significant at a 25% level. Thus the above discussion provides at least some evidence that M2 is more strongly associated with real output than M0 or M1.[13]

It is of some interest to compare 16 European and 5 non-European developed countries. For European countries, the average $r[m(-1), g]$ for money (M1) is 0.17, while the average $r[m,g]$ is only 0.03. For non-European countries, the average is 0.22 for $r[m(-1), g]$ and 0.20 for $r[m,g]$. Thus, money was more strongly connected with output in non-European countries (in particular in Japan) than in European countries. The tendency of money changes to precede output changes was much stronger in European countries, where $r[m(-1), g]$ was much higher than $r[m,g]$ on average.

Regarding high-powered money (M0), the average $r[m(-1), g]$ was 0.09 for European countries, and 0.18 for non-European countries. The average $r[m,g]$ was 0.11 in Europe and 0.31 outside Europe. Thus, also high-powered money was more strongly connected with output in non-European countries than in European countries. In non-European countries, there was a stronger tendency of output changes to precede high-powered money changes.

For money plus quasi money (M2), the average $r[m(-1), g]$ was 0.24 for European countries and 0.14 for non-European countries. The average $r[m,g]$ was 0.12 in European countries and 0.15 in non-European countries. Here, the association of M2 and real output is not stronger in non-European countries than in European countries since $r[m(-1), g]$ is too high in European countries. It is partly because M2 and the real product were strongly connected in Germany and to some extent in Austria. Changes in

[12] Duczynski (2004) observes that money (M1) or money plus quasi money (M2) is more strongly connected with real output than high-powered money (M0).

[13] Duczynski (2001, 2004) provides additional evidence in this respect.

M2 preceded changes in output only in European countries. M2 was more strongly associated with real output than M0 or M1 again only in European countries.

3. Evidence from High-inflation Countries

This section considers those South American countries for which the standard deviation of annual money growth rates exceeded 50 %. The countries considered are high-inflation countries.[14] The rational expectations literature practically implies monetary neutrality for such economies. The sample contains 5 countries (Argentina, Bolivia, Brazil, Chile, and Peru). The sample of countries and the starting years of the time periods considered depend on data availability. The monetary data have been taken from the IFS.

In Argentina, the arithmetic average of annual money growth rates in 1961–1990 was 301 % (standard deviation 764 %). The correlation coefficients between the money growth rates and the per capita output growth rates are $r[m(-1), g] = -0.17$ and $r[m,g] = -0.39$.

In Bolivia, the average money growth rate in 1951–1990 was 233 % (standard deviation 944 %). The correlation coefficients are $r[m(-1), g] = -0.22$ and $r[m,g] = -0.14$.

In Brazil, the mean growth rate of money in 1951–1990 was 166 % (standard deviation 415 %). The correlation coefficients are $r[m(-1), g] = -0.35$ and $r[m,g] = -0.34$.

In Chile, the average money growth rate in 1962–1990 was 78 % (standard deviation 87 %). The correlation coefficients are $r[m(-1), g] = -0.22$ and $r[m,g] = -0.37$.

In Peru, the average money growth rate in 1951–1990 was 259 % (standard deviation 1082 %). The correlation coefficients are $r[m(-1), g] = -0.21$ and $r[m,g] = -0.24$.

All the correlation coefficients are negative; in absolute value, these correlations are somewhat higher than correlations for developed countries. This observation goes beyond the expected neutrality result. It is likely that extremely large monetary expansions are harmful for the real output growth.[15] Of course, it is also possible that defects in the real economic activity lead to rapid monetary growth rates (a fall in the tax revenue in recessions may result in higher seignorage needs). The averages of the correlation coefficients in the sample of the 5 South American countries are –0.23 for $r[m(-1), g]$ and –0.30 for $r[m,g]$. The higher absolute value for $r[m,g]$ than for $r[m(-1), g]$ indicates that causality from output to money may be an important part of the story.

[14] Cagan (1956) is a classic study examining high inflations. Cagan studied hyperinflations in Austria, Germany, Hungary, Poland, and Russia after World War I, and Greece and Hungary after World War II.

[15] Duczynski (2001, 2004) shows that extremely high money growth rates are associated with below-average output growth rates in broad samples of developing countries.

4. Concluding Remarks

This paper examines money-output and price-output associations in the sample of 21 developed countries, typically in the 1951–1990 period. The average correlation coefficients between (half-lag and half-lead) changes in monetary aggregates and per capita output changes are positive and significantly different from zero, be it for high-powered money, money, or money plus quasi money. This observation is consistent with the notion that money changes cause output changes, although it is also possible that money endogenously responds to the real economic activity.

For money and for money plus quasi money, there is some tendency for a stronger correlation between half-lag money changes and per capita output changes than between half-lead money changes and per capita output changes. Thus, in some sense money changes precede output changes. This observation indicates that there probably is some causality from money to output.[16] Nevertheless, for high-powered money, the average correlation between half-lag money changes and per capita output changes is weaker than the correlation between half-lead money changes and per capita output changes. The given difference is, however, practically insignificant.

We have at least some evidence that money plus quasi money is on average more strongly correlated with real output than money or high-powered money. There is, however, no difference in average correlations of money and output, and high-powered money and output.

The price level was significantly countercyclical on average. This observation suggests that the importance of real shocks for output fluctuations was higher than the importance of monetary shocks.

The negative money-output association in high-inflation countries stands in contrast to the positive money-output association in developed countries. The direction of causality between money and output in high-inflation countries (as well as better inference regarding the direction of causality in developed countries) is left for future research.

The present study can help provide some recommendations to the policy of the Czech National Bank (as well as other central banks). The Czech economy has experienced relatively low inflation in recent years. According to the theory of rational expectations, money should matter in low-inflation economies. The present paper shows that it is quite likely that money affects real output in the short run. This finding corresponds to the belief of most economists. Nevertheless, we also find that correlations between money and output changes are relatively low (averages are typically in the range between 0.1 and 0.2). Thus, one could assume that money probably matters, but not extremely. This is consistent with the idea presented in (Barro, 1997, pp. 715–717). Nevertheless, some other monetary studies (Duczynski, 2001, 2004) observe that declines in monetary aggregates are connected with significantly below-average output growth. For example, for declines in M1 the output growth is 2–3 percentage points below average, which indicates quite an important association between money and output.

[16] Money can still be endogenous, but the fact that money changes precede output changes is more difficult to explain in the framework with no causality from money to output.

It is therefore possible that there exists some *nonlinearity* in the effect of money on output – the effect is very strong for unusual money changes (such as declines in monetary aggregates). Thus, the central bank should *prevent declines in monetary aggregates*. In addition, Duczynski (2001, 2004) observes that extremely large money growth rates (above 50 % or 100 % per year) are also associated with below-average output growth. This observation is consistent with the present finding that money-output correlations are negative in high-inflation Latin-American countries. This evidence supports the idea that there are nonlinearities in the effect of money on output. If we are ready to believe in causality from money to output also in this case, the central bank should *prevent extremely large money growth rates* not only from the viewpoint of inflation, but also from the viewpoint of the product growth.[17]

[17] Having examined Czech (Czechoslovak) data to 2001 in the IFS, the author finds out that M0 grew by more than 100 % in 1990 and then fell sharply in 1991. M1 grew by more than 50 % in 1994 and declined in 1990, 1997, and 1998. M2 declined slightly in 1990.

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SUMMARY

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On the Empirics of the Non-neutrality of Money: Evidence from Developed Countries

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The paper examines the cyclical behavior of money and prices in a sample of developed countries dating from 1951 to 1990. Evident in the data is a tendency toward an average countercyclical behavior of the price level and a weakly procyclical behavior of nominal monetary aggregates. For money (M1) and money plus quasi-money (M2), correlation coefficients between the real per capita output growth rate and the half lag in the money growth rate are higher on average than correlation coefficients between the real per capita output growth rate and the half lead in the money growth rate, thus indicating that money changes precede output changes. There is at least some evidence that M2 is more strongly associated with real output M1 or high-powered money (M0). As opposed to developed countries, high-inflation Latin American countries exhibit a countercyclical behavior of money.