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**On the Empirics of the Nonneutrality of Money:  
Evidence from Developed Countries**

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# On the Empirics of the Nonneutrality of Money: Evidence From Developed Countries

Petr Duczynski\*

## Abstract

The paper examines the cyclical behavior of money and prices in the sample of developed countries, typically in 1951-1990. There exists a statistically significant tendency towards an average countercyclical behavior of the price level and a weakly procyclical behavior of monetary aggregates. For money and money plus quasi money, 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. Money plus quasi money tends to be more strongly associated with real output than money or high-powered money.

**JEL classification:** E31, E32, N10

**Keywords:** Consumer prices; Half-lag and half-lead growth rates; Nominal monetary aggregates; Real output

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## I. 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 nonneutral in the short run. The long-run neutrality of money is documented, for example, in Kormendi and 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 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 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 real effects. 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 and Duck, 1983, and Kormendi and Meguire, 1984).

The present paper complements the existing literature by providing evidence from a sample of developed countries (including Cyprus, Greece, and Malta). 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 and Heston, 1991, and the web site <http://pwt.econ.upenn.edu/>, RGDPCH variable). The paper examines the series of data on the real output per capita growth, the growth of the monetary base (code 14 – reserve money<sup>1</sup> – in the IFS), money (code 34 in the IFS), money plus quasi money (code 351 in the IFS),<sup>2</sup> and the price level (code 64 – consumer prices – in the IFS) in the period from 1951 to 1990 (whenever the data are available).

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<sup>1</sup> Reserve money also includes currency outside deposit money banks.

<sup>2</sup> Money is approximately M1 and money plus quasi money is approximately M2.

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 the macroeconomic theory. Although the rational expectations literature (Lucas, 1972, 1973, and 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 nonneutral, 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, it is discussed how the growth 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, and Friedman and 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).<sup>3</sup> 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

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<sup>3</sup> This difference does not apply for the price level because consumer prices are computed as period averages.

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 because money endogenously responds to the previous real economic activity. [The issue of the endogeneity of money is extremely complicated and cannot be fully explained in the present paper. At a minimum, one should be aware that a positive correlation of money (or even lagged values of money) and output does not imply that monetary changes cause output changes. This consideration is important but examining the correlation of money and output is still relevant because it sheds some light on an important issue - the association of money and the real economy. For the issue of the endogeneity of money and related topics, see, for example, Tobin (1970), Black (1972), and King and 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.<sup>4</sup>

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 partially confirmed.

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 – 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 and Duck (1983), and Kormendi and Meguire (1984). To address this issue, I present correlation coefficients 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

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<sup>4</sup> On the contrary, elsewhere (Duczynski, 2001) I find some evidence that money may be long-run nonneutral.

neutrality implication of the rational expectations literature. It may be that dramatic monetary expansions are harmful for growth, although reverse causality cannot be a priori excluded.

To summarize, the paper addresses the following fundamental questions:

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

## **II. Evidence from individual countries**

This section presents results for individual countries. The analysis is based on comparing individual growth rates rather than detrended variables. The advantage of this approach is that the results do not depend on the method of detrending.

### *Australia*

In 1951-1990, the arithmetic average of annual growth rates of real output per capita was 2.0% (standard deviation 3.5%). The arithmetic average of annual growth rates of the consumer price index (CPI) was 6.8% (standard deviation 4.9%). The correlation coefficient (henceforth denoted by  $r$ ) between the given growth rates was  $r=-0.54$  (computed from annual observations).

In recessions,<sup>5</sup> the CPI growth rates were 19.8% in 1951, 17.2% in 1952, 6.3% in 1956, 2.5% in 1957, 2.5% in 1961, 4.0% in 1965, 15.1% in 1974,

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<sup>5</sup> In this paper, recessions are defined as declines in real output per capita in a given year relative to the previous year.

12.3% in 1977, 11.1% in 1982, and 7.3% in 1990. The average CPI growth rate in a recession was 9.8%, which is 3.0% above the long-run average.

In booms (per capita output growth rates above 4%), the CPI growth rates were 4.3% in 1953, 0.7% in 1954, 1.3% in 1958, 1.8% in 1959, -0.3% in 1962, 0.5% in 1963, 2.4% in 1964, 2.7% in 1968, 7.9% in 1978, 10.1% in 1983, and 7.2% in 1988. The average CPI growth rate in a boom was 3.5%, which is 3.3% below the long-run average. Thus the price level is countercyclical.

The average growth rate of money in 1951-1990 was 7.9% (standard deviation 7.7%). The correlation coefficient of the one-and-half-lag growth rate of money and the per capita output growth rate is  $r[m(-2),g]=-0.38$ .<sup>6</sup> The correlation coefficient of the half-lag money growth rate and the per capita output growth rate is  $r[m(-1),g]=-0.18$ . The correlation coefficient of the half-lead money growth rate and the per capita output growth rate is  $r[m,g]=0.32$ . The correlation coefficient of the one-and-half-lead money growth rate and the per capita money growth rate is  $r[m(+1),g]=-0.19$ .

Half-lag and half-lead changes in money were below average in most recessions. The average half-lag change in recessions was 0.3% above the long-run average, while the average half-lead change was 5.3% below average. Half-lag and half-lead changes in money were below average in most booms. The average half-lag change in booms was 3.2% below the long-run average, whereas the average half-lead change was 0.9% above average. Thus, half-lag changes in money are weakly countercyclical, while half-lead changes are procyclical.

For changes in high-powered money, the correlation coefficients with per capita output changes are  $r[m(-1),g]=-0.19$  and  $r[m,g]=0.50$ . For money plus quasi money, the correlation coefficients are  $r[m(-1),g]=0.09$  and  $r[g,m]=0.15$ .

### *Austria*

In 1951-1990, the average growth rate of output per capita was 3.8% (standard deviation 2.8%), and the average CPI growth rate was 4.7% (standard deviation 4.6%).  $r=-0.09$ .

In recessions, the growth rates of consumer prices were 13.6% in 1952, 8.5% in 1975, 3.6% in 1978, and 6.8% in 1981. The average CPI growth rate in a recession was 8.1%, which is 3.4% above the long-run average.

In booms (per capita output growth rates above 5%), the growth rates of consumer prices were 27.5% in 1951, 4.0% in 1954, 0.0% in 1955, 2.8% in 1957, 2.0% in 1960, 3.9% in 1964, and 6.5% in 1972. The average growth rate in a boom was 6.7%, which is 2% above the long-run average. The price level is countercyclical except for the strongly procyclical behavior in 1951.

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<sup>6</sup> 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 2 years in this case.



The average growth rate of money in 1951-1990 was 8.0% (standard deviation 6.2%). The correlation coefficients with the output growth are  $r[m(-2),g]=0.08$ ,  $r[m(-1),g]=0.17$ ,  $r[m,g]=0.14$ , and  $r[m(+1),g]=0.09$ .

Half-lag and half-lead changes in money were above the long-run average as frequently as below the long-run average in recessions. The average half-lag changes in recessions were 4.3% above the long-run average. The average half-lead changes were 1.4% below the long-run average. The half-lag changes in money were above average in most booms, whereas the half-lead changes in money were below average in most booms. The average half-lag change in money in booms was 3.4% above the long-run average. The average half-lead change in money was 5% above average. Except for the behavior of the half-lag changes in money in recessions, monetary changes appear to be procyclical.

For changes in high-powered money (in 1951-1990), the correlation coefficients with the per capita output growth are  $r[m(-1),g]=0.16$  and  $r[m,g]=-0.02$ . For money plus quasi money (in 1954-1990), the correlation coefficients are  $r[m(-1),g]=0.60$  and  $r[m,g]=0.22$ .

### *Belgium*

In 1951-1990, the average per capita output growth rate was 2.8% (standard deviation 2.2%). The average CPI growth rate was 4.2% (deviation 3.3%).  $r = -0.23$ .

In recessions, the CPI growth rates were 1.3% in 1958, 12.7% in 1975, 7.6% in 1981, and 7.7% in 1983. The average growth rate in a recession was 7.3%, which is 3.1% above the long-run average.

In booms (per capita output growth rates above 5%), the CPI growth rates were 0.3% in 1960, 4.2% in 1964, 3.8% in 1969, 4.0% in 1970, 6.9% in 1973, 9.1% in 1976, and 1.2% in 1988. The average CPI growth rate in a boom was 4.2%, which is equal to the long-run average. Due to the behavior in recessions there is a moderately countercyclical pattern of the price level.

In 1951-1990, the average growth rate of money was 5.3% (standard deviation 4.0%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=0.12$ ,  $r[m(-1),g]=0.28$ ,  $r[m,g]=-0.13$ , and  $r[m(+1),g]=0.26$ .

Half-lag changes in money were below the long-run average in most recessions, while half-lead changes were above average in most recessions. The average half-lag change in a recession was 2.7% below the long-run average. The average half-lead change was 2.8% above average. In most booms, both half-lag and half-lead changes in money were above the long-run average. The average half-lag change in booms was 1.8% above the long-run average, while the average half-lead change was 1.1% below average. Thus the half-lag changes in money are procyclical, while the half-lead changes are countercyclical.

For changes in high-powered money, the correlation coefficients with per capita output changes are  $r[m(-1),g]=0.12$  and  $r[m,g]=0.12$ . For money plus quasi money, the correlation coefficients are  $r[m(-1),g]=0.39$  and  $r[m,g]=0.05$ .

### *Canada*

In 1951-1990, the average per capita output growth rate was 2.5% (standard deviation 2.9%). The average CPI growth rate was 4.8% (standard deviation 3.5%).  $r=-0.09$ .

In recessions, the CPI growth rates were 0.6% in 1954, 3.2% in 1957, 2.6% in 1958, 1.3% in 1960, 10.8% in 1982, and 4.7% in 1990. The average CPI growth rate in a recession was 3.9%, which is 0.9% below the long-run average.

In booms (per capita output growth rates above 5%), the CPI growth rates were 0.2% in 1955, 1.4% in 1956, 2.5% in 1965, 7.5% in 1973, 7.3% in 1976, and 4.3% in 1984. The average CPI growth rate in a boom was 3.9%, which is 0.9% below the long-run average. Thus the price level appears to be acyclical.

The average money growth rate in 1951-1990 was 7.5% (standard deviation 7.1%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=0.05$ ,  $r[m(-1),g]=0.40$ ,  $r[m,g]=0.04$ , and  $r[m(+1),g]=0.12$ .

Half-lag growth rates of money were below the long-run average in all recessions. Half-lead rates were below average in most recessions. The average half-lag growth rate of money in a recession was 5.6% below the long-run average. The average half-lead growth rate of money was 1.2% below average. In most booms, both the half-lag and the half-lead growth rates of money were above the long-run average. The average half-lag growth rate in a boom was 1.6% above the long-run average. The average half-lead growth rate was 2.1% above average. Thus the half-lag money changes are procyclical, and the half-lead money changes are weakly procyclical.

For changes in high-powered money, the correlation coefficients with per capita output changes are  $r[m(-1),g]=0.32$  and  $r[m,g]=0.34$ . For money plus quasi money, the coefficients are  $r[m(-1),g]=-0.02$  and  $r[m,g]=0.19$ .

### *Cyprus*

In 1951-1990, the average per capita output growth rate was 4.6% (standard deviation 7.8%). The average CPI growth rate was 4.9% (standard deviation 3.9%).  $r=-0.20$ .

In recessions, the CPI growth rates were 4.7% in 1954, 4.4% in 1958, 0.8% in 1960, -0.3% in 1964, 6.4% in 1974, 14.2% in 1975, and 10.6% in 1981. The average CPI growth rate in a recession was 5.8%, which is 0.9% above the long-run average.

In booms (per capita output growth rates above 8%), the CPI growth rates were 4.4% in 1952, 4.2% in 1953, 8.0% in 1956, 0.1% in 1962, 0.2% in 1965, 0.7% in 1967, 2.5% in 1969, 4.1% in 1971, 3.8% in 1976, 7.4% in 1977, and 9.6% in 1979. The average CPI growth rate in a boom was 4.1%, which is 0.8% below the long-run average. Thus the price level is weakly countercyclical.

In 1959-1990, the average money growth rate was 10.8% (standard deviation 8.9%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=-0.30$ ,  $r[m(-1),g]=0.12$ ,  $r[m,g]=0.37$ , and  $r[m(+1),g]=0.04$ .

In most recessions, both half-lag and half-lead money growth rates were below the long-run average. The average half-lag growth rate in a recession was 4.4% below the long-run average. The average half-lead growth rate was 5.2% below average. In most booms, the half-lag and half-lead money growth rates were above the long-run average. The average half-lag money growth rate in a boom was 0.9% above the long-run average. The average half-lead growth rate of money was 4.6% above the long-run average. Thus the monetary growth rates are procyclical.

For changes in high-powered money (in 1959-1990), the correlation coefficients with per capita output changes are  $r[m(-1),g]=0.13$  and  $r[m,g]=0.07$ . For money plus quasi money (in 1959-1990), the coefficients are  $r[m(-1),g]=0.39$  and  $r[m,g]=0.42$ .

### *Denmark*

In 1951-1990, the average per capita output growth was 2.5% (standard deviation 3.1%). The average CPI growth was 6.3% (standard deviation 3.5%).  $r=-0.50$ .

In recessions, the CPI growth rates were 10.5% in 1951, 5.5% in 1955, 6.1% in 1963, 15.1% in 1974, 9.6% in 1975, 12.4% in 1980, 11.7% in 1981, and 4.0% in 1987. The average CPI growth rate in a recession was 9.4%, which is 3.1% above the long-run average.

In booms (per capita output growth rates above 5%), the CPI growth rates were 0.9% in 1953, 1.7% in 1959, 1.3% in 1960, 3.5% in 1961, 7.4% in 1962, 3.1% in 1964, 3.5% in 1969, and 9.0% in 1976. The average CPI growth rate in a boom was 3.8%, which is 2.5% below the long-run average. Thus the price level is countercyclical.

In 1951-1990, the average growth rate of money was 9.7% (standard deviation 6.6%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=-0.31$ ,  $r[m(-1),g]=0.37$ ,  $r[m,g]=0.06$ , and  $r[m(+1),g]=-0.09$ .

Half-lag growth rates of money were below the long-run average in most recessions. Half-lead growth rates were below average as frequently as above average. The average half-lag growth rate of money in a recession was 3.8%

below the long-run average. The average half-lead growth rate was 0.2% below average. In most booms, half-lag growth rates of money were above the long-run average, whereas half-lead growth rates of money were below average as frequently as above average. The average half-lag growth rate of money in a boom was 2.6% above the long-run average. The average half-lead growth rate was 1.0% below average. Thus, the half-lag growth rates of money are procyclical, whereas the half-lead growth rates are acyclical.

For changes in high-powered money, the correlation coefficients with per capita output changes are  $r[m(-1),g]=0.22$  and  $r[m,g]=-0.01$ . For money plus quasi money, the coefficients are  $r[m(-1),g]=0.35$  and  $r[m,g]=0.14$ .

### *Finland*

In 1951-1990, the average per capita output growth rate was 3.6% (standard deviation 3.6%). The average CPI growth rate was 7.0% (standard deviation 4.7%).  $r=-0.28$ .

In recessions, the CPI growth rates were 2.0% in 1953, 11.3% in 1957, 6.6% in 1958, 17.7% in 1975, 14.4% in 1976, 12.6% in 1977, and 6.2% in 1990. The average CPI growth rate in a recession was 10.1%, which is 3.1% above the long-run average.

In booms (per capita output growth rates above 6%), the CPI growth rates were 16.3% in 1951, 0.0% in 1954, -2.9% in 1955, 1.5% in 1959, 3.2% in 1960, 1.8% in 1961, 4.8% in 1965, 2.3% in 1969, 2.9% in 1970, 7.3% in 1972, 11.2% in 1973, 7.6% in 1979, and 6.6% in 1989. The average CPI growth in a boom was 4.8%, which is 2.2% below the long-run average. Thus the price level is countercyclical.

The average growth rate of money in 1951-1990 was 11.0% (standard deviation 10.3%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=-0.42$ ,  $r[m(-1),g]=0.19$ ,  $r[m,g]=0.22$ , and  $r[m(+1),g]=-0.07$ .

Half-lag and half-lead growth rates of money were below the long-run average in most recessions. The average half-lag growth rate of money in a recession was 1.9% below the long-run average. The average half-lead growth rate was 2.4% below average. In most booms, the half-lag growth rate of money was above average, whereas the half-lead growth rate of money was below average. The average half-lag growth rate in a boom was 0.7% above the long-run average. The average half-lead growth rate of money was 3.9% above average (this is because of the extremely high money growth in 1951). Thus monetary growth rates are procyclical.

For changes in high-powered money, the correlation coefficients with per capita output changes are  $r[m(-1),g]=-0.04$  and  $r[m,g]=0.27$ . For money plus quasi money, the correlation coefficients are  $r[m(-1),g]=0.20$  and  $r[m,g]=0.44$ .

## *France*

In 1951-1990, the average per capita output growth rate was 3.2% (standard deviation 1.9%). The average CPI growth rate was 6.5% (standard deviation 4.6%).  $r=-0.37$

In recessions, the CPI growth rates were 11.5% in 1975, 13.3% in 1981, and 9.4% in 1983. The average CPI growth rate in a recession was 11.4%, which is 4.9% above the long-run average.

In booms (per capita output growth rates above 5%), the CPI growth rates were 17.7% in 1951, 4.3% in 1956, 4.1% in 1960, 5.3% in 1962, 3.2% in 1964, and 5.7% in 1969. The growth of CPI was below average in most booms, although the average CPI growth rate in a boom was 6.7%, which is 0.2% above the long-run average. The price level seems to be countercyclical due to the strongly above-average behavior in recessions.

The average growth rate of money in 1951-1990 was 10.6% (standard deviation 5.3%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=-0.13$ ,  $r[m(-1),g]=0.00$ ,  $r[m,g]=-0.05$ , and  $r[m(+1),g]=0.09$ .

In most recessions, the half-lag money growth rate was below the long-run average, while the half-lead money growth rate was above average. The average half-lag money growth rate in a recession was 0.2% below the long-run average. The average half-lead money growth rate was 1.8% above average. In most booms, the half-lag money growth rate was above the long-run average, whereas the half-lead money growth rate was above average as frequently as below average. The average half-lag growth rate in booms was 2.3% above the long-run average, and the average half-lead growth rate was 0.7% above average. The half-lag growth rates of money are acyclical (as measured by the correlation coefficient with output) or weakly procyclical (as measured by the behavior in recessions and booms), and the half-lead growth rates of money are acyclical.

For changes in high-powered money, the correlation coefficients with per capita output changes are  $r[m(-1),g]=-0.10$  and  $r[m,g]=0.25$ . For money plus quasi money, the coefficients are  $r[m(-1),g]=0.02$  and  $r[m,g]=0.02$ .

## *Germany (West)*

In 1951-1990, the average per capita output growth rate was 3.7% (standard deviation 3.0%). The average CPI growth rate was 3.1% (standard deviation 2.1%).  $r=-0.37$ .

In recessions, the CPI growth rates were 1.6% in 1967, 6.9% in 1974, 6.1% in 1975, 6.4% in 1981, and 5.2% in 1982. The average CPI growth rate in a recession was 5.2%, which is 2.1% above the long-run average.

In booms (per capita output growth rates above 6%), the CPI growth rates were 7.7% in 1951, 2.1% in 1952, -1.9% in 1953, 0.2% in 1954, 1.7% in 1955, 1.0% in 1959, 1.5% in 1960, 2.4% in 1964, 1.9% in 1969, and 4.3% in 1976. The average CPI growth rate in a boom was 2.1%, which is 1.0% below the long-run average. Thus the price level is countercyclical.

The average growth rate of money in 1951-1989 was 8.8% (standard deviation 4.1%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=0.29$ ,  $r[m(-1),g]=0.67$ ,  $r[m,g]=0.15$ , and  $r[m(+1),g]=0.12$ .

In most recessions, the half-lag money growth rate was below the long-run average, while the half-lead money growth rate was above average. The average half-lag money growth rate in a recession was 5.5% below the long-run average. The average half-lead money growth rate was 0.7% below average. In most booms, both the half-lag and the half-lead money growth rates were above the long-run average. The average half-lag money growth rate in a boom was 4.0% above average. The average half-lead growth rate was 0.8% above average. Thus the half-lag growth of money is strongly procyclical, and the half-lead growth is weakly procyclical.

For changes in high-powered money (in 1952-1989), the correlation coefficients with per capita output changes are  $r[m(-1),g]=0.29$  and  $r[m,g]=0.47$ . For money plus quasi money (in 1952-1989), the correlation coefficients are  $r[m(-1),g]=0.67$  and  $r[m,g]=0.46$ .

### *Greece*

In 1951-1990, the average per capita output growth rate was 4.1% (standard deviation 3.7%). The average CPI growth rate was 10.4% (standard deviation 8.4%).  $r=-0.64$ .

In recessions, the CPI growth rates were 5.1% in 1952, 28.1% in 1974, 20.5% in 1983, and 16.3% in 1987. The average CPI growth rate in a recession was 17.5%, which is 7.1% above the long-run average.

In booms (per capita output growth rates above 7%), the CPI growth rates were 9.0% in 1953, 3.7% in 1956, 1.9% in 1961, 2.9% in 1963, 0.9% in 1964, 3.1% in 1965, 0.0% in 1968, 2.3% in 1969, 2.2% in 1970, and 4.2% in 1972. The average CPI growth rate in a boom was 3.0%, which is 7.4% below the long-run average. Thus the price level is relatively strongly countercyclical.

The average money growth rate in 1951-1990 was 18.0% (standard deviation 7.2%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=-0.11$ ,  $r[m(-1),g]=-0.32$ ,  $r[m,g]=-0.03$ , and  $r[m(+1),g]=-0.32$ .

In most recessions, the half-lag growth rate of money was above the long-run average. The half-lead growth rate of money was above average as frequently as below average. The average half-lag growth rate of money in a recession was

4.3% above the long-run average. The average half-lead growth rate was 2.5% below average. In most booms, the half-lag and half-lead growth rates of money were below the long-run average. The average half-lag growth rate of money was 3.3% below average, and the average half-lead growth rate was 1.5% below the average. Thus, the half-lag growth rate of money is countercyclical, and the half-lead growth rate is acyclical.

For changes in high-powered money (in 1954-1990), the correlations with per capita output changes are  $r[m(-1),g]=-0.29$  and  $r[m,g]=-0.47$ . For money plus quasi money (in 1954-1990), the coefficients are  $r[m(-1),g]=-0.22$  and  $r[m,g]=-0.17$ .

### *Iceland*

In 1951-1990, the average per capita output growth rate was 3.3% (standard deviation 4.8%). The average CPI growth rate was 21.8% (standard deviation 18.9%).  $r=-0.16$

In recessions, the CPI growth rates were 15.6% in 1951, 12.8% in 1952, 10.3% in 1956, 3.9% in 1957, 4.3% in 1960, 4.6% in 1961, 3.3% in 1967, 12.6% in 1968, 84.2% in 1983, 25.8% in 1988, 20.8% in 1989, and 15.5% in 1990. The average CPI growth rate in a recession was 17.8%, which is 4.0% below the long-run average.

In booms (per capita output growth rates above 7%), the CPI growth rates were -1.3% in 1953, 1.3% in 1954, 3.8% in 1955, 6.4% in 1958, 12.8% in 1963, 10.7% in 1966, 13.1% in 1970, 6.7% in 1971, 30.6% in 1977, and 17.7% in 1987. The average CPI growth rate in a boom was 10.2%, which is 11.6% below the long-run average. Thus the CPI growth rate tends to be low in recessions and very low (as compared to the long-run average) in booms.

The average growth rate of money in 1952-1990 was 26.4% (standard deviation 18.2%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=-0.09$ ,  $r[m(-1),g]=0.06$ ,  $r[m,g]=0.07$ , and  $r[m(+1),g]=-0.10$ .

In most recessions, the half-lag and half-lead growth rates of money were below the long-run average. The average half-lag growth rate in a recession was 9.7% below average. The average half-lead growth rate was 7.4% below average. In most booms, the half-lag and half-lead growth rates of money were also below average. The average half-lag money growth in a boom was 6.2% below average. The average half-lead money growth was 5.5% below the long-run average. Thus the growth rates of money are acyclical.

For changes in high-powered money (in 1951-1990), the correlation coefficients with per capita output changes are  $r[m(-1),g]=0.21$  and  $r[m,g]=0.08$ . For money plus quasi money (in 1952-1990), the coefficients are  $r[m(-1),g]=0.02$  and  $r[m,g]=0.03$ .

## *Ireland*

In 1951-1990, the average per capita output growth rate was 3.1% (standard deviation 2.8%). The average CPI growth rate was 7.5% (standard deviation 5.7%).  $r=-0.26$

In recessions, the CPI growth rates were 9.2% in 1952, 4.3% in 1956, 4.1% in 1957, 4.4% in 1958, 10.5% in 1983, and 3.8% in 1986. The average CPI growth rate in a recession was 6.1%, which is 1.4% below the long-run average.

In booms (per capita output growth rates above 6%), the CPI growth rates were 0.0% in 1959, 4.7% in 1968, 7.4% in 1969, 13.6% in 1977, 7.6% in 1978, 4.1% in 1989, and 3.3% in 1990. The average CPI growth rate in a boom was 5.8%, which is 1.7% below the long-run average. Thus the CPI growth was low both in recessions and in booms.

The average money growth rate in 1951-1990 was 8.6% (standard deviation 5.9%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=0.03$ ,

$r[m(-1),g]=0.18$ ,  $r[m,g]=0.26$ , and  $r[m(+1),g]=0.08$ .

In most recessions, half-lag and half-lead money growth rates were below the long-run average. The average half-lag growth rate in a recession was 4.1% below average. The average half-lead growth rate was 4.2% below average. In most booms, the half-lag and half-lead growth rates were above average. The average half-lag growth rate in a boom was 1.6% above the long-run average. The average half-lead growth rate was 3.5% above the long-run average. Thus the growth rates of money are procyclical.

For changes in high-powered money, the correlation coefficients with per capita output changes are  $r[m(-1),g]=0.00$  and  $r[m,g]=0.10$ . For money plus quasi money, the coefficients are  $r[m(-1),g]=0.13$  and  $r[m,g]=0.22$ .

## *Italy*

In 1951-1990, the average per capita output growth rate was 3.9% (standard deviation 2.7%). The average CPI growth rate was 7.7% (standard deviation 6.1%).  $r=-0.35$

In recessions, the CPI growth rates were 16.9% in 1975, 17.8% in 1981, and 16.4% in 1982. The average CPI growth rate in a recession was 17.0%, which is 9.3% above the long-run average.

In booms (per capita output growth rates above 6%), the CPI growth rates were 14.3% in 1951, 1.4% in 1953, 3.0% in 1955, 1.4% in 1960, 2.7% in 1961, 3.1% in 1967, 10.7% in 1973, and 16.6% in 1976. The average CPI growth rate



in a boom was 6.7%, which is 1.0% below the long-run average. Thus the price level is countercyclical.

The average money growth rate in 1951-1990 was 14.4% (standard deviation 5.7%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=-0.17$ ,

$r[m(-1),g]=0.07$ ,  $r[m,g]=0.15$ , and  $r[m(+1),g]=-0.05$ .

The half-lag growth rate of money was below the long-run average in all recessions. The half-lead growth rate of money was above average in most recessions. The average half-lag money growth rate in a recession was 1.9% below the long-run average. The average half-lead money growth rate was 0.2% above average. In most booms, the half-lag money growth rate was below average, whereas the half-lead money growth rate was above average. The average half-lag money growth rate in a boom was 0.6% below the long-run average. The average half-lead growth rate was 0.9% above average. Thus the growth rates of money are acyclical or slightly procyclical.

For changes in high-powered money (in 1956-1990), the correlation coefficients with per capita output changes are  $r[m(-1),g]=0.02$  and  $r[m,g]=-0.32$ . For money plus quasi money (in 1954-1990), the coefficients are  $r[m(-1),g]=0.29$  and  $r[m,g]=-0.09$ .

### *Japan*

In 1951-1990, the average per capita output growth rate was 6.0% (standard deviation 3.6%). The average CPI growth rate was 5.3% (standard deviation 4.6%).  $r=-0.13$ .

In the recession in 1974, the CPI growth rate was 23.3%, which is 18.0% above the long-run average. In the years of slow per capita output growth (below 3%), the CPI growth rates were 6.4% in 1971, 11.7% in 1975, 2.8% in 1982, 1.9% in 1983, and 0.6% in 1986. The average CPI growth rate in these years was 4.7%, which is 0.6% below the long-run average.

In booms (per capita output growth rate above 10%), the CPI growth rates were 16.5% in 1951, 3.6% in 1960, 5.4% in 1961, 3.8% in 1964, 4.0% in 1967, and 5.5% in 1968. The average CPI growth rate in a boom was 6.5%, which is 1.2% above the average. Thus there seems to be no systematic relationship between the growth rates of prices and real output.

The average money growth rate in 1954-1990 was 12.2% (standard deviation 7.5%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=0.14$ ,

$r[m(-1),g]=0.47$ ,  $r[m,g]=0.45$ , and  $r[m(+1),g]=0.50$ .

There was just one recession (in 1974), in which the half-lag (half-lead, respectively) growth rate of money was 4.5% above average (0.7% below average, respectively). If we add years in which per capita output grew less than 3%, we observe that the half-lag and half-lead growth rates of money were

below average in most of these years. In the given years, the average half-lag money growth rate was 1.6% below the long-run average, and the average half-lead money growth rate was 0.8% below average. In most booms, the half-lag and half-lead money growth rates were above average. The average half-lag money growth rate in a boom was 6.1% above the long-run average, and the average half-lead money growth rate was 4.3% above average. Thus the growth rates of money are procyclical (except for the half-lag growth rate in 1974).

For changes in high-powered money, the correlation coefficients with per capita output changes (in 1954-1990) are  $r[m(-1),g]=0.17$  and  $r[m,g]=0.55$ . For money plus quasi money, the coefficients are  $r[m(-1),g]=0.25$  and  $r[m,g]=0.34$ .

### *Malta*

In 1955-1989, the average per capita output growth rate was 5.3% (standard deviation 4.5%). The average CPI growth rate was 3.3% (standard deviation 3.8%).  $r=0.17$ .

In recessions, the CPI growth rates were -2.0% in 1955, 2.3% in 1957, 1.3% in 1959, and 0.2% in 1962. The average CPI growth rate in a recession was 0.5%, which is 2.8% below the long-run average.

In booms (per capita output growth rates above 7%), the CPI growth rates were 2.0% in 1956, 1.6% in 1965, 0.5% in 1966, 0.7% in 1967, 2.0% in 1968, 2.3% in 1969, 3.7% in 1970, 7.3% in 1974, 8.8% in 1975, 0.6% in 1976, 10.0% in 1977, 0.9% in 1988, and 0.8% in 1989. The average CPI growth rate in a boom was 3.2%, which is just 0.1% below the long-run average. Due to its significant behavior in recessions, the price level appears to be slightly procyclical. (Out of the 24 countries considered, Malta is the only country with such a pattern.)

The average money growth rate in 1958-1989 was 9.7% (standard deviation 7.2%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=0.21$ ,  $r[m(-1),g]=0.32$ ,  $r[g,m]=0.25$ , and  $r[g(+1),m]=0.46$ .

The half-lag growth rate of money was above average in the recession in 1959 and below average in the recession in 1962. The half-lead growth rate of money was below average in both of these recessions. The average half-lag money growth rate in recessions was 4.8% above the long-run average. The average half-lead money growth rate was 6.5% below average. In most booms, the half-lag and half-lead growth rates of money were above the long-run average. The average half-lag money growth in booms was 2.4% above average. The average half-lead money growth was 1.6% above average. As measured by the correlation coefficient with output, the half-lag money growth rates are procyclical. Despite this, the half-lag growth of money was very high (23.6%) in the recession in 1959. The half-lead money growth rates are procyclical.

For changes in high-powered money (in 1961-1989), the correlation coefficients with per capita output changes are  $r[m(-1),g]=0.21$  and  $r[m,g]=0.27$ . For money plus quasi money (in 1961-1989), the coefficients are  $r[m(-1),g]=0.44$  and  $r[m,g]=0.46$ .

### *Netherlands*

In 1951-1990, the average per capita output growth rate was 2.7% (standard deviation 3.0%). The average CPI growth rate was 4.3% (standard deviation 3.1%).  $r=-0.16$ .

In recessions, the CPI growth rates were 11.9% in 1951, 0.0% in 1952, 2.2% in 1958, 10.2% in 1975, 6.5% in 1980, 6.7% in 1981, and 5.9% in 1982. The average CPI growth rate in a recession was 6.2%, which is 1.9% above the long-run average.

In booms (per capita output growth rates above 5%), the CPI growth rates were 0.0% in 1953, 4.0% in 1954, 1.9% in 1955, 1.9% in 1956, 2.3% in 1960, 5.8% in 1964, 3.7% in 1968, 7.4% in 1969, and 3.7% in 1970. The average CPI growth rate in a boom was 3.4%, which is 0.9% below the long-run average. Thus the price level is weakly countercyclical.

In 1951-1990, the average money growth rate was 7.6% (standard deviation 4.8%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=0.34$ ,  $r[m(-1),g]=0.34$ ,  $r[m,g]=-0.10$ , and  $r[m(+1),g]=0.06$ .

In most recessions, the half-lag money growth rate was below the long-run average, whereas the half-lead money growth rate was above average. The average half-lag money growth rate in recessions was 5.7% below average. The average half-lead growth rate was 1.2% above average. In most booms, the half-lag and half-lead growth rates of money were above the long-run average. The average half-lag growth rate in booms was 0.3% above average. The average half-lead growth rate was 0.5% below average. Thus, the half-lag growth rates of money are procyclical, and the half-lead growth rates are weakly countercyclical.

For changes in high-powered money, the correlation coefficients with per capita output changes are  $r[m(-1),g]=0.20$  and  $r[m,g]=0.10$ . For money plus quasi money, the coefficients are  $r[m(-1),g]=0.32$  and  $r[m,g]=0.11$ .

### *New Zealand*

In 1951-1990, the average per capita output growth rate was 1.4% (standard deviation 3.9%). The average CPI growth rate was 7.9% (standard deviation 5.0%).  $r=-0.30$ .

In recessions, the CPI growth rates were 11.1% in 1951, 7.8% in 1952, 4.8% in 1953, 3.5% in 1956, 4.4% in 1958, 6.1% in 1967, 4.3% in 1968, 14.5% in

1975, 14.6% in 1977, 11.9% in 1978, 15.4% in 1985, 15.7% in 1987, 6.4% in 1988, and 6.1% in 1990. The average CPI growth rate in a recession was 9.0%, which is 1.1% above the long-run average.

In booms (per capita output growth rates above 4%), the CPI growth rates were 4.5% in 1954, 0.8% in 1960, 3.4% in 1965, 4.9% in 1969, 8.2% in 1973, 11.3% in 1974, 15.3% in 1981, and 6.2% in 1984. The average CPI growth rate in booms was 6.8%, which is 1.1% below the long-run average. Thus the price level is countercyclical.

In 1951-1990, the average money growth rate was 9.3% (standard deviation 11.6%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=-0.32$ ,

$r[m(-1),g]=0.10$ ,  $r[m,g]=0.15$ , and  $r[m(+1),g]=-0.20$ .

In most recessions, the half-lag and half-lead money growth rates were below the long-run average. The average half-lag money growth rate in recessions was 0.8% above average. The average half-lead money growth rate was 0.2% above average. In most booms, the half-lag and half-lead money growth rates were above average. The average half-lag money growth rate in booms was 4.1% above the long-run average. The average half-lead money growth rate was 0.4% above average. Due to the significant behavior in booms, the half-lag money growth rates are weakly procyclical. The half-lead growth rates are weakly procyclical (as measured by the correlation coefficient with output) or acyclical (as follows from the behavior in recessions and booms). The money growth rates would be more procyclical if there were no extremely high money growth rates in 1987 and 1989 accompanied by recessions in 1987, 1988, and 1990.

For changes in high-powered money, the correlation coefficients with per capita output changes are  $r[m(-1),g]=0.33$  and  $r[m,g]=0.11$ . For money plus quasi money, the coefficients are  $r[m(-1),g]=0.03$  and  $r[m,g]=0.02$ .

### *Norway*

In 1951-1990, the average per capita output growth rate was 3.1% (standard deviation 1.9%). The average CPI growth rate was 6.3% (standard deviation 3.5%).  $r=-0.21$ .

In recessions, the CPI growth rates were 11.4% in 1982, 6.7% in 1988, and 4.6% in 1989. The average CPI growth rate in a recession was 7.6%, which is 1.3% above the long-run average.

In booms (per capita output growth rates above 5%), the CPI growth rates were 2.0% in 1953, 4.4% in 1967, 7.2% in 1972, 9.2% in 1976, 6.3% in 1984, and 5.7% in 1985. The average CPI growth rate in a boom was 5.8%, which is 0.5% below the long-run average. Thus the price level is weakly countercyclical.

In 1951-1990, the average money growth rate was 11.0% (standard deviation 8.6%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=-0.09$ ,  $r[m(-1),g]=-0.14$ ,  $r[m,g]=-0.23$ , and  $r[m(+1),g]=0.28$ .

In all recessions, half-lag and half-lead money growth rates were above the long-run average. The average half-lag money growth rate in recessions was 18.2% above the long-run average. The average half-lead growth rate was 6.2% above average. In most booms, the half-lag and half-lead money growth rates were also above average. The average half-lag money growth rate in booms was 2.2% above the long-run average. The average half-lead growth rate was 3.2% above average. Thus the growth rates of money are weakly countercyclical; on average they are high in booms and very high in recessions.

For changes in high-powered money, the correlation coefficients with per capita output changes are  $r[m(-1),g]=0.47$  and  $r[m,g]=0.30$ . For money plus quasi money, the coefficients are  $r[m(-1),g]=0.21$  and  $r[m,g]=0.16$ .

### *Portugal*

In 1951-1990, the average per capita output growth rate was 4.7% (standard deviation 4.1%). The average CPI growth rate was 10.2% (standard deviation 9.3%).  $r=-0.40$ .

In recessions, the CPI growth rates were 20.4% in 1975, 25.1% in 1983, and 29.3% in 1984. The average CPI growth rate in a recession was 24.9%, which is 14.7% above the long-run average.

In booms (per capita output growth rates above 7%), the CPI growth rates were -1.4% in 1951, 1.6% in 1961, 3.5% in 1965, 5.5% in 1967, 6.1% in 1968, 4.5% in 1970, 7.5% in 1971, 10.4% in 1973, 9.4% in 1987, 12.6% in 1989, and 13.4% in 1990. The average CPI growth rate in a boom was 6.6%, which is 3.6% below the long-run average. Thus the price level is countercyclical.

The average money growth rate in 1951-1990 was 12.5% (standard deviation 8.5%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=-0.20$ ,  $r[m(-1),g]=0.03$ ,  $r[m,g]=-0.16$ , and  $r[m(+1),g]=-0.19$ .

In most recessions, half-lag money growth rates were below the long-run average, while half-lead money growth rates were above average. The average half-lag money growth rate in recessions was 0.7% below the long-run average. The average half-lead money growth rate was 3.9% above average. In most booms, the half-lag and half-lead growth rates of money were below the long-run average. The average half-lag money growth rate in booms was 0.6% above average. The average half-lead growth rate was 1.5% below average. Thus, the half-lag money growth rates are acyclical or weakly procyclical, and the half-lead money growth rates are weakly countercyclical.

For changes in high-powered money (in 1954-1990), the correlation coefficients with per capita output changes are  $r[m(-1),g]=0.12$  and  $r[m,g]=-0.00$ . For money plus quasi money (in 1954-1990), the coefficients are  $r[m(-1),g]=-0.08$  and  $r[m,g]=-0.13$ .

### *Spain*

In 1951-1990, the average per capita output growth rate was 4.2% (standard deviation 4.3%). The average CPI growth rate was 9.1% (standard deviation 5.7%).  $r=-0.44$ .

In recessions, the CPI growth rates were 1.6% in 1953, 7.3% in 1959, 17.5% in 1975, 19.9% in 1978, 15.6% in 1979, and 14.4% in 1981. The average CPI growth rate in a recession was 12.7%, which is 3.6% above the long-run average.

In booms (per capita output growth rates above 7%), the CPI growth rates were 9.4% in 1951, 1.2% in 1954, 1.2% in 1960, 2.0% in 1961, 5.7% in 1962, 8.7% in 1963, 2.2% in 1969, and 8.4% in 1972. The average CPI growth rate in a boom was 4.9%, which is 4.2% below the long-run average. Thus the price level is countercyclical.

In 1951-1990, the average money growth rate was 14.8% (standard deviation 5.6%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=-0.29$ ,  $r[m(-1),g]=-0.07$ ,  $r[m,g]=0.24$ , and  $r[m(+1),g]=0.22$ .

The half-lag money growth rate was below average as frequently as above average in recessions. In most recessions, the half-lead money growth rate was below the long-run average. The average half-lag money growth rate in recessions was 0.7% above average. The average half-lead money growth rate in recessions was 3.1% below the long-run average. In most booms, the half-lag and half-lead money growth rates were below the long-run average. The average half-lag money growth rate in booms was 3.2% below average. The average half-lead money growth was 0.5% below average. Thus, the half-lag money growth is weakly countercyclical, and the half-lead money growth is weakly procyclical (due to the significant behavior in recessions).

For changes in high-powered money (in 1953-1990), the correlation coefficients with per capita output changes are  $r[m(-1),g]=-0.34$  and  $r[m,g]=-0.08$ . For money plus quasi money (in 1953-1990), the coefficients are  $r[m(-1),g]=0.09$  and  $r[m,g]=0.25$ .

### *Sweden*

In 1951-1990, the average per capita output growth rate was 2.4% (standard deviation 1.7%). The average CPI growth rate was 6.4% (standard deviation 3.6%).  $r=-0.63$ .

In recessions, the CPI growth rates were 7.4% in 1971, 11.5% in 1977, and 12.1% in 1981. The average CPI growth rate in a recession was 10.3%, which is 3.9% above the long-run average.

In booms (per capita output growth rates above 4%), the CPI growth rates were 0.8% in 1954, 0.8% in 1959, 2.2% in 1961, 2.9% in 1963, 3.4% in 1964, 2.7% in 1969, and 8.0% in 1984. The average CPI growth rate in booms was 3.0%, which is 3.4% below the long-run average. Thus the price level is relatively strongly countercyclical.

In 1951-1989, the average money growth rate was 7.6% (standard deviation 3.7%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=-0.35$ ,

$r[m(-1),g]=-0.21$ ,  $r[m,g]=-0.29$ , and  $r[m(+1),g]=-0.36$ .

In most recessions, half-lag and half-lead money growth rates were above the long-run average. The average half-lag money growth rate in recessions was equal to the long-run average. The average half-lead money growth rate was 2.4% above the long-run average. In most booms, the half-lag and half-lead money growth rates were below the long-run average. The average half-lag money growth rate in booms was 1.2% below average. The average half-lead money growth rate was 1.5% below average. Thus the monetary growth rates are moderately countercyclical.

For changes in high-powered money, the correlation coefficients with per capita output changes are  $r[m(-1),g]=-0.05$  and  $r[m,g]=-0.04$ . For money plus quasi money, the coefficients are  $r[m(-1),g]=0.05$  and  $r[m,g]=-0.10$ .

### *Switzerland*

In 1951-1990, the average per capita output growth rate was 2.3% (standard deviation 3.1%). The average CPI growth rate was 3.3% (standard deviation 2.3%).  $r=-0.28$ .

In recessions, the CPI growth rates were 2.5% in 1952, 1.8% in 1958, 6.7% in 1975, 1.7% in 1976, and 5.7% in 1982. The average CPI growth rate in a recession was 3.7%, which is 0.4% above the long-run average.

In booms (per capita output growth rates above 4%), the CPI growth rates were 4.8% in 1951, 0.7% in 1954, 0.9% in 1955, 1.5% in 1956, -0.7% in 1959, 1.4% in 1960, 1.9% in 1961, 2.5% in 1969, 3.6% in 1970, and 4.0% in 1980. The average CPI growth rate in a boom was 2.1%, which is 1.2% below the long-run average. Thus the price level is moderately countercyclical.

In 1951-1990, the average growth rate of money was 5.3% (standard deviation 6.3%). There were frequent monetary contractions in the 1970s and the 1980s. The correlation coefficients with the per capita output growth are  $r[m(-2),g]=0.33$ ,  $r[m(-1),g]=0.34$ ,  $r[m,g]=-0.04$ , and  $r[m(+1),g]=0.05$ .

The half-lag money growth rate was below average in all recessions. The half-lead money growth rate was above average in most recessions. The average half-lag money growth rate in recessions was 5.4% below the long-run average. The average half-lead money growth rate was 2.1% above average. In booms, the half-lag money growth rate was below average as frequently as above average. The half-lead money growth rate was above average in most booms. Both the average half-lag and the average half-lead growth rates were 0.8% above the long-run average in booms. Thus, the half-lag money growth rate is procyclical, whereas the half-lead money growth rate is acyclical.

For changes in high-powered money, the correlation coefficients with per capita output changes are  $r[m(-1),g]=0.11$  and  $r[m,g]=0.03$ . For money plus quasi money, the coefficients are  $r[m(-1),g]=0.43$  and  $r[m,g]=-0.15$ .

### *United Kingdom*

In 1951-1990, the average per capita output growth rate was 2.3% (standard deviation 2.1%). The average CPI growth rate was 7.0% (standard deviation 5.3%).  $r=-0.47$ .

In recessions, the CPI growth rates were 6.1% in 1952, 2.9% in 1958, 16.0% in 1974, 24.3% in 1975, 18.0% in 1980, 11.9% in 1981, and 9.5% in 1990. The average CPI growth rate in a recession was 12.7%, which is 5.7% above the long-run average.

In booms (per capita output growth rates above 4%), the CPI growth rates were 1.9% in 1953, 3.2% in 1964, 9.3% in 1973, 3.5% in 1986, 4.1% in 1987, and 4.8% in 1988. The average CPI growth rate in a boom was 4.5%, which is 2.5% below the long-run average. Thus the price level is countercyclical.

The average money growth rate in 1952-1990 was 8.5% (standard deviation 7.9%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=0.05$ ,

$r[m(-1),g]=0.39$ ,  $r[m,g]=0.21$ , and  $r[m(+1),g]=-0.04$ .

In recessions, the half-lag growth rate of money was below average as frequently as above average. The half-lead growth rate of money was above average in most recessions. The average half-lag money growth rate in recessions was 1.5% below the long-run average. The average half-lead money growth rate was 1.1% below average. In most booms, the half-lag money growth rate was above average. In booms, the half-lead money growth rate was below average as frequently as above average. The average half-lag money growth rate in booms was 8.5% above the long-run average. The average half-lead money growth rate was 4.4% above average. Thus the monetary growth rates are procyclical.

For changes in high-powered money (in 1951-1990), the correlation coefficients with per capita output changes are  $r[m(-1),g]=0.01$  and  $r[m,g]=0.45$ .



For money plus quasi money (in 1952-1990), the coefficients are  $r[m(-1),g]=0.20$  and  $r[m,g]=0.23$ .

### *United States*

In 1951-1990, the average per capita output growth rate was 1.9% (standard deviation 2.7%). The average CPI growth rate was 4.4% (standard deviation 3.3%).  $r=-0.31$ .

In recessions, the CPI growth rates were 2.2% in 1952, 0.4% in 1954, 1.5% in 1956, 3.4% in 1957, 2.7% in 1958, 5.7% in 1970, 11.2% in 1974, 9.0% in 1975, 13.5% in 1980, 6.2% in 1982, and 5.4% in 1990. The average CPI growth rate in a recession was 5.6%, which is 1.2% above the long-run average.

In booms (per capita output growth rates above 4%), the CPI growth rates were -0.3% in 1955, 0.9% in 1959, 1.1% in 1962, 1.3% in 1964, 1.7% in 1965, 3.0% in 1966, 6.3% in 1973, 5.8% in 1976, 7.5% in 1978, and 4.3% in 1984. The average CPI growth rate in booms was 3.2%, which is 1.2% below the long-run average. Thus the price level is countercyclical.

In 1951-1990, the average money growth rate was 5.4% (standard deviation 4.1%). The correlation coefficients with the per capita output growth are  $r[m(-2),g]=-0.20$ ,  $r[m(-1),g]=0.32$ ,  $r[m,g]=0.04$ , and  $r[m(+1),g]=0.13$ .

In most recessions, half-lag and half-lead growth rates of money were below the long-run average. The average half-lag money growth rate in recessions was 2.5% below the long-run average. The average half-lead growth rate was 1.1% below average. In most booms, the half-lag and half-lead growth rates of money were below the long-run average. The average half-lag money growth rate in booms was 0.8% above average. The average half-lead money growth rate was 0.7% below average. Thus, the half-lag money growth rates are procyclical, and the half-lead money growth rates are acyclical.

For changes in high-powered money, the correlation coefficients with per capita output changes are  $r[m(-1),g]=0.25$  and  $r[m,g]=0.03$ . For money plus quasi money, the coefficients are  $r[m(-1),g]=0.36$  and  $r[m,g]=0.05$ .

### **III. Statistical computations**

The sample contains 24 countries. Except for Malta, the correlation coefficients between the growth of CPI and the per capita output growth are negative in all the countries. The average correlation coefficient makes -0.30 (standard deviation 0.19). The t-statistic for the difference of the mean

correlation coefficient from zero is 7.95. Thus there exists a significant countercyclical pattern of the price level.<sup>7</sup> This observation 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.<sup>8</sup>

Tables 1, 2, and 3 summarize the statistics for money, high-powered money, and money plus quasi money. The tables show the 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 correlation coefficient  $r[m(-2),g]$  is marginally significantly negative. This observation is consistent with the idea that money is neutral in the long run. The coefficients  $r[m(-1),g]$  and  $r[m,g]$  are significantly positive (be it for money, high-powered money, or money plus quasi money), although their average values are not very great. Thus there exists a significant association between nominal money and real output in the short run, although it is likely that money is not the most important driving force of output fluctuations. For money, the 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.<sup>9</sup>

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 some evidence that money (money plus quasi money) changes precede output changes.<sup>10</sup> The t-statistic for the difference in the means of  $r[m(-1),g]$  and  $r[m,g]$  is 1.21 for money and 1.33 for money plus quasi money. In comparison, the critical value for a 10%

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<sup>7</sup> Studies examining correlations between detrended output and detrended prices typically find a countercyclical pattern of the price level in the postwar period [see Backus and Kehoe, 1992, Chadka and Prasad, 1994, and (with the exception 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.

<sup>8</sup> In Duczynski (2001) I examine the average output performance in all countries (developed and developing) for which I have data between 1970 and 1990 for years in which the CPI declined. In these years, the average output growth was significantly below the long-run cross-country average. This procyclical character of the price level contrasts with the present finding.

<sup>9</sup> The positive value of  $r[m(+1),g]$  may also reflect that money causes output and that money is autocorrelated over time.

<sup>10</sup> Additional evidence that money changes precede output changes is provided in Duczynski (2001).

significance level in a one-tail test is 1.30. However, for high-powered money, the average of  $r[m(-1),g]$  is below the average of  $r[m,g]$ . In this case, the value of the t-statistic for the difference in means is 0.50, 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 1.04, 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 0.66 in this case, which is insignificant at a 25% level. If we pool the observations for  $r[m(-1),g]$  and  $r[m,g]$ , the average is 0.11 for high-powered money and 0.12 for money. The t-statistic for the difference in means is 0.27 in this case, which is clearly insignificant. Thus there is only very weak evidence that money is more strongly associated with real output than high-powered money. The evidence is stronger if high-powered money is compared with money plus quasi money. The average of  $r[m(-1),g]$  ( $r[m,g]$ , respectively) for money plus quasi money is above the average of  $r[m(-1),g]$  ( $r[m,g]$ , respectively) for high-powered money, and the corresponding t-statistics for differences in means are 2.01 for  $r[m(-1),g]$  and 0.14 for  $r[m,g]$ . If we pool the observations for  $r[m(-1),g]$  and  $r[m,g]$ , the average is 0.18 for money plus quasi money. The t-statistic for the difference in means in the pooled samples (comparing 0.11 with 0.18) is 1.49, which is significant at a 10% 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 0.82 for  $r[m(-1),g]$  and 0.92 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 0.12 with 0.18) is 1.22, which is close to the critical value at a 10% significance level (1.29). Thus the above discussion provides at least some evidence that broader monetary aggregates tend to be more strongly associated with real output than narrower monetary aggregates.<sup>11</sup>

#### **IV. 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 rational expectations literature implies monetary neutrality for such economies. The sample contains 5 countries (Argentina, Bolivia, Brazil, Chile, and Peru).

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<sup>11</sup> Duczynski (2001) provides additional evidence in this respect.

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. This observation goes beyond the expected neutrality result. It is likely that extremely large monetary expansions are harmful for the real output growth.<sup>12</sup> 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.

## V. Conclusion

This paper examines money-output and price-output associations in the sample of 24 developed countries (including Cyprus, Greece, and Malta), 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.

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<sup>12</sup> Elsewhere (Duczynski, 2001) I show that monetary expansions higher than 100% per year were associated with significantly below-average per capita output growth rates in a sample of developing countries in 1970-1990.

Thus, in some sense money changes precede output changes. This observation indicates that there probably is some causality from money to output.<sup>13</sup> 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, statistically insignificant.

There is also some tendency of broad monetary aggregates to be more strongly associated with real output than narrow monetary aggregates. In particular, the average correlations between money-plus-quasi-money changes and per capita output changes are higher than the average correlations between money (or high-powered money) changes and per capita output changes. The difference between the money-output and the high-powered-money-output correlations is, however, not significant.

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 a better inference regarding the direction of causality in developed countries) is left for future research.

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<sup>13</sup> 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.

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Table 1: Statistics for the correlation coefficients between money changes and per capita output changes.

	$r[m(-2),g]$	$r[m(-1),g]$	$r[m,g]$	$r[m(+1),g]$
mean	-0.07	0.16	0.09	0.04
deviation	0.23	0.24	0.19	0.22
t-statistic	1.51	3.31	2.24	0.84

Table 2: Statistics for the correlation coefficients between changes in high-powered money and per capita output changes.

	$r[m(-1),g]$	$r[m,g]$
mean	0.10	0.13
deviation	0.20	0.25
t-statistic	2.41	2.58

Table 3: Statistics for the correlation coefficients between changes in money plus quasi money and per capita output changes.

	$r[m(-1),g]$	$r[m,g]$
mean	0.22	0.14
deviation	0.22	0.19
t-statistic	4.90	3.48