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Are Money Growth and Inflation Related to Government Deficits? Evidence from Ten Industrialized Economies

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We present empirical evidence on the relation between the government debt growth, money growth and inflation for ten industrialized countries over the post World War II period. Non-parametric and parametric tests reveal little evidence that government debt growth is either related to money growth or permanently related to inflation over periods of a decade or less. But the *level* of debt is significantly associated with subsequent inflation from 1974 to 1983. These results are consistent with the hypothesis that central banks in developed economies can conduct independent monetary policy over long periods, notwithstanding government deficits.

The role of government debt in influencing monetary and real variables is an issue of central importance for both macroeconomists and policymakers. This study investigates the relation between the growth of government debt, and money and inflation since World War II in ten industrialized countries. We present some parametric and non-parametric tests of two relations: that money growth has systematically followed debt growth, and that inflation has systematically followed debt growth, after adjusting for money growth.

The empirical relation between debt growth and money growth in the United States has been investigated extensively.[1] These studies indicate that there is only

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weak evidence, at best, that monetary policy is influenced by debt growth in the United States. Unfortunately, there is much less comparable research for countries other than the USA.[2] Our paper investigates the relation between government debt and money for the industrialized countries for which there exist reliable data. We selected all the industrialized countries for which there are sufficiently long series of IFS data for the variables that we use, *viz.*, government debt, money, prices, and real GNP (or GDP). The existence of sufficiently long government debt series turned out to be the limiting criterion. The countries selected all have well-developed financial markets and access to foreign borrowing.

Section I overviews the behavior of debt, money, real output, and prices in the ten industrialized countries in our sample: Canada, Finland, France, Germany, Holland, Italy, Japan, Switzerland, the United Kingdom, and the United States. The data highlight the dramatic upward shift in the growth rate of nominal government debt that occurred after 1974 in *all* of these countries, as well as what appears to be sharply differing behavior of the monetary aggregates. Section II discusses the theoretical relation between government debt, and the money supply and inflation. Section III calculates non-parametric and multivariate regression statistics that bear on the relations developed in Section II. Section IV offers some conclusions.

I. Overview of the Data

In this section we present an overview of the data and analyze the empirical regularities that appear across the countries in the post World War II era.[3] Of significance is that the behavior of debt growth, money growth, inflation, and the growth of real GNP change dramatically after 1974. The extent of this change is illustrated by the simultaneous acceleration of debt growth and the slowing of real income growth in every one of the ten countries. The pattern of money growth and inflation also changed, but not in the same direction for all the countries. Table 1 summarizes the behavior of the debt-to-GNP ratio, and of the growth rates of debt, real GNP, prices, and money (the monetary base and M1), during three subperiods: 1952–62, 1962–74, and 1974–83. The selection of the 1962 cutoff is arbitrary, but the 1974 cutoff is chosen because of the dramatic shift in the behavior of all the variables. This division into subperiods is used only in this overview and most of the non-parametric tests. We impose no arbitrary time divisions on the data in the regression analyses.

The average annualized growth rate of nominal debt for all the countries is 3.2 per cent and 6.5 per cent for the 1952–62 and 1962–74 subperiods, respectively. But the average growth rate for the 1974–83 subperiod increases dramatically to 19.8 per cent, a three-fold increase from the previous subperiod.

The path of real GNP growth also changes markedly after 1974. The average growth rates of real GNP for all countries for the subperiods 1952–62 and 1962–74 are 5.2 per cent and 4.8 per cent, respectively. However, the average growth rate of real GNP falls to only 2.0 per cent after 1974, and it falls relative to its pre-1974 level in every country. Furthermore, the growth rates of real output fall by at least one-half relative to the previous 10-year period in every case except the USA and Finland.

Although changes in the growth rates of debt and real GNP between the 1962–74 and 1974–83 subperiods are similar across the ten countries, Table 1 indicates

TABLE 1. Selected variables for ten industrialized countries.

	(1) Debt/GNP*	(2) Debt growth	(3) Real GNP growth	(4) Inflation (GNP deflator)	(5) Base growth	(6) M1 growth
Canada						
1952–62	0.44	2.9	4.2	1.3	3.3	4.4
1962–74	0.23	4.8	5.4	4.9	9.0	9.4
1974–83	0.35	15.7	2.1	8.8	7.9	7.5
Overall	—	7.3	4.1	4.9	6.8	7.3
Finland						
1952–62	0.09	2.9	5.3	3.5	5.4	6.8
1962–74	0.02	1.9	4.6	8.1	8.7	12.0
1974–83	0.14	32.0	2.7	9.7	17.2	12.0
Overall	—	11.0	4.3	7.1	10.1	10.3
France						
1952–62	0.24	5.7	5.3	3.8	8.7	11.3
1962–74	0.07	0.8	5.2	5.3	8.6	8.9
1974–83	0.15	20.5	2.1	10.4	5.6	10.5
Overall	—	8.1	4.3	6.3	7.8	10.1
Germany						
1952–62	0.08	11.2	7.4	2.3	9.6	10.0
1962–74	0.07	8.1	4.0	4.4	8.4	7.9
1974–83	0.20	17.3	1.8	4.1	4.8	6.8
Overall	—	11.8	4.4	3.6	7.7	8.3
Holland						
1952–62	0.41	−0.7	5.2	2.3	6.3	5.2
1962–74	0.22	6.2	5.0	6.6	6.1	9.2
1974–83	0.46	16.0	1.6	5.9	8.1	7.5
Overall	—	6.8	4.0	5.0	6.7	7.4
Italy						
1952–62	0.35	5.9	6.3	2.9	13.0	10.8
1962–74	0.46	13.3	4.8	6.4	12.1	14.7
1974–83	0.79	23.6	1.5	16.0	17.9	16.0
Overall	—	13.9	4.3	8.1	14.2	13.8
Japan						
1952–62	0.04	−2.5	8.1	4.1	11.8	12.0
1962–74	0.07	21.3	8.9	6.5	17.0	17.2
1974–83	0.26	35.7	4.2	3.8	6.8	6.5
Overall	—	17.4	7.3	4.9	12.4	12.4
Switzerland						
1952–62	0.18	n.a.	4.9	2.3	6.4	5.9
1962–74	0.08	2.7	3.8	5.5	7.5	6.5
1974–83	0.13	10.6	0.2	3.9	2.8	5.1
Overall	—	4.7	3.1	4.0	5.8	5.9
UK						
1952–62	1.00	1.9	2.8	3.2	3.9	1.2
1962–74	0.48	2.9	2.9	6.0	7.8	7.0
1974–83	0.43	12.8	1.4	12.9	6.6	12.4
Overall	—	5.4	2.4	7.1	6.2	6.7

continued

TABLE 1. *continued*

	(1) Debt/GNP*	(2) Debt growth	(3) Real GNP growth	(4) Inflation (GNP deflator)	(5) Base growth	(6) M1 growth
USA						
1952–62	0.44	1.4	2.9	2.0	0.4	1.7
1962–74	0.25	2.9	3.7	4.1	6.0	5.2
1974–83	0.36	13.4	2.3	7.0	6.4	7.1
Overall	—	5.5	3.0	4.2	4.3	4.6
All countries						
1952–62	—	3.2	5.2	2.8	6.9	6.9
1962–74	—	6.5	4.8	5.8	9.1	9.8
1974–83	—	19.8	2.0	8.2	8.4	9.1
Overall	—	9.2	4.1	5.5	8.2	8.7

Notes:

* The Debt/GNP column shows the level of the ratio at the end of each period.

All the data are from the IFS. Growth rates are calculated as $\ln(x_{t+1}/x_t)$. GDP is used instead of GNP when the GNP deflator is not available.

Japan: Debt is 1955–79, Base and M1 are 1953–82.

Switzerland: Debt is 1960–82.

Italy: Base is 1955–82.

that changes in inflation and in the growth rate of the monetary aggregates differ sharply. In order to highlight the differences among the countries, we divide our sample into two groups designed to illustrate the differences in the post-1974 inflation experiences. Countries in group I, composed of Germany, Holland, Japan, and Switzerland, maintained or reduced their average inflation rates after 1974. Countries in group II, Canada, Finland, France, Italy, the UK, and the USA, had significantly higher inflation rates after 1974. The characteristics of these two groups are summarized in Table 2. Coincidentally, each of these groups had identical inflation experience in the first two subperiods, 2.8 and 5.8 per cent, respectively. However, countries in group I had average inflation of only 4.4 per cent in the third subperiod, lower than the 1962–74 average, while the group II countries had average inflation of 10.8 per cent, nearly double the 1962–74 average and almost four times the 1952–62 average.

One can also see from Table 2 that group I countries sharply reduced their monetary base growth, from 9.8 per cent to 5.6 per cent, between the second and third subperiods, while the second group of countries slightly increased their base growth. One explanation of these findings is that countries in group I reduced their money growth rate in response to the lower real growth, forestalling higher inflation, while countries in group II did not. Furthermore, despite the reduction in money growth in group I countries, the growth rate of nominal government debt for these countries during the last subperiod is slightly higher than that of group II countries (19.9 versus 19.7 per cent) and more than double that of the middle subperiod. This overview indicates that, at least over periods of about ten years, debt growth and money growth can display substantial independence. It is the purpose of the next section to review some of the theory concerning the relation between debt, and money and prices in order to make an econometric evaluation possible.

TABLE 2. Average growth rates for variables of Group I and II countries.

	Debt	RGNP	GNPD	Base
Group I Countries				
1952–62	2.7	6.4	2.8	8.5
1962–74	9.6	5.4	5.8	9.8
1974–83	19.9	2.0	4.4	5.6
Overall	10.2	4.7	4.4	8.2
Group II Countries				
1952–62	3.5	4.5	2.8	5.8
1962–74	4.4	4.4	5.8	8.7
1974–83	19.7	2.0	10.8	10.3
Overall	8.5	3.7	6.3	8.2

RGNP = Real GNP (or GDP).
GNPD = GNP Deflator.
Group I Countries: Germany, Holland, Japan, Switzerland.
Group II Countries: Canada, Finland, France, Italy, UK, USA.

II. Theoretical Background

II.A. Government Debt and the Money Supply: The Monetization Relation

The process by which an increase in government debt results in an increase in the money supply is termed 'Monetization' of the debt. In industrialized economies with well-developed capital markets, monetization of the debt is not an automatic process, since government debt is usually sold to the private sector directly. As long as there exist sufficiently deep capital markets (or foreign borrowing capabilities) to absorb the debt created by the treasury, government debt need not be financed by the central bank, and money and debt creation are operationally separate.

The Monetization relation asserts that despite the operational independence of debt and money creation, there exist three channels through which debt creation may lead to money creation:

1. Economic limits on the debt-to-GNP ratio.
2. The 'time-inconsistency' problem of government policy.
3. Political pressures to stabilize interest rates.

On a purely theoretical level, it can be argued that there exists a long-term constraint that imposes a limit on the growth of interest bearing nominal government debt relative to nominal income.[4] If the government is unwilling (or unable) to raise taxes sufficiently to keep the debt-to-income ratio from rising faster than this limit, then one possible long-run equilibrium is that the monetary authority is eventually forced to monetize some of the debt. In this scenario current excess debt growth will be financed, at least in part, by future money growth, although current money growth may not be affected. This is one channel through which debt policy may influence monetary policy.

A second channel by which debt policy affects monetary policy is the 'time-inconsistency' problem facing monetary policymakers.[5] The essence of the time-

inconsistency problem for monetary policy is that the existence of nominal, fixed interest rate government debt provides policymakers with an incentive to generate unanticipated inflation. This incentive exists because it is possible to engineer a reduction in the real value of the debt (and hence in future tax liabilities) by inflating at a rate greater than bondholders anticipate when purchasing the debt. Once nominal, fixed interest-bearing government debt of a positive maturity is issued, policymakers, as well as the general public taken as a whole, have an incentive to generate an unexpectedly high inflation, thereby imposing a nondistortionary lump-sum 'tax' on the holders of government bonds.[6] Although this 'tax' may have distributional effects, it enables the government to impose lower distortionary taxes elsewhere in the economy and hence reduce deadweight losses. Therefore, policymakers have incentives to increase the inflation rate above what they have implicitly promised to deliver. The rate of inflation is limited in this scenario because policymakers (and the public) find inflation undesirable. The government balances the benefits from inflating more than expected against the disadvantages of inflation. It should be noted that this channel of the Monetization relation predicts that the incentive to monetize the debt is related to the *level* and not the *rate of growth* of government debt.

The third channel by which government debt policy may influence monetary policy is the response of the monetary authority to the possible increase in interest rates, nominal and/or real, engendered by the increase in debt. If an increase in government debt raises real rates of interest and the central bank attempts to lessen or to offset this rise, then the monetary authority will monetize the deficit because of the policy response to real interest rates. Even if real rates do not rise, this third channel may be operative. If an increase in debt growth increases the expectations of future money growth, then the nominal rate of interest will rise, and this rise may elicit central bank action. Therefore, monetization of the debt may be amplified if the central bank takes additional steps to lessen the rise in interest rates.[7]

II.B. The Relation between Government Debt and Prices

The Monetization relation predicts that high debt growth is associated with high money growth through various channels. To the extent that an increase in government debt growth causes an increase in money growth (either now or in the future), this will cause higher inflation. The relation between current money growth and inflation has been long established in the monetary theory literature, and we do not review it in this study.

The relation we wish to examine is the association of excessive growth of government debt with inflation, an association beyond what may already be 'explained' by the impact of debt growth on the current or future money growth. We shall call this the 'Inflation-Debt' relation. The most common theoretical rationale behind this relation is that an increase in government debt raises interest rates (holding the money supply constant), and the higher interest rates increase the price level. This occurs because the demand for money is sensitive to the rate of interest, and increases in interest rates increase the velocity of money and hence raise prices.[8] Clearly it is possible for both the Monetization relation and the Inflation-Debt relation to hold simultaneously.

III. Econometric Tests of the Relations Between Debt Growth, and Money Growth and Inflation

In this section we present some formal econometric tests to examine the relations between debt growth, and money growth and inflation. Specifically, we examine:

1. The Monetization relation, *i.e.*, that increases in the rate of debt creation are associated with systematic increases in the rate of money creation.
2. The Inflation-Debt relation, that increases in the rate of debt creation, holding the money supply constant, are associated with systematic increases in the inflation rate.

We bring to bear two types of econometric tests on these propositions. The first is a set of non-parametric rank correlation tests based on the average growth rates reported in Table 1. The second is a set of tests based on regression equations using annual data from the countries in our sample for the entire post-war period.

It should be noted these tests are not designed to examine any of the structural hypotheses that relate these variables. The tests are designed only to examine whether there has been a statistically significant relation between debt growth and monety growth, and debt growth and inflation among the countries in our sample in the post-war period. Lack of statistical significance does not necessarily imply that structural relations do not exist. And if there are significant relations, that does not imply that debt growth necessarily influences money growth or inflation. The reverse path of causality also is economically feasible. For instance, high-money growth and inflation lead to high nominal interest rates which increase the deficit for any given path of real expenditures and taxes.

III.A. Non-Parametric Tests

In order to implement the non-parametric tests and to control for cross-country variations in real growth, we adjust debt and money growth for each country by subtracting real growth. We do this to avoid spurious correlation between debt and money growth due to their independent relation with real growth. We define these adjusted variables as *excess* debt and money growth.[9]

One way to assess the relations between debt growth, and money growth and inflation is to compute the rank correlation coefficients between excess debt growth and excess money growth, and excess debt growth and inflation for each of the ten countries. We rank the countries according to their excess growth rate of debt and compare that ranking to the ranking according to their excess growth rate of the monetary base, M1, and the growth of the GNP deflator. We use both the Spearman rank correlation and the Kendall τ coefficients to assess the correlation of these rankings.

Panel A of Table 3 reports the rank correlation coefficients within each subperiod between the excess growth rate of government debt and the excess growth of money and inflation, as measured by the GNP (or GDP) deflator. These correlation coefficients indicate whether, within each subperiod, countries with high excess debt growth also tend to have high excess money growth and high inflation. The table also reports the rank correlation coefficients for the whole period.

The test statistics indicate that the correlation between excess debt growth and excess money growth over the entire 1952–83 period is large and highly significant.

TABLE 3. Rank correlations of debt with money and prices.

Panel A: Rank correlation coefficients within subperiods[1]				
Time period	Statistic	Debt-base	Debt M1	Debt-prices
1952–62	Spearman (r_s)	0.22	0.32	−0.20
		(0.59)	(0.88)	(0.54)
	Kendall τ (r_τ)	0.11	0.17	−0.17
		(0.42)	(0.63)	(0.63)
1962–74	Spearman (r_s)	0.58*	0.59*	−0.22
		(1.99)	(2.06)	(0.65)
	Kendall τ (r_τ)	0.42	0.42	−0.11
		(1.70)	(1.70)	(0.45)
1974–83	Spearman (r_s)	0.26	0.20	0.09
		(0.70)	(0.58)	(0.26)
	Kendall τ (r_τ)	0.24	0.20	0.07
		(0.98)	(0.80)	(0.27)
1952–83	Spearman (r_s)	0.79**	0.77**	0.31
		(3.69)	(3.41)	(0.92)
	Kendall τ (r_τ)	0.60*	0.60*	0.29
		(2.41)	(2.41)	(1.16)

Panel B: Rank correlation coefficients of changes across subperiods[1]				
Time period	Statistic	Debt-base	Debt-M1	Debt-prices
from	Spearman (r_s)	0.02	0.42	0.27
1952–62		(0.04)	(1.21)	(0.73)
to	Kendall τ (r_τ)	0.00	0.39	0.17
1962–74		(0.00)	(1.46)	(0.63)
from	Spearman (r_s)	0.36	−0.08	0.04
1962–74		(1.08)	(0.22)	(0.12)
to	Kendall τ (r_τ)	0.33	−0.02	0.02
1974–83		(1.34)	(0.09)	(0.09)

Notes:

* Significant at the 5 per cent level for a one-tail test.

** Significant at the 1 per cent level for a one-tail test.

[1] *t*-statistics are in parentheses. Real GNP growth is subtracted from Debt, Base, and M1 growths.

For example, the Spearman rank correlation between excess debt and base growth is 0.79 with a *t*-statistic of 3.69. At the same time, the overall correlation between excess debt growth and inflation is relatively small and statistically insignificant.

In contrast to the results for the overall period, the rank correlations within each subperiod indicate much less correlation between excess debt and money growth. The average correlation coefficient between excess debt and money growth is 0.31 and the largest is 0.59. The *t*-statistics are typically less than 1.00. However, there is an interesting pattern to these correlations. The correlations for the first and third subperiods are very small and insignificant. The average correlation is 0.22 and the largest *t*-statistic is 0.88. But the correlations for the middle subperiod (1962–74) are relatively high and just significant at the 5 per cent level. In interpreting the

meaning of these correlations one must realize that the existence of very low correlations in the third subperiod is very important, because it is in the third subperiod that excess debt growth increases so dramatically for all the countries.

These correlation tests suggest that there may be substantial periods of time over which debt and money growth can diverge, contrary to the predictions of the Monetization relation, but over the entire 32-year period money and debt growth are correlated.[10] However, this high overall correlation is also consistent with other scenarios that are unrelated to the Monetization relation. One possibility is that high money growth could cause inflation which, by increasing nominal interest rates, raises the deficit and nominal debt growth. Another possibility is that the government may wish to maintain a target range for the debt-to-income ratio, which would necessitate debt growth whenever the price level increases. A positive correlation between debt and money growth over the whole sample is consistent with many hypotheses. However, *failure* to uncover a significant relation between debt and money growth in the individual subperiods casts doubt on any operative causal path by which debt influences monetary policy over decade-long periods.

Table 3, Panel A also provides evidence that there is no significant correlation between excess growth of government debt and inflation, either within the subperiods or throughout the entire 1952–83 period. These results do not test for the existence of the Inflation-Debt relation, since that relation is predicated on a constant money stock. The test of the Inflation-Debt relation must await the regression analysis presented in Section III.B.

A similar set of non-parametric statistics is reported in Panel B, Table 3. In this table we show the rank correlation coefficients for the *change* in the excess growth of debt between two consecutive subperiods (between 1952–62 and 1962–74, and between 1962–74 and 1974–83), and the *change* in the excess growth of money and the change in inflation. These statistics indicate whether countries whose debt growth increases relative to real growth across subperiods also show increases in their money growth rates and their inflation rates. Inspection of Panel B, Table 3 reveals that these rank correlation coefficients are small, and none is statistically significant at conventional levels. These statistics suggest that it is very unlikely that there is any association between *increases* in excess debt growth, and *increases* in excess money and in inflation.

The Monetization relation also predicts a positive correlation between the debt-to-GNP ratio and future excess money growth and inflation. We examine this hypothesis by calculating two types of rank correlation coefficients. The first, shown in Table 4, Panel A, is the correlation between the beginning-of-period debt-to-GNP ratio and excess money growth and inflation during that period. The second type of correlation coefficient is between the beginning-of-period debt-to-GNP ratio and the *change* in excess money growth and inflation from the previous period. If one is willing to interpret the changes in excess money growth and inflation as largely unanticipated, then this second test corresponds more closely to the time-inconsistency argument, *i.e.*, that it is optimal to monetize the debt with unanticipated inflation.

These non-parametric tests seem to lend some support to the time-inconsistency argument of the Monetization relation. There is a strong association between inflation (and changes in inflation) and the beginning-of-period debt-to-income ratio for the 1974–83 subperiod. This finding supports the notion that, at least over the past decade, the larger the nominal government debt, the stronger the

TABLE 4. Rank correlations of debt-to-GNP ratio with money and prices.

Panel A: Rank correlation coefficients within subperiods[1]				
Time period	Statistic	Debt/GNP-base	Debt/GNP-M1	Debt/GNP-prices
1952–62 (1952 D/GNP ratio)	Spearman (r_s)	−0.40	−0.73**	−0.43
		(1.15)	(2.85)	(1.27)
	Kendall τ (r_τ)	−0.22	−0.61*	−0.28
		(0.79)	(2.66)	(0.98)
1962–74 (1961 D/GNP ratio)	Spearman (r_s)	−0.27	−0.20	−0.25
		(0.78)	(0.57)	(0.72)
	Kendall τ (r_τ)	−0.24	−0.16	−0.11
		(0.98)	(0.62)	(0.45)
1974–83 (1973 D/GNP) ratio)	Spearman (r_s)	0.77**	0.70*	0.77**
		(3.41)	(2.75)	(3.41)
	Kendall τ (r_τ)	0.60*	0.51*	0.64*
		(2.12)	(1.81)	(2.59)
Panel B: Rank correlation coefficients of changes across subperiods[1]				
Time period	Statistic	Debt/GNP-base	Debt/GNP-M1	Debt/GNP-prices
from 1952–62 to 1962–74 (1961 D/GNP ratio)	Spearman (r_s)	0.21	0.15	0.19
		(0.61)	(0.43)	(0.54)
	Kendall τ (r_τ)	0.02	0.11	0.16
		(0.09)	(0.45)	(0.63)
from 1962–74 to 1974–83 (1973 D/GNP ratio)	Spearman (r_s)	0.75**	0.64*	0.72**
		(3.16)	(2.33)	(2.95)
	Kendall τ (r_τ)	0.56*	0.51*	0.51*
		(2.24)	(2.06)	(2.06)

See notes to Table 3.

incentives for the government to engage in unanticipated inflation. However, the same correlations calculated for the 1962–74 and 1952–62 subperiods are all negative and statistically insignificant.

III.B. Multivariate Regression Tests

As an alternative to the rank correlation tests, we calculate reduced form regressions of money growth and of inflation on past values of debt growth and other variables that are likely to influence the evolution of money growth and inflation over the entire post-war period. By comparing the explanatory power of these regressions with regressions that exclude the debt growth terms, it is possible to assess the effect of debt growth on money growth and inflation in each country. This approach, which has been used extensively in the literature, allows us to account for variations across countries in money growth associated with real growth and with the history of money growth, and it does not rely on analysis by subperiod. However, the two tests address somewhat different questions. The rank

correlation statistics test whether, in *each subperiod*, there is a cross-sectional relation between debt growth, and money growth and inflation, while the regression statistics test whether, for *each country*, there is such a relation over the entire sample period.

III.B.1. The Relation Between Debt Growth and Money Growth

We calculate two tests in order to examine the Monetization relation. The first test is intended to determine the statistical support for the proposition that a permanent increase in debt growth is associated with a permanent increase in money growth. The second test is aimed at examining a weaker proposition: that debt growth has a positive effect on money growth, though this effect need not be permanent.

To test the Monetization relation, we formulate a reduced form regression equation of current annual money growth on its own four lags, and on four lags of annual debt growth and real GNP growth; specifically,

$$\langle 1 \rangle \qquad \tilde{m}_t = \sum_{i=1}^{4} \mu_i m_{t-i} + \sum_{i=1}^{4} \delta_i d_{t-i} + \sum_{i=1}^{4} \gamma_i y_{t-i} + \tilde{\varepsilon}_t,$$

where m_t, d_t, and y_t are money growth, debt growth, and real GNP (or GDP) growth, respectively.[11]

If a permanent increase in debt growth results in a permanent increase in money growth, then the sum of the debt coefficients in equation ⟨1⟩ must be positive and statistically significant. The first test calculates the statistical significance of the sum of debt coefficients for each country. If debt growth has some, but not necessarily permanent, effect on money growth, then there will be a statistically significant reduction in the log-likelihood value from removing the debt growth variables from the money growth regression. We label this second test the LL-ratio test.[12]

The Monetization relation predicts that the sum of debt coefficients, as well as the LL-ratio statistic, should be positive and statistically significant. Both tests and their results are reported in Table 5 for each of the ten countries. The tests are calculated using both the monetary base and M1 as measures of money.

Our overall conclusion from Table 5 is that the data provide very little support for the hypothesis that an increase in debt growth is associated with an increase in money growth. With the monetary base as the measure of money, the sum of the debt coefficients is not significant for any country, and in most cases they are far from significant at conventional levels. Furthermore, with the exception of Italy, the point estimates for all these sums are small, and they are negative for five out of the ten countries. As a check on the results, we calculate the long-run impact of debt growth on money, which is given by $(\delta_1+\delta_2+\delta_3+\delta_4)/(1-\mu_1-\mu_2-\mu_3-\mu_4)$. This coefficient differs from the simple sum of coefficients because it accounts for the impact of past debt growth on past money growth. Examining the long-run impact coefficients does not change the conclusions on the effect of debt growth on the monetary base.

The test statistic of the weaker proposition, that increased debt growth is associated with increased money growth over some time interval, is significant at the 5 per cent level only for France and the UK. Since the sum of coefficients is statistically insignificant for these two countries, this finding indicates that while debt growth may have a temporary impact on monetary policy, this effect most likely is offset in subsequent periods.

TABLE 5. The effect of debt growth on money growth.

	LL-ratio statistic[1]		Sum of Debt coefficients[2]		Long-run impact coefficient[2]
	Base	M1	Base	M1	Base
CA	3.36/4	1.16/4	−0.061	0.315	−0.288
			(0.15/14)	(0.22/14)	(0.12)
FI	5.38/4	8.64*/3	0.324	−0.080	0.297
			(1.66/14)	(0.34/14)	(1.22)
FR	10.33*/4	15.33**/4	0.738	0.266	0.458
			(1.70/14)	(1.08/14)	(1.23)
GE	6.10/4	1.29/4	−0.280	−0.003	−0.742
			(0.78/14)	(0.01/14)	(0.44)
HO	1.00/4	4.81/4	0.042	−0.053	0.031
			(0.17/14)	(0.16/14)	(0.18)
IT	7.12/4	4.35/4	1.004	0.700	1.035
			(1.42/11)	(0.83/14)	(1.24)
JA	4.50/4	23.47**/4	−0.149	−0.243**	−0.074
			(1.02/7)	(2.97/7)	(1.24)
SW	2.57/4	15.98**/4	−0.220	1.713	−0.270
			(0.04/3)	(1.88/3)	(0.03)
UK	7.91*/3	8.71/4	−0.065	−0.740	−0.078
			(0.12/14)	(1.73/14)	(0.11)
US	4.92/4	4.22/4	0.038	0.177	0.129
			(0.09/14)	(0.79/14)	(0.11)

Notes: * Significant at the 5 per cent level.
** Significant at the 1 per cent level.
[1] The χ^2 statistics were computed between a regression with no debt growth and regressions in which debt growth lags were introduced one at a time. *Any* significant χ^2 statistic from these calculations is reported, because there is no theoretical basis on which to set the lag length for these tests. Maximum lag length is set at 4 in part as a result of the overall degree of freedom constraint, and in part because lengthening the lag length of one variable at time while holding the lag length of the other variables fixed did not result in significant χ^2 statistics. The numbers to the right of '/' show the lag length that corresponds to the reported statistic.
[2] The numbers in parentheses are the *t*-statistic and the remaining degrees of freedom in the regression equation. Significance levels are for a one-tailed test.

With money measured by M1 instead of the monetary base, the results show only a slightly stronger relation between debt and money growth. In the case of Japan, the sum of debt coefficients is significantly different from zero, but it is negative. No other sum of coefficients, except for Switzerland, is positive and large, and the sums of coefficients are negative for five of the ten countries.[13] The long-run impact coefficients provide no additional information, and they are not reported. The LL-ratio statistic is significant for Finland, France, Japan, and Switzerland. But for Finland and Japan the sum of debt coefficients is negative (and significant for Japan) so that these significant LL-ratios cannot be interpreted as evidence in favor of a positive association of debt and money. Only in France and Switzerland

(the latter subject to the qualifications of footnote 13), is an increase in debt growth significantly associated with an increase in money growth, as measured by M1. Overall these regression results lend little support to the Monetization relation.

III.B.2. The Relation Between Inflation and Debt Growth

Next we turn to the examination of the Inflation-Debt relation, *i.e.*, that debt growth influences inflation other than through its impact on money growth. If debt growth influences inflation systematically over some time interval, then the LL-ratio statistic should be significant. If the effect of debt growth on inflation is not offset in subsequent periods, then the sum of debt coefficients would be significant also.

By using the same methods as in the previous section, we formulate a reduced form regression equation of current annual inflation on its own four lags, on lagged values of annual money growth, debt growth, and real GNP growth. Specifically,

$$\langle 2 \rangle \qquad \tilde{p}_t = \sum_{i=1}^{4} \pi_i p_{t-i} + \sum_{i=1}^{4} \mu_i m_{t-i} + \sum_{i=1}^{4} \delta_i d_{t-i} + \sum_{i=1}^{4} \gamma_i y_{t-i} + \tilde{\varepsilon}_t,$$

where p_t, m_t, d_t, and y_t are inflation, money growth, debt growth, and real GNP (or GDP) growth, respectively. As before, we calculate both the sum of the debt coefficients and the LL-ratio statistic.[14]

The tests are reported in Table 6, Panel A for each of the ten countries. Overall, the test results provide weak support for the Inflation-Debt relation, that debt growth is independently associated with inflation. The sum of debt coefficients is significantly positive for Italy and the long-run impact coefficient is significant for Japan, when the monetary base is the money measure. However, in no instance are either the sums or the impact coefficients (not reported) significant when M1 is the money measure. Furthermore, three of the nine sums of the debt coefficients in the monetary base equations, and five of the nine sums of debt coefficients in the M1 equations are negative, although not statistically different from zero. The LL-ratio test statistic is significant in five of the nine countries in the monetary base equations, and in four of the nine countries in the M1 equations. The results seem to indicate a short-run association between debt growth and inflation in some cases, but in the long-run this association appears to have been quite weak, at best.

Next, we try to assess whether there is a significant relation between debt growth and inflation jointly across countries, by implementing a joint test. We do this by estimating equation ⟨2⟩ simultaneously for all nine countries and testing for the overall significance of the debt terms. The results from this joint test, reported in Table 6, Panel B, confirm the conclusions reached from the country-by-country approach. The hypothesis that lagged debt is not related to inflation jointly is rejected for both the monetary base and M1. At the same time the sum of debt coefficients jointly is not statistically different from zero.

This joint test also allows us to explore whether the effect of debt on inflation is identical in each country. To test this, we restrict the debt coefficients for each lag to be the same across countries. The test results, also shown in Table 6, Panel B, reject the hypothesis that debt has the same effect on inflation in each country. The findings overall support the view that debt growth has no permanent effect on inflation. At the same time, there is support for the view that debt growth is temporarily, and independently, related to inflation, but the relation seems to dissipate within four years.

TABLE 6. The effect of debt growth on inflation.[1]

Panel A: For each country

	LL-ratio statistic[2]		Sum of debt coefficients[3]		Long-run impact coefficient[3]
	With base	With M1	With base	With M1	With base
CA	18.58**/4	10.04*/4	0.257	0.356	0.418
			(1.40/10)	(0.61/10)	(1.78)
FI	3.99/4	4.45/4	0.087	0.058	−0.280
			(0.36/10)	(0.73/10)	(0.60)
FR	5.04/4	4.00/4	−0.229	−0.255	−0.704
			(0.56/10)	(0.87/10)	(0.39)
GE	2.95/4	4.05/4	−0.038	−0.055	−1.687
			(0.51/10)	(0.43/10)	(0.03)
HO	17.49**/4	13.96**/4	−0.047	−0.008	−0.566
			(0.39/10)	(0.09/10)	(0.19)
IT	15.10**/4	9.26*/3	0.772*	0.615	0.975
			(2.63/7)	(1.48/10)	(0.95)
JA	34.86**/4	7.14/4	0.269	0.074	0.058**
			(1.97/3)	(0.49/3)	(5.10)
UK	3.39/4	8.11*/3	0.423	−0.618	0.563
			(0.39/10)	(1.15/10)	(1.78)
US	25.71**/4	8.20/4	0.315	−0.128	0.199
			(0.49/10)	(0.29/10)	(0.72)

Panel B: Jointly for all countries

	LL-ratio statistic[1]		Sum of debt coefficients	
	With base	With M1	With base	With M1
Is debt jointly significant?	157.54**/36	71.31**/36	13.97/9[4]	5.71/9[4]
Is the effect of debt the same in each country?	136.54**/32	68.21**/32	0.117**[5] (3.05)	0.019[5] (0.46)

Notes:

* Significant at the 5 per cent level.

** Significant at the 1 per cent level.

[1] There are no results for Switzerland in this table because of lack of degrees of freedom for that country.

[2] The χ^2 statistics were computed between a regression with no debt growth and regressions in which debt growth lags were introduced one at a time. *Any* significant χ^2 statistic from these calculations is reported, because there is no theoretical basis on which to set the lag length for these tests. Maximum lag length is set at 4 in part as a result of the overall degrees of freedom constraint, and in part because lengthening the lag length of one variable at a time while holding the lag length of the other variables fixed did not result in significant χ^2 statistics. The numbers to the right of '/' show the lag length that corresponds to the reported statistic.

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III.B.3. The Relation Between Inflation, Money Growth, and the Level of Debt

Finally we undertake several tests of the relation advanced in the time-inconsistency hypothesis, *i.e.*, that there is a positive association between the debt-to-GNP ratio and both future inflation and money growth. We test this relation in the context of these multivariate regression tests by adding the lagged value of the debt-to-GNP ratio to the money growth and inflation regressions (equations ⟨1⟩ and ⟨2⟩). We add only one lagged value because of the degrees-of-freedom constraint. The coefficients of the lagged debt-to-GNP ratio are shown in Table 7.

The remarkable aspect of this table is that almost all the coefficients are negative, though with three exceptions they are statistically insignificant. These results may seem to contradict the rank correlation tests of the time inconsistency relation. However, closer examination yields some clues to the seeming contradiction. The rank correlation tests show a strong negative association in the first subperiod, a weaker, but still negative association in the second subperiod, and a strong and positive association in the third subperiod, across countries. By comparison, the regression tests show a persistently negative, but generally not statistically significant relation over the sample period for each of the countries. The statement that since 1974 there seems to be a strong relation between money growth and the debt-to-GNP ratio is still valid. Unfortunately there are not enough degrees of freedom to test whether this relation also holds over time for each country after 1974.

IV. Conclusion

Our results yield virtually no support to the proposition that increases in government debt growth in excess of the growth in real income are associated with increases in money growth. We find no association between debt and money growth in our regression equations, which include lags up to four years. Non-parametric tests also reveal no association in two of the three decade-long subperiods, and particularly in the 1974–83 subperiods, even though that period witnessed rapid government debt creation in all the countries. However, we do find a significant relation between debt growth and money growth over the entire 32-year period.

We interpret these results as evidence against the hypothesis that debt growth plays a causal role in monetary policy over periods lasting a decade or less. Over longer periods of time, debt growth may play such a role, although there are other reasons why government debt and money may be correlated. We find support in the 1974–83 subperiod for the 'time-inconsistency' proposition that a higher debt-to-income ratio is associated with higher subsequent inflation. But there is no support for this proposition for earlier periods.

Finally, our analysis lends rather weak support to the Inflation-Debt relation, *i.e.*, that excess increases in debt growth are associated with increases in inflation,

Notes to table 6 continued:

[3] The numbers in parentheses are the *t*-statistic and the remaining degrees of freedom in the regression equation. Significance levels are for a one-tailed test.

[4] This statistic is a test of the proposition that the sum of debt coefficients is significantly different from zero, jointly for all countries, and it is χ^2 distributed. The second number is the degrees of freedom for the test.

[5] The sum of the restricted debt coefficients; the *t*-statistic is in parentheses.

TABLE 7. The effect of debt-to-GNP ratio.[1]

	Effect of debt/GNP(−1) on money		Effect of debt/GNP(−1) on inflation	
	With base	With M1	With base	With M1
CA	−0.335	−0.222	−0.057	−0.223
	(1.51)	(0.40)	(0.55)	(1.58)
FI	−2.426**	−2.28	−0.553	−1.177
	(3.05)	(1.83)	(0.52)	(1.50)
FR	−0.244	−0.078	−0.183	−0.210
	(0.84)	(0.63)	(1.10)	(1.38)
GE	−0.876	−0.559	0.001	−0.011
	(1.69)	(1.23)	(0.01)	(0.08)
HO	−0.227	−0.723	−0.314	−0.310
	(1.62)	(1.89)	(1.50)	(1.72)
IT	−0.380	−0.328	0.163	0.151
	(1.25)	(1.77)	(1.39)	(1.72)
JA	−1.052	−0.269	−0.530	−1.593*
	(1.28)	(0.49)	(0.91)	(2.63)
SW	−2.730	−0.834	—	—
	(1.52)	(0.80)		
UK	−0.092	−0.145	−0.065	−0.036
	(1.24)	(1.43)	(1.82)	(0.59)
US	−0.459	−0.214	0.006	−0.346*
	(2.10)	(1.10)	(0.06)	(2.32)

Notes:

[1] The table shows the coefficient Debt/GNP(−1) takes when it is added to equations ⟨1⟩ and ⟨2⟩; *t*-statistics are in parentheses.

There are no results for Switzerland in the inflation columns because of lack of adequate degrees of freedom.

holding money growth constant. We find significant temporary effects of debt on prices, but these effects tend to be reversed in later periods, so that the cumulative effect is insignificant in most cases.

In conclusion, our study indicates that, at least over periods of ten years or less, there is no significant association between increases in debt growth and increases in money growth, and very weak association between increases in debt growth and permanent increases in inflation. Our study encompasses industrialized economies with access to foreign and domestic borrowing in the post-war period. None of these countries had massive deficits, such as those of several Latin American countries and Israel, in which monetization of the government debt clearly occurred. Our results support the argument that central banks in industrialized countries with moderate deficits can pursue an independent monetary and inflation policy over long periods of time, notwithstanding the size of government deficits.

Notes

1. Barro (1978), Niskanen (1978), Dwyer (1982), Joines (1984), and King and Plosser (1985) find no significant relation between money and debt growth, while Hamburger and Zwick (1981), Levy (1981), Allen and Smith (1983), and Laney and Willett (1983) find some relation for parts of their sample.
2. A notable exception is King and Plosser (1985), who investigate the time series relation between debt growth and seignorage in the United States and several foreign countries. They find no strong evidence that debt growth predicts the growth of the monetary base over periods of several years. Laney and Willett (1982) find some relation between debt and money growth in some of the countries they study.
3. Long-term historical studies have shown that during periods when an economy is neither at war nor in recession, the debt-to-income ratio normally decreases. Before World War II, the decreases in the debt-to-income ratio are due both to actual surpluses run by the government and to the expansion of real income. For a description of the 200-year history of debt in the USA and the UK, see Barro (1984). Joines (1984) gives an extensive 110-year analysis of the US data.
4. We are referring to the transversality condition on debt growth. Important works that study this effect are Sargent and Wallace (1981), McCallum (1984), who derives the appropriate limiting conditions, and Buiter (1983).
5. The time-inconsistency problem of optimal government plans was first analyzed by Kydland and Prescott (1977). See also Calvo (1978), Turnovsky and Brock (1980), and Lucas and Stokey (1983). For specific applications to monetary policy, see Barro and Gordon (1983a,b) and Canzoneri (1984).
6. Another incentive to inflate at a rate greater than anticipated is the possibility that government can exploit a short-run Phillips Curve in order to lower unemployment.
7. If the central bank has no control over real rates, then current monetization may actually increase inflationary expectations and hence nominal rates, defeating the goals of the bank. However, Sargent and Wallace (1981) show that engaging in current, rather than future monetization may actually lower inflationary expectations.
8. It should be noted that, under this scenario, for a permanent increase in the growth rate of debt to result in a permanent increase in inflation, it must be that the real rate of interest rises continuously.
9. This definition of excess debt growth does not take account of the effect of the business cycle on the government deficit. In our regression results that we present later, this deficiency is corrected by including real output as an explanatory variable.
10. We also calculated analogous rank correlation coefficients between debt growth and money growth and inflation, not adjusted for real growth. The results are quite similar. The differences are that, (1) the second subperiod correlations between debt and money growth are not as high, and they are not statistically significant, and (2) the correlations for the whole period between debt and money growth are somewhat higher.
11. The variables and the lag length for all the variables were chosen as a compromise between the need to capture as many sources of influence and as long a lag as possible without sacrificing too many degrees of freedom. Money lags are included to capture the autocorrelation of money growth, debt lags are included to insure that as much as possible of the potential relation between money growth and debt growth is captured, and real growth is included to capture both any cyclical behavior of money growth and differential money growth across countries that may be related to differential real growth. As for the choice of four lags, very few of the coefficients on the fourth lag are statistically different from zero, providing some assurance that the important lag relations are captured with four lags.
12. This test is similar to the standard 'Granger-causality' tests conducted in a multivariate regression setting. We do not include the current values of debt and real GNP growth since we do not address the question of two-way contemporaneous causality.
13. The relevance of both the sum of coefficients and of the LL-ratio tests is suspect for Switzerland because, due to fewer available observations than the other countries, the Swiss regression has only three degrees of freedom. This is far from a large sample, which is the basis of the χ^2 test. Furthermore, the sum of debt coefficients with base as the measure of money is negative and large, while the same sum for M1 is positive and large, which seems inconsistent.
14. There are no statistics reported for Switzerland in this section, because there aren't enough observations in the Swiss data to make the tests possible.

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