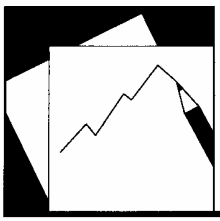
WP/06/121



IMF Working Paper

Public Debt, Money Supply, and Inflation: A Cross-Country Study and Its Application to Jamaica

Goohoon Kwon, Lavern McFarlane, and Wayne Robinson

INTERNATIONAL MONETARY FUND

 WP/06/121

IMF Working Paper

Western Hemisphere Department

Public Debt, Money Supply, and Inflation: A Cross-Country Study and Its Application to Jamaica

Prepared by Goohoon Kwon, Lavern McFarlane, and Wayne Robinson[1]

Authorized for distribution by Sanjaya Panth

May 2006

Abstract

This paper provides comprehensive empirical evidence that supports the predictions of Sargent and Wallace's (1981) "unpleasant monetarist arithmetic" that an increase in public debt is typically inflationary in countries with large public debt. Drawing on an extensive panel dataset, we find that the relationship holds strongly in indebted developing countries, weakly in other developing countries, but generally not in developed economies. These results are robust to the inclusion of other variables, corrections for endogeneity biases, and relaxation of common-slope restrictions and are invariant over sub-sample periods. We estimate a VAR to trace out the transmission channel and find the impulse responses consistent with the predictions of a forward-looking model of inflation. Wealth effects of public debt could also affect inflation, as posited by the fiscal theory of the price level, but we do not find supportive evidence. The results suggest that the risk of a debt-inflation trap is significant in highly indebted countries, and pure money-based stabilization is unlikely to be effective over the medium term. Our findings stress the importance of institutional and structural factors in the link between fiscal policy and inflation.

JEL Classification Numbers: E31, E62, E63, C59

Keywords: Money demand, the fiscal theory of the price level, dynamic panel, GMM

Author(s) E-Mail Address: gkwon@imf.org, wayne.robinson@boj.org.jm

---

[1] We thank Ruben Atoyan, Mark de Broeck, Jaewoo Lee, John Robinson, Jeronimo Zettelmeyer and participants of seminars in WHD and the Bank of Jamaica for valuable comments and suggestions. All remaining errors are our responsibility. Lavern McFarlane is an economist and Wayne Robinson is a chief economist at the Bank of Jamaica. The views expressed in this paper are not necessarily those of the IMF or the Bank of Jamaica.

Contents Page

I. INTRODUCTION

The most widely accepted school of thought on inflation is that it is a monetary phenomenon, and, therefore, the reduction of inflation is largely the purview of monetary policy, particularly in the initial stages of disinflation. This school of thought, based on the quantity theory of money, posits that inflation is determined solely by the change in the relative supply of money and goods. Against this background disinflation policy in many countries is framed with the objective of constraining monetary growth to be in line with the expansion in nominal income. Hence, an increasing number of countries have granted their central banks autonomy in the hope that it will insulate them from having to accommodate imprudent fiscal policies.

However, given that current money demand should depend on expectations about future inflation, a purely monetary effort at reducing inflation may not be successful. Theoretically, once account is taken of forward-looking expectations, multiple equilibrium paths for inflation can coexist. Under such circumstances, money supply alone may not be sufficient to pin down the time path of inflation.

Against this background, attention has increasingly been given to the role of fiscal policy in determining inflation. The main result of the seminal paper by Sargent and Wallace (1981) is that the effectiveness of monetary policy in controlling inflation depends critically on its coordination with fiscal policy. In their model, tighter monetary policy could lead to higher inflation under certain circumstances, even when the traditional relation between money and the price level holds. The rationale is that, with the demand for government bonds given and in the absence of changes in future fiscal policy, a part of government obligations has to be covered by seignorage at some point in the future.

A similar line of reasoning lies behind the fiscal theory of the price level (FTPL). Apart from seignorage financing, traditional analysis of the fiscal impact on inflation focus mostly on Keynesian aggregate demand considerations, public wage spillovers to private sector wages, and taxes affecting marginal costs and private consumption (Elmendorf and Mankiw, 1999). The FTPL identifies the wealth effect of government debt as an additional channel of fiscal influence on inflation and, amid debates on the coherence of the theory (Buiter, 1999; Niepelt, 2004), has spawned an extensive literature (Woodford, 1994; Sims, 1994; Loyo, 1999; Christiano and Fitzgerald, 2000; Canzoneri, Cumby, and Diba, 2001; Cochrane, 2001; Woodford, 2001; Gordon and Leeper, 2002; Cochrane, 2005). This theory posits that increased government debt adds to household wealth and, hence, to demand for goods and services, leading to price pressures.

This paper provides a comprehensive empirical examination of the link between fiscal policy and inflation identified by the forward looking fiscal-monetary models of inflation. We draw on an extensive cross-country dataset for 71 countries spanning up to 43 years. We think that this helps overcome, or mitigate substantially, potential biases arising from the selection of sample countries and sample periods. In addition, given the importance of policy regimes in the forward looking models, we rely on flexible econometric techniques allowing for cross-country heterogeneity, which is often neglected in empirical studies for the sake of stronger

testing power. Our approach also differs from much of the existing empirical literature (Evans, 1987a and 1987b; Elmendorf, 1993; Ardagna et al., 2004; Catao and Terrones, 2005) in that we focus on the role of public debt—instead of the budget deficit—in determining inflation and inflation expectations. In so doing we account for the nontraditional channels of fiscal influence on inflation—namely monetization expectations and wealth effects of public debt—which can be formed independently of the size of the budget deficit. The focus on the stock variable is also important empirically since budget deficits often diverge substantially from changes in public debt due to non-debt financing, debt-indexation, and exchange rate movements, as well as the government's assumption of quasi-fiscal liabilities (IMF 2003; Singh et al., 2005).

The rest of the paper is organized as follows. Section II describes a simple forward-looking model of inflation that is used for our empirical work. Section III presents basic stylized facts on public debt and inflation, discusses modeling strategies, and presents our empirical findings. Section IV applies the empirical model to Jamaica. Section V discusses policy implications of the findings and Section VI summarizes and concludes.

II. Conceptual Framework

There is a rich literature on forward-looking models of inflation. Aiyagari and Gertler (1985) introduced an overlapping generation model, deriving a simple, direct link between public debt and the price level. Calvo (1988) developed an alternative model based on a loss function of the authorities, which establishes a similar link between prices and public debt. Bohn (1988) also created a rational expectation model of a similar nature. Key common ingredients of these models are rational expectations, Cagan-type money demand, and a non-Ricardian regime that takes government bonds as net wealth.

Our model is a simplified version of Castro et al. (2003). In our model, a representative household is endowed with fixed resources, y, for each period, and allocates its real wealth among real consumption (c), real domestic money (m/p), and non-indexed real government bonds (b/p) in order to maximize the following utility function:

$$\sum_{t=0}^{\infty} \beta^t \left(\ln(c_t) + \gamma \ln\left(m_t / p_t\right)\right) \tag{1}$$

subject to a resource constraint of

$$c_t + \frac{m_t}{p_t} + \frac{b_t}{p_t} = y_t - \tau_t + \frac{m_{t-1}}{p_t} + \frac{i_{t-1} b_{t-1}}{p_t} \tag{2}$$

where τ is the lump-sum tax and i_{t-1} is a nominal gross return of a government bond between periods $t-1$ and t. This maximization problem yields the following standard first-order conditions for consumption and real money demand, respectively:

$$\frac{c_{t+1}}{c_t} = \frac{\beta i_t}{\pi_{t+1}} \tag{3}$$

$$\frac{m_t}{p_t} = \frac{\gamma c_t i_t}{i_t - 1} \tag{4}$$

where $\pi_t = p_{t+1}/p_t$. These two first order conditions nest a Cagan-type money demand function, which is inversely related to inflation expectations.

The government is faced with the following intertemporal budget constraint:

$$G_t + (i_{t-1} - 1)\frac{B_{t-1}}{p_t} = \tau_t + \frac{(M_t - M_{t-1})}{p_t} + \frac{(B_t - B_{t-1})}{p_t} \tag{5}$$

Forward iteration on (5) and no-Ponzi game conditions on the government imply the following long-term budget constraint of the government:

$$\frac{i_{t-1}B_{t-1}}{p_t} = \sum_{j=0}^{\infty}\frac{\tau_{t+j}}{R_{t,j}} - \sum_{j=0}^{\infty}\frac{G_{t+j}}{R_{t,j}} + \sum_{j=0}^{\infty}\frac{M_{t+j} - M_{t+j-1}}{p_{t+j}R_{t,j}} \tag{6}$$

where *G* is real government spending and *Rt,j* is the compounded real discount rate, as expressed as $R_{t,j} = \prod_{h=1}^{j} r_{t+h}$ where r_{t+h} is the exogenous real interest rate between periods t+h-1 and t+h. In the case of a fiscal policy rule of backing a part, (1-δ), of the debt service by future primary surpluses and monetizing the remainder (δ), we obtain the following money supply function:

$$\frac{M_t}{P_t} = \frac{i_t - 1}{i_t}\left[\frac{\delta \cdot i_{t-1}B_{t-1}}{p_t} + \frac{M_{t-1}}{p_t} - \sum_{j=1}^{\infty}\frac{M_{t+j}}{p_{t+j}R_{t,j}}\frac{i_{t+j} - 1}{i_{t+j}}\right]. \tag{7}$$

Equation (7) shows that the path of money supply is determined by the extent of debt monetization (the first variable in the right) and savings in the future interest payments brought about by current monetary financing of the budget deficit (the third variable).

Imposing equilibrium conditions on Equations (4) and (7) and exploiting the recursive nature of the Euler equation in (3), we obtain the equilibrium price as following:

$$p_t = \frac{(1-\beta)(M_{t-1} + \delta \cdot i_{t-1}B_{t-1})}{\gamma c_t} \tag{8}$$

Given the recursive nature of the equilibrium and no arbitrage between bond and real asset returns ($r_{t+1} = i_t/(p_{t+1}/p_t)$), the equilibrium price can be rearranged to:

$$p_t = \frac{(1-\beta)(M_t + \delta B_t)}{\gamma c_t} \tag{9}$$

Equation (9) can be log-linearized to obtain a more easily estimable specification as following:

$$\hat{p}_t = \lambda_1 \hat{M}_t + \lambda_2 \hat{B}_t - \hat{c}_t, \text{ where } \lambda_1 = \frac{M^*}{M^* + \delta B^*}, \text{and } \lambda_2 = \frac{\delta B^*}{M^* + \delta B^*} \tag{10}$$

where hats in the above terms represent deviations from equilibrium values in logarithms that are denoted with asterisks. This transformation establishes a linear relationship between inflation and increases in money supply and in public debt so that the relationship can be tested empirically. In a dynamic setting that allows restoration to the equilibrium over time, Equation (10) could be modified to the following unrestricted form:

$$\hat{p}_t = \alpha \hat{p}_{t-1} + \beta_1 \hat{M}_t + \beta_2 \hat{B}_t - \beta_3 \hat{c}_t \tag{11}$$

Equation (9), which relates the equilibrium price to money and public debt, nests the quantity theory of money and the unpleasant monetary arithmetic of Sargent and Wallace (1981). In the reduced form equation, the monetization factor δ reflects the extent of monetary accommodation of fiscal policy and, more broadly, the nature of coordination between monetary and fiscal policy as was introduced in Equation (7). Suppose the government does not monetize its debt at all and runs a balanced budget over the long term. The monetization factor δ then reduces to zero and Equation (9) simplifies into the conventional quantity theory of money. More broadly, if fiscal policy is not predetermined and instead undertaken flexibly, for example, in ways to keep the debt-to-GDP ratio fixed, then the debt growth term in Equations (10) and (11) will simply disappear, with no effect on inflation. Alternatively, if the implied fiscal and monetary arrangement is full monetization of all public debt, δ becomes 1, meaning that the issuance of the public debt influences inflation as strongly as money supply does. In reality, the parameter is likely to vary between 0 and 1, with the exact scale depending on the capacity and willingness of the government to service public debt, as often construed from the debt size, policy credibility and institutional and political constraints.

Equation (9) is also consistent with the predictions of the FTPL. While our simple model does not incorporate the wealth effect of government debt, as advanced by the FTPL, Equation (9) is fully consistent with the implications of the FTPL on the relationship between public debt and prices. This means that the establishment of a positive significant relationship between public debt and prices does not necessarily answer whether the link is from the monetization concerns or the wealth effects. We will discuss theoretical and empirical implications of the two competing models of inflation in the following section and attempt to address the issue of interpretation by distinguishing the residency of public debt holders.

III. Empirical Findings of the Cross-Country Study

A. Basic Stylized Facts

Our main dataset is a panel data spanning 71 countries over up to 42 years (1963–2004). Table 1 below provides selected descriptive statistics of the main dataset. It shows that, during the sample period, the average annual growth of money exceeded average inflation by about 4 percentage points. Money supply grew at about the same pace as nominal GDP, implying a virtually unchanged level of money velocity during the sample period. In contrast, public debt grew faster than both nominal GDP and money by about 0.5 percentage point per annum—a small but significant difference if extended over the long term. This could reflect financial deepening, which tends to expand non-monetary financial instruments faster than monetary aggregates.

Table 1. Descriptive statistics of long-term average cross country data
(In percentage changes per annum, unless otherwise noted)

	Real GDP Growth	Inflation	Money Growth	Debt Growth	Debt-GDP Ratio
Mean	3.7	12.1	16.2	16.6	50.1
Median	3.9	6.2	11.4	12.1	40.1
Standard deviation	0.54	2.54	2.69	2.57	5.0
Number of countries	71	71	71	71	71
Underlying observations	2963	2854	2689	2243	2302

There is considerable variation across countries in the data, indicating potentially large gains from using panel data. Table 2 below shows a summary of regional variations of selected macroeconomic indicators averaged over the sample period. Among 48 developing countries in the full sample, average annual inflation (geometric) in Latin America is only second to Europe, as number of these countries experienced hyperinflation during the transition to market economies in the early 1990s. With regard to public debt and inflation, the dataset shows that public debt tends to rise nearly twice as fast as inflation in low inflation regions but not quite as fast in high inflation regions. This implies that nominal debt issuance, if excessive, is eroded quickly by inflation, pointing to the existence of a natural limit to real debt growth and a debt-inflation nexus. A similar observation could be made with respect to money growth and inflation but the extent is less prominent.

Table 2. Selected Macro Economic Indicators (1963-2004) 1/
(average annual percentage changes, unless indicated otherwise)

	Real GDP growth	Inflation	Money growth*	Public debt growth	Debt-GDP (ratio)	M-GDP (ratio)*	Nominal GDP growth	Seignorage (in % of GDP)	Fx deprec.	Fx regime **	Years covered ***	Starting year	End year
Unweighted averages	3.6	14.2	18.6	21.9	51.8	18.6	18.3	2.8	9.9	2.3	30	1973	2002
Major advanced economies (13)	2.9	5.7	9.1	12.4	54.2	39.7	8.9	4.2	0.1	2.0	32	1968	1999
Other advanced economies (10)	3.6	11.2	13.9	17.2	46.5	11.4	15.7	3.4	5.6	2.4	36	1967	2003
Developing countries (48)	3.7	17.4	22.4	25.8	52.2	14.2	21.6	2.3	13.9	2.3	28	1975	2003
Latin America and Caribbean (20)	3.0	21.7	26.6	30.9	51.7	11.9	25.2	2.1	18.5	1.9	28	1975	2003
Latin America (13)	3.3	29.1	34.9	39.4	36.5	11.2	33.1	3.0	26.0	2.4	28	1976	2003
Caribbean (7)	2.4	8.0	11.3	15.0	79.9	13.0	10.6	0.5	4.6	1.4	28	1975	2003
Asia (9)	4.9	8.2	13.9	15.8	48.9	12.1	14.0	1.8	6.0	2.0	31	1971	2002
Middle East (6)	5.1	7.1	16.0	19.2	63.7	22.0	13.9	2.5	3.0	1.9	31	1971	2002
Europe (5)	3.7	32.6	37.4	37.6	50.3	24.5	36.2	4.4	25.2	3.7	17	1986	2002
Africa (8)	3.4	13.0	15.3	20.2	49.9	11.2	16.6	1.9	9.9	2.5	29	1974	2003

Sources: IFS, WEO, OECD, and IMF's WHD databases and Reinhart and Rogoff (2004)

1/ Country groupings are based on IMF's WEO classfication as of September 2005. Details are in Appendix A.

*Narrowest definitions of money available from IFS, WEO and OECD databases.

**Based on de-facto exchange regimes (scaled from 1 to 5) of Reinhart and Rogoff (2004). The higher are the indices, the more flexible are the exchange regimes.

***Average number of years. For each country, the coverage year is adjusted for the shortest time periods for which data are available.

Our preferred form of data for regressions is in the first differences, notwithstanding some evidence of co-integration of the level data. Our panel co-integration tests are not conclusive, as is often the case with medium-sized panels. The tests for stationarity, based on Pedroni (1999), reject the null of co-integration of the 4 main variables (CPI, money, public debt, and real output) in both the pooled and group mean *t* tests at a 5 percent level but not always in the panel and group ρ tests (Table 3). In light of these mixed outcomes, we proceed mainly with their first difference terms, which are stationary, as we are keen to avoid the risk of spurious panel regressions arising from partially, if not all, non-stationary or highly persistent data.[2] Figure 1 shows the means of cross-country data in the first difference logarithmic terms over the full sample period. Similar patterns are observed in their median values.

Table 3. Panel Cointegration Tests*

	Panel v	Panel rho	Panel t	Panel adf	Group rho	Group t	Group adf
Weighted by long-term variances							
Cross section common-time effects subtracted							
Homogenous time trends	**7.34**	**-4.62**	**-8.08**	**-2.64**	**-4.14**	**-12.40**	**-3.66**
Heterogeneous time trend	**8.47**	-1.09	**-6.23**	-0.41	1.18	**-7.73**	0.07
No cross-section common-time effects							
Homogenous time trends	**4.96**	-1.23	**-4.32**	-0.64	-0.92	**-6.93**	-1.65
Heterogeneous time trend	**3.13**	0.22	**-4.32**	-0.19	1.23	**-6.48**	-1.19
Non-weighted							
Cross section common-time effects subtracted							
Homogenous time trends	**6.60**	**-3.76**	**-6.32**	**-2.73**	**-4.14**	**-12.40**	**-3.66**
Heterogeneous time trend	**7.72**	0.60	**-3.05**	-1.41	1.18	**-7.73**	0.07
No cross-section common-time effects							
Homogenous time trends	**2.59**	0.45	**-2.37**	0.86	-0.92	**-6.93**	-1.65
Heterogeneous time trend	1.24	0.86	**-3.00**	0.20	1.23	**-6.48**	-1.19

*Based on unbalanced panel cointegration tests of Pedroni (1999) for price, money, public debt and output. Statistics in bold note the rejection of the null of no-cointegration at the 5 percent confidence level.

B. Limitations of Long-Term Average Data

We first undertake a simple long-term cross-country regression as one quick way of analyzing relations among the variables. The outcome confirms the findings of other empirical studies that long-term average inflation is strongly positively associated with long-term money growth and negatively with long-term output growth but, at best, weakly with debt growth. This is in line with the quantity theory of money and consistent with many empirical studies on this subject (Schwartz, 1972; Vogel, 1974; Lucas, 1980; Duck, 1993; Favero and Spinelli, 1999). In addition, the regression results show that more flexible exchange regimes tend to be associated with higher inflation, although the causality is by no means established in this simple regression. With regard to the role of public debt, there is a positive linear relationship between inflation and public debt growth and a weak association between inflation and the size of public debt (Table 4 and Figure 2). However, both fiscal variables completely lose their explanatory power for inflation when money growth is controlled for, raising a doubt about the influence of public debt on inflation.

Table 4. Cross-country OLS regression results for inflation*

Explanatory variables				
Money growth	**0.88**			**0.89**
Debt growth		**0.79**		0.03
Debt-GDP ratio			0.05	-0.01
Exchange rate regimes			**9.60**	**0.78**
Real GDP growth			**-2.26**	**-1.22**
R-squared	0.97	0.92	0.20	0.99
Adjusted R-squared	0.97	0.92	0.19	0.99
Number of observations	71	71	71	71

*Coefficients significant at the 5 percent level are in bold.

[2] The authors are thankful to Peter Pedroni for sharing his computer programs.

It is, however, difficult to make direct inferences about the link between public debt and inflation from these long-term average data. While these results appear to reconfirm the dominant influence of money supply on long-term inflation, they do not necessarily reject the possibility that large public debt could push up inflation over the long term. The reason for the lack of a statistical relationship between debt and inflation in these regressions becomes clear when one considers the fact that essentially, public debt is transitory over the long term. In other words, a change in debt is an intermediate manifestation of the fiscal stance and eventually gets repaid with either a real primary surplus or, if not sustainable, gets deflated by monetization over the long term. The ultimate link between debt and inflation therefore depends critically on the policy regimes in place (Sargent, 1982), which differ by countries and could change over time.

C. Main Results of Panel Data Regressions

Given the limitations of long-term average data, our main empirical modeling strategy is to use panel data, which allows for variability of individual countries and yet preserve the dynamics of adjustment within countries. Our basic specification is Equation (11), an autoregressive version of Equation (10), with unobserved country-specific effects. This is designed to capture potentially complex dynamics of public debt, inflation and other macroeconomic variables within the constraints of a medium-sized panel. The existence of the fixed country effects, as opposed to the random effects, is supported by the results of the Breusch-Pagan Lagrange Multiplier test (1980). The poolability of the panel data is easily rejected by the standard Chow test.

Specifically, the estimated model is:

$$Y_{it} = \alpha Y_{it-1} + \beta X_{it} + \eta_i + \nu_{it}$$

for i=1,..., N, and t=2,..., T, where η_i and ν_{it} have the standard error component structure

$$E[\eta_i] = E[\nu_{it}] = E[\eta_i \nu_{it}] = 0.$$

Y refers to inflation (*dlogcpi*) and X represents a set of explanatory variables in the model including changes in public debt (*dlogpdebt*), money (*dlogmoney*), real GDP (*dlogrgdp*), all in first-difference logarithms, and an unobserved country-specific effect. In a detailed form, the model can hence be rewritten as following:

$$dlogcpi_{it} = \alpha dlogcpi_{it-1} + \beta_1 dlogmoney_{it} + \beta_2 dlogpdebt_{it} + \beta_3 dlogrgdp_{it} + \gamma Z_{it} + \eta_i + \nu_{it.}$$

We assume that the transient errors are serially uncorrelated

$$E[\nu_{it} \nu_{is}] = 0 \text{ for } s \neq t \text{ for i=1,..., N, and t=2,..., T}$$

and, for now, that variables in X are predetermined

$$E[X_{it-s}\, \nu_{it}] = 0 \text{ for } s \geq 0.$$

The equilibrium condition in Equation (9) suggests that the coefficients for debt and money should be positive, and one for output negative. Also, Equation (10) suggests that the coefficient for debt would be higher if the larger the debt monetization factor, δ. In most specifications, we assume that coefficients in vector β are constant for each country group but we relax this slope-homogeneity assumption in robustness tests. No other restrictions are imposed on the coefficients of the explanatory variables as the conceptual framework is ambivalent about the time period during which the equilibrium equation (9) should hold.

Regressions are separately run for different groups of countries in order to address a potential problem of slope heterogeneity without sacrificing efficiency gains from panel data. In line with the conceptual framework, the grouping of countries is made on the basis of the extent of economic development and, among subgroups, sovereign indebtedness—as classified by the most recent IMF WEO (2005). The detailed country list is in Appendix A. The possible existence of serial correlation of errors is handled through the use of a robust GMM estimator. Table 5 presents the one-step first difference GMM estimates. We prefer one-step first difference GMM estimates as two-step GMM estimates are prone to small sample biases, which could be considerable, in particular, in sub-period regressions. Pooled OLS estimates and dynamic fixed effect estimates are also presented for comparison.[3]

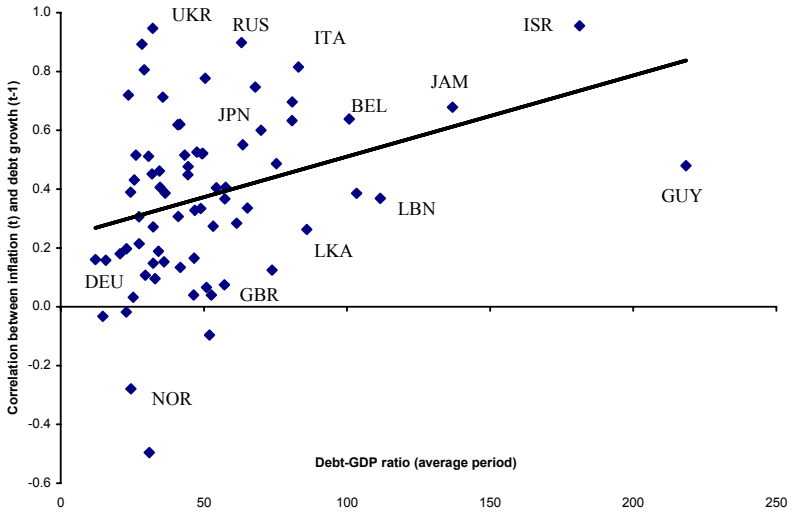
Below is a summary of the main findings. First, our regression results show a strong and stable positive effect of debt growth on inflation in developing and non-major advanced economies. The coefficient for public debt is nearly 0.2 for the short term and 0.25 for the long term (see Table 5). This implies that a 1 percent increase in public debt leads to a 0.2 percentage point increase in inflation. The short and long-term coefficients are lower than those of money growth but are significant at the 5 percent level, and rise to 0.3 and 0.5, respectively, for a subset of 25 indebted developing countries for whom the main financing source is borrowing from the non-official sector. The existence of the strong debt-inflation linkage, after controlling for money growth, stands in strong contrast to the results of the long-term cross-country regression above and does not square well with the static monetarist model of inflation.

In contrast, in 13 major advanced economies, none of the explanatory variables, except lagged inflation, show significant short-term associations with inflation. This result is consistent with other empirical studies on inflation, which find virtually no short-term relationships between money and inflation in developed countries (Christiano and Fitzgerald, 2003; Dwyer, 1982). The result is also consistent with cross-country studies that report the

[3] A dynamic pool model is likely to bias the coefficient of a lagged dependent variable upwards due to its correlation with time-invariant country effects (Bond, 2002). In contrast, estimates from a dynamic fixed effect model are likely to be biased downwards due to the de-meaning process of the fixed effect model. However, the extent of the bias is low in large T samples such as ours.

existence of a significant positive relationship between budget deficits and inflation only in high inflation episodes and mostly in developing countries (Catao and Terrones, 2005; Fischer, Sahay, and Vegh, 2002). Similar findings were reported in studies on the relationship between contemporaneous public debt and interest rates (Feldstein, 1986; Orr et al., 1995; Engen and Hubbard, 2004). These heterogeneous outcomes are well explained by our simple forward-looking model of inflation in which the nature of the coordination between monetary policy and fiscal policy plays a critical role in determining the debt-inflation linkage. Supportive empirical evidence is found also in other studies of fiscal reaction functions, which conclude that fiscal policies in developed economies are undertaken in ways to limit the increase in the debt to GDP ratio (Bohn, 1998) while those in developing countries are not (IMF 2003). It should be noted, however, that the fact that we define money primarily as reserve money may have weakened the linkage between money and inflation, since a host of financial instruments have been used as money substitutes, as countries have experienced financial deepening.

We also find that public debt growth tends to be more inflationary in high debt countries. The simple scatter plot below suggests that inflation is more sensitive to debt growth in high debt countries than in low debt countries. As a formal test, we first derive the sensitivity coefficients from a modified dynamic fixed effect model allowing for heterogeneous slopes. Then, the estimated coefficients—taken as a proxy for the expectation of debt monetization—are regressed on average debt-to-GDP ratios and other factors that might affect public expectation of debt monetization—including central bank independence, exchange rate regimes, average long-term depreciation, and average long-term money and output growth. The results show that a 10 percentage point difference in the debt-GDP ratio is associated with a 1 percentage point higher elasticity of inflation to debt growth (Table 6). The tests also indicate that statutory independence of the central bank, as measured by Cukierman (1992), does not play an important role in line with findings of many existing studies.[4]



[4] Cross-country empirical evidence on this subject is mixed, largely depending on the choice of sample countries. Campillo and Miron (1997) reports no significant or sensible statistical relationship between central bank independence and average inflation over 1973–1994 in 49 developed and developing countries, while Cukierman (1992) and Alesina and Summers (1993) find empirical evidence of the influence of central bank independence on inflation for high income countries. Recently, Castro et al. (2003) report that the extent of debt monetization in OECD countries is negatively associated with the degree of central bank independence.

Table 5. Panel regression outcomes (Dependent Variable: Inflation 1963-2004)*

	Major advanced economies			Other countries			o/w: debtor countries**		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Lagged inflation	**1.54**	**1.36**	0.46	**0.33**	**0.26**	**0.22**	0.32	**0.30**	0.24
	0.63	0.56	0.32	0.13	0.14	0.09	0.16	0.17	0.13
Money growth	0.08	0.14	0.30	**0.39**	**0.36**	**0.24**	**0.33**	**0.33**	**0.36**
	0.07	0.13	0.30	0.11	0.06	0.12	0.10	0.06	0.09
Debt growth	-0.01	0.00	0.01	0.12	0.12	**0.19**	**0.32**	**0.32**	**0.37**
	0.01	0.01	0.01	0.08	0.07	0.07	0.08	0.06	0.07
Real GDP growth	0.40	0.34	-1.66	**-0.01**	-0.10	**-1.02**	**-0.38**	**-0.37**	**-0.99**
	0.39	0.48	1.43	0.00	0.07	0.40	0.11	0.10	0.38
Depreciation	0.00	0.01	0.01	**0.00**	**0.01**	0.00	0.00	**0.00**	0.00
	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
GDP gap	0.00	0.00	**0.00**	**0.00**	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R-square	0.02	0.02		0.57	0.57		0.91	0.91	
Within		0.02			0.40			0.84	
Between		0.24			0.95			1.00	
Arellano-Bond AR (2)			-0.74			**1.59**			**0.79**
Number of countries	13	13	13	58	58	58	25	25	25
Number of observations	428	428	415	1706	1706	1646	737	737	712

*Coefficients significant at the 5 percent level are in bold.
The standard errors are below the estimated coefficients.
**Indebted developing countries, whose main source of financing is non-official financing.
(1) Pooled panel OLS.
(2) Dynamic fixed effects.
(3) GMM based on the 1-st difference transformation, assuming that explanatory variables are predetermined. Standard errors are adjusted for intracountry serial correlations and heteroscadasticity.

Table 6. Cross-country regression outcomes: Sensitivity of inflation to debt growth*

	Whole sample			Developing and other advanced economies		Developing countries	
	(1)	(2)	(3)	(1)	(2)	(1)	(2)
Debt-to-GDP ratio	**0.12**	**0.12**	**0.14**	**0.10**	**0.12**	0.08	**0.12**
	0.05	0.02	0.06	0.05	0.03	0.05	0.04
Money growth	0.68	**0.26**	-0.14	1.00	0.26	**1.16**	**0.26**
	0.51	0.04	0.58	0.57	0.04	0.50	0.04
Depreciation	-0.48		0.38	-0.85		-1.04	
	0.55		0.62	0.62		0.56	
Real GDP growth	-1.34		-0.56	-1.88		**-1.94**	-0.20
	0.84		1.07	1.01		0.96	0.63
Exchange rate regime index**	1.00		2.30	1.47		1.23	
	1.37		1.27	1.57		1.58	
Central bank independence***			-1.52				
			7.29				
R-squared	0.41	0.39	0.48	0.43	0.38	0.40	0.34
Adjusted R-squared	0.37	0.38	0.42	0.38	0.37	0.34	0.31
Number of observations	71	71	45	58	58	48	48

*Coefficients significant at the 5 percent level are in bold. The standard errors are below the coefficients. The sensitivity measure is the coefficient of debt growth as derived from a dynamic fixed effect model for inflation in Table 5. Independent variables are long-term average cross-country data.
**Reinhart and Rogoff (2004) ***Cukierman (1992).

Finally, exchange rate regimes matter in the link between debt growth and inflation. The fixed rate regime dummy in our regressions covers exchange rate regimes with a peg, limited flexibility, and managed floats as defined by Reinhart and Rogoff (2004). The results do not change substantially if we exclude managed floats from the fixed rate regime dummy. The regression outcomes in Table 7 show that the sensitivity of inflation to debt is higher and significant under a floating rate regime while it is low and often insignificant under a fixed rate regime. This could reflect, as stressed by Ghosh et al. (1997), the positive commitment effect of the fixed exchange rate regime to the extent that the regime is credible.

D. Robustness of the Results

We explore several alternative specifications as a test of the robustness of the model. Given that potential biases from endogeneity in the GMM estimator are particularly serious in the case of large T relatively to N (Alvarez and Arellano, 2003), we relax the restriction of the predetermination of explanatory variables through the use of lagged explanatory variables, exploiting the moment conditions of our basic model. The results presented above are robust to corrections for possible endogeneity of explanatory variables (Table 8). The coefficients for lagged debt growth remain significant and positive in pooled OLS, fixed effect, and GMM estimators for 25 indebted developing countries.

We also we run rolling regressions for sub-sample periods in order to address a potential problem of parameter instability. The main results as described above are largely maintained in regressions over each rolling 20 year period of 1963–1983, 1972–1993, and 1983–2003. The sensitivity of inflation to debt growth in indebted developing countries is significant and similar to its sensitivity to money growth (Table 9). It is notable that the sensitivity coefficients are larger in the later period than in the earlier period, possibly reflecting the relative dominance of flexible exchange rate regimes during the post-Breton Woods period.

The main results are robust to the relaxation of common slope coefficients across countries. Pesaran and Smith (1995) illustrates that, in the case of dynamic panel data with heterogeneous slopes, pooling and aggregating give inconsistent and potentially highly misleading estimates of the coefficients. Hence we relax the common slope assumption and calculate the mean group estimator (Pesaran and Smith, 1995) and the panel fully modified OLS estimator (Pedroni, 2000). Mean group estimates show that debt growth, both contemporaneous and lagged ones, affect inflation positively and its degree is stronger in indebted developing countries (Table 10). Similar patterns are observed in fully modified OLS estimates (FMOLS) although the levels of the coefficients are not directly comparable to those from regressions in log difference form (Table 11). The panel FMOLS estimator is one of the least restrictive estimators for panel data, which is adjusted for endogeneity and short-run cross-country heterogeneity while exploiting long-run information contained in the panel.

Table 7. Panel regression outcomes (Dependent Variable: Inflation 1963-2004)*

	Major advanced economies			Other countries			o/w: debtor countries**		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Lagged inflation	**1.51**	**1.34**	**0.69**	**0.25**	**0.19**	**0.08**	**0.25**	**0.23**	**0.11**
	0.62	0.54	0.27	0.11	0.12	0.04	0.12	0.09	0.02
Money growth	0.08	0.15	0.38	**0.27**	**0.24**	**0.42**	**0.24**	**0.22**	**0.46**
	0.07	0.13	0.37	0.07	0.04	0.14	0.07	0.04	0.08
Debt growth									
Fixed rate regime	-0.01	0.00	-0.01	0.03	0.02	0.07	**0.11**	**0.06**	0.16
	0.01	0.01	0.02	0.03	0.02	0.07	0.03	0.02	0.10
Floating rate regime	-0.19	0.49	2.87	**0.36**	**0.39**	**0.42**	**0.47**	**0.51**	**0.43**
	0.16	0.57	2.89	0.10	0.08	0.11	0.06	0.05	0.07
Real GDP growth	0.37	0.41	0.89	-0.11	-0.10	-1.53	**-0.28**	**-0.29**	-0.58
	0.38	0.56	1.34	0.07	0.07	0.85	0.10	0.09	0.63
Depreciation	0.01	0.00	-0.05	**0.01**	**0.01**	-0.01	0.00	**0.00**	0.00
	0.01	0.01	0.05	0.00	0.00	0.16	0.00	0.00	0.00
GDP gap	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	-0.01
	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00
R-square	0.03	0.02		0.62	0.61		0.93	0.93	
Within		0.02			0.46			0.89	
Between		0.03			0.92			0.98	
Arellano-Bond AR (2)			-0.91			**1.92**			**0.74**
Number of countries	13	13	13	58	58	58	25	25	25
Number of observations	428	428	415	1706	1706	1646	737	737	712

*Coefficients significant at the 5 percent level are in bold.

**Indebted developing countries, whose main source of financing is non-official financing.

(1) Pooled panel OLS.

(2) Dynamic fixed effects.

(3) GMM based on the 1-st difference transformation, assuming that explanatory variables are predetermined. Standard errors are adjusted for intracountry serial correlations and heteroscadasticity.

Table 8. Panel regression outcomes (Dependent Variable: Inflation 1963-2004)*

	Major advanced economies			Other countries			of which: debtor countries**		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Lagged inflation	1.73	1.58	0.42	**0.32**	**0.23**	**0.13**	**0.54**	**0.48**	**0.12**
	0.79	0.75	0.35	0.18	0.17	0.06	0.13	0.18	0.07
Lagged money growth	-0.16	-0.10	0.44	**0.34**	**0.30**	**0.49**	**0.14**	**0.13**	**0.36**
	0.23	0.20	0.39	0.12	0.09	0.12	0.06	0.08	0.09
Lagged debt growth	0.00	0.01	0.01	0.10	0.09	**0.23**	**0.20**	**0.19**	**0.47**
	0.01	0.01	0.01	0.06	0.06	0.07	0.08	0.07	0.04
Lagged real GDP growt	1.40	1.44	-1.40	-0.06	-0.05	-0.26	-0.10	-0.06	**-0.44**
	1.18	1.26	1.28	0.07	0.06	0.15	0.13	0.11	0.22
Lagged depreciation	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
GDP gap	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R-square	0.03	0.03		0.49	0.49		0.78	0.78	
Within		0.02			0.29			0.61	
Between		0.24			0.93			1.00	
Arellano-Bond AR (2)			-0.67			**2.19**			**0.95**
Number of countries	13	13	13	58	58	58	25	25	25
Number of observations	430	430	417	1686	1686	1646	727	727	712

*Coefficients significant at the 5 percent level are in bold.

**Indebted developing countries, whose main source of financing is non-official financing.

(1) Pooled panel OLS.

(2) Dynamic fixed effects.

(3) GMM based on the 1st difference transformation, assuming contemporaneous correlations between shoc explanatory variables. Standard errors are adjusted for intracountry serial correlations and heteroscadasticity

Table 9. Panel Regression outcomes (Dependent Variable: Inflation 1963-2003)*

	Major advanced economies			Other countries			of which: debtor countries**		
	1963-83	1973-93	1983-03	1963-83	1973-93	983-03	1963-83	1973-93	1983-03
Lagged inflation	**0.53**	**0.79**	1.48	**0.64**	**0.53**	0.22	**0.55**	0.33	**0.25**
	0.05	0.05	0.86	0.07	0.10	0.13	0.12	0.19	0.11
Money growth	0.04	**0.05**	0.11	0.06	**0.27**	**0.42**	**0.09**	**0.31**	**0.36**
	0.04	0.02	0.17	0.02	0.05	0.07	0.03	0.07	0.06
Debt growth	0.01	0.02	0.00	0.02	**0.17**	0.13	**0.09**	**0.28**	**0.34**
	0.02	0.02	0.00	0.01	0.05	0.09	0.04	0.05	0.06
Real GDP growth	**-0.52**	**-0.17**	0.07	-0.07	-0.06	-0.09	**-0.24**	**-0.44**	**-0.37**
	0.10	0.08	0.47	0.05	0.04	0.08	0.10	0.13	0.16
Depreciation	0.00	0.00	0.03	**0.00**	0.01	**0.02**	0.00	**0.01**	0.01
	0.00	0.00	0.03	0.00	0.00	0.01	0.00	0.00	0.01
GDP gap	**-0.01**	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00
R-square	0.74	0.79	0.02	0.76	0.86	0.58	0.69	0.92	0.93
Within	0.66	0.73	0.01	0.43	0.62	0.41	0.42	0.73	0.87
Between	0.97	0.99	0.31	0.99	0.92	0.94	0.99	1.00	0.99
Number of countries	13	13	13	46	54	58	20	24	25
Number of observations	209	265	232	633	935	1118	263	400	494

*Coefficients significant at the 5 percent level are in bold. Based on a dynamic fixed effects model. The standard errors are below the estimated coefficients.

**Indebted developing countries, whose main source of financing is non-official financing.

Table 10. Mean Group Estimates (Dependent Variable: Inflation 1963-2003)*

	Whole sample			Countries other than major advanced economies			o/w:debtor countries**		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Lagged inflation	**0.50**	**0.55**	**0.50**	**0.44**	**0.50**	**0.43**	**0.42**	**0.49**	**0.42**
	0.04	0.03	0.05	0.04	0.03	0.05	0.05	0.04	0.08
(Lagged) Money growth	**0.07**	**0.08**	**0.08**	**0.07**	**0.08**	**0.08**	**0.07**	**0.08**	**0.08**
	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.04
(Lagged) Debt growth	**0.08**	**0.08**	**0.11**	**0.09**	**0.10**	**0.14**	**0.11**	**0.11**	**0.16**
	0.02	0.02	0.03	0.02	0.02	0.03	0.03	0.03	0.06
(Lagged) Real GDP growth	**-0.24**	0.08	0.07	**-0.26**	**-0.28**	0.03	**-0.40**	**-0.47**	-0.20
	0.10	0.09	0.12	0.12	0.11	0.14	0.18	0.18	0.30
GDP gap	0.00			0.00			0.00		
	0.00			0.00			0.00		
Number of countries	71	71	71	58	58	58	25	25	25

*Coefficients significant at the 5 percent level are in bold. Based on country-by-country dynamic OLS regressions. The standard errors are below the estimated coefficients.

**Indebted developing countries, whose main source of financing is non-official financing.

(1), (2): Mean of OLS regression coefficients for each country (over contemporaneous explanatory variables).

(3): Mean of OLS regression coefficients for each country (over one-year lag explanatory variables).

Table 11. Fully Modified OLS Estimates*

	Whole sample		Advanced economies		Developing countries**		o/w:debtor countries**			
	Coeff	T-stat	Coeff	T-stat	Coeff	T-stat	Coeff	T-stat	Coef***	T-stat
Money	**0.58**	78.39	**0.26**	17.31	**0.56**	87.13	**0.59**	60.83	**0.25**	13.4
Public debt	**0.13**	11.95	**0.21**	11.86	**0.05**	4.14	**0.25**	25.32	**0.19**	26.78
Real GDP	**-0.25**	-11.4	-0.09	-1.32	**-0.31**	-19.72	-0.32	-1.51	**0.08**	-2.89
Number of countries	71		23		48		25		25	

*Coefficients significant at the 5 percent level are in bold.
Based on FMOLS regressions over the variables in the level (Pedroni 2000).

**Indebted developing countries, whose main source of financing is non-official financing.

***Common time dummies not included. Common time dummies included in all other regressions.

E. Transmission Channels

We undertook a simple vector autoregression (VAR) to trace out the transmission channels of the fiscal influence on inflation. Our panel VAR consists of inflation and growth of public debt, money, and real GDP. Impulse responses are based on the Cholesky de-composition of the structural shocks in the order of output, public debt, money, and prices. In the choice of the lag length, we use the Schwarz criterion that impose a larger penalty for additional coefficients than the AIC criterion. Our panel VARs show a weak or no response of inflation to fiscal shocks in major advanced economies (Figure 3a). A similar pattern is observed in the monetary response to fiscal shocks. It is also notable that public debt declines in response to positive output shocks, a possible indication of the existence of counter-cyclical fiscal policy. The results are robust to changes in the shock ordering and the lag length.

The panel VAR outcomes render additional support to the prediction of the fiscal-monetary model of inflation—that the debt-inflation link is affected by institutional and structural factors. Impulse responses for advanced economies are starkly different from those for other countries (Figures 3a and 3b). The latter show a strong and positive response of money supply and inflation to fiscal shocks whereas the impulse responses for major advanced economies do not. This suggests that in developing countries, increases in public debt are more often than not accommodated by monetary easing—a phenomenon of fiscal dominance in developing countries that is well documented in the literature. The VARs for developing countries also exhibit little fiscal and monetary response to output shocks, implying that macroeconomic policies in such countries are typically acyclical—a finding consistent with many empirical studies of macroeconomic shocks and policy responses (Melitz, 1997; Akitoby et al., 2004; Kaminsky, Reinhart, and Vegh, 2004).

F. Implications of the Unpleasant Monetary Arithmetic and the Fiscal Theory of the Price Level

The implications of rising public debt for inflation are observationally similar between the Sargent-Wallace framework (1981) and the Fiscal Theory of the Price Level (FTPL). Nonetheless, there is an important theoretical distinction between the two (Leeper and Yun, 2005). Under the FTPL , an increase in government debt raises the wealth of bond holders while not reducing those of others. Hence, long-term bond prices rise, boosting aggregate demand and pushing up the price level. Money supply, which is endogenous in this regime, will increase in accommodation of the higher money demand. In this regime, the price level is the factor equilibrating nominal value of future discounted primary surplus and nominal value of public debt. Under the Sargent-Wallace framework of the so-called unpleasant monetary arithmetic, an increase in government debt, not fully backed by future real primary surplus, will increase concerns about monetization of public debt, raising inflation expectations and thereby reducing bond demands and increasing long-term interest rates. This will in turn reduce money demand and push up the price level even without a contemporaneous increase in money supply.

With both models predicting higher prices in response to rising public debt, it is difficult to infer the credibility of fiscal measures in countries without developed bond markets. Suppose that public debt was issued initially without a full backing of future primary surpluses, prompting monetization concerns and higher prices. Later, the government pledges to undertake corrective actions. If the fiscal measures are credible, both bond and goods prices will rise in economies with developed bond markets. If not, goods prices will rise while bond prices will fall. However, in economies without developed bond markets, goods prices will rise but bond prices will change little, making difficult to infer market perception of the fiscal efforts.

This interpretation problem could be resolved by including the residency of public debt holders in the regressions. The FTPL implies that the wealth effect of corrective fiscal actions should materialize mainly from public debt held by residents. In contrast, monetization concerns should be affected by the total size of public debt, regardless of the residency of the debt holders. Our simple regressions of a smaller dataset spanning a subset of 30 Latin and Caribbean countries between 1997 and 2004 indicate the dominance of the effects of monetization concerns as opposed to the wealth effects (Table 12). They show that the impact of public debt growth on inflation is significant and positive but the impact of domestic public debt on inflation is insignificant.

Table 12. Latin America and Caribbean Countries: Inflation*

	Total public debt		of which: Domestic	
	OLS	Fixed	OLS	Fixed
Lagged inflation	**0.59**	**0.24**	**0.64**	**0.15**
	0.05	0.05	0.05	0.05
Money growth	**0.13**	**0.07**	**0.13**	**0.05**
	0.03	0.03	0.03	0.02
Debt growth	**0.04**	**0.03**	0.01	0.00
	0.02	0.01	0.00	0.00
Real GDP growth	-0.05	-0.07	-0.04	-0.11
	0.05	0.06	0.05	0.07
R-squared	0.55	0.74	0.58	0.77
D.W. statistics	2.44	2.29	2.45	2.15
Number of countries	30	30	30	30
Number of observations	270	270	210	210

*Coefficients significant at the 5 percent level are in bold.
The standard errors are below the estimated coefficients.

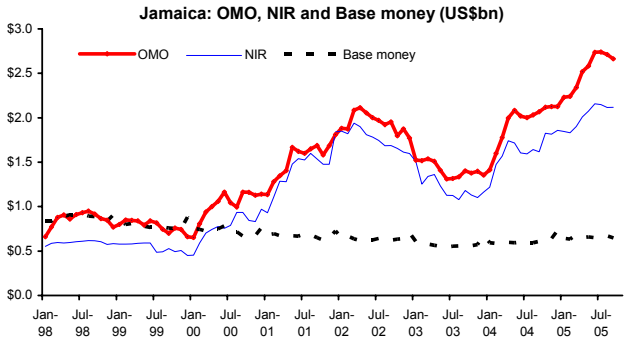
IV. APPLICATION TO JAMAICA

Jamaica is one of the most heavily indebted countries in the world. The public debt sharply increased to nearly 140 percent of GDP over the past decade from an already high level of 80 percent of GDP. The sharp increase was due mainly to the assumption of off-budget liabilities, notably the bailout of financial institutions in the late 1990s—budget deficits accounted for only a quarter of the surge. Debt service costs have hovered around 15 percent of GDP in recent years and to help meet these payments, primary surpluses have been generated in excess of 10 percent of GDP over the past several years.

Motivated by the need to reduce the large public debt, the Jamaican authorities started in 2004 an ambitious program that includes as its objective the goal of reducing inflation to single digits. The ultimate goal of the government's comprehensive program is to reduce public debt to 100 percent of GDP by 2008 through fiscal consolidation. This consolidation effort, in turn, is expected to lead to a virtuous circle of higher economic growth, lower inflation and lower interest rates, and hence reduced debt.

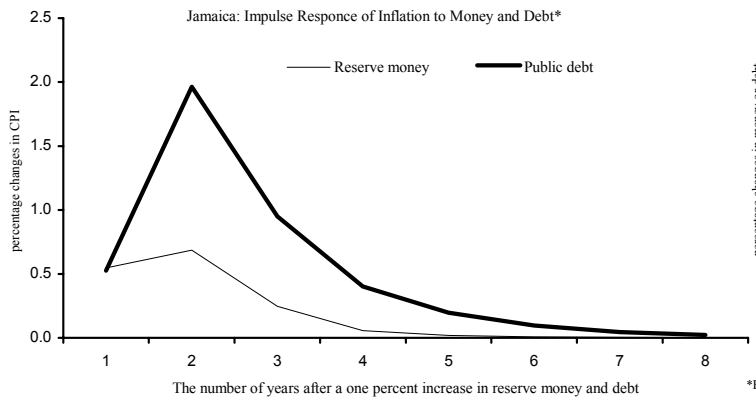
Inflation in Jamaica has been high and volatile, compared with neighboring countries. Unlike many other countries in similar circumstances, the Bank of Jamaica (BOJ) has traditionally

adopted a conservative monetary policy stance, with seignorage financing of the budget deficit rarely exceeding 1 percent of GDP. This policy stance was possible thanks to its strong operational autonomy, notwithstanding overall low statutory independence (Jácome and Vazquez, 2005). Inflation nonetheless has remained at double digits since 2003 and fluctuated widely while most neighboring countries had much lower and stable inflation during the same period. The BOJ's ability to reduce inflation was hampered by frequent exogenous shocks, large government debt and open market instruments (OMOs) and already high sterilization costs (1½–2½ percent of GDP per year in recent years).

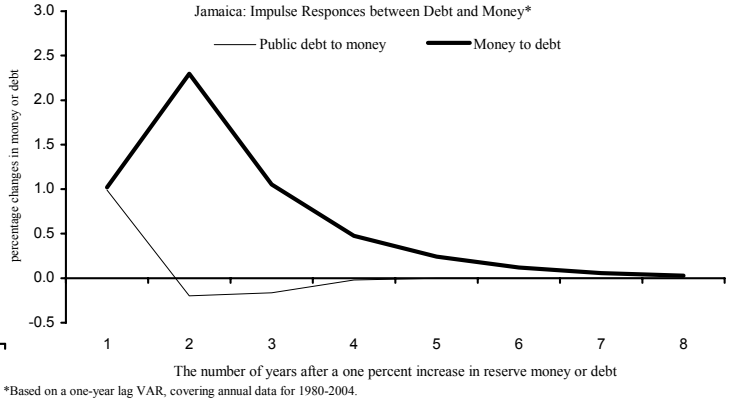


A VAR is applied to Jamaica to test whether the cross-country debt-inflation relationship identified from the panel regressions holds for Jamaica. The estimation uses annual data between 1980 and 2004 for CPI, real GDP, reserve money, and government debt which includes OMO debt. The exchange rates are also included in the robustness test to control for possible biases from exchange rate volatility on the debt dynamics. Data for GDP and CPI are from the Statistical Institute, and government debt from the Finance Ministry. All other data are from the Bank of Jamaica. All the variables are nonstationary and, as such, we test whether any stationary long-run relation exists among the variables. Both the trace and maximum eigenvalue tests based on the full information maximum likelihood method reject the null hypothesis of no co-integration but the number of co-integration vectors depend on the specification of the co-integration equations, most probably in reflection of the short time span. Hence, we run VARs both with and without the error correction terms.

The VAR outcomes confirm the significance of public debt dynamics in determining inflation in Jamaica. The impulse response functions show that the price level is positively affected by money supply and public debt but the latter has more lasting effects on inflation (see the charts below). Also, positive fiscal shocks have positive and persistent effects on money supply while the opposite does not hold. These results are similar to those from the panel VAR estimates for developing countries and robust to changes in the ordering of the shocks. The directions of the impulse responses remain unchanged in an alternative VAR



*Based on a one-year lag VAR, covering annual data for 1980-2004.



*Based on a one-year lag VAR, covering annual data for 1980-2004.

including the exchange rate as an endogenous variable and alternative regressions based on the vector error correction model.

Caution is needed, however, in interpreting these outcomes, as the results are applicable for annual data, but not necessarily for higher frequency data, and it is not clear which precise fiscal channel is driving inflation in Jamaica. The main drivers in our conceptual framework are expectations, which take time to form and influence behaviors. In fact, our simple VAR of monthly data for Jamaica between 1996 and 2005—consisting of prices, money, exchange rates and open market instruments—shows that monthly inflation is explained mostly by lagged inflation, money supply and the exchange rate although open market instruments also positively affect inflation with about a half-year lag. More importantly, the regression results do not separate the wealth effects of public debt from its effects on monetization expectations. It could well be that the wealth effects are important in Jamaica, given the high primary surpluses and the strong commitments of the authorities for fiscal consolidation. It should, therefore, be stressed that our results for Jamaica do not necessarily mean that the relatively high inflation compared with trading partners and an upswing in inflation in recent years signal concerns about monetization of debt in the future. Notwithstanding this caveat, our regression results confirm that the movements of public debt do matter for inflation dynamics in Jamaica.

V. POLICY IMPLICATIONS

Our regression results point to a number of budgetary and policy implications for countries with high debt. First, there is a significant risk of a debt-inflation trap in highly indebted countries. A rise in inflation expectations will eventually push up nominal interest rates, elevating public debt unless fully countered by a primary surplus. The debt increase will in turn raise inflation expectations further. This vicious feedback effect implies that rising inflation expectations could increase budgetary costs more than proportionally.[5] This also means that rising inflation expectations could be destabilizing to the debt dynamics more than an adverse real output shock does—possibly by as much as one third to one half (the numerical relationship is derived in Appendix B).

Second, the importance of inflation expectations in the debt-inflation dynamics implies that the budgetary costs of non-credible disinflation policy are potentially large in highly indebted countries. In Jamaica, for example, the central bank has medium-term inflation forecasts of 5 percent, which are considerably lower than current inflation. Suppose that bond holders believe that inflation would indeed fall but only to 10 percent over the medium term. The nominal interest that they demand for holding debt would then be correspondingly higher. In the event that inflation actually falls to 5 percent, the ex-post budgetary real interest payments would be higher (by about 3 percent of GDP, given Jamaica's debt profile) than in the case of 10 percent inflation. Conversely, unanticipated inflation would help reduce

[5] A similar observation has been made in Favero and Giavazzi (2004) and Blanchard (2004), which examined the relationship between depreciation expectations and public debt in Brazil.

borrowing costs in the short term but only exacerbate the credibility problem and ratchet up borrowing costs over the medium term. This points to the merits of managing inflation and inflation expectations so that there are minimal surprises.

Third, institutional and structural factors matter a lot in affecting the dynamics between public debt and inflation. Fiscal rules that limit the size of budget deficits or public debt could, under appropriate circumstances, be an important institutional means of safeguarding price stability to the extent that the commitment is credible. Independence of the central bank could also help reduce monetization concerns although our regressions do not indicate a significant effect of the central bank's statutory independence on the debt-inflation relationship (see Table 6). The development of the financial sector could help promote price stability as the financial sector tends to support the central bank's policy autonomy (Posen, 1995). It could also reinforce fiscal discipline by providing immediate and clear signals about perceived risks of debt monetization (Rubin and Weisberg, 2003).

More broadly, the conduct of monetary policy is extremely challenging in highly indebted developing countries. In principle, flexibility in monetary policy would be severely constrained by considerations about implications of interest and exchange rate movements on debt dynamics. Operationally, monetary data alone might not provide reliable indications of emerging inflationary pressures, as growth in government debt in lieu of money printing could also affect inflation expectations. In this regard, sustained sterilized intervention could backfire since such interventions would limit growth in money supply but raise public debt. In sum, in countries with significant debt overhangs, purely money-based stabilization is unlikely to be effective without the support of fiscal consolidation.

VI. Summary and Conclusions

Our study provides comprehensive and robust evidence in support of Sargent and Wallace's (1981) "unpleasant monetary arithmetic" that an increase in government debt is typically inflationary in countries with large public debt. The regression results show that an increase in public debt is significantly and strongly associated with high inflation in indebted developing countries, after controlling for money growth, real output growth, currency depreciation and output gap. In contrast, this pattern holds less strongly in other developing countries and does not hold in major advanced economies, consistent with the thesis of a forward-looking model of inflation that—unlike the implications of a static aggregate demand model—policy regimes matter in the debt-inflation nexus. These results are invariant over sub-sample periods and robust to corrections for possible endogeneity biases and relaxation of common-slope restrictions. Our regressions also show that public debt growth is more inflationary in high debt countries than in low debt countries and that the debt-inflation linkage is weak in inflexible exchange rate regimes. A panel VAR traces out the transmission mechanism that a positive innovation to debt has a positive and persistent effect both on the price level and money supply. The significance of public debt dynamics on inflation is confirmed in Jamaica. Wealth effects of public debt could also affect inflation, as hypothesized by the fiscal theory of the price level, but our study does not find supportive evidence.

The findings highlight challenges for price stabilization in highly indebted countries such as Jamaica. They point to a significant risk of a debt-inflation trap, potentially large budgetary costs of noncredible disinflation policy, and limitations of sustained sterilized interventions in stabilizing prices and exchange rates. They also stress the importance of institutional and structural factors in the debt-inflation link, such as fiscal rules, inflation targeting, and the depth and breadth of the financial sector. They also indicate that, notwithstanding an important role of monetary policy in managing and meeting short-term inflation expectations, fiscal policy would likely be the dominant factor for inflation in highly indebted developing countries. This implies that price stability achieved mainly through the issuance of central bank open market instruments (i.e., accumulation of public debt) in lieu of deficit monetization could be sustained only if supported by fiscal consolidation and other reforms to address fiscal dominance.

Further research could be usefully undertaken in several areas. The link between inflation and economic growth has been extensively investigated both in empirical (for example, Barro, 1996; Ghosh and Phillips, 1998) and theoretical studies (Smith and Egteren, 2005, for a recent one). However, our findings on the debt-inflation link could shed further light on the effect of fiscal policy on economic growth to the extent that public debt growth affects inflation directly. In addition, our empirical framework could be modified to assess the impact of public debt structures (mostly, currency and maturity) on inflation dynamics although data limitations did not allow us to extend the assessment. Our rich empirical findings could also be utilized to fine-tune debt sustainability analysis.

Figure 1. Jamaica: Mean of Cross-Country Data for Each Year

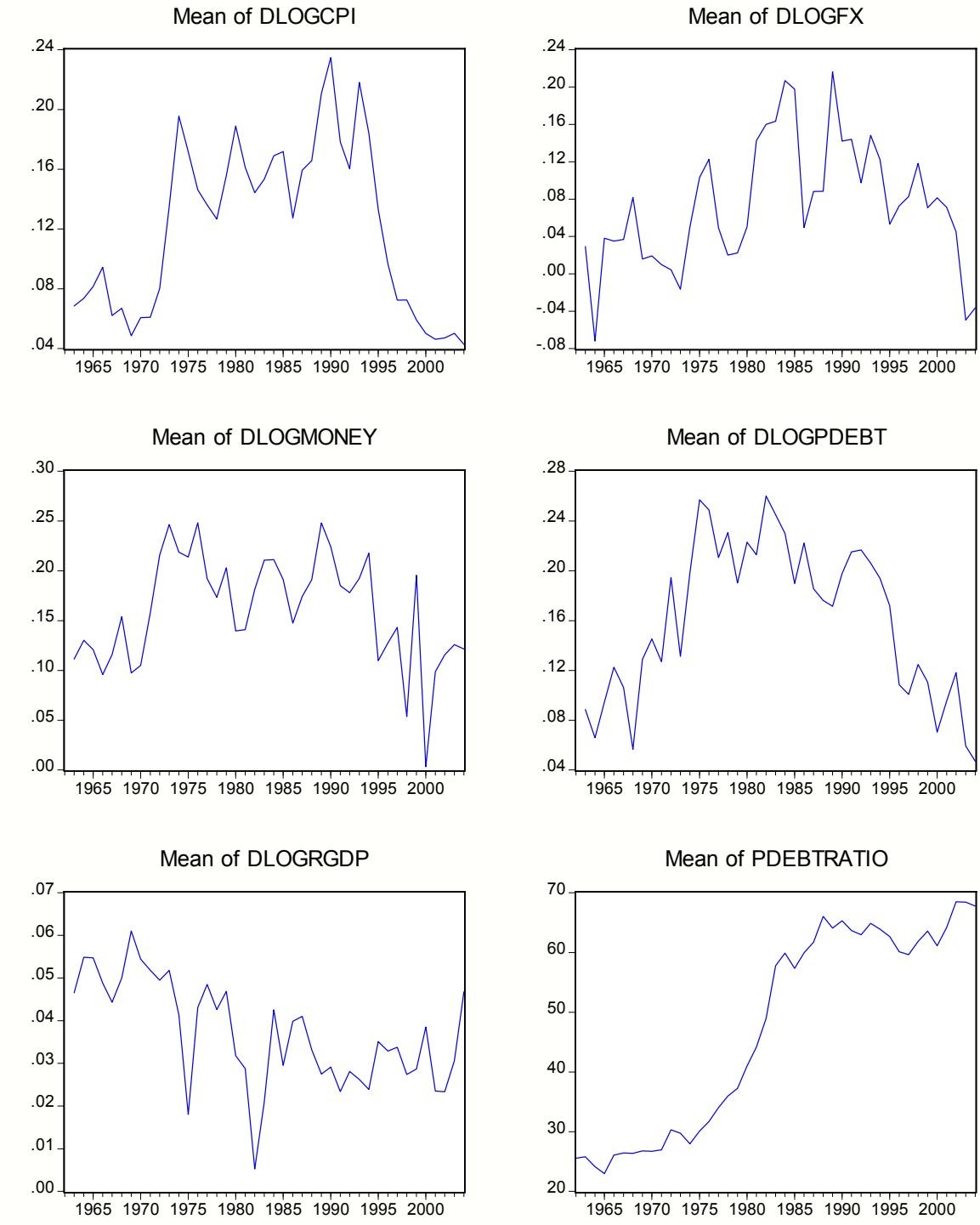


Figure 2. Scatter Plots of Selected Macroeconomic Indicators and Public Debt Growth
(Mean of time-series data for each country)

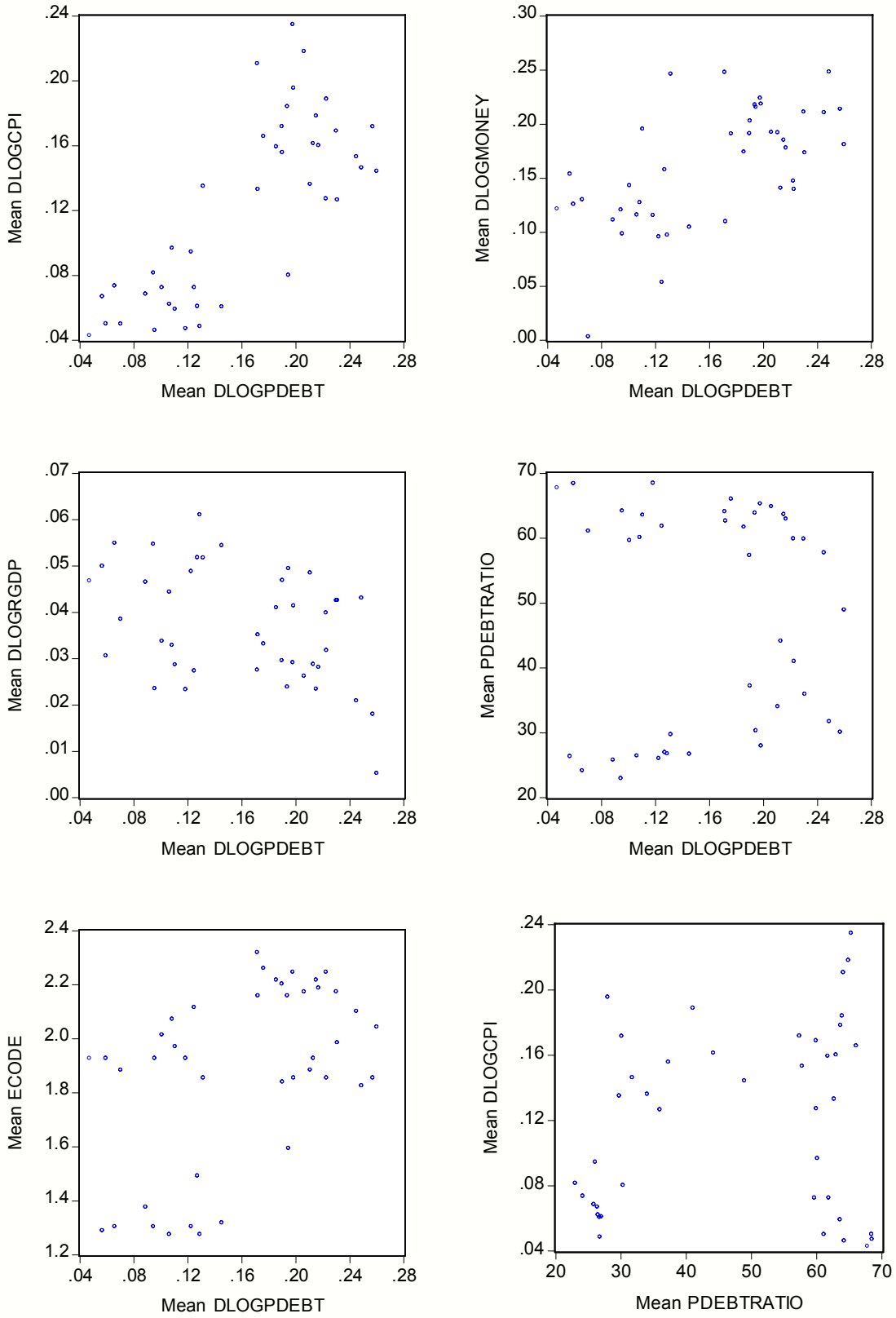


Figure 3a. Impulse Responses in Major Advanced Economies

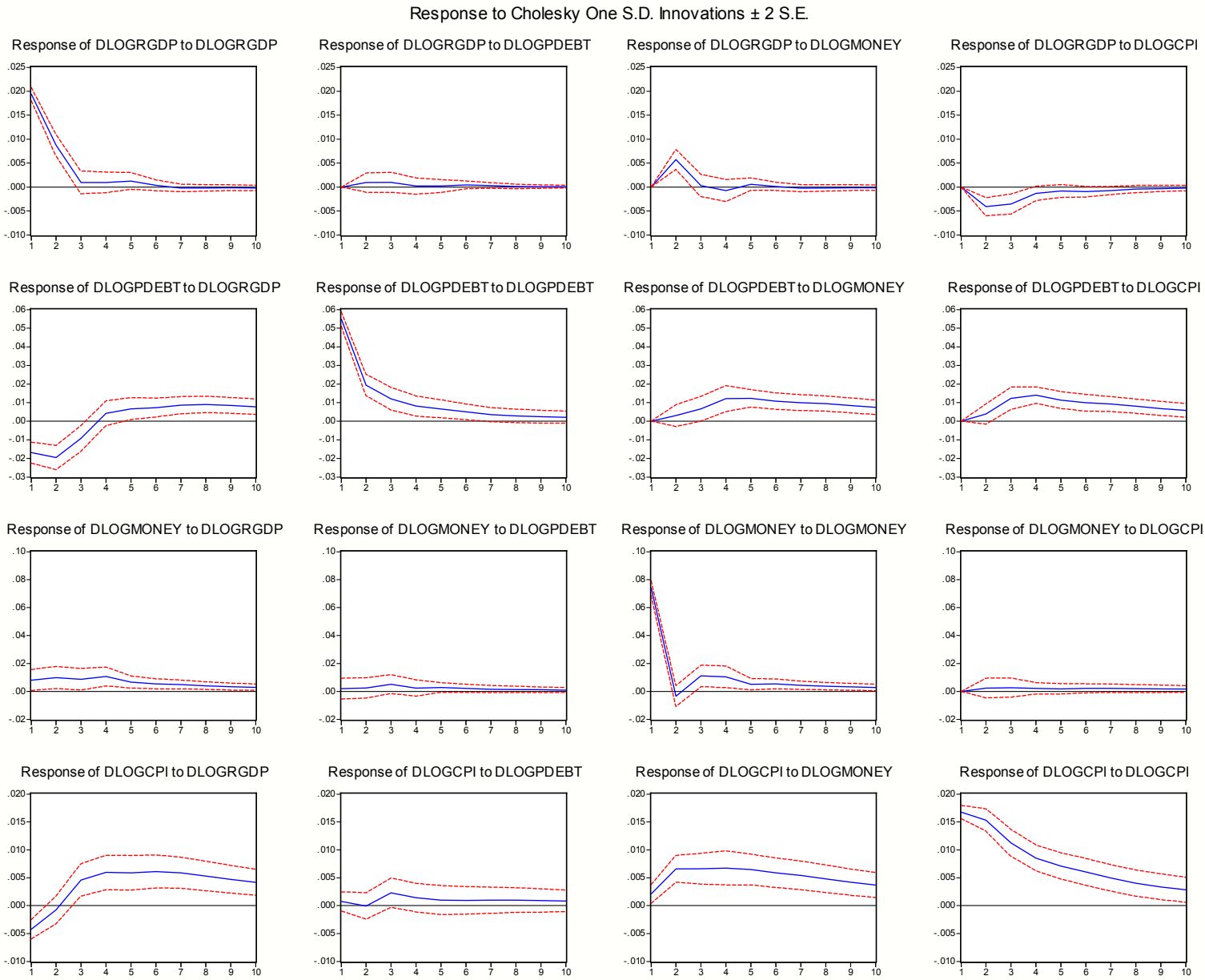
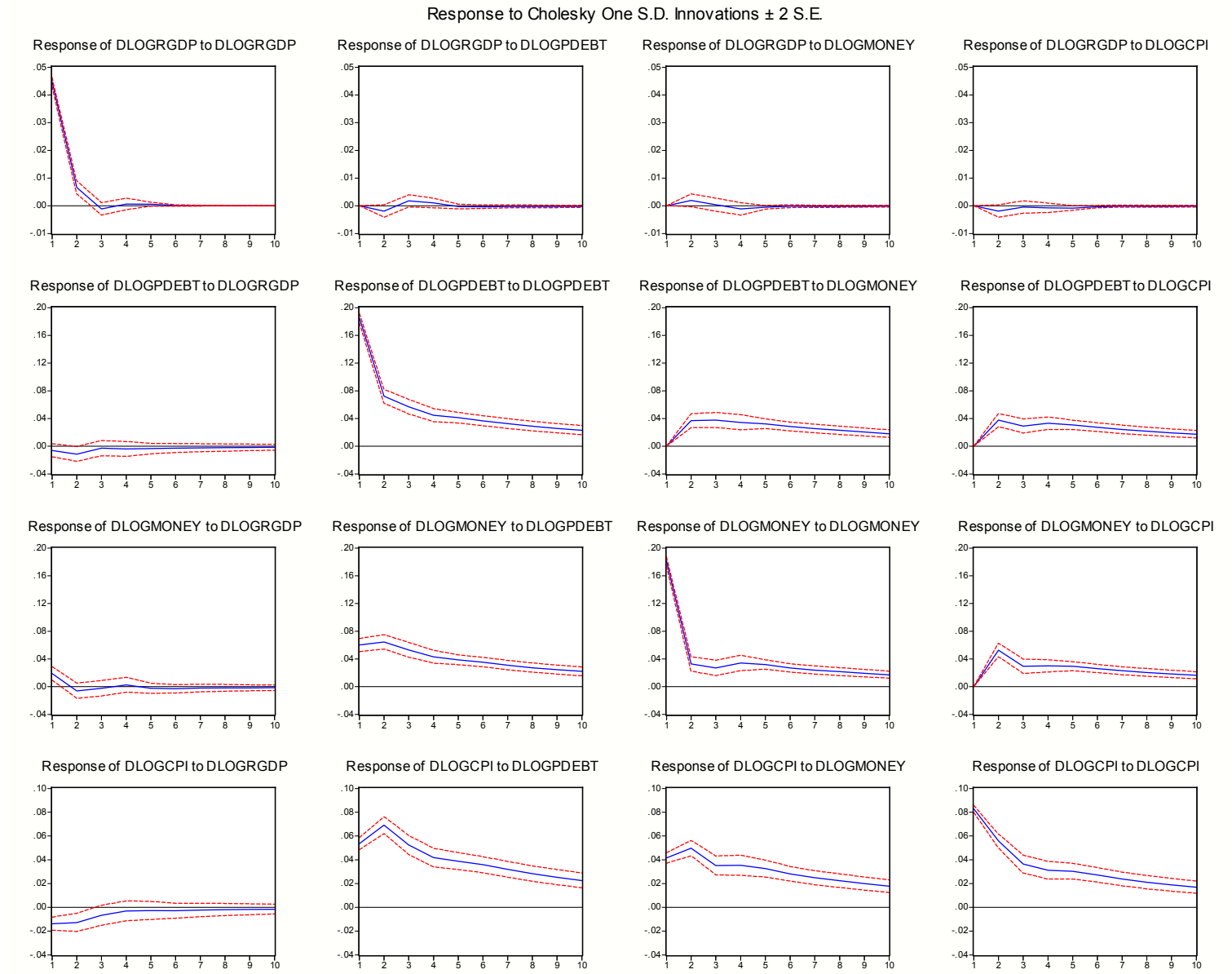


Figure 3b. Impulse Responses in Countries Other than Major Advanced Economies



A. Data Sources and Definitions and Country Grouping

Our main dataset is a panel dataset spanning 71 countries over up to 43 years, collected from a variety of sources. The main dataset includes annual data for CPI, money, public debt and real GDP of each country for the maximum period of 1962–2004. Country selections were based primarily on the availability of the data and hence excludes many African countries and some small Caribbean countries. Data for inflation and real GDP—a proxy for real consumption—are mostly from the International Financial Statistics (IFS) but, in some cases, the WEO dataset of the IMF. Public debt data are from a variety of sources, including the IFS, WEO, OECD databases, and, for Jamaica, Russia, and Turkey, the country authorities. Monetary data are mainly from the IFS and the WEO, and, in the case of the Euro-zone countries, the OECD. The definition of money is reserve money, or the narrowest definition available in the databases.

In addition to the four main variables, several other data were used for alternative specifications and various robustness tests. These include exchange rate regimes (Reinhart and Rogoff, 2004), exchange rates (IFS), central bank independence (Cukierman, 1992), and output gap estimates (derived from de-trended real GDP using the Hodrick-Prescott filter).

Countries are divided into 13 major advanced countries and other 58 countries, based on the classification of the most recent IMF World Economic Outlook (2005). The other countries include 48 developing countries and 10 non-major advanced economies as defined in the WEO such as Korea, Israel and Ireland, which could be considered as developing countries in a broad sense. This classification is broadly in line with other studies on fiscal variables and inflation (Catao and Terrones, 2005), which reported some evidence of significant heterogeneity between developed and developing countries. The detailed list is below.

Advanced economies

Major advanced economies (developed economies)
Austria
Belgium
Canada
Finland
France
Germany
Ireland
Italy
Japan
Netherlands
Spain
United Kingdom
United States

Other advanced economies
Australia
Cyprus
Denmark
Iceland
Israel
Korea
New Zealand
Norway
Sweden
Switzerland

Other emerging market and developing countries

Net credit countries
Botswana
Malaysia
Oman
Russia
Ukraine
Venezuela, Rep. Bol.

Net debtor countries whose main external finance source is official financing
Argentina
Burundi
Colombia
El Salvador
Etiopia
Honduras
Indonesia
Lebanon
Nepal
Pakistan
Papua New Guinea
Paraguay
Rwanda
Sierra Leone
Sri Lanka
St. Lucia
Uruguay

Net debtor countries whose main external finance source is non-official financing
Albania
Bahamas, The
Barbados
Brazil
Chile
Costa Rica
Fiji
Guatemala

Guyana
India
Jamaica
Jordan
Maldives
Malta
Mauritius
Mexico
Morocco
Panama
Philippines
South Africa
St. Vincent and the Grenadines
Swaziland
Trinidad and Tobago
Tunisia
Turkey

B. DEBT-INFLATION TRAP AND DEBT SUSTAINABILITY

A rise in inflation will eventually push up nominal interest rates, which will in turn increase public debt unless countered by a higher primary surplus. This feedback effect implies that budgetary costs of rising inflation expectations rise more than proportionally to the increase in inflation expectations. This point can be illustrated by simple debt dynamic accounting as follows:

$$\frac{\Delta B_t}{B_t} = \mathrm{R}_t - \frac{S_t}{B_t}, \textit{ where } B \textit{ is public debt}, R \textit{ is an interest rate}, \textit{and } S \textit{ is primary surplus}.$$

If the interest rate is set in line with inflation expectations (π_t^e) and the primary surplus in percent of GDP is predetermined,[6] the debt dynamics can be simplified as follows:

$$\frac{\Delta B_t}{B_t} = (\pi_t^e + r) - \frac{S_t}{Y_t} / \frac{B_t}{Y_t} = (\pi_t^e + r) - C, \textit{ where } C = \frac{S_t}{Y_t} / \frac{B_t}{Y_t}$$

In a steady state of no change in the debt-to-GDP ratio, C is constant. If inflation expectations (π_t^e) rise in a proportion to debt growth ($\frac{\Delta B_t}{B_t}$) in line with our empirical findings, $\pi_t^e = \alpha(\frac{\Delta B_t}{B_t}) + \beta \mathrm{X} + \varepsilon$, *then* $\frac{\Delta B_t}{B_t} = \frac{\beta \mathrm{X} + \varepsilon + r - C}{1 - \alpha}$.

Hence, an increase in inflation expectations (as embodied in a jump in ε) raises debt not only directly (through an immediate increase in the borrowing cost) but also indirectly (through a multiplier effect resulting from the debt-inflation nexus).

An alternative way of looking at this is to see the implications on the debt-stabilizing levels of the primary surplus (S_t^*). The levels can be represented as follows:

---

[6] These are strong, simplified assumptions that hardly hold in reality in the current form since most revenues and expenditures are likely to be affected by contemporaneous inflation and inflation expectations. Persson et al. (1998) presents, for example, a calibrated model where changes in inflation and inflation expectations affect government revenues and expenditures significantly due to a variety of indexation schemes in tax rules and expenditure arrangements. In his model, changes in inflation expectations do not necessarily lead to simultaneous and equal changes in interest rates.

$$\frac{S_t^*}{Y_t} = \left[\frac{R_t B_t}{Y_t} - \frac{B_t}{Y_t}\frac{\Delta Y_t}{Y_t} \right] = \frac{B_t}{Y_t}(R_t - \frac{\Delta Y_t}{Y_t})$$

$$= \frac{B_t}{Y_t}((1+\pi_t^e)(1+r) - (1+\pi_t)(1+g_t)) \approx \frac{B_t}{Y_t}((\pi_t^e - \pi_t) + (r - g_t))$$

Given that inflation expectations (π_t^e) could rewritten as:

$$\pi_t^e = \frac{\beta \mathrm{X} + \varepsilon + r}{1-\alpha} - \frac{\alpha \cdot C}{1-\alpha},$$

it follows that the debt-stabilizing primary surplus could be rearranged to the following simplified form:

$$\frac{S_t^*}{Y_t} \approx \frac{B_t}{Y_t}(\beta \mathrm{X} + \varepsilon + r) + (1-\alpha)\frac{B_t}{Y_t}(-\pi_t + r - g_t)$$

This means that rising inflation expectations (as embodied in a jump in ε) would elevate the debt-stabilizing level of the primary surplus more than the same percentage decline in real GDP growth would. Our regression results for the debt-inflation link place α at the range of ¼ (mean group estimator) to ½ (GMM estimator). This implies that the effect of rising inflation expectations could be larger than the effect of a decline in real GDP by as much as one third to one half.

REFERENCES

Aiyagari, S., and M. Gertler, 1985, "The Backing of Government Debt and Monetarism," *Journal of Monetary Economics*, Vol. 16, pp. 19–44.

Akitoby, Bernardin, B. Clements, S. Gupta, and G. Inchauste, 2004, "The Cyclical and Long-Term Behavior of Government Expenditures in Developing Countries," IMF Working Paper 04/202 (Washington: International Monetary Fund).

Alesina, Alberto, and L.H. Summers, 1993, "Central Bank Independence and Macroeconomic Performance: Some Comparative Evidence," *Journal of Money, Credit, and Banking*, Vol. 25, No. 2, pp. 151–62.

Alvarez, J., and M. Arellano, 2003, "The Time Series and Cross-Section Asymptotics of Dynamic Panel Data Estimator," *Econometrica,* Vol. 71, pp. 1121–59.

Ardagna, Silvia, F. Caselli, and T. Lane, 2004, "Fiscal Discipline and the Cost of Public Debt Service: Some Estimates for OECD Countries," NBER Working Paper No. 10788 (Cambridge, Massachusetts: National Bureau of Economic Research).

Barro, R.J., 1996, "Inflation and Growth," *Federal Reserve Bank of St. Louis Review* (May/June), pp.153–69.

Blanchard, Olivier, 2004, "Fiscal Dominance and Inflation Targeting: Lessons from Brazil," NBER Working Paper No. 10389 (Cambridge, Massachusetts: National Bureau of Economic Research).

Bohn, Henning, 1988, "Why Do We Have Nominal Government Debt?" *Journal of Monetary Economics,* Vol. 21, pp. 127–40.

———, 1998, "Behavior of U.S. Public Debt and Deficits," *The Quarterly Journal of Economics,* Vol. 113, No. 3, pp. 949–63.

Bond, R. Stephen, 2002, "Dynamic Panel Data Models: A Guide to Micro Data Methods and Practice," *Portuguese Economic Journal*, Vol. 1, pp. 141–62.

Breusch, T.S., and A.R. Pagan, 1980, "The Lagrange Multiplier Test and its Application to Model Specification in Econometrics," *Review of Economic Studies*, Vol. XLVII, pp. 239–53.

Buiter, Willem H., 1999, "The Fallacy of the Fiscal Theory of the Price Level," NBER Working Paper No. 7302 (Cambridge, Massachusetts: National Bureau of Economic Research).

Calvo, Guillermo A., 1988, "Servicing the Public Debt: The Role of Expectations," *American Economic Review*, Vol. 78, No. 4, pp. 647–61.

Campillo, Marta, and Jeffrey A. Miron, 1997, "Why Does Inflation Differ across Countries?" *Reducing Inflation: Motivation and Strategy*, ed. by Christina D. Romer and David H. Romer (Chicago: The University of Chicago Press).

Canzoneri, M., R. Cumby, and B. Diba, 2001, "Is the Price Level Determined by the Needs of Fiscal Solvency?" *American Economic Review*, Vol. 91, No. 5, pp. 1221–38.

Castro, R., C. De Resende, and F. Ruge-Murcia, 2003, "The Backing of Government Debt and the Price Level," The Centre for Interuniversity Research in Quantitative Economics (CIREQ), Working Paper 16–2003 (Montreal: University of Montreal).

Catao, L., and M. Terrones, 2005, "Fiscal Deficits and Inflation," *Journal of Monetary Economics*, Vol. 52, pp. 529–54.

Christiano, L., and T. Fitzgerald, 2000, "Understanding the Fiscal Theory of the Price Level," NBER Working Paper No. 7668 (Cambridge, Massachusetts: National Bureau of Economic Research).

———, 2003, "Inflation and Monetary Policy in the Twenties Century," *Economic Perspectives*, Federal Reserve Bank of Chicago, Vol. 27, No. 1, pp. 22–45.

Cochrane, J.H., 2001, "Long-Term Debt and Optimal Policy in the Fiscal Theory of the Price Level," *Econometrica*, Vol. 69, pp. 69–116.

———, 2005, "Money as Stock," *Journal of Monetary Economics*, Vol. 52, pp. 501–28.

Cukierman, Alex, 1992, *Central Bank Strategy, Credibility and Independence: Theory and Evidence* (Cambridge, Massachusetts: MIT Press).

Duck, W. Nigel, 1993, "Some International Evidence on the Quantity Theory of Money," *Journal of Money, Credit and Banking*, Vol. 25, No. 1.

Dwyer, Jr. Gerald P., 1982, "Inflation and Government Deficits," *Economic Inquiry*, Vol. XX (July), pp. 315–29.

Elmendorf, Douglas W., 1993, "Actual Budget Deficit Expectations and Interest Rates," *Harvard Institute of Economic Research*, Discussion Paper No. 1639.

———, and Gregory Mankiw, N., 1999, "Government Debt," *Handbook of Macroeconomics*, Vol. 1, ed. by J. B. Taylor and M. Woodford (Amsterdam: North Holland).

Engen, Eric, and G. Glenn Hubbard, 2004, "Federal Government Debts and Interest Rates," NBER Working Paper Series No.10681 (Cambridge, Massachusetts: National Bureau of Economic Research).

Evans, Paul, 1987a, "Do Budget Deficits Raise Nominal Interest Rates? Evidence from Six Countries," *Journal of Monetary Economics* 20, pp. 281–300.

———, 1987b, "Interest Rates and Expected Future Budget Deficits in the United States," *Journal of Political Economy,* Vol. 95, No. 1, pp. 34–58.

Favero, Carlo A., and Francesco Giavazzi, 2004, "Inflation Targeting and Debt: Lessons from Brazil," NBER Working Paper No. 10390 (Cambridge, Massachusetts: National Bureau of Economic Research).

———, and Franco Spinelli, 1999, "Deficits, Money Growth and Inflation in Italy: 1875–1994," *Economic Notes* by Banca Monte dei Paschi di Siena SpA, Vol. 28, No.1, pp.43–71.

Feldstein, Marin, 1986, "Budget Deficits, Tax Rules and Real Interest Rates," NBER Working Paper Series No. 1970 (Cambridge, Massachusetts: National Bureau of Economic Research).

Fischer, Stanley, R. Sahay, and C. Vegh, 2002, "Modern Hyper- and High inflations," *Journal of Economic Literature*, Vol. 40, No. 3 (September), pp. 837–80.

Ghosh, A., Gulde, A.-M., Ostry, J.D., Wolf, H, 1997, "Does the Nominal Exchange Rate Regime Matter?" NBER Working Paper No. 5874 (Cambridge, Massachusetts: National Bureau of Economic Research).

Ghosh, A., and Stephen Phillips, 1998, "Warning: Inflation May Be Harmful to Your Growth," *IMF Staff Papers,* Vol. 45, No. 4, pp. 672–710.

Gordon, D., and E. Leeper, 2002, "The Price Level, The Quantity Theory of Money, and The Fiscal Theory of the Price Level," NBER Working Paper No. 9084 (Cambridge, Massachusetts: National Bureau of Economic Research).

International Monetary Fund, 2003, "Chapter 3. Public Debt in Emerging Markets: Is It Too High?" *World Economic Outlook* (September).

Jácome, Luis I., and Francisco Vázquez, 2005, "Any Link Between Central Bank Independence and Inflation? Evidence from Latin America and the Caribbean," IMF Working Paper 05/75 (Washington: International Monetary Fund).

Kaminsky, Graciela L., Carmen M. Reinhart, and Carol Vegh, 2004, "When it Rains, It Pours: Procyclical Capital Flows and Macroeconomic Policies," NBER Working Paper No. 10780 (Cambridge, Massachusetts: National Bureau of Economic Research).

Leeper, M. Eric, and Tack Yun, 2005, "Monetary-Fiscal Policy Integration and the Price Level: Background and Beyond," the 61st Congress of the International Institute of Public Finance Conference.

Loyo, Eduardo, 1999, "Tight Money Paradox on the Loose: A Fiscalist Hyperinflation," (unpublished).

Lucas, Robert E., 1980, "Two Illustrations of the Quantity Theory of Money," *American Economic Review*, Vol. 70 (September), pp.1005–14.

Mélitz, Jacques, 1997, "Some Cross-Country Evidence About Debt, Deficits and the Behavior of Monetary and Fiscal Authorities," CEPR, Discussion Paper Series No. 1653 (London: Centre for Economic and Policy Research).

Niepelt, Dirk, 2004, "The Fiscal Myth of the Price Level," *The Quarterly Journal of Economics*, Vol. CXIX (February), pp. 277–300.

Orr, Adrian, Malcolm Edey, and Michael Kennedy, 1995, "Real Long-Term Interest Rates: The Evidence from Pooled Time-Series," *OECD Economic Studies,* No. 25, pp. 75–107 (Paris, OECD).

Pedroni, Peter, 1999, "Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors," *Oxford Bulletin of Economics and Statistics*, Special Issue, 0305–9049, pp. 653–70.

———, 2000, "Fully Modified OLS for Heterogeneous Cointegrated Panels," *Advances in Econometrics*, Vol. 15, pp. 93–130.

Persson, Mats, Torsten Persson, and Lars E. O. Svenson, 1998, "Debt, Cash Flow and Inflation Incentives: A Swedish Example," *The Debt Burden and Its Consequences for Monetary Policy*, ed. by Guillermo Calvo and Mervyn King, pp. 28–62 (New York: Palgrave Macmillan).

Pesaran, M. Hashem, and Ron Smith, 1995, "Estimating Long-run Relationships from Dynamic Heterogeneous Panels," *Journal of Econometrics*, Vol. 68, pp. 79–113.

———, Ron Smith, and Kyung So Im, 1996, "Dynamic Linear Models for Heterogeneous Panels," *The Econometrics of Panel Data*, ed. by Matyas, L. and P. Sevestre, pp. 145–95 (Kluwer Academic Publishers).

Posen, Adam S., 1995, "Declarations Are Not Enough: Financial Sector Sources of Central Bank Independence," *NBER Macroeconomics Annual*, *1995,* ed. by Ben Bernanke and Julio Rotemberg, pp. 253–74 (Cambridge, Massachusetts: National Bureau of Economic Research).

Reinhart, Carmen M., and Kenneth Rogoff, 2004, "The Modern History of Exchange Rate Arrangements: A Reinterpretation," *The Quarterly Journal of Economics*, Vol. CXIX (February), pp. 1–48.

Rubin, Robert E., and Jacob Weisberg, 2003, *In an Uncertain World: Tough Choices from Wall Street to Washington* (New York: Random House).

Sargent, T.J., 1982, "Beyond Demand and Supply Curves in Macroeconomics," *The American Economic Review*, Vol. 72, No. 2, pp. 382–89.

———, 1993, *Rational Expectations and Inflation*, second ed. (New York: HarperCollins).

———, 1999, "A Primer on Monetary and Fiscal Policy," *Journal of Banking and Finance*, Vol. 23, pp. 1463–82.

Sargent, T.J., and N. Wallace, 1981, "Some Unpleasant Monetary Arithmetic," *Quarterly Review* (Fall), Federal Reserve Bank of Minneapolis, pp. 1–17.

Schwartz, Anna J., 1973, "Secular Price Change in Historical Perspective," *Journal of Money, Credit and Banking,* Vol. 5 (February), pp. 243–269.

Sims, C., 1994, "A Simple Model for Study of the Price Level and the Interaction of Monetary and Fiscal Policy," *Economic Theory*, Vol. 4, pp. 381–99.

Singh, Anoop, Agnes Belaisch, Charles Collyns, Paula De Masi, Reva Krieger, Guy Meredith, and Robert Rennhack, 2005, *Stabilization and Reform in Latin America: a Macroeconomic Perspective on the Experience Since the Early 1990s*, IMF Occasional Paper No. 238 (Washington: International Monetary Fund).

Smith, R. Todd, Henry van Egteren, 2005, "Inflation, investment and economic performance: The role of internal financing," *European Economic Review*, Vol.49, pp. 1283–1303.

Vogel, Robert C., 1974, "The Dynamics of Inflation in Latin America, 1950–1969," *American Economic Review,* Vol. 64 (March), pp. 102–14.

Woodford, M., 1994, "Monetary Policy and Price Level Determined in a Cash-in-Advance Economy," *Economic Theory*, Vol. 4, pp. 345–80.

———, 1995, "Price Level Determinacy without control of a Monetary Aggregate," *Carnegie Rochester Conference Series on Public Policy*, pp. 1–46.

———, 2001, "Fiscal Requirement for Price Stability," *Journal of Money, Credit and Banking*, Vol. 33, pp. 669–728.