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Jamaica: Selected Issues

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JAMAICA

Selected Issues

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March 9, 2006

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INTRODUCTION

1. **One of the most striking features of the Jamaican economy is the high public debt, which is a recurring theme in the three papers comprising this volume**. Jamaica has had very high public debt for a long time—some progress in reducing the debt in the early 1990s was reversed by the banking crisis that ensued in 1996, following which the government absorbed an additional 40 percent of GDP in debt. Since then, Jamaica has been grappling with a legacy of public debt averaging between 130–145 percent of GDP. This debt has rendered the economy vulnerable to market sentiments and contributed to high and volatile inflation as well as low economic growth. The debt has also severely constrained the flexibility of macroeconomic policy making and required the development of a sophisticated debt management strategy. The attached series of papers (two of which have been co-authored with staff from the Ministry of Finance and the Bank of Jamaica) explore various aspects of the links between debt on the one hand, and growth and inflation on the other, and the features of Jamaica's debt management strategy.

2. **The first chapter analyzes Jamaica's experience of low growth despite consistently high investment rates, and suggests that the link between public debt and productivity is part of the answer to the puzzle**. Mismeasurement is a possible explanation for the high investment-low growth experience, though further analysis suggests that it does not go far enough in solving the puzzle. The study then considers whether high public debt, through its adverse impact on productivity, may lie behind the high investment-low growth experience. The central hypothesis revolves around the idea that high debt adversely affects investment and productivity by: (i) distorting the allocation of investment toward less productive areas; and (ii) reducing the scope for public sector investment, which often has a special complementary role in increasing the effectiveness of private investment. The hypothesis is tested using a cross-country database, with the analysis yielding evidence of a significant and negative relationship between total public debt and productivity. The study then attempts to flesh out the specific channels through which high levels of debt affect productivity and the allocation of resources. It argues that in the case of Jamaica, high public debt has been associated with macroeconomic uncertainty and an output structure that relied excessively on a few maturing sectors for which the scope for high productivity gains is low. At the same time, public investment has been crowded out by debt service, further adversely affecting productivity.

3. **The link between public debt and inflation is explored in the second chapter in the context of a forward-looking model of inflation**. A simple conceptual framework is presented, followed by cross-country empirical analysis focusing on the role of public debt as against the budget deficit in determining inflation. Such an approach helps to capture the non traditional channels of fiscal influence on inflation, namely monetization expectations and wealth effects, which might not be evident in a traditional aggregate demand model focusing on the budget deficit. The study shows that: (i) increases in public debt are significantly associated with high inflation in developing countries; (ii) this relationship is weak in inflexible exchange rate regimes and does not hold in major advanced economies; and

(iii) public debt growth is more inflationary in high debt countries than in low debt countries. The findings highlight challenges for price stabilization in highly indebted developing countries such as Jamaica. They point to a significant risk of a debt-inflation trap, potentially large budgetary costs of non credible disinflation policy, and limitations of sustained sterilized interventions. They also indicate that price stability achieved mainly through the issuance of central bank open market instruments (i.e., the accumulation of public debt) in lieu of deficit monetization cannot be sustained without fiscal consolidation.

4. **The final chapter considers Jamaica's debt management strategy and its optimal debt structure**. The chapter reviews the institutional framework for debt management in Jamaica. It then presents a newly constructed dataset that documents Jamaica's notable market access to long-maturity, fixed interest rate, domestic currency bond placements. Using this dataset, the chapter considers the problem of optimally allocating securities to meet public financing needs, while maximizing resistance to adverse budget and price shocks. It derives the government's optimal security portfolio assuming prices are given and on the basis of the historical pattern of shocks. The paper also seeks to infer market expectations of future shocks from the existing debt structure and costs.

I. JAMAICA: THE DIFFICULT QUEST FOR GROWTH[1]

A. Introduction

1. **Jamaica has experienced persistent low growth despite high rates of investment**. Real GDP grew, on average, by 1.6 percent from 1980 to 2004 while investment rose from 15 percent of GDP to 33 percent over the same period. Understanding this puzzle of high investment and low growth is key to addressing the constraints to lifting economic growth, improving debt sustainability, and alleviating poverty.

2. **The study finds that Jamaica's 'high investment-low growth' experience appears, in some part, to be due to measurement problems**. Specifically, official growth rates may be underestimated because the informal economy, which has increased rapidly in size, is not being picked up in the statistics. Secondly, the capital stock appears overestimated.

3. **However, the mismeasurement only partially helps resolve the high investment-low growth phenomenon and the paper considers whether high public debt, through its adverse impact on productivity, may help explain the rest of the puzzle**. The paper's central hypothesis revolves around the idea that high debt adversely affects investment and productivity by: (i) distorting the allocation of investment toward less productive areas; and (ii) reducing the scope for public sector investment, which often has a special complementary role in increasing the effectiveness of private investment.

4. **In exploring its arguments, the study expands on the existing literature on the link between debt and growth**.

- First, total public debt, both external and domestic, is used as the key explanatory variable in this study, while others that have looked at the issue of debt and growth have used only external debt. Using a cross-country database, the paper presents evidence of a significant and negative relationship between total public debt and productivity. Specifically, it is found that a doubling of total public debt leads to a reduction in productivity growth of about 1.5 percentage points.

- Second, the paper attempts to flesh out the specific channels through which high levels of debt affect productivity and the allocation of resources. It argues that in the case of Jamaica, high public debt has been associated with macroeconomic uncertainty and an output structure that relied excessively on a few maturing sectors—tourism and mining—while the manufacturing sector declined steadily and the informal economy increased substantially. At the same time, public investment has gotten crowded out by debt service, further adversely affecting productivity.

[1] Prepared by Rodolphe Blavy.

5. **The remainder of the paper is organized in five sections**. Section B summarizes the key stylized facts. Section C addresses the issue of mismeasurement. Section D estimates, based on cross-country data, the impact of public debt on productivity and Section E looks at sectoral evidence from Jamaica for the high debt-low productivity growth hypothesis laid out in the paper. Section F takes stock and concludes.

B. The Paradox: Low Growth and High Investment

Stylized facts

6. **In spite of a favorable environment, GDP growth in Jamaica has been low**. The growth potential of Jamaica is strong. The country has a solid endowment in natural beauty and mining resources and in human capital with a well-educated, English-speaking workforce. Moreover, given its position in the Caribbean, close to the largest market in the world (North America), Jamaica could benefit from regional integration and regional trade flows. However, growth in Jamaica has underperformed other Caribbean countries and was substantially below growth rates experienced by other emerging economies. In addition, economic growth has been very volatile, reflecting the vulnerability of the country to frequent natural disasters, adverse external shocks, and shifts in foreign investors' sentiment—this is illustrated in the top panel of Figure 1. Over the 1993–2003 period, GDP per capita (in constant 2000 US$) remained unchanged at about US$3,150, which is lower than 1970 GDP per capita levels of US$3,328.

7. **On the macroeconomic front, public debt ballooned during the 1990s and has averaged above 110 percent of GDP for the last decade**. Total public debt was 144 percent of GDP during the FY 2003/04, placing Jamaica among the most indebted countries in the world. Its share of domestic debt (67 percent of GDP) was unusually large, with external debt totaling 77 percent of GDP. Combined with high unemployment, emigration, and rising crime rates, macroeconomic uncertainty created by this large debt overhang likely had negative feedback effects and may have dampened further output growth.

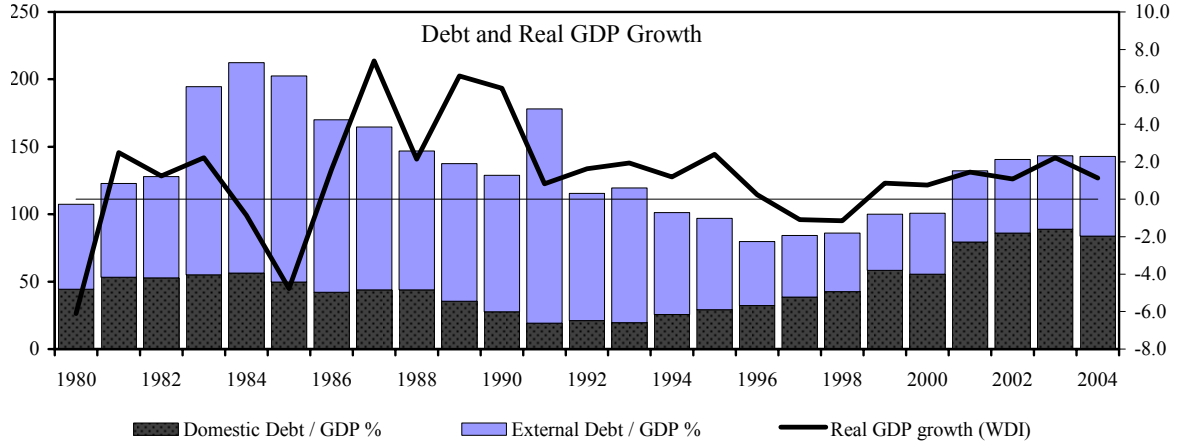
Constraints to growth

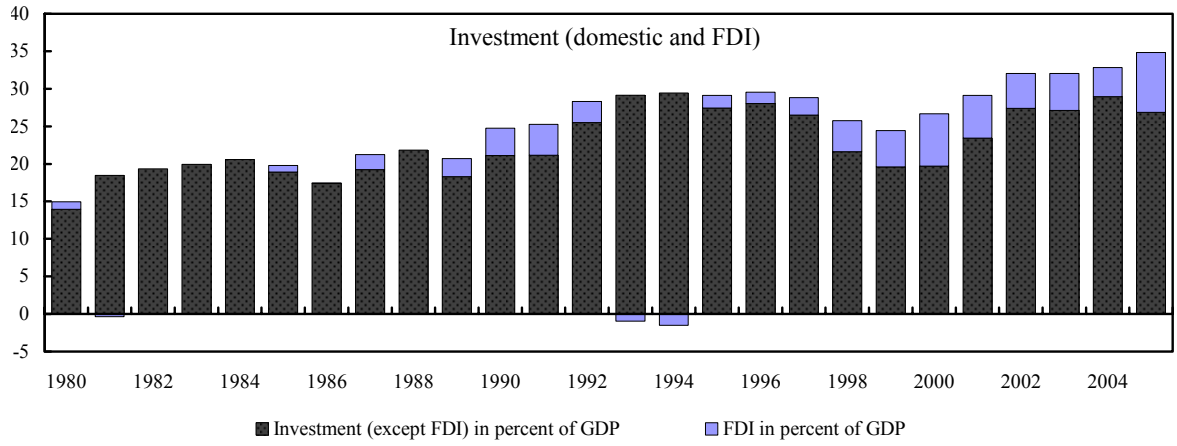
8. **Jamaica, like other Caribbean countries, faces special challenges, notably, its small size and extreme vulnerability to external events, particularly natural disasters, which can cause high volatility in national income and impair the growth process**.

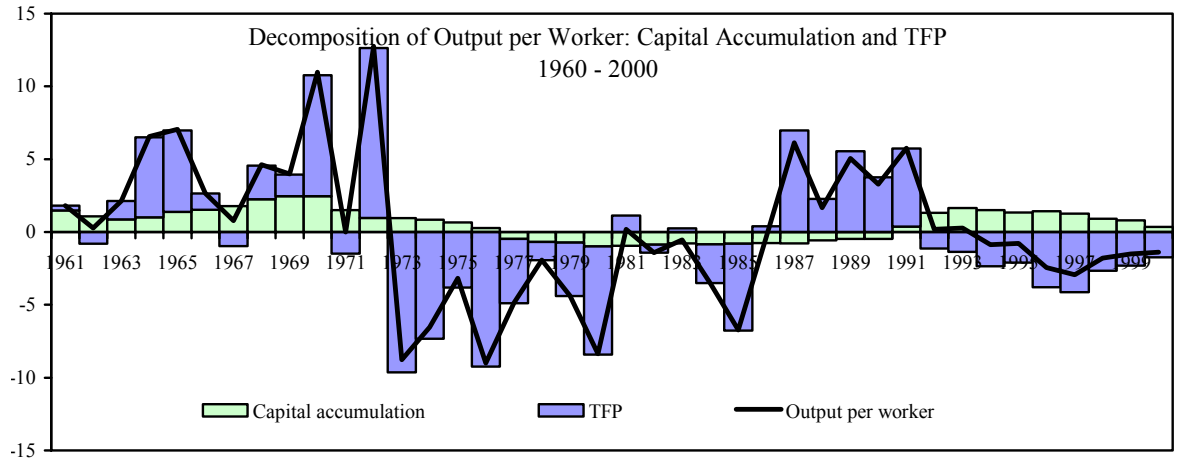
Some additional constraints to economic growth are:

- **Competitiveness declined substantially as the real effective exchange rate appreciated and labor costs increased substantially**. Real exchange rate movements are commonly used to measure competitiveness. In Jamaica, the real

Figure 1. Jamaica: Selected Growth Trends, 1980-2004
(unless otherwise specified)







Sources: IMF WEO and IFS Databases; Bosworth and Collins (2003); and Fund staff estimates.

effective exchange rate appreciated by more than 35 percent from 1990 to 2001 (see Box 2 "Jamaica's Competitiveness over Time" in the Staff Report), leading to a decline in external competitiveness.[2] As an illustration of its impact, the World Bank (2003) reports a 50 percent decline in Jamaica's market share of world merchandise exports from 1994 to 2001.[3] At the same time, real wages increased rapidly. Trends in unit labor costs compared to the rest of the world are particularly illustrative. From 1994 to 2001, unit labor costs increased twice as fast in Jamaica as in its major trading partners, without clear evidence of a comparable increase in labor productivity. In US$ terms, Planning Institute of Jamaica (PIOJ) data indicate that salary earnings almost doubled between 2005 and 2000 when employment fell by over 2 percent. A numbers of factors may explain this sharp increase in labor costs. Rigidities in the labor market limit flexibility and adjustment. Large emigration and the pull of high foreign wages may also drive the reservation wage higher, in particular for the educated workforce. Household surveys indicate that about 80 percent of tertiary graduates emigrated from Jamaica in the 1990s.

- **Access to finance for the private sector has been limited, in particular for small domestic producers, given the narrow scope of the financial sector, and the crowding out of credit to the private sector by the public sector**. The ratio of net government debt to bank deposits (45 percent in June 2003, not including 10 percent for public enterprise debt) is very high by international standards. Capital costs are also high because high levels of public debt have pushed up interest rates. In addition to the macroeconomic causes identified here, borrowers face a number of structural constraints. Insolvency procedures and creditors' rights may be outdated, as they are based on U.K. legislation of the 1880s and corporate entities of 1948. In the absence of credit registries, asymmetry of information increases lending risks for the banking sector. Finally, collateral procedures may need to be improved—surveys show dissatisfaction with the courts' performance on commercial issues, in particular with long delays in litigation. Limited access to bank lending for the private sector may not be inconsistent with high levels of investment in an economy where investment is financed in large parts by foreign direct investment as well as internal finance and retained earnings. While investment may remain high, its quality, however, may be affected, with investment being concentrated in few, already well-developed sectors. This issue is developed further in Section E of the paper.

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[2] Real exchange rate appreciation was partially reversed in 2002 by the real depreciation of the exchange rate.

[3] As external competitiveness declined during the 1990s, some textile and tire manufacturing companies exited Jamaica. Private businessmen mention high costs of doing business as a key constraint to private sector development in the country. For example, energy-intensive industries are less profitable than in Trinidad and Tobago, where energy costs are subsidized.

- **Crime exacts high costs on the economy**. Jamaica had one of the highest rates of intentional homicide in the world in 2001 (44 per 100,000 inhabitants), lower only than Colombia and South Africa. Crime increased steadily over the last two decades, reflecting severe social problems, including high unemployment, organized crime associated with the drug trade, creation of slums (World Bank (2003)). A World Bank study estimated the annual cost of crime in Jamaica at around 5 percent of GDP, including costs of investment in fighting crime and production losses due to crime. Government spending on crime control is estimated at 3.1 percent of GDP. Lost production and health care expenses due to violent crimes cost the economy 0.6 percent of GDP. Finally, private expenditure on security is estimated by the World Bank at 1.3 percent. The impact of crime may be even more pervasive. Crime impacts business expansion and investments to improve productivity. It also adversely affects productive activities by limiting night shifts and longer opening times, and provides an incentive for firms to relocate outside of Jamaica.[4]

While those constraints are important challenges for the Jamaican economy, a further decomposition of the growth process is needed to fully understand the 'high investment-low growth' puzzle.

Declining productivity

9. **A simple growth decomposition exercise for Jamaica shows that low rates of economic growth are explained by a steady decline in productivity, while capital accumulation has contributed positively to economic growth**. The bottom chart of Figure 1 illustrates how growth was dominated by large shifts in TFP. TFP enters as a residual in the growth accounting framework, thereby reflecting any change not captured by the physical and human capital accumulation variables. Mismeasurement of total output and of capital accumulation may also be significant and discussed in subsequent sections of the paper. However, the general trends are clear. The decline in productivity from the early 1970s to the mid-1980s and then throughout the 1990s explained most of the poor performance of the economy over the last three decades. In particular, during the 1990s, the positive contribution of physical capital accumulation was insufficient to compensate for the decline in productivity.

10. **On average, Jamaica experienced a decline in productivity of 0.5 percent a year from 1960 to 2000, compared with a 0.2 percent increase in Latin America and 0.9 percent increase for the world average**. The TFP estimates computed by Bosworth and Collins (2003) address a number of limitations associated with growth decomposition exercises and are used in this paper. They allow for international comparisons, as summarized in Table 1. Output growth in Jamaica was below output in Latin America and in

[4] The World Bank conducted a survey that showed that 42 percent of all business managers considered themselves likely to be murdered at the workplace.

a sample of 84 countries by almost 2.5 percentage points during both the 1960–2000 and 1990–2000 periods. Human capital accumulation (proxied by education) was in line with Latin American and world averages. Physical capital was slightly lower than those averages. This contrasts with the large differential (as high as 2.5 percent during the 1990s) in TFP growth between Jamaica and the rest of the world.

Table 1. Jamaica and Latin America: Sources of Growth, 1960-2000

			Contribution of:		
Region/Period	Output	Output per Worker	Physical Capital	Education	Factor Productivity
World (84)					
1960-70	5.1	3.5	1.2	0.3	1.9
1970-80	3.9	1.9	1.1	0.5	0.3
1980-90	3.5	1.8	0.8	0.3	0.8
1990-2000	3.3	1.9	0.9	0.3	0.8
1960-2000	4.0	2.3	1.0	0.3	0.9
Jamaica					
1960-70	4.8	4.0	1.3	0.3	**2.4**
1970-80	-0.8	-3.6	-0.3	0.5	**-3.8**
1980-90	2.5	0.3	-1.1	0.3	**1.0**
1990-2000	1.0	-0.6	0.9	0.2	**-1.7**
1960-2000	1.8	0.0	0.2	0.3	**-0.5**
Latin America (23)					
1960-70	5.5	2.8	0.8	0.3	1.6
1970-80	6.0	2.7	1.2	0.3	1.1
1980-90	1.1	-1.8	0.0	0.5	-2.3
1990-2000	3.3	0.9	0.2	0.3	0.4
1960-2000	4.0	1.1	0.6	0.4	0.2

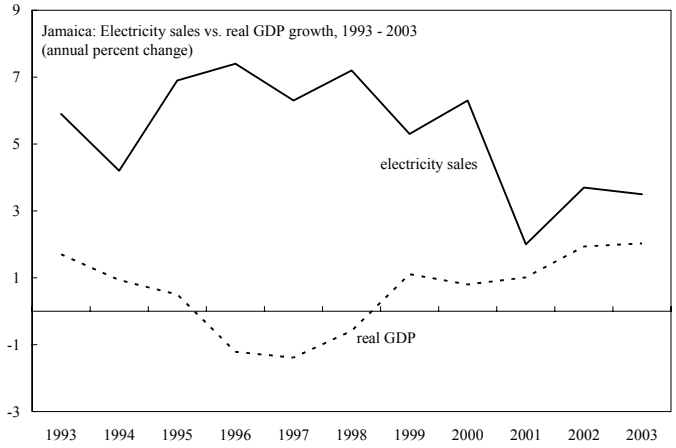
Source: Bosworth and Collins (2003).

C. The Mismeasurement Story

11. **Measurement problems are often cited to explain the measured underperformance of the Jamaican economy**. They may also explain the "high investment-low growth" puzzle. On the one hand, actual GDP growth may be substantially higher than measured. There is evidence that the informal economy is large and has been growing faster than the rest of the economy. On the other hand, investment figures may not reflect fully changes in the capital stock. In particular, low capacity utilization, damages due to hurricanes, non-productive investment may all point towards lower-than-measured capital stocks.

Is GDP growth underestimated?

12. **The computation of national accounts is particularly difficult given the structure of the Jamaican economy**. Services, which account for more than 70 percent of output, are difficult to measure, particularly in an open economy where income from tourism and services may be recorded abroad. Other issues are related to the size of illegal activities and a growing informal economy.[5] Data comparing the growth in electricity consumption and real GDP growth show a large discrepancy between the two, suggesting that, indeed, real GDP growth may have been underestimated (see attached figure).



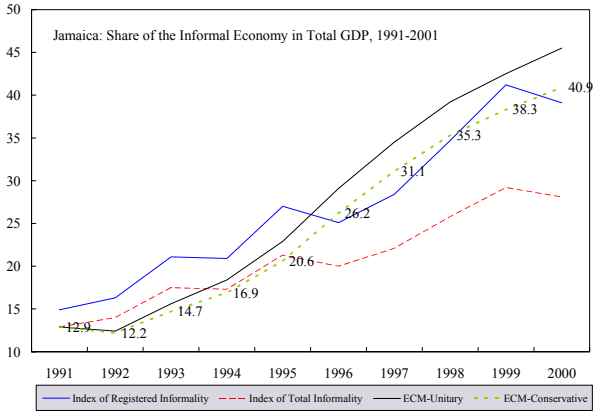
The informal economy: size and impact on growth rate estimates

13. **The informal sector accounted for about 35 to 40 percent of total GDP in 2000–01 (see attached table), according to a comprehensive study of the informal sector in Jamaica.** The survey was conducted by the Inter-American Development Bank (IADB, 2002) using different methodologies and data collected as part of the 2001 Jamaica Survey of Living Conditions.

14. **The share of the informal economy in total output grew continuously from 1991 to 2000, from 12.9 percent of GDP in 1991 to about 40 percent in 2000**. This increase in the size of the informal economy over time has implications for the measurement of economic growth over the period. Correcting for this underestimation, average GDP growth during the 1991–2000 period may be estimated as high as 3.0 percent, or 2.7 percent higher than officially recorded.[6]

[5] Technical issues are also a potential source of underestimation, notably (i) the imputed income from housing appears low, and (ii) the large inputted financial service charge that may need to be reconsidered.

[6] Previous studies report similar results for the first two decades after independence. Witter and Kirton (1990) estimate that the size of the informal economy increased from 8 percent of GDP to 24 percent in 1984 using Gutmann's model based on the size of fiduciary money in the economy, or from 18 percent to 63 percent for the same period using Feige's method based on the velocity of money.



Jamaica: Size of the Informal Sector, 2000-01

Monetary approach	
Share over registered GDP, 2000	39.1
Share over registered GDP (predicted), 2001	43.7
Share over total GDP, 2000	28.1
Electricity Consumption Method	
Share over total GDP, 2000	45.5
Share over total GDP (conservative scenario), 2000	40.9
Method of Additions	
Share over registered GDP, 2001	43.5
Share over registered GDP (conservative scenario), 2001	42.9

Source: Inter-American Development Bank, 2002.

Table 2. Jamaica: Correcting GDP Growth for the Informal Economy (in constant prices)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Average
Share of informal GDP	14.9	16.3	21.1	20.9	27	25.1	28.4	34.7	41.2	39.1	
Formal GDP	19,098	19,416	19,799	19,977	20,181	19,970	19,624	19,558	19,473	19,603	
Formal GDP (adjusted for informal economy) 1/	17,983	18,156	18,034	18,218	17,693	17,739	17,029	16,094	14,925	15,408	
Growth		*0.96*	*1.97*	*0.90*	*1.02*	*(1.05)*	*(1.73)*	*(0.34)*	*(0.43)*	*0.67*	*0.29*
Informal GDP 2/	3,344	3,781	5,295	5,278	7,464	6,692	7,784	10,393	13,644	12,586	
Growth		*13.08*	*40.03*	*(0.31)*	*41.41*	*(10.34)*	*16.31*	*33.52*	*31.28*	*(7.76)*	*15.87*
Total GDP	21,327	21,937	23,329	23,496	25,157	24,431	24,813	26,487	28,569	27,994	
Growth		*2.86*	*6.35*	*0.72*	*7.07*	*(2.88)*	*1.56*	*6.74*	*7.86*	*(2.02)*	*3.07*

Sources: IADB, 2002; Statistical Institute of Jamaica; and author's calculations.

For more details on the various methodologies used to estimate the size of the informal sector, see IADB (2002).

1/The adjustment assumes that STATIN captures about one third of the informal economy in official statistics.

2/ The informal GDP is computed using the estimates from IADB for the share of the informal economy in total official output. For each year, informal GDP is computed, with the corresponding growth rates reported in the table.

Is productive investment overestimated?

15. **Statistical evidence is limited but points toward an overestimation of the capital stock, adding to the mismeasurement problem**.

- **Capacity utilization appears low, in particular in cyclical downturns**. The volatility of economic growth results in periods of high investment in production capacity followed by periods during which capacity utilization drops dramatically. Much of the investment undertaken during the economic and building boom of the 1980s and early 1990s was subsequently underutilized. Though no hard data is available on capacity utilization, informal indications suggest that it could be as low as 50–60 percent in the manufacturing sector.

- **Capital stock depreciation may also be understated**. Hurricanes in particular are an issue in calculating the capital stock in Jamaica. A study conducted by the Planning Institute of Jamaica (PIOJ) estimated the damages associated with major hurricanes, at 65 percent of GDP for Hurricane Gilbert in 1988, 8 percent for Hurricane Ivan in 2004, and 1 percent for Hurricanes Dennis and Emily in 2005.[7] The use of a low and constant depreciation rate thus underestimates both the volatility and magnitude of capital stock depreciation in Jamaica. Moreover, hurricanes imply that a substantial share of investment is simply for replacement.

- **High investment may also reflect a substitution of capital for labor due to high real wages and labor rigidities, rather than an expansion in production capacities**. In particular, imported machinery and equipment became relatively less expensive after the real exchange rate appreciation experienced in the 1990s.

- **Finally, crime prevention-related investment contributed weakly to increases in production capacities**. While crime reduction may yield high long term returns, its immediate impact on economic growth is limited. A World Bank (2004) study estimated expenditure on security as high as 4.4 percent of GDP (3.1 percent incurred by the public sector, and 1.3 percent by the private sector).

The composition of fixed capital formation by type of capital goods, presented in Table 3, reinforces the mixed investment picture. First, building construction accounted for more than 40 percent of total investment in 2004, of which a large share is related to the boom in residential housing.[8] The boom in residential construction results from high remittances, replacement investment after weather-related destruction, and the appetite for real assets in an uncertain macroeconomic environment. Second, industrial machinery and equipment, and large transport equipment experienced a steady decline from 1995 to 2004—corresponding to the steady decline of industrial production capacity. This contrasts with a steep increase in "other machinery and capital goods," which possibly reflects the trend increase in the informal economy, investment in crime prevention, and replacement investment.

Implications of mismeasurement

16. **While the informal economy likely contributed to higher than officially measured growth rates in the past, it does not offer a solution to Jamaica's problem**s.

[7] Other hurricanes caused smaller, but cumulatively large, damages, notably 1 percent for hurricane Michelle in 2001. During the 1980s, Jamaica was affected by a hurricane in 1980 and floods in 1986 and 1991, with respective losses estimated at 2 percent, 3 percent, and 6 percent of GDP.

[8] The breakdown of construction data between residential and nonresidential is not currently available.

Table 3. Jamaica: Composition of fixed capital formation by type of capital goods at current prices, 1994-2004

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Construction	49.7	42.6	41.3	45.2	49.7	43.8	40.3	36.3	43.4	44.0
Building construction	45.6	39.2	37.3	40.6	44.2	39.6	36.1	33.0	39.8	40.3
Other construction (inc. land improvement)	4.1	3.3	4.0	4.6	5.5	4.2	4.1	3.3	3.6	3.7
Transport equipment	12.4	14.2	22.3	16.3	13.8	13.5	15.4	15.4	12.0	7.1
Motor cars	2.1	2.4	2.6	2.7	2.3	2.1	1.8	1.8	1.5	1.4
Trucks and buses	7.1	7.5	7.0	9.0	7.8	8.0	8.4	7.8	6.5	2.4
Other transport equipment	3.2	4.3	12.8	4.6	3.7	3.3	5.1	5.8	4.0	3.3
Other machinery and equipment	37.9	43.2	36.4	38.4	36.5	42.7	44.4	48.3	44.5	48.8
Agricultural machinery and equipment	1.2	1.0	0.9	0.8	0.8	1.4	0.7	0.8	0.7	0.7
Industrial machinery and equipment	12.7	16.1	10.6	11.2	8.7	9.2	9.1	10.4	9.8	9.7
Other machinery and other capital goods	24.0	26.1	24.9	26.4	27.0	32.1	34.6	37.1	34.0	38.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Statistical Institute of Jamaica.

17. **First, financing and legal constraints may hinder growth prospects of the informal private sector**. The benefits (in terms of growth prospects) of being in the formal (rather than the informal) sector include access to finance and to a supporting legal environment. As discussed above (see Section B), one significant constraint to growth in Jamaica has been the limited access to finance to fund business expansion and to the legal system for entering and enforcing contracts—hence incentives for private companies to operate in the formal sector are limited.

18. **Second, the informal economy does not contribute to alleviating macroeconomic difficulties**. In particular, the presence of sizeable activities outside of the tax net adds to the difficulties in conducting fiscal policy.

19. **Third, the large informal economy, even if growing rapidly does not portend well for future growth prospects**. Informal activities typically develop in sectors with low value-added and limited potential for productivity increases. In particular, informal activities are more prevalent in sectors characterized by low entry barriers in terms of skill, capital and organization. The IADB (2002) study finds that they are typically family owned and small-scale operations, with labor-intensive production, low levels of productivity and a low capacity of capital accumulation. Most of the informal employed labor force is concentrated in three sectors of the economy: agriculture, forestry and fishing (48 percent); wholesale, retail, hotels and restaurants (26.4 percent); and community, social and personal services (13.4 percent). Employment in the formal economy is more diverse, with a significant share of employees concentrated in the manufacturing, construction, and financial services sectors.

Jamaica: Employment by Industry Group (in percent), 2001

	Informal	Formal
Agriculture, forestry and fishing	48	7.4
Mining, quarry, and refining	0	1.1
Manufacturing	3.9	10.3
Gas, electricity, water	0	1.6
Construction	3	11.6
Wholesale, retail, hotels and restaurants	26.4	17.4
Transport, storage, and communication	4.5	7.3
Financing, insurance, real estate and business services	0.8	6.1
Community, social and personal services	13.4	37.2

Source: IADB, 2002.

20. **Fourth, the quality of human capital may decrease when the informal labor force expands**. Informal employees are more vulnerable, have lower access to social services and to on-the-job training. Own account and unpaid workers, as reported in labor force statistics, can be used as a proxy for employment in the informal economy. They accounted for about 41 percent of the total employed labor force in 2001. This affects over time the quality of human capital. Informal sector employees are on average older and less educated than employees from the formal sector. The analysis of wage and salary data conducted by the IADB reveals that for every J$1.00 earned by an individual in the informal market, a formal worker earns J$1.5. This is consistent with the fact that a large proportion of the individuals in the informal sector carry out primary activities.

D. Low Productivity: Does the Level of Debt Matter?

21. **Mismeasurement explains only partially the 'high investment-low growth' puzzle**. **Productivity estimates remain low even with revised growth and investment measures**—Bartelsman (2002) conducts a growth decomposition exercise adjusting for informal sector employment and disaggregating and depreciating more rapidly the capital stock. His estimate of average TFP growth for the 1991–2000 period is -0.8 percent. Thus, there clearly has been a declining productivity problem. Addressing this continuous decline in productivity is critical to raising economic growth in Jamaica.

The effects of debt on growth and productivity

22. **The link between external debt and economic growth has been extensively documented in the growth literature**. The most recent studies, for example Cohen (1993), Cohen (1997), Patillo and others (2002) and Patillo and others (2004), provide empirical evidence of a nonlinear relationship between external debt and economic growth. At low levels of external debt, borrowing provides countries constrained by small capital stocks with the necessary financing, as long as they are not constrained by macroeconomic instability, distorted policies and institutional weaknesses. This helps growth. Above a certain threshold, however, debt is found to reduce growth.

23. **The debt overhang literature (Sachs, 1989; Krugman, 1988; Cohen, 1993) purports that, as external debt rises above a country's repayment ability, investment is discouraged by the expectation of higher future taxes**.[9] Uncertainty associated with high debt and the probability of debt relief and/or default reduces investors' incentives and economic growth. Further, high debt service may crowd out private investment.

24. **Few studies have, however, focused on the impact of debt on the various components of growth**. Patillo and others (2004) show that high debt stocks affect growth through their effects on both capital accumulation and total factor productivity. Applying a growth accounting framework to a group of 61 emerging economies over the 1969–98 period, they find that the average impact of external debt on per capita GDP growth is negative for net present value of debt above 160–170 percent of exports and 35–40 percent of GDP. Their results suggest that a doubling of external debt reduces by almost 1 percentage point both growth in per capita physical capital and growth in total factor productivity. In terms of contribution to growth, one-third of the effect of debt of growth occurs via the capital accumulation channel and two-thirds via total factor productivity growth. Their study also concludes that the relationship between debt and the various components of growth is non-linear, and negative only for highly indebted countries.

25. **While most studies have looked at the role of external debt on growth, a comprehensive analysis of the impact of both external and domestic public debt is, however, lacking**. High levels of total public debt, including its domestic component, may have substantial effects on the economy, raising domestic interest rates, crowding out public investment within the budget and private investment in general, and raising the degree of macroeconomic uncertainty. The domestic debt component is particularly important in countries like Jamaica, where its proportion in the total public debt stock is large.

26. **This paper expands on the work of Patillo and others (2004) in several ways**. Using a similar growth accounting framework, the study focuses on the impact of total debt on productivity. This is motivated by our focus on Jamaica and the importance of the productivity decline in explaining low economic growth in that country.

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[9] Cohen (1993) represents the relationship between the face value of debt and investment as a "Laffer curve." When outstanding debt increases above a certain threshold, the expected repayment and investment begins to fall. "The premise is that, if debt will exceed the country's repayment ability with some probability in the future, expected debt service is likely to be an increasing function of the country's output level. Thus some of the returns from investing in the domestic economy are effectively 'taxed' away by existing foreign creditors and investment by domestic and new foreign investors is discouraged" (Claessens and others, 1996, p. 17). Given the link between capital accumulation and growth, the Laffer curve representation is extended to the debt and growth relationship.

27. **High levels of debt may affect the allocation of resources, and hence, productivity, through different channels**: (i) uncertainty, (ii) higher financing costs, and (iii) fewer externalities from public investment:

- **The debt overhang raises the discount rate for potential investors, due to the future tax accompanying an outstanding debt burden**. This is particularly true if future growth is insufficient to cover future debt service. As a result, short-term investment projects would be favored over long-term ones that might otherwise be more productive in terms of higher net present value (for example, Corden, 1989).

- **Uncertainty associated with high levels of debt directly and adversely affects investment prospects (Serven, 1997)**. Specifically, higher variance of returns creates incentives to postpone longer-term investments in favor of short-run projects, even if they are less efficient, in the hope that the uncertainty will be resolved before the irretrievable long-term investment has to be undertaken. Uncertainty affects any activity that involves incurring costs up-front for the sake of increased output in the future. Such activities include investment in human capital (education and health), and in technology acquisition, all with strong long-term effects on growth (Claessens and others, 1996). Misallocated resources and less efficient investment projects could thus contribute to slower productivity growth (Claessens, and others, 1993).

- **The liquidity constraint, when binding, may also skew investments toward projects with fast returns**. For example, even with no uncertainty, investments that would generate better pay-offs in the future may need to be postponed indefinitely in favor of ones that will yield lower returns but sooner. In other words, perfunctory maintenance, or small investments yielding fast returns may be preferred so that funds will be at hand for the repayment of loans.

- **The high debt burden may also absorb a significant portion of public resources, and reduce the overall level of public capital expenditure.** A fall in productivity of private investment may ensue because of lost externalities from certain types of public investment (such as physical infrastructure).

- **Governments may be less willing to undertake difficult and costly policy reforms if it is perceived that the future benefit in terms of higher output will accrue partly to creditors (foreign and domestic).** The poorer policy environment affects the efficiency of investment and productivity (Clements and others, 2003; Patillo and others, 2004).

Cross-country evidence

28. **Total debt, rather than external debt alone, is the relevant variable for Jamaica. Jamaica appears to be an outlier when only the external debt-growth relationship is examined—its growth experience has underperformed significantly countries with similar levels of external debt**. Including domestic debt in the analysis removes this

apparent underperformance (see Figure 2, left-hand side bottom chart). Jamaica, with an average total public debt of 109 percent and an average real GDP growth rate of 0.4 percent, is shown close to the fitting line for the overall sample. An examination of the relationship between debt levels and productivity (the left-hand side bottom chart of Figure 1) tends to confirm this empirical result (see Figure 2, right-hand side charts). Again, the relevant variable for Jamaica is not the level of external debt but rather total public debt.

Data, methodology, and model specification

29. **The study expands on previous research by assessing the impact of public debt on growth and productivity**. The model specification follows closely the one proposed by Pattillo and others (2004). The model uses a spline function to test for a non-linear relationship between debt and growth, and between productivity and growth. The external debt variables are replaced by the total public sector debt stock variable.[10]

30. **We estimate the panel model with total factor productivity as the dependent variable and total public debt as the explanatory variable**. We also control for the initial level of development (lagged income per capita), the investment rate, human capital, and the initial level of debt (all in logs); and fiscal balance.[11]

31. **The relationship between debt and productivity is estimated using the spline function:**

$$y_{it} = \alpha_{it} + \beta X_{it} + \gamma D_{it} + \chi \left(D_{it} - D^*_{it} \right) Z + \varepsilon_{it}, \qquad (1)$$

where y_{it} is the log difference in TFP (or GDP), X_{it} is the set of control variables, D_{it} is the logarithm of debt variable, and D^* is a pre-determined debt threshold. Z is a dummy variable that takes value 1 if debt is superior to D^* and 0 otherwise, allowing to have a structural break in the impact of debt on the dependent variable at the level of the debt threshold. The public debt threshold is at 21 percent of GDP.[12] It is determined by estimating the model with different values for D^* and retaining the value that yields the highest R-squared.

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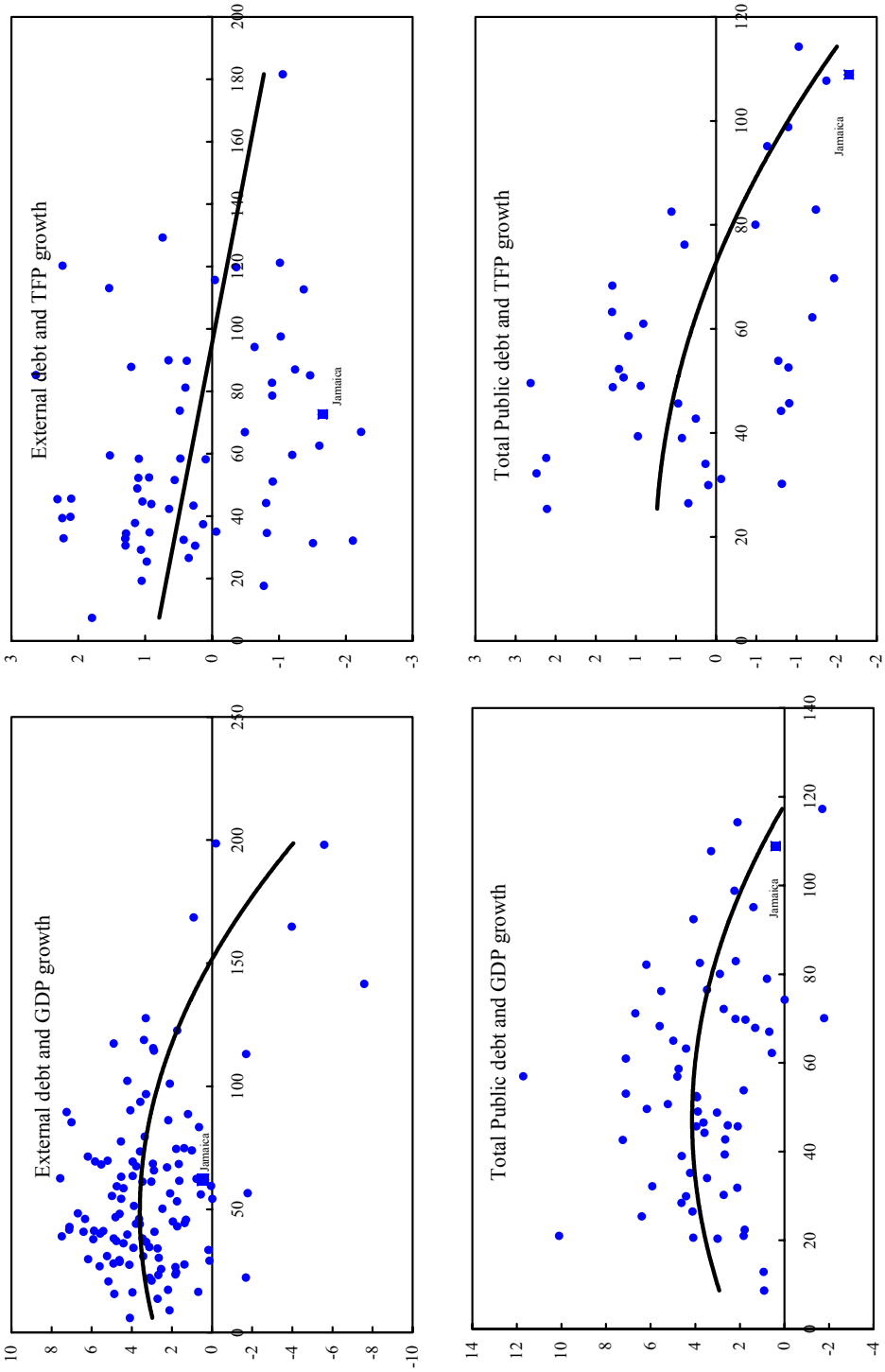
[10] A forthcoming working paper includes external debt variables for comparison purposes.

[11] The initial set of control variables also included secondary school enrollment rates, openness (defined as exports plus imports over GDP), and exogenous shocks (as measured by changes in the terms of trade). However, these variables were not statistically significant and are not included in the results presented here.

[12] Patillo and others (2004) identify a debt threshold of similar magnitude, at 18 percent of GDP for external debt only. The inclusion of domestic public debt raises the debt threshold, as should be expected.

Figure 2. Emerging Economies: Debt, Growth and Productivity, 1990 - 2000 (averages)



Sources: WEO, WDI, Bosworth and Collins (2003), and Fund staff estimates.

32. **The dynamic panel specification is estimated using five different estimators**: (a) ordinary least squares (OLS), (b) fixed effects to capture country specific effects, (c) random effects (d) differenced GMM and, (e) system GMM to take into account endogeneity problems and biases associated with lagged variables.

Results

33. **The results are presented in Table 4**. The first five columns correspond to the five estimation methods and an average is presented in the last column. The control variables have the expected impact on total factor productivity.[13] The estimated coefficients for the debt variable are provided, for total public debt and for the "above-threshold" debt. The sum of the two estimated coefficients allows assessing the average impact of high levels of debt on productivity.

34. **The results support a nonlinear relationship between productivity and total public debt**. The coefficient on the public debt term is positive and generally significant, suggesting that low levels of debt are positively associated with productivity. The coefficient for the "above-threshold" debt is negative and significant at the 5 percent level with all estimation methods, confirming the presence of a structural break in the public debt coefficients.[14] The total effect of high debt is significantly negative. A doubling of total public debt is associated with an average reduction in productivity growth of about 1.5 percentage point. This result is robust across estimation methodologies.

35. **These results are consistent with the findings of previous studies**. Patillo and others (2004) find that a doubling of external debt leads to a reduction of 1 percentage in total factor productivity growth. The impact estimated here is greater. This may reflect a shorter estimation period during which countries with high debt significantly underperformed countries with low debt. It may also reflect the additional distortions and negative impact of domestic debt on productivity growth.

[13] Investment, and to a lesser extent, the fiscal balance and the initial level of development, are positively associated with productivity growth. The relationship between population growth and TFP growth is negative. Additional variables—openness and terms of trade changes—were taken out of the model because they were not statistically significant.

[14] To confirm the nonlinearity of the relationship between public debt and TFP growth, results on a linear model were estimated. Though the direction of the relationship is similar, the estimated coefficients for the debt variables are on average smaller than those estimated with the spline function. This would be expected in the presence of nonlinearity.

Table 4. Nonlinear Effects of Public Debt on Productivity, 1990-2000

	OLS	Fixed Effects	Random Effects	GMM Differenced 1/	GMM System 1/
Log (Public Debt)	5.40	5.25	5.76	1.20	10.57
	*(1.80)**	*(1.42)*	*(1.75)**	*(0.35)*	*(2.99)****
Log(Public Debt) if Public Debt > 21 percent of GDP	-8.53	-10.64	-9.33	-9.86	-15.58
	*(2.47)***	*(2.27)***	*(2.48)***	*(1.98)***	*(3.23)****
Log(Per Capita GDP)	-0.16	0.53	0.20	-1.59	-0.20
	(0.64)	*(1.77)**	*(0.09)*	*(1.33)*	*(0.56)*
Population Growth	-0.59	-0.58	-0.58	-0.40	-0.34
	*(2.70)***	*(2.18)***	*(2.53)***	*(4.41)****	*(1.57)*
Log (Investment)	5.89	9.98	7.51	11.93	10.47
	*(4.36)****	*(4.61)****	*(5.11)****	*(2.53)***	*(5.72)****
Fiscal Balance	0.41	0.04	0.05	0.02	0.04
	*(6.78)****	*(3.28)****	*(3.87)****	*(1.10)*	*(6.13)****
Constant	-11.61	-19.03	-14.84		-23.99
	*(2.11)***	*(3.17)****	*(2.75)****		*(3.50)****
Observations	383	383	383	348	383
R-Squared	0.2822	0.2242	0.2741		
Memorandum item:					
Coefficient for High Debt	-3.13	-5.39	-3.57	-8.66	-5.01

Source: Author's calculations.

Notes: t-statistics: robust estimates reported in parenthesis; *: significant at 10 percent; **: significant at 5 percent; ***: significant at 1 percent.

E. High Debt and Declining Productivity: The Case of Jamaica

36. **Jamaica is at the lower end of the public debt and low growth spectrum, suggesting that the channels through which high public debt negatively impacts growth (as outlined in Section D) might have been fully at play**. Investments in Jamaica have been concentrated in well-established, maturing sectors, with limited room for long-term productivity gains but attractive to investors as they were shielded from Jamaica-specific risks. Finally, public investment shrank drastically, impairing its crucial role in infrastructure and public service provision.

Sectoral evidence

37. **The previous section discussed how high levels of public debt could result in heightened uncertainty and fewer externalities due to low public investment, thereby distorting the allocation of investment and reducing its efficiency**. In effect, investment could be concentrated in sectors which provide safe and rapid returns, to the expense of diversification and/or development of new, higher-yielding economic sectors with greater risk and longer-term returns. Such economic environment would thus result in increased and continued concentration of economic activities and investment in a few maturing sectors—where productivity gains are limited and growth low.

38. **Tentative sectoral evidence is presented to advance the hypotheses regarding the channels through which high debt is likely to have affected both investment and**

productivity. The exercise is partial for two main reasons. First, it is difficult to isolate the specific impact of public debt among a wider range of factors that affect economic development. For example, the concentration of economic activity in a few sectors may result from explicit policy choices; it could also be the consequence of lack of diversification in a small island economy. Second, sectoral data is very sparse. At best, the analysis may provide general trends and broad stylized facts. Improvements in data collection, in particular a breakdown of investment and productivity by sector, are needed for a better understanding of the mechanisms at play.

39. **Nevertheless, available evidence suggests that economic growth has been characterized by the continued concentration of the formal economy in a limited number of sectors—the "enclave" tourism and mining industries—and the fast growth of the informal sector**. The manufacturing sector declined dramatically, notably due to the exit of some textile and tire manufacturing companies. Growth was positive in a limited number of sectors including nontradable sectors such as communications and power, and location- and natural-resource based activities, such as transport, mining, and tourism. The latter two sectors centered on large projects and large-scale investments but usually in isolation from the rest of the economy.[15] Uncertainty was likely a key factor in this evolution as the sectors that grew (tourism and bauxite) are shielded to a large extent from Jamaica-specific risks, given that they are natural resource-based and have earnings in foreign exchange.

40. **Sectoral data for the 1990s confirm that economic diversification diminished in the 1990s**. The share of services in total output increased substantially, led by tourism, while the manufacturing sector shrank.[16] This trend is consistent over a set of economic indicators:

- **The share of tourism in total GDP increased substantially during the 1990s**. While the share of manufacturing declined from 21 percent of GDP in 1990 to 16 percent in 2000, the share of tourism (reflecting part of a broader increase in services) increased from 2.1 percent in 1990 to 9.2 percent in 2000. Construction declined slightly and the share of other sectors remained broadly constant.

- **Contributions to growth reflect the same trends, with most of the growth during the 1990s coming from the tourism and mining sectors**. The mining and tourism

[15] Tourism is not traditionally considered an enclave sector, given its reliance on wide-ranging supporting services and its impact on domestic labor markets. In the case of Jamaica, however, linkages with the rest of the economy may have been limited: backward linkages, for example on food supply, have been few; the high incidence of crime has justified the development of enclave resorts. Anecdotal evidence suggests that this pattern may be evolving today, with a tourism product that is more integrated with the back-country, and diversifies away from being simply a beach-resort product.

[16] The departure of the textile and tire manufacturing industries at the end of the 1990s were the most salient examples of the manufacturing decline.

sectors, and more broadly the service industry, contributed positively, albeit weakly, to economic growth. Their average contributions during the 1990s were 0.7 and 2.6 percentage points of GDP, respectively. The contributions of the manufacturing and construction sectors were large and negative, at -2.2 and -1.4 percentage points on average, respectively, over the same period.

Jamaica: GDP by Sectors (Based on GDP at Constant 1986 Prices), 1990-2000

	1990	2000	Sectoral contribution to GDP growth
Agriculture forestry and fishing	6.2	7.1	0.4
Mining and quarrying	8.7	9.1	0.7
Manufacturing	21.1	15.8	-2.2
Construction and installation	9.8	7.6	-1.4
Services	54.2	60.3	5.1
Of which: Hotels, restaurants, clubs	2.1	9.2	2.6
GDP at constant market prices	17,446.1	19,153.9	2.6

Sources: Statin, and Fund staff estimates.

- **Bank lending is concentrated in a limited number of sectors**. This is illustrated with the breakdown of commercial banks' loans and advances by sector. At end-2004, government services and personal loans accounted for 26.3 percent and 29.5 percent of total loans, respectively. The share of government services increased dramatically from 5.5 percent of total loans in 1993 to 26.3 percent in 2004. The increase in retail lending likely reflects the risk-averse attitude of banks and their preference for intermediating short-term loans. Tourism is the only other sector whose share in total bank lending increased, albeit more modestly, from 8.5 percent in 1993 to 13.9 percent in 2004. This contrasts with the sharp decline in the proportion of loans advanced to the manufacturing and the construction sector, from 12.8 percent to 3.3 percent and from 14.1 to 5.2 percent of total loans, respectively. The data reflects the scarce availability of bank credit for the private sector, with close to 70 percent of total credit dedicated to government services, personal loans, and tourism. In light of the high levels of investment prevailing in the country, the data suggest that a substantial share of that investment is financed through retained earnings and foreign financing—the most likely impact of this is that the former would be available only to well-established, cash-flow generating companies, and the latter would be directed towards activities shielded from Jamaica-specific risks.

Jamaica: Commercial Banks - Analysis of loans and advances, 1993 - 2004
(in percent of total loans)

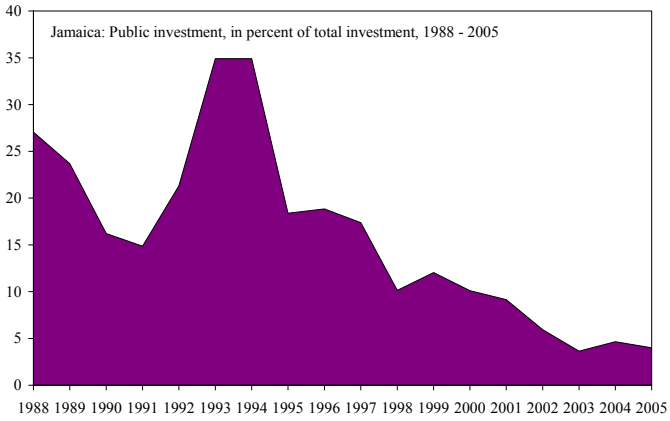
	1993	1995	2000	2004
Agriculture	6.0	4.1	3.8	1.1
Mining	0.5	0.8	0.2	0.2
Manufacturing	12.8	13.3	7.5	3.3
Construction & Land Development	14.1	12.2	5.0	5.2
Tourism	8.5	8.4	11.7	13.9
Government Services	5.5	7.3	16.5	26.3
Personal	17.2	19.4	26.9	29.5
Other	35.5	34.6	28.3	20.6

Source: Bank of Jamaica.

Low public investment and low productivity

41. **In addition to the channels reviewed above, high levels of public debt affect productivity and economic growth by constraining public investment**. The experience of Jamaica is consistent with cross-country evidence of a strong association between public debt levels and public investment, and between public investment and economic growth.

42. **High levels of debt have crowded out public investment within the government budget, which steadily declined to negligible levels of GDP and total investment (see attached figure)**. Public investment accounted for 4.7 percent of total investment and 1.5 percent of GDP in 2004, compared with 27 percent of total investment and 6 percent of GDP in 1988. This resulted in the striking fact that Jamaica has high overall investment rates but low public investment.



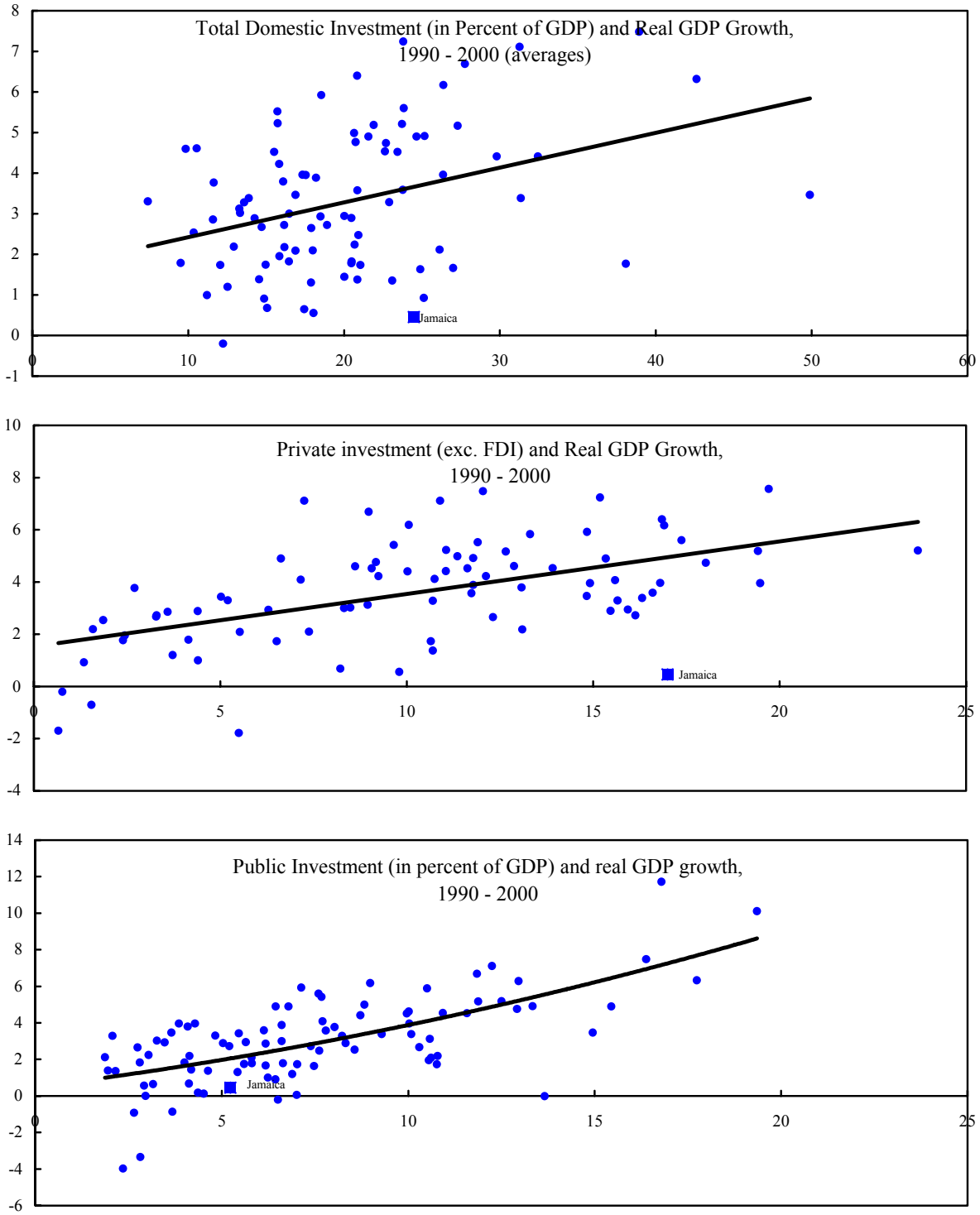
Source: WEO Database, February 2006.

43. **Public investment has an important role of its own within the overall investment envelope because of the complementary role it plays with regard to private investments**. Positive externalities from the provision of public infrastructure and of public and social services raise the efficiency of private investment and the overall level of productivity in the economy. Figure 3 illustrates the importance of low public investment in explaining low economic growth in Jamaica. High overall investment rates are not sufficient in themselves to ensure high economic growth, if public investment is lacking. Jamaica significantly underperformed other emerging economies with similar levels of total investment and similar levels of domestic private investment. However, its growth performance is only slightly inferior to the average growth recorded for countries with similar levels of public investment.

F. Taking Stock: Summary and Conclusions

44. Jamaica's 'high investment-low growth' puzzle is, in part, due to measurement problems although it should be noted that similar problems are likely to exist in other countries. There is some evidence that official Jamaican GDP estimates may understate actual economic growth. In particular, the share of the informal economy in total output is likely to have grown substantially over the 1990s. Investment figures may also overestimate productive investments in Jamaica. In particular, capital depreciation may be understated—for example, hurricane-related damage may not be fully accounted for. Further, there is some indication that considerable investment goes to nonproductive activities, such as crime

Figure 3. Emerging Economies: Composition of Investment and Growth, 1990-2000



Sources: WEO, October 2005; and author's estimates.

prevention and residential housing. At the same time, it is important to note that similar problems with the data are not entirely uncommon. Hence the implications for assessing Jamaica's growth experience in the international context are not clear.

45. **Regardless of the informal sector, productivity remains a key constraint to medium-term growth prospects in Jamaica and high levels of public debt appear to be important in this regard**. Using panel data analysis for a sample of 35 emerging economies, low productivity is shown to be robustly associated with high levels of public debt. In particular, a doubling in total public debt is estimated to result in a 1.5 percentage point reduction in productivity growth. High levels of public debt distort the allocation of capital, by increasing uncertainty and leading to fewer externalities from public investment.

46. **Economic growth in Jamaica has been characterized by the continued concentration of the formal economy in a limited number of sectors, which is consistent with a pattern of debt affecting productivity and growth**. The growing "enclave" tourism and mining industries are shielded from many Jamaica-specific risks and rewards. Furthermore, activity appears fast growing in the informal sector, which is also out of reach of the state and hence somewhat immune to developments in the formal sector. These trends carry substantial risks for the sustainable development of the country, in particular: (i) lack of diversification, which increases the vulnerability of the economy to exogenous shocks, (ii) the further growth of "economic enclaves" with little spillovers and externalities to the rest of the economy, and (iii) the growth of sectors characterized by low productivity, notably the informal economy.

47. **Declining and low levels of productivity in the context of high overall investment levels suggest that the challenge for Jamaica is to increase the productivity of investment**. Addressing the debt burden and ensuring macroeconomic stability are paramount to raising growth in the country. Moreover, a good investment climate is needed to channel investments into productive sectors and nontraditional areas. The provision of an adequate physical and social infrastructure network by the state complements a sound regulatory framework to attract, retain, and increase the efficiency and productivity of private investment.

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II. Public Debt, Money Supply, and Inflation: A Cross-Country Study and Its Application to Jamaica[1]

A. Introduction

1. **Jamaica is one of the most heavily indebted countries in the world**. The public debt sharply increased from an already high level of 80 percent of GDP to nearly 140 percent of GDP over the past decade. 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 in excess of 10 percent of GDP have been generated over the past several years. The public debt is broadly evenly spilt between foreign and local currency denominated issuances, with the bulk of the latter in short durations. This structure has rendered the debt very sensitive to exchange rate as well as domestic interest rate changes.

2. **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 lower debt. The key role of inflation in the program raises, however, important analytical and policy questions about what its main determinants are in highly-indebted countries like Jamaica and what policies would be need to sustain price stability.

3. **The most widely accepted school of thought on inflation is that it is a monetary phenomenon and as such 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 and hence supply more money than there is demand for.

4. **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 29 equilibrium paths for inflation can co-exist. Under such circumstances, money supply alone may not be sufficient to pin down the time path of inflation.

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[1] Prepared by Goohoon Kwon, jointly with Lavern McFarlane and Wayne Robinson of the Bank of Jamaica.

5. **Against this background, attention has increasingly been given to the fiscal role 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. This idea of fiscal dominance in price determination has spawned an extensive literature on fiscal policy and inflation (Aiyagari and Gertler 1985; Leeper 1991; Castro et. al. 2003).

6. **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 (Woodford 1994; Sims, 1994; Loyo, 1999; Christiano and Fitzgerald, 2000; Canzoneri, Cumby, and Diba 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.

7. **This paper provides a comprehensive empirical examination of the link between fiscal policy and inflation identified by the various forward looking fiscal-monetary models of inflation**. We draw on an extensive cross-country dataset for 71 countries spanning up to 43 years in order to overcome potential biases arising from the selection of sample countries and sample periods. Given the importance of policy regimes on inflation expectations, we rely on flexible econometric techniques allowing for cross-country heterogeneity. 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. This will better ensure that we capture the nontraditional channels of fiscal influence on inflation, namely monetization expectations and wealth effects of debt, which can arise independently 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 on account of the use of non-debt financing, debt-indexation, exchange rate movements and the government's assumption of quasi-fiscal liabilities (IMF 2003; Singh et. al. 2005).

8. **The rest of the paper is organized as follows**. Section B describes a simple forward-looking macroeconomic model that we use for the empirical estimation. Section C presents basic stylized facts on public debt and inflation, discusses empirical modeling strategies, and presents our empirical findings. Section D applies the empirical model to Jamaica. Section E discusses budgetary and policy implications of the findings and Section F summarizes and concludes.

B. Conceptual Framework

9. **We draw on a simple fiscal-monetary model of inflation**. A number of authors have developed theoretical models of fiscal dominance and FTPL[2]. Our model is a simplified version of Castro et. al. (2003). In our model, a representative household is endowed with resources, *y,* for each period, and allocates its wealth between 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:

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

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*.

10. **The government is faced with the following intertemporal budget constraint:**

$$G_t + (i_{t-1} - 1)\frac{B_{t-1}}{p_t} = \tau_t + \frac{(M_t - M_{t-1})}{p_t} + \frac{(B_t - B_{t-1})}{p_t} \tag{3}$$

where *G* is government expenditure, and *B* and *M* are the aggregate stocks of outstanding bonds and money, respectively (i.e. the sum of *b* and *m* across all households). Iterating (2)-(3) and using no arbitrage and market-clearing conditions, it can be shown (see Appendix, Section I) that:

$$p_t = \frac{(1-\beta)(M_t + \delta B_t)}{\gamma c_t}, \text{ where } p_t \text{ is the equilibrium price level.} \tag{4}$$

Equation (4) is log-linearized to obtain a more easily estimable specification as follows:

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[2] Aiyagari and Gertler (1985) introduced an overlapping generation model, which establishes a link between public debt and a 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 as opposed to Ricardian equivalence (Barro 1974).

$$\hat{p}_t = \lambda_1 \hat{M}_t + \lambda_2 \hat{B}_t - \hat{c}_{t,} \; where \; \lambda_1 = \frac{M^*}{M^* + \delta B^*}, and \; \lambda_2 = \frac{\delta B^*}{M^* + \delta B^*} \qquad (5)$$

where hats above terms represent deviations from equilibrium values in logarithms (denoted with asterisks). This establishes a linear relationship between inflation and growth in money and public debt, which can be tested empirically through a variety of specifications allowing for dynamics and heterogeneity among countries.

11. **The precise nature of the fiscal policy determines the reduced form of the equation (5) relating prices to money and debt**. This derives from the critical implicit assumption in this model that monetary policy accommodates fiscal policy. Consider for a moment the monetization factor δ. 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 (4) simplifies into the conventional quantity theory of money. Similarly, if the implied fiscal rule is full monetization of all public debt, δ becomes 1 and, hence, debt heavily influences inflation. In reality, the parameter is likely to vary between 0 and 1, with the exact amount depending on the capacity and willingness to service public debt, as often reflected in the debt size, credibility of policy commitment, and institutional and political constraints. In our log-linearized form in equation (5), the larger the monetization factor δ, the higher the coefficient for debt growth.

C. Empirical Findings of the Cross-Country Study

Data and basic stylized facts

12. **The attached table provides some interesting descriptive statistics of long-term cross country data derived from the main dataset**. During the sample period, the average annual growth of money exceeded average inflation by a wide margin (see Appendix, Section II for data sources and definitions). The differential between average money growth and average inflation is average real money growth, which is about equivalent to real GDP growth in the dataset. This empirical relationship between real money and real GDP implies that the velocity of money in the 71 sample countries remained, on average, virtually unchanged during the sample period. Average public debt, however, rose faster than 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 increase the money multiplier.

Descriptive statistics of long-term average cross country data
(In average 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
Maximum	51.7	387.8	432.3	316.0	663.7
Minimum	-84.4	-10.3	-119.7	-105.1	0.6
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

13. **There is considerable variation across countries in the dataset, indicating potentially large gains from using panel data**. The table below shows a summary of regional variations of selected macroeconomic indicators averaged over the sample period. Among developing countries, average annual inflation (geometric) in Latin America is only second to Europe, much of which suffered hyperinflation during the transition to market in the 1990s of the eastern European countries. It is also notable that the average debt-to-GDP ratio of Caribbean countries is the highest, their growth rate the lowest, and their exchange regime the least flexible, compared with other regions.[3] As regards public debt and inflation the data set appears to indicate that debt tends to rise nearly twice faster than inflation in low inflation regions but not as fast in high inflation regions. This suggests that there might be a natural limit to real debt growth. A similar observation could be made with respect to money growth and inflation.

Table. Selected Macro Economic Indicators (up to 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 WHD databases and Reinhart and Rogoff (2004)
1/ Country groupings are based on IMF's WEO (2005).
*Narrowest definitions of money available from IFS, WEO and OECD databases.
**Based on Reinhart and Rogoff (2004). The higher the indices are, the more flexible the exchange regimes are.
***Adjusted for the shortest time periods for which data are available.

14. **Our finally preferred econometric framework is indeed panel estimation on first differences, notwithstanding some evidence of co-integration (see below on limitations of long-term average data)**. Most macro variables in the dataset are non-stationary in their levels but all become stationary in their first differences. 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. In light of these mixed outcomes, we proceed mainly with their first difference terms. Figure 1 show 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.

[3] Caribbean countries in our database are the Bahamas, Barbados, Guyana, Jamaica, Trinidad and Tobago, St. Lucia, and St. Vincent and the Grenadines. Other Caribbean countries are not included due to data problems.

Limitations of long-term average data

15. **A simple long-term cross-country regression 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**. This is in line with the quantity theory of money and consistent with many empirical studies on this subject (Schwartz 1973; Vogel 1974; Lucas 1980; Duck 1993; Favero and Spinelli 1999). In addition, the regression shows that more flexible exchange regimes tend to be associated with higher inflation although the causality is by no means established in this simple regression. As regards the role of public debt, there is evidence of a positive linear relationship between inflation and public debt growth and a weak association between inflation and the size of public debt (see table below and Figure 2). However, both fiscal variables lose their explanatory power for inflation completely when money growth is controlled for.

Cross-country OLS regression results*

Explanatory variables			
Money growth			**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	0.92	0.20	0.99
Adjusted R-squared	0.92	0.19	0.99
Number of observations	71	71	71

Coefficients significant at the 5 percent level are in bold.

16. **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. Nor do they simply the absence of debt monetization (i.e., $\delta = 0$ in our model). 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 are likely to change over time. To really bring out the relationship, one thus needs to conduct panel regressions, the results of which are described below.

Basic results of panel data regressions

17. **Given the limitations of long-term average data, our main empirical modeling strategy is to use panel data, which provide variability of individual countries and yet preserves the dynamics of adjustment within countries**. Our basic specification is an autoregressive version of equation (5) with unobserved country-specific fixed effects. This is designed to capture the potentially complex dynamics of public debt, inflation and other macroeconomic variables within the constraints of a medium-sized panel (see Appendix, Section II for details). The existence of the fixed effects is supported by the results of the Breusch-Pagan test (1980). Regressions are run separately for different groups of countries in order to address the 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 economic development levels and, among subgroups, sovereign indebtedness—both as classified by the most recent IMF WEO (2005).[4] The possible existence of serially correlated errors is handled through the use of a robust estimator. Table 1 in the Appendix presents one-step dynamic GMM estimates. Pooled OLS estimates and dynamic fixed effect estimates are also presented for comparison.[5]

18. Below is a summary of the main findings.

- **Our panel regressions 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 (Appendix Table 1). This implies that a 1 percent increase in public debt leads to a 0.2 percentage point increase in inflation. The debt coefficients are lower than those of money growth but are sufficiently significant 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. Arellano-Bond's second-order serial correlation test for the residuals is rejected in support of the GMM specification. 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.

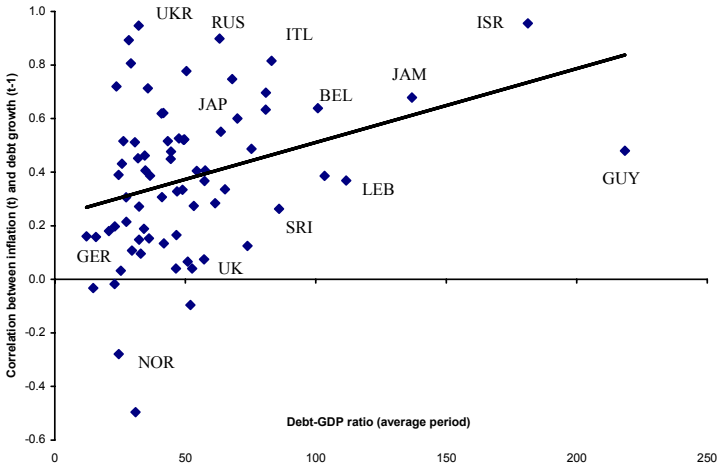
- **None of the explanatory variables, except lagged inflation in 13 major advanced economies, show significant short-term associations with inflation**. This result is consistent with other empirical studies on inflation, which find virtually no short-term relationships between money and inflation in developed countries (Christiano and Fitzgerald 2003; Dwyer 1982). The result is also consistent with other studies that report the existence of a significant 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). It should be noted, however, that the fact that we define money primarily as reserve money may have further weakened the

[4] Countries are divided into 13 major advanced countries and other 58 countries. 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.

[5] 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, a dynamic fixed effect model is likely to bias that downward due to the demeaning process of the fixed effect model. However, the extent of the bias in the latter is low in large T samples such as ours although we still prefer the GMM estimator due to the need for testing the robustness of the regression results over sub-sample periods.

linkage between money and inflation, since a host of financial instruments are used as money substitutes as countries increasingly become financially developed.

- **Public debt growth is 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. For 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 ratios and other institutional or economic factors that might affect the expectation of debt monetization—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 (Appendix Table 7). The tests also indicate that statutory independence of the central bank, as measured by Cukierman (1992), does not play an important role.[6]



- **Exchange rate regimes matter in the link between debt growth and inflation**. The fixed rate regime dummy in our regressions distinguishes between exchange rate regimes with a peg, those with limited flexibility, and managed floats (as defined by Reinhart and Rogoff, 2004). The regression outcomes 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 (Appendix Table 3).

Robustness of the results

19. **Our results are robust to corrections for possible endogeneity biases, changes in the regression periods, and relaxation of common slope restrictions**. The results presented above are robust to corrections for possible endogeneity of explanatory variables

[6] 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) reports that the extent of debt monetization in OECD countries is negatively associated with the degree of central bank independence.

(Appendix Table 2). The coefficients for lagged debt growth remain significant and positive in pooled OLS, fixed effect, and GMM estimators for a small subset of 25 indebted developing countries. The results remain broadly unchanged for a large subset of 58 widely-defined developing countries. The main results are also largely maintained in regressions over each rolling 20-year period (Appendix Table 4). In absolute terms, the sensitivity coefficients are larger in 1983–2003 than in 1963–1983, possibly reflecting the adoption of flexible exchange rate regimes after the breakdown of the Breton Woods system. The relaxation of common slope coefficients does not change the main result either. Mean group estimates (Pesaran and Smith 1995) show that debt growth (both contemporaneous and lagged) affects inflation positively and its degree is stronger in indebted developing countries (Appendix Table 5). Similar patterns are observed in fully modified OLS estimates (Pedroni 2000) although the coefficients are not directly comparable to those from other regressions (Appendix Table 6).[7]

Transmission channels

20. **We undertook a simple vector autoregression (VAR) to trace out the transmission channels of the fiscal influence on inflation**. Our panel VAR. show a weak or no response of inflation to fiscal shocks in major advanced economies[8] (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.

21. **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 countries that are not advanced economies, an increase in public debt is mostly accommodated by monetary easing, contemporaneously and with lags—a phenomenon of fiscal dominance. 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 that is consistent with many empirical studies of macroeconomic shocks and policy responses (Melitz 1997; Akitoby et. Al. 2004; Kaminsky, Reinhart and Vegh 2004).

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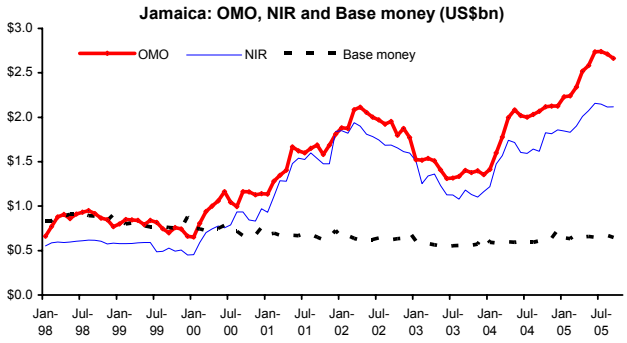
[7] We are thankful to Pedroni for sharing his computer program for the FMOLS estimator.

[8] 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

D. Application to Jamaica

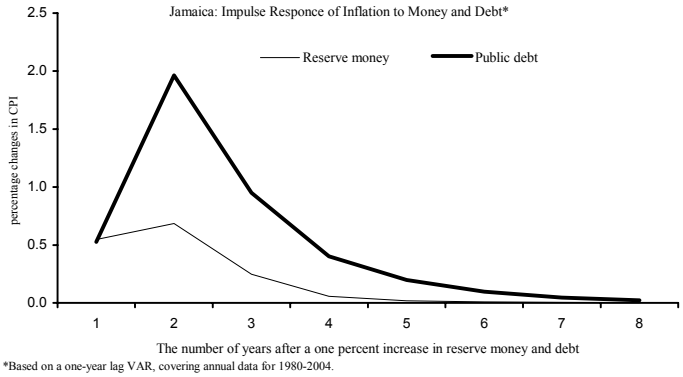
22. **In Jamaica, monetary policy is constrained severely by fiscal considerations due to the large public debt**. Unlike many other countries in similar circumstances, the central bank (BOJ) has traditionally adopted a conservative monetary policy stance, with seignorage financing of the budget deficit rarely exceeding 1 percent of GDP. This policy stance was possible thanks to its strong operational autonomy, notwithstanding little statutory independence compared with other countries in the region (Jácome and Vazquez 2005). Inflation nonetheless has remained high historically, rising to double digits since 2003, in contrast to most neighboring countries that have much lower inflation. The BOJ's main policy instrument is its stock of short-term bills (OMOs)—used to sterilize the accumulation of international reserves (NIR) and credit to the public sector—but room for their utilization has been limited due to the large volume of OMOs outstanding (amounting to about one-fourth of GDP) and already high sterilization costs 1½–2½ percent of GDP per year in recent years).



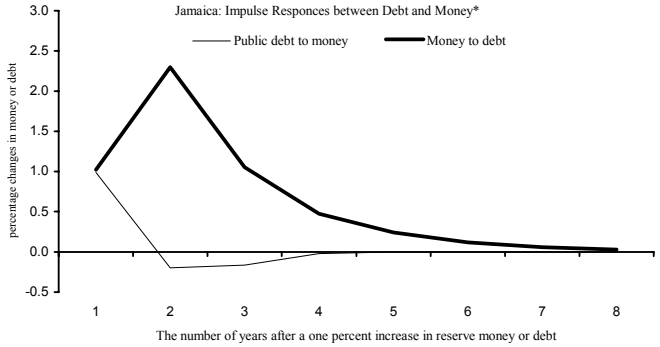
23. **A VAR is applied to Jamaica to test whether the cross-country debt-inflation relationship identified from the panel regressions holds for Jamaica**. The estimation uses annual data between 1980 and 2004 for CPI, real GDP, reserve money, and enlarged government debt including OMO debt. The exchange 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 non stationary and, as such, we test whether any stationary long-run relation exists among the variables. Both the trace and maximum eigen value 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.

24. **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. Also, positive fiscal shocks have positive and persistent effects on money supply while the opposite does not hold (see the charts below for the impulse responses). 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 including the exchange rate as an endogenous variable and alternative regressions based on the vector error correction model.

25. **Caution is, however, needed 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 an upswing in inflation in recent years signals concerns about monetization of debt in future. Notwithstanding this caveat, our regression results confirm that the movements of public debt do matter for inflation dynamics in Jamaica.



*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.

E. Budgetary and Policy Implications

26. **Our regression results point to a number of budgetary and policy implications applicable to countries with high debt**.

- **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.[9] This also means that rising inflation expectations could be destabilizing the debt dynamics

[9] 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.

more than an adverse real output shock does—possibly by as much as one third to one half (see Appendix, Section III for details).

- **The budgetary costs of noncredible 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 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.

- The evidence of cross-country heterogeneity in the debt-inflation link indicates that institutional and structural factors are critically important. 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 Appendix Table 7). 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.

F. Summary and Conclusions

27. **Our study provides comprehensive and robust evidence that an increase in government debt is typically inflationary in countries with large public debt**. Our regression results (see Appendix Table 1) show that an increase in public debt is significantly associated with high inflation in developing countries, after controlling for money growth, real output growth, currency depreciation, and output gap. This pattern however 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 (see Appendix Table 4) and robust to corrections for possible endogeneity biases (see Appendix Table 2) and relaxation of common-slope restrictions (see Appendix Tables 5 and 6). Our regressions also show that public debt growth is more inflationary in high debt countries than in low debt countries (see Appendix Table 7) and that the debt-inflation linkage is weak in inflexible exchange rate regimes (see Appendix Table 3). 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.

28. **Our 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 designed for stability in 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 trend 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.

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

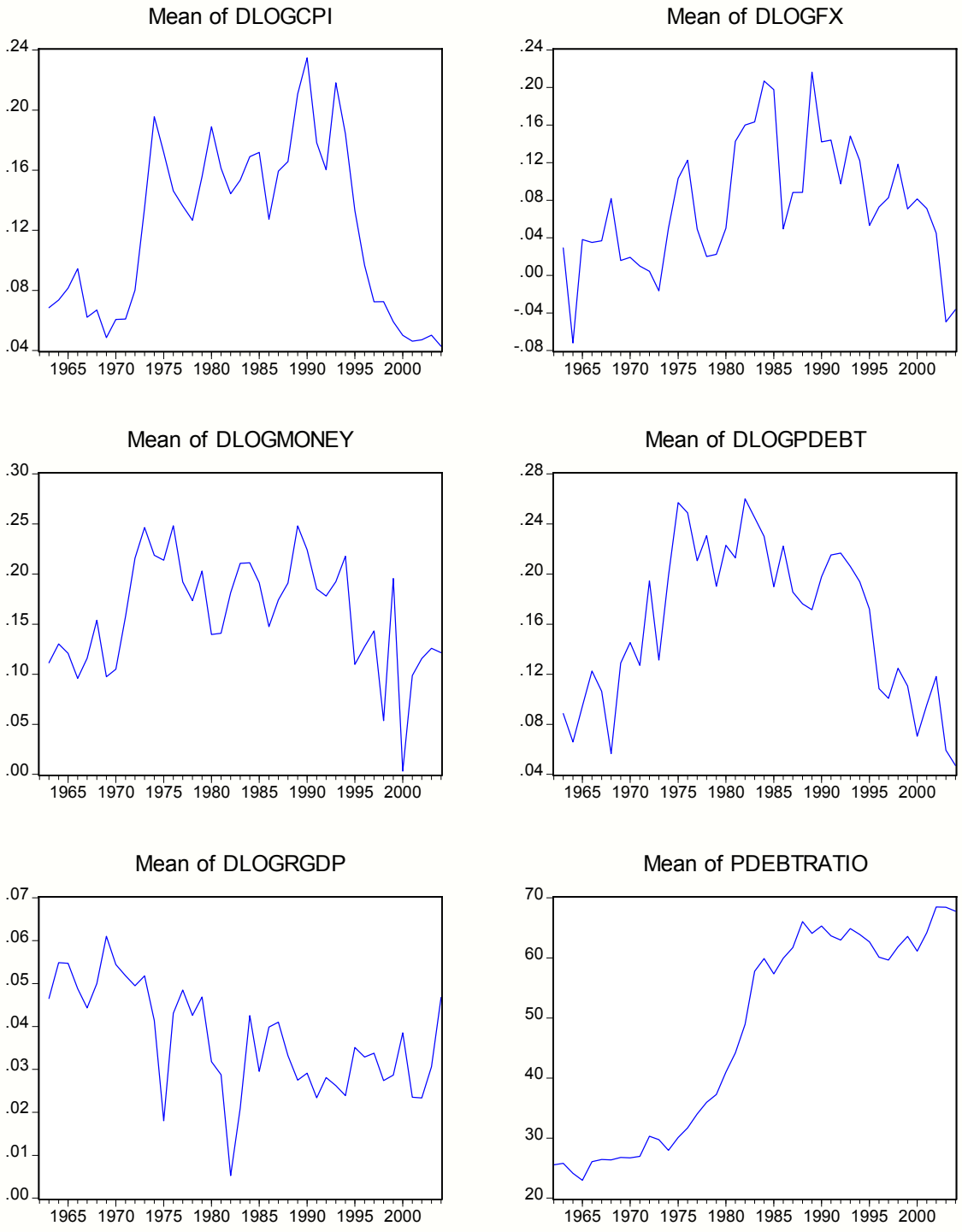


Figure 2. Jamaica: Scatter Plots of Selected Macroeconomic Indicators and Public Debt Growth
(Mean of time-series data for each country)

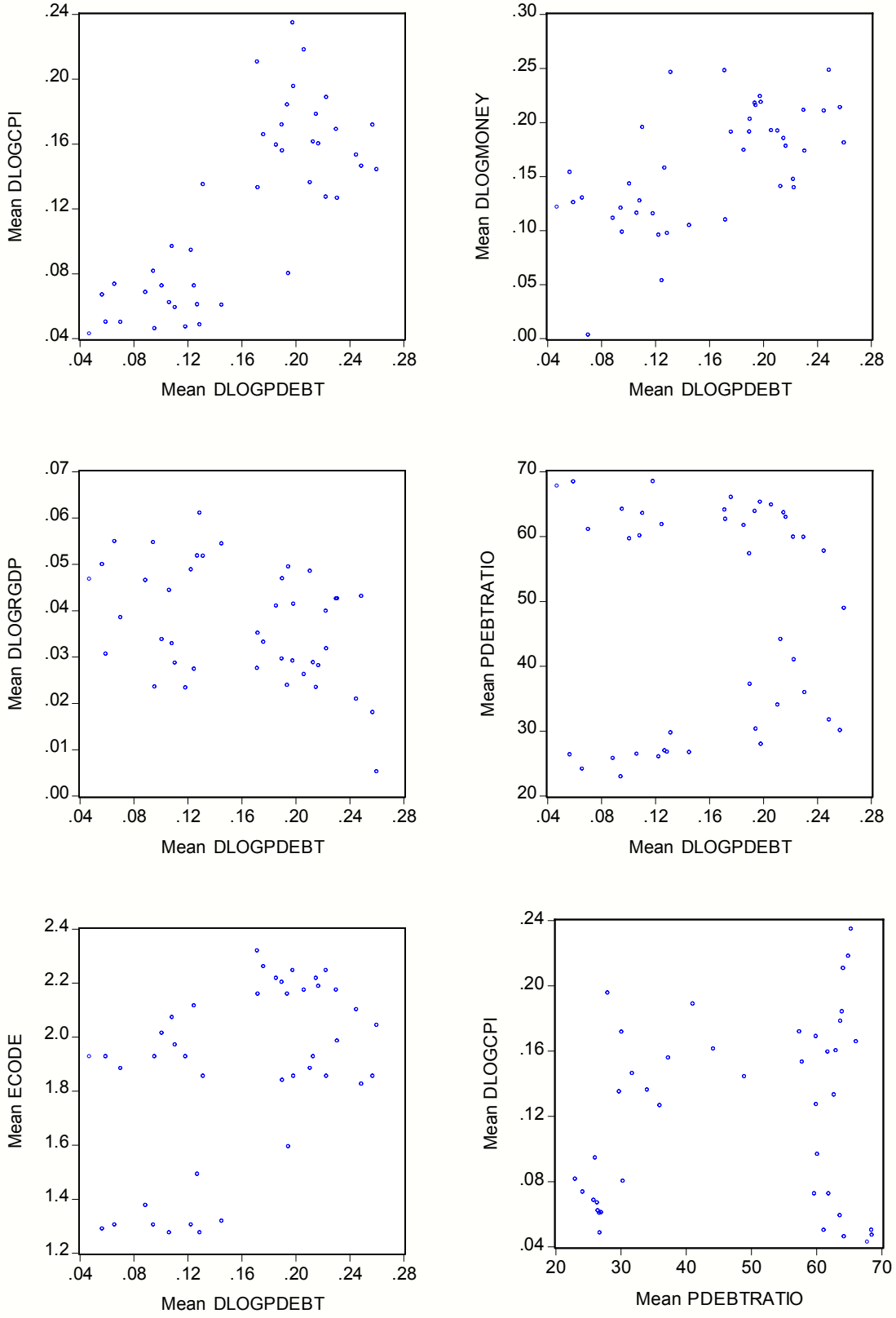


Figure 3a. Jamaica: Impulse Responses in Major Advanced Economies

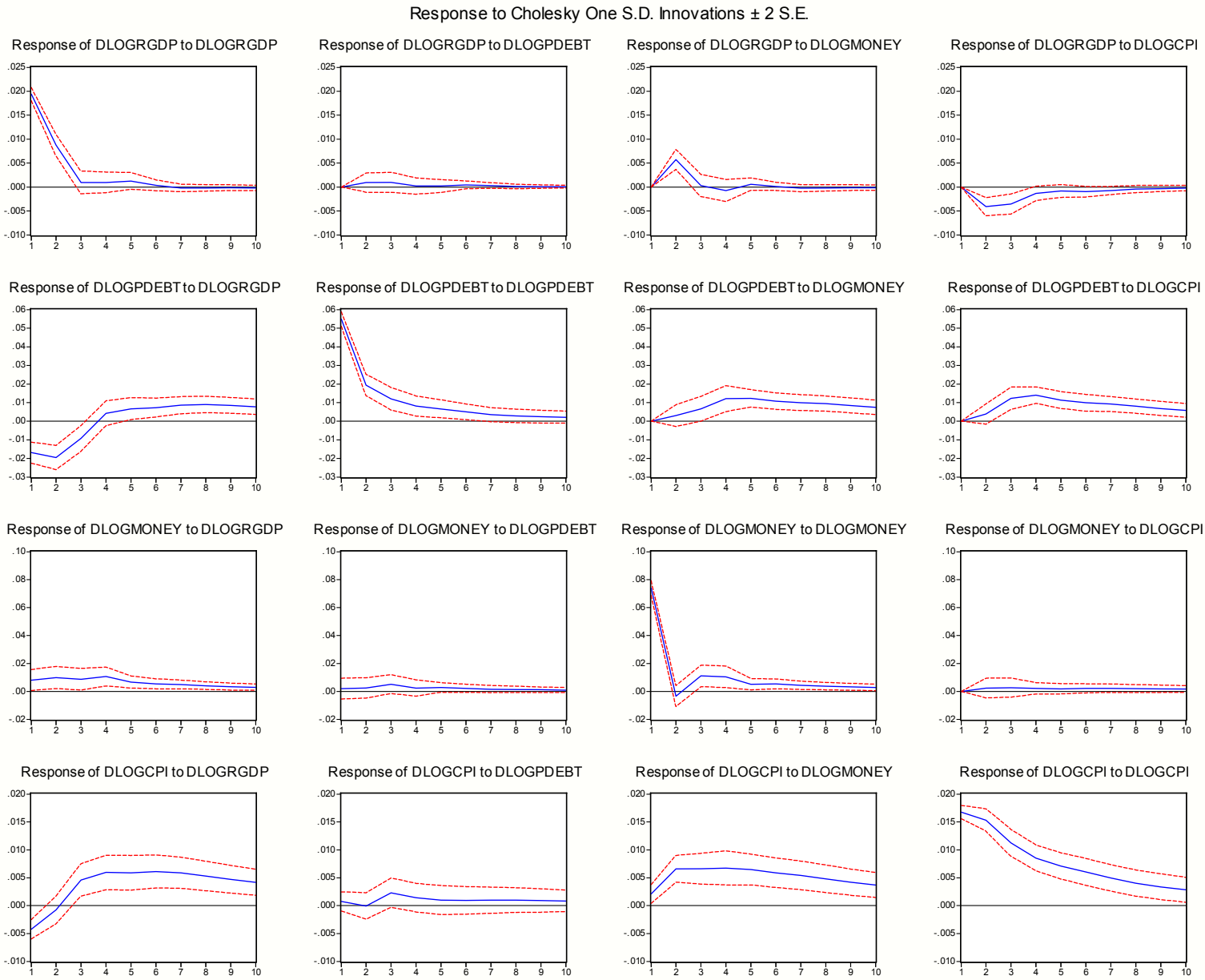
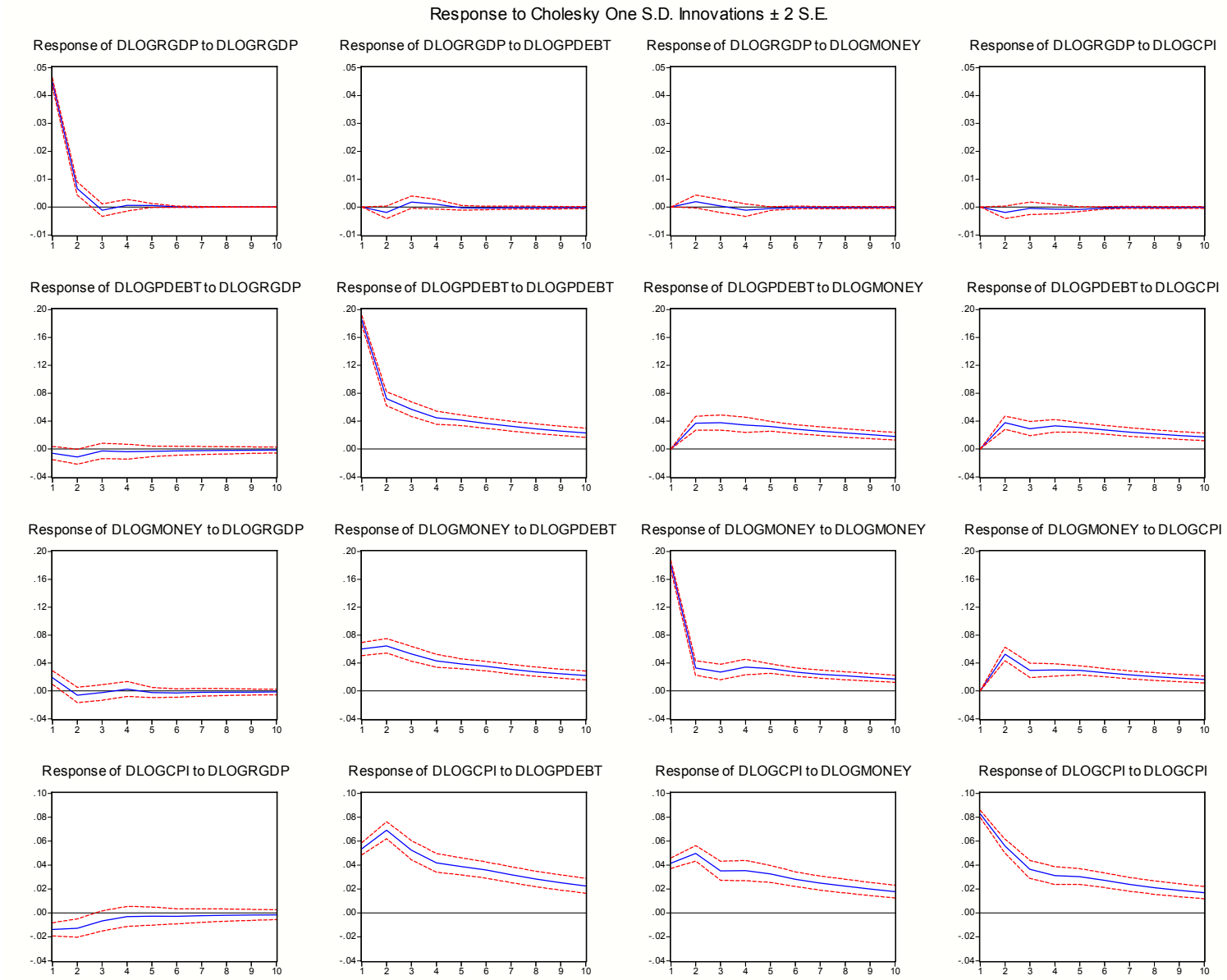


Figure 3b. Jamaica: Impulse Responses in Countries Other than Major Advanced Economies



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I. DERIVATION OF THE ESTIMATED EQUATION

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

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

In the utility maximization, the household is 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 yields the following standard first order conditions for consumption and 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 intertemporal 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 government spending and $R_{t,j}$ 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

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

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

Using the conditions for money market equilibrium in (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 ($r_{t+1} = i_t / (p_{t+1} / p_t)$), this can be rearranged to:

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

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

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

In a dynamic setting which allows restoration to the equilibrium over time, equation (10) could be expressed as the following general unrestricted form:

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

II. DATA SOURCES, DEFINITIONS, AND SPECIFICATIONS

Our main dataset is a panel data spanning 71 countries over up to 43 years. 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, in some cases, the authorities' websites. 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).

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 $\eta_i + \nu_{it}$ has the standard error component structure

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

We assume that the transient errors are serially uncorrelated

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

and, for now, that variables in X are predetermined

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

Y refers to inflation (*dlogcpi*) and X represents a set of explanatory variables in the model including changes in public debt (*dlogpdebt*), money (*dlogmoney*) and real GDP (*dlogrgdp*), all in first-difference logarithms. 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 debt monetization factor, δ, is larger. In most specifications, we assume that coefficients in vector β are constant for each group but we relax this slope-homogeneity assumption in robustness tests. No other restrictions are imposed on the coefficients of the explanatory variables.

III. 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:

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

If the interest rate is set in line with inflation expectations (π_t^e) and the primary surplus in percent of GDP is predetermined,[26] the debt dynamics can be simplified as follows:

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

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

Hence, an increase in inflation expectations raises debt not only directly (through an immediate increase in the borrowing cost) but also indirectly (through a multiplier effect (1/(1-α)) 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:

[26] 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.

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

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

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:

$$\frac{S_t^*}{Y_t} \approx (1-\alpha) \frac{D_t}{Y_t} \left[\frac{\beta \mathrm{X} + \varepsilon + r}{1-\alpha} - \pi_t + r - g_t \right]$$

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.

Main Findings from Panel Regressions

Summary Table 1. 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. 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.

Summary Table 2. 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 growth	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. 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 1st difference transformation, assuming contemporaneous correlations between shocks and explanatory variables. Standard errors are adjusted for intracountry serial correlations and heteroscadasticity.

Summary Table 3. 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. 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.

Summary Table 4. 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	1983-03	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.
**Indebted developing countries, whose main source of financing is non-official financing.

Summary Table 5. Mean Group Estimates*

	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.
**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).

Summary Table 6. Fully Modified OLS Estimates*

	Whole sample		Advanced economies		Developing countries		o/w:debtor countries**			
	(1)		(1)		(1)		(1)		(2)	
	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**	-11.38	-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 level variables (Pedroni 2000).
**Indebted developing countries, whose main source of financing is non-official financing.
(1) Common time dummies included. (2) Common time dummies not included.

Summary Table 7. 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

*The sensitivity measure is the elasticity of inflation to public debt growth as derived from a dynamic fixed effect model. Independent variables are period averages of respective variables for each country.
**Reinhart and Rogoff (2004) ***Cukierman (1992).

III. PUBLIC DEBT MANAGEMENT IN JAMAICA[1]

A. Introduction

1. **In a highly indebted economy such as Jamaica, effective debt management assumes a pivotal role in any fiscal strategy**. Jamaica has one of the highest public debt-to-GDP ratios and fiscal primary surpluses in the world. The authorities have embarked on an ambitious fiscal adjustment to address the crushing debt burden. A debt structure that minimizes the probability of financial distress through liability management is critical to successfully executing the medium-term strategy. Debt management also mitigates the impact of future shocks on debt service costs and consequently, the overall economy.

2. **The first section of this paper provides some background on the institutional framework for debt management in Jamaica**. The development of the framework has, in recent years, been geared towards successfully managing debt in an increasingly transparent and globalized market that has brought new pressures to bear.[2] The first section of this paper briefly describes the debt management framework in Jamaica.

3. **The subsequent sections of the paper seek to analytically identify the optimal allocation of debt across the various types of debt instruments available to the government**. The scope of this study is limited to market instruments (i.e., not official financing), of which four types are considered: (1) short-term fixed-rate domestic currency bonds (defined here as those with maturity of one-year or less), (2) long-term fixed-rate domestic currency bonds, (3) variable-rate long-term domestic currency bonds, and (4) long-term fixed-rate foreign currency bonds.[3]

4. **The optimal debt structure results from balancing the costs of the different debt instruments against their various abilities to hedge against each other as well as against unexpected shocks**. Each of the debt instruments possesses a different risk profile for both

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[2] Jamaica is among the Selected Case Studies for implementing sound practices published in *Guidelines for Public Debt Management: Accompanying Document*, IMF 2001.

[3] All bond yields not explicitly classified as short-term debt used in the portfolio calculations are brought to 6.5 years (constant maturity), and called long-term debt for the purposes of this study. Short-term debt in this study is considered to be one-year constant maturity debt. Note that this differs from the usual classification for emerging markets, where one-year maturity (or greater) is considered long-term debt. The choice of 6.5 year maturity is driven by both the average maturity of actively quoted global bonds during the early part of the sample period, and the long maturities of domestic bonds. To date, it has been the policy of the Jamaican authorities to not issue outstanding variable interest rate global bonds, so these are not considered.

the government, and the counterparty investor. For example, variable interest rate domestic currency debt exposes the government to higher costs if the domestic Treasury Bill rate increases. But this instrument insulates the government from exchange rate movements. Similarly, fixed rate instruments insulate the government from interest rate movements, and if they are domestic currency denominated, also from exchange rate movements. Of course, as the government is more insulated from shocks, the lender (i.e., the market investor) is more exposed, and accordingly, will charge a higher interest rate. The search for an optimal debt portfolio balances these higher costs against the risk reduction provided by the instruments, as well as liquidity risk stemming from shocks to the budget.

5. **The resulting portfolio is ex-ante optimal—it reflects the government's desired portfolio at the existing prices, but this is a partial equilibrium result**. The partial nature of the results stems from the fact that as the government attempts to shift from its existing to its desired portfolio, it necessarily changes the supply of bonds, and bond prices change. But the desired portfolio is calculated for a given set of prices. Hence, this price change is not re-factored into the derivation of the desired portfolio. There are also other effects priced into the debt, which are also not factored into the calculation of the optimal portfolio.[4] For example, as a government issues new debt and its debt ratio increases, the risks borne by creditors still holding onto earlier debt issuances increases. This leads all investors to price into current yields potential future debt issuances. Taking into account all of these, as well as factors such as downward sloping demand curves, short-sale constraints, and second order effects would yield an optimal portfolio in the general equilibrium sense. If markets are functioning well, the actual prices in effect should, therefore, ex-post reflect this general equilibrium optimal portfolio.

6. **Combining current bond yields and the optimal portfolio solution reveals the market's equilibrium expectations, including with regard to fiscal shocks and exchange rate movements**. As discussed in the preceding paragraph, the ex-post observed portfolio incorporates the market's demand curve. When investors buy a bond, they take a view of future developments affecting its return, such as exchange rate movements and probabilities of destabilizing fiscal shocks. Bond prices clear the market when investors and the government reach a consensus about the outlook for such future developments. The portfolio optimization framework can back out from the equilibrium portfolio and prices the market's expectations of depreciation and debt sustainability. Hence, the framework employed in this paper attempts to discern the market's views concerning fiscal shocks and future exchange rate movements.

7. **This study thus reports two results: (i) an optimal debt portfolio from the government's perspective taking as given the existing prices; and (ii) the market's view of economic conditions derived from the equilibrium prices**. For the given prices**,** and under a significant range of expectations regarding exchange rate depreciation and the

[4] See, for example, as argued by Chin and Paasche (2002).

possibility that the plan to reduce debt does not succeed due to shocks, the optimal portfolio consists of borrowing most in short maturity domestic currency fixed rate bonds, second in global bonds, and lastly in long-term domestic currency fixed rate bonds. Ideally, the government would lend in variable rate domestic currency bonds for hedging purposes. The relative ranking and weights that the government would assign to each of the instruments changes, however, depending on assumptions of expected future exchange rates and fiscal shocks. As regards the second result, attempting to extract the market's perceptions from the observed equilibrium prices (in the context of the model studied here) suggests that during the second half of FY 2005/06, there were expectations of a 6 percent exchange rate depreciation over 12 months and a 5 percent probability assigned by the market to the possibility of the debt ratio increasing because of a destabilizing shock.

8. **The rest of the study is organized as follows**: The next section provides some background on Jamaica's institutional debt management framework. Section C of the paper outlines the conceptual framework. Section D gives an exposition of the dataset created for this paper. It then presents some detail about Jamaica's historical placements, given that the dataset is new and Jamaica is unusual among emerging market economies in terms of its ability to place long-term, domestic currency debt. Section E estimates the optimal debt portfolio for Jamaica, and discusses estimates of investor views embedded in the current market portfolio. Section F concludes and presents some important caveats concerning the results.

B. Institutional Framework

9. **Since the early 1990s, Jamaica has been facing major challenges from a substantial debt burden, requiring an effective debt management strategy**. The debt burden has constrained the government's ability to invest in the physical and social infrastructure—a situation which was compounded in the mid-1990s by the fiscal costs of a financial sector crisis. Consequently, since the late-1990s, management of the debt dynamics became a major element of government policy, and the formulation and implementation of the strategy became an integral part of the government's medium-term macroeconomic program.

10. **Jamaica has progressively strengthened its approaches towards debt management**. Continuous institutional strengthening has resulted in more efficient and modern methods of managing the debt and its risks, and a more prudent debt structure. For example, the maturity profile has been successfully extended, with market issues with 10 to 30 year maturities. The fixed rate component of domestic debt has increased to 59 percent at March 2005 from 20 percent in March 2000. Foreign currency exposure of domestic debt has declined, and the investor base has been broadened and diversified. There is increased transparency and predictability along with increasing development of domestic capital markets. More competitive pricing of government securities has followed from the standardization of features, the removal of distortions, and increasing confidence.

11. **The Jamaican legal, regulatory, and institutional framework, and the supporting institutional capacity, facilitate debt management efficacy**. Market confidence in Jamaica's creditworthiness is underpinned by a constitutional requirement that sets debt service as the first expenditure priority. In April 1998, debt management functions of the Government of Jamaica were consolidated and centralized within the Ministry of Finance and Planning (MoFP), and allocated to a newly created Debt Management Unit (DMU). A clear separation and allocation of responsibilities between MoFP and the Bank of Jamaica was instituted under the Financial Administration and Audit Act, which lays down the basic principles for the management and control of public resources. It gives the Ministry of Finance and Planning the authority to borrow on behalf of the Government, thereby giving the MoFP overall responsibility for debt management.

Debt management strategy and implementation

12. **Jamaica's debt strategy is defined in the context of a clear and consistent medium-term macroeconomic framework, and with the goals of promoting a prudent, transparent and diversified debt structure**. A credible debt management strategy with medium-term targets is formulated by the DMU, consistent with international best practices. Borrowing requirements are determined by MoFP within the context of the annual and medium-term macroeconomic programs. The previous fiscal year's portfolio targets, debt developments, and execution of measures are evaluated. Additionally, the current fiscal year objectives and an assessment of domestic and international market conditions and expectations are prepared to determine debt management measures and targets. These targets are driven by the objectives of transparency and diversification to achieve a prudent debt structure. Adhering to these guiding principles helps minimize costs while ensuring medium to long term debt sustainability and minimizing risk exposure.

13. **The strategy seeks to protect fiscal operations from interest rate and exchange rate shocks, and ensure a stable and low cost of funding for the budget**. The authorities have identified a medium-term target of 60 percent fixed rate debt as representing the appropriate mix of fixed and variable rate instruments. Significant consideration is also given to ensuring the use of a wide range of instruments, (including the choice between domestic or external, the currency mix, and timing) with the aim of extending and smoothing the maturity profile. However, trade-offs constantly arise in seeking to avoid exposing the portfolio to excessive risks in an effort to lower cost while also extending the maturity. Diversification through different markets, currencies and across the yield curve helps keep borrowing costs low and mitigate exchange rate and refinancing risks. The DMU is continuously seeking to broaden the geographic distribution of the investor base.

14. **The authorities have identified promoting liquidity and efficiency in the domestic market as fundamental to lowering the cost of borrowing over time**. The introduction of a multi-price auction system since October of 1999 for the sale of medium-to-long-term securities was one of the first steps taken in this direction. In addition, the ministry accesses the market on a regular and pre-announced basis, and has moved to standardize securities and harmonize their tax treatment. There are currently plans to establish

benchmarks to boost liquidity and reduce fragmentation. Finally, the ministry is currently collaborating with the stock exchange and the financial sector to establish a central securities depository for fixed income securities to increase trading efficiency.

15. **While adhering to their prudent management practices, the authorities continue to face constraints and challenges in implementation**. Shocks to the fiscal and macroeconomic program, instability in the foreign exchange market, high interest rates, exogenous and endogenous shocks to economic growth, all disrupt strategy implementation. In addition, the current level of development of domestic capital markets and market infrastructure, particularly the clearing and settlement systems, also constrain liquidity conditions and raise costs. Finally, the Ministry faces resource constrains for capacity building and maintaining the cadre of well-trained staff with the necessary skill sets.

Communications strategy

16. **Timely and high disclosure levels ensure orderly market access, facilitate the development of a well-functioning domestic capital market, and increase confidence and credibility**. The annual publication by the DMU entitled Debt Management Strategy describes the plan for debt operations. The publication is submitted to cabinet and parliament for approval and subsequently, there is widespread distribution in print and electronic form. As the strategy is implemented by the DMU, close coordination of debt management with the conduct of fiscal, and monetary policies by the authorities, through regular meetings at policy and technical levels, ensures consistency through information sharing.

17. **A comprehensive communications strategy is executed using various media and outreach forums**. The Debt Management Strategy presented to parliament is posted on the ministry's website. In addition, it is supported by regular monthly publication of debt stocks and issuance data on the website**.** A calendar of announcements, a monthly schedule of market issues, and quarterly announcement of borrowing requirements are also published electronically. The DMU also ensures timely publication of the results of market issues in print and electronic media, and there is increased use of market-mechanisms for issuance of securities (auctions) and competitive bidding for private placements. In addition, the MoFP holds regular meetings with domestic and international market participants and rating agencies. The Minister of Finance and Planning personally addresses the market through quarterly conference calls, to provide economic and financial updates. This communication strategy helps contribute to good relationships with market participants, and a broadening of the investor base.

C. A Conceptual Framework for the Paper

18. **Previous analytical work motivates managing a debt portfolio as either for smoothing taxes and inflation, or to achieve a stabilization target**. When smoothing taxes and inflation, the optimal debt structure is chosen so that debt service payments match the

government's revenue stream.[5] If the objective of debt management is to stabilize the debt ratio, the optimal portfolio is chosen to balance increases in roll-over and other types of risk against lower debt costs.[6]

19. **In this study, the question of debt management is cast in the context of a debt stabilization plan.**[7] The government's overall objective is operationally assumed to be the successful stabilization (or interchangeably the reduction) of the debt-to-GDP ratio. Indeed, the model uses the growth of the debt to GDP ratio as signaling failure of a stabilization plan. This plan is anchored on achieving a fiscal target, and is subject to budgetary and macroeconomic shocks. Hence, the probability of increasing the debt-to-GDP ratio is anchored on the probability of meeting the fiscal target.[8]

20. **The optimal debt portfolio consists of weights among the available debt instruments that satisfy financing requirements**. These weights result from balancing the expected increase in the probability of plan-failure (increase in the debt ratio) from increasing the cost of one kind of instrument (due to its premium) against decline in the probability of plan failure that this instrument provides by hedging against some specific risk. By way of example, domestic currency long-term fixed rate debt may hedge against inflation,

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[5] This approach is taken by Barro (1997), Barro (1999), Goldfajn (1998), among others. This approach seeks to minimize distortions from intertemporal changes in taxes and inflation, under different assumptions that deviate from perfect capital markets and Ricardian Equivalence. Often these models include a stronger set of assumptions, such as a fixed future path of government primary expenditure, than models centered on debt stabilization.

[6] The debt stabilization target approach used here is taken by Giavazzi and Missale (2004), Blommestein (2005), Rigobón and García (2003), among others. While maintaining a straight forward framework, it allows for fiscal execution, rollover, currency, interest rate, and other risks.

[7] This section adapts the Giavazzi and Missale (2004) framework for optimal debt management to the institutional environment for Jamaica. Giavazzi and Missale (2004) address optimal debt management for Brazil, which entails considering debt instruments which are unavailable in Jamaica, much shorter debt maturities, and a different set of challenges in estimation. They are unable to forecast economic shocks based on historical data due to structural breaks and other data problems, and consider different types of debt instruments specific to Brazil, for example inflation indexed debt, which Jamaica does not issue. These differences lead to substantive differences in the theoretical outcome, as well as the estimation approach employed.

[8] In this study, an increase in the debt ratio can also be variously interpreted as the point at which destabilizing feed back effects between different shocks begin to occur. The assumption in the paper that there are no feedback effects prior to this point allows for a tractable model that focuses on crisis prevention, rather than focus on the dynamics of an evolving crisis. Additionally, a question not addressed within the scope of this study considers the benefit of introducing new types of financing instruments, for example, inflation indexed debt issues, or indexation to real variables such as GDP indexed debt instruments. See IMF (2004) for exploratory discussions on these issues.

interest rate, and exchange rate shocks, but may also be more costly and hence risk increasing the debt ratio (i.e., plan-failure) because of the higher interest costs.

21. **To formalize this framework, a simple model is presented around the evolution of the debt ratio and the probability of its increase**. Assume that the government faces a trend debt-to-GDP ratio in the next period, B_{t+1}^T, under the current policy stance, but instead adopts a fiscal adjustment program (all variables expressed as ratios to GDP), denoted A_{t+1}, to stabilize or decrease the current ratio B_t. Since the policy execution generally tends to deviate from fiscal programs for a variety of reasons, these unanticipated deviations are captured by shocks to the fiscal outturn, X_t. Hence, the stabilization plan is deemed to have failed if the debt ratio increases. This is expressed as:

$$B_{t+1}^T - A_{t+1} + X_t > B_t \tag{1}$$

22. **The evolution of the macroeconomic and fiscal variables drives the change in the debt**. The adjustment in the fiscal program depends on the accounting identities that affect debt ratios, namely, the interest payments, denoted $I_{t+1}B_t$, the trend primary surplus, denoted S_{t+1}^T, output, Δy_{t+1}, and inflation, π_{t+1}, and valuation adjustments to dollar-denominated debt, where Δe_{t+1} is the exchange rate, and q is the share of dollar debt. Combining these yields:

$$\Delta B_{t+1}^T = \underbrace{\left(I_{t+1}B_t - S_{t+1}^T\right)}_{Budget\ balance} + \underbrace{\left(\Delta e_{t+1} q B_t\right)}_{FX\ Valuation} - \underbrace{\left(\Delta y_{t+1} + \pi_{t+1}\right) B_t}_{Output\ /\ Inflation} \tag{2}$$

23. **The debt instruments drive the interest costs for the government, each providing both a new set of risks, and an opportunity to hedge**. Interest payments in (2) depend on the current yields and the allocation of debt across the available financing instruments. In the case of Jamaica, these instruments are: U.S. dollar debt (including dollar denominated or linked debt), variable interest rate debt, and fixed interest rate short-term and long-term debt. Denoting the share of variable rate debt as h, and short-term debt as *s*, the interest payment is:

$$I_{t+1}B_t = \underbrace{\left(i_{t+1}^s\right) s B_t}_{Short-term\ debt} + \underbrace{\left(R_t^{US} + RP_t\right) q B_t}_{US\ Dollar\ debt} + \underbrace{\left(R_t^T + i_{t+1}\right) h B_t}_{Variable-rate\ debt} + \underbrace{R_t\ \left(1 - s - q - h\right) B_t}_{Long-term\ fixed-rate\ debt} \tag{3}$$

Where i_{t+1}^s the short-term domestic currency (fixed) interest rate, R_t^{US} is the U.S. interest rate, RP_t is the Jamaica risk premium, R_t^T is the reset coupon on variable rate debt paid over i_{t+1}, which is the (reference) Jamaican Treasury bill rate, R_t is the fixed interest rate in Jamaica on long-term debt. As in Giavazzi and Missale (2004), the risk premium is assumed to capture the exchange risk without loss of generality, so that $\left(R_t^{US} + RP_t\right) \approx \left(R_t^{US} + RP_t\right)\left(1 + \Delta e_{t+1}\right)$.

24. **The uncertainty in the trend primary surplus is modeled as reflecting the uncertainty over the budgetary response to innovations in output and inflation**. Denoting the budget's elasticities with respect to output and inflation as η_y and η_π respectively, the trend surplus is:

$$S_{t+1}^T = E_t S_{t+1}^T + \eta_y \left(y_{t+1} - E\left[y_{t+1} \right] \right) + \eta_\pi \left(\pi_{t+1} - E\left[\pi_{t+1} \right] \right) \tag{4}$$

Here, π_{t+1} is inflation, and y_{t+1} is the natural logarithm of GDP.

25. **The objective of minimizing the probability of failure of the stabilization plan is modeled as minimizing the expected probability of an increase in the debt ratio**. This implies hedging the adjustment effort against shocks to the budget from revenue shortfalls or expenditure overruns. Plan failure occurs if such unanticipated shocks overwhelm the adjustment effort and increase the debt-to-GDP ratio. The probability distribution describing the possible budget shocks is denoted here by $\phi(X)$. The government wants to minimize the expected probability of an increase in the debt ratio. The portfolio weights that minimize this expected probability gives the optimal instrument mix, shown here as:

$$\min_{s,q,h} E_t \Pr\left[X > A_{t+1} - \Delta B_{t+1}^T \right] = \min_{l,q,h} E_t \int_{A_{t+1} - \Delta B_{t+1}^T}^{\infty} \phi(X) dx \tag{5}$$

s.t. (2), (3), and (4) hold.

26. **Solving this, five terms enter into the optimal weight equation for each kind of debt, short-term, foreign currency-denominated and indexed:**

$$s^{*}_{Short-term} = \underset{Term\,1:Output}{f(\eta_y)\beta_{i_{t+1}^s, y_{t+1}}} + \underset{Term\,2:Inflation}{f(\eta_\pi)\beta_{i_{t+1}^s, \pi_{t+1}}} - \underset{Term\,3:FX}{q^{*}\beta_{i_{t+1}^s, e_{t+1}}} - \underset{Term\,4:Indexed}{h^{*}\beta_{i_{t+1}^s, i_{t+1}}} + \underset{Term\,5:Term\ prem.,\ fiscal}{TP_t^{*} f(E_t(X_{t+1}))} \tag{6}$$

$$q^{*}_{FX} = \underset{Term\,1:Output}{f(\eta_y)\beta_{e_{t+1}, y_{t+1}}} + \underset{Term\,2:Inflation}{f(\eta_\pi)\beta_{e_{t+1}, \pi_{t+1}}} - \underset{Term\,3:\ Short-term}{s^{*}\beta_{e_{t+1}, i_{t+1}^s}} - \underset{Term\,4:Indexed}{h^{*}\beta_{e_{t+1}, i_{t+1}}} + \underset{Term\,5:FX\ prem.,\ fiscal}{FP_t^{*} f(E_t(X_{t+1}))} \tag{7}$$

$$h^{*}_{Indexed} = \underset{Term\,1:Output}{f(\eta_y)\beta_{i_{t+1}, y_{t+1}}} + \underset{Term\,2:Inflation}{f(\eta_\pi)\beta_{i_{t+1}, \pi_{t+1}}} - \underset{Term\,3:\ FX}{q^{*}\beta_{i_{t+1}, e_{t+1}}} - \underset{Term\,4:Short-term}{s^{*}\beta_{i_{t+1}, i_{t+1}^s}} + \underset{Term\,5:Index\ prem.,\ fiscal}{IP_t^{*} f(E_t(X_{t+1}))} \tag{8}$$

The five terms in each equation ((6) **through** (8)**) capture different risks:**

- The first two terms in each equation hedge against output growth and inflation, both of which affect the debt ratio directly, as well as indirectly, through their effect on the primary surplus. As inflation or output co-vary positively with the debt's risk (or variance), the portfolio weight on that debt increases since improvements in the budget can finance the increased costs of the debt.

- **In each equation, terms (3) and (4) hedge the correlation risk from the other debt instruments in the portfolio**. For example, for a positive holding of q^*, if the yields on short-term domestic currency (equation (6)) and dollar debt (equation (7)) move together (i.e., they have a positive correlation), the short-term debt weight s^* is reduced.

- **The last term in each equation represents the difference between the long-term fixed rate domestic currency debt yield and the relative debt instrument's yield**. The costlier long-term debt is relative to the instrument in consideration, the higher is the weight on that debt instrument. The cost, however, is weighted by a function of X that reflects the expected debt reduction anticipated in the fiscal program.

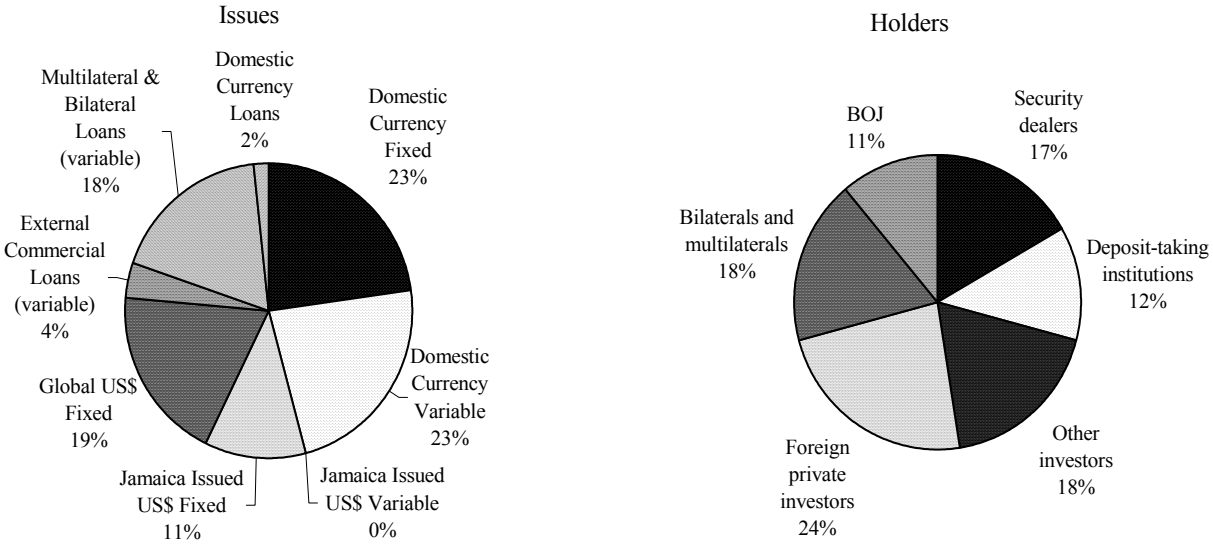
D. Data

27. **This section describes the Jamaican government debt stock**. It presents characteristics such as maturities and denominations of the outstanding debt stock, as well as the diversification of instruments and holders.

28. **At over 130 percent of GDP, Jamaica's debt burden is among the highest in the world, and characterized by a highly diversified investor base holding a variety of instruments (Figure 1)**. These include everything from fixed rate domestic currency debt to official external financing. This study focuses on market issues (that is, arm's length market issued bonds). As regards creditors at issuance (right panel), this focus implies excluding official creditors and Bank of Jamaica holdings of government debt (under 30 percent of debt). As regards instruments (the left panel), the focus of the study on market-treaded debt implies excluding direct loans (under 30 percent of outstanding debt).

29. **Jamaica's debt structure is highly unusual among emerging market economies in that it issues long maturities in domestic currency**. Figure 2 shows the maturity structure for Jamaican debt. The stacked bars are subdivided into percent of total domestic or external debt by outstanding maturity for each year. For domestic debt, approximately half is maintained at between one and five years' maturity over the period, and approximately 25 to 30 percent is greater than five years' maturity (see Table 1). It is noteworthy that over 10 percent of Jamaica's domestic debt is consistently maintained at over 10 years' maturity. Furthermore, over 50 percent of domestic debt and over three-quarters of external debt have fixed interest rates (Figure 6).

Figure 1. Jamaica: Debt Issues and Debt Holders



Sources: Jamaican authorities; and Fund staff estimates.

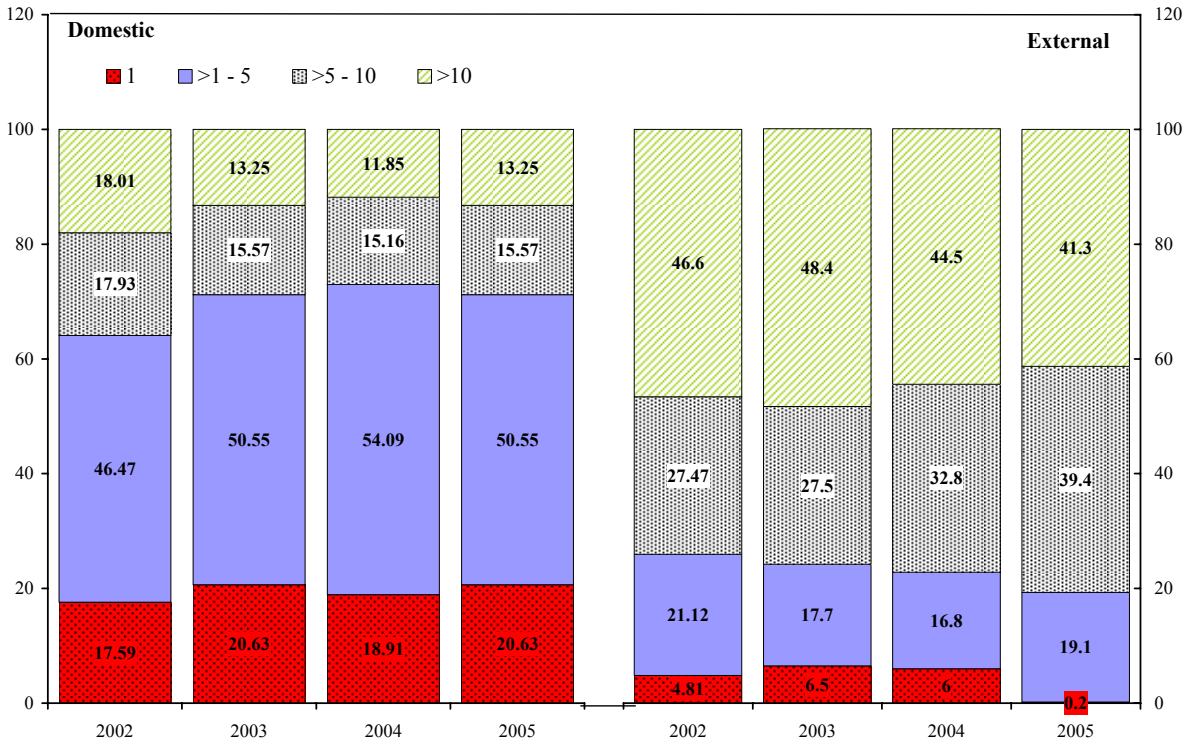
30. **Ideally, to find the optimal debt structure, a time series of bond yields would be obtained from secondary market trading, but because such data are unavailable, alternate data were constructed**. In Jamaica, developed secondary debt markets do not yet exist and only the bond yield at the point of issue is available for pricing domestic debt. Hence, the data used here are constructed from bond coupons for debt sold at par, or yields from debt auctions, at the time of issue.[9] Meaningful series of such data are available from the fourth quarter of 1999, with yields averaged per quarter but show gaps, possibly indicating times when the authorities were unable or elected not to access domestic capital markets.[10]

[9] The source of the data is the monthly Rate Sheets and New Issues tables, published by the Jamaican Ministry of Finance and Planning, which is the only real measure of money-backed expectations on Jamaican debt. On this basis, and taking advantage of the high frequency and diversity of Jamaican bond issues, one can construct a series of quarterly domestic yields.

[10] This raises the question of self-selection in debt issuance based on favorable market conditions, which is beyond the scope of this paper, but plagues these types of data sets in general.

Figure 2. Jamaica: Debt Maturity

(in years, as percent of total external or domestic debt)

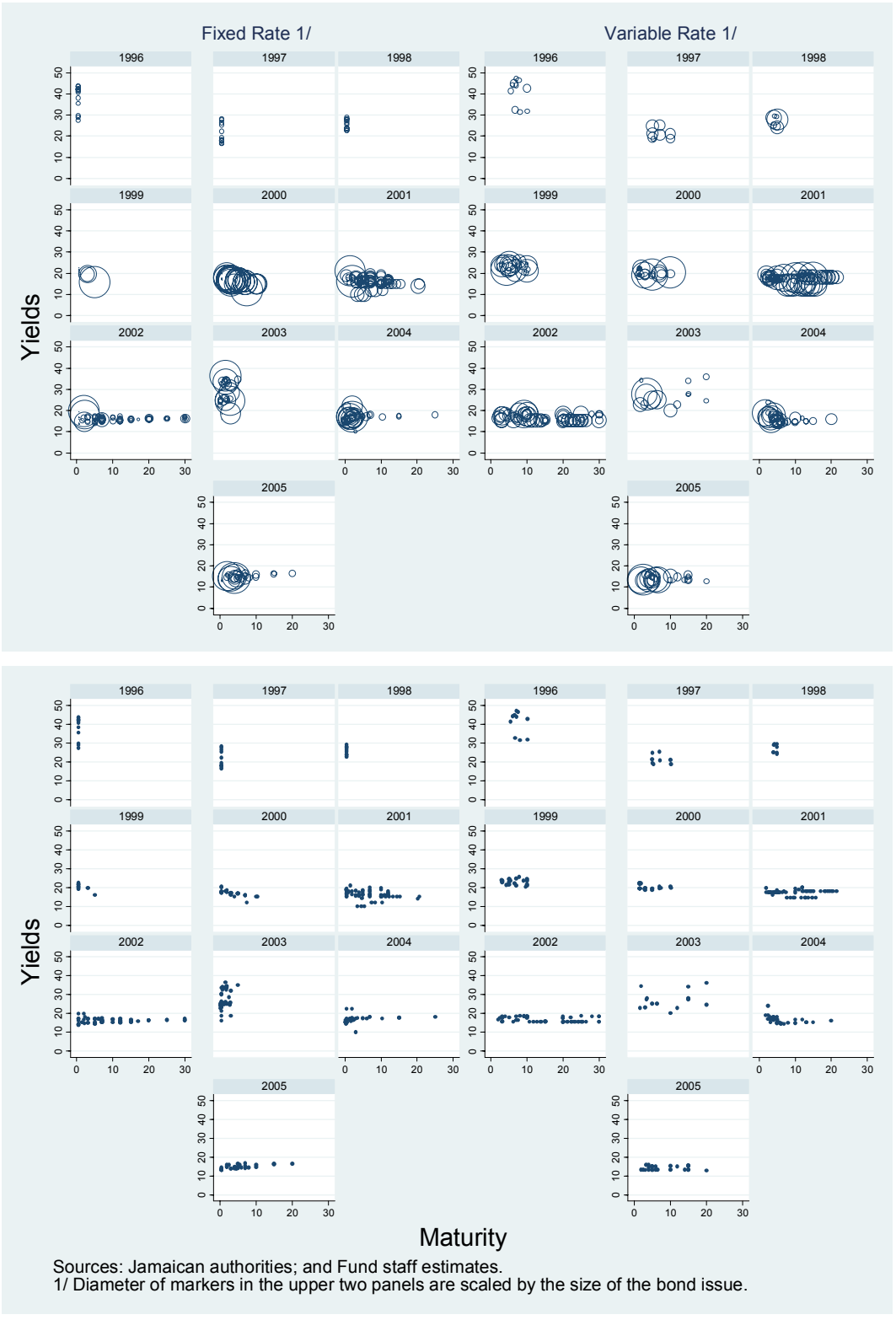


Source: Jamaican Authorities; IMF Staff Estimates.

31. **The data thus constructed have some interesting features**. Figure 3 shows the derived domestic currency bond yield curves, broken down by variable or fixed rate instruments. Each graph represents bonds issued in a given year, graphing yields against bond maturities. The top panel in the figure shows the annual yield curves, where the hollow bubbles are scaled to the size of the debt issue (a large bubble represents a large bond). The lower panel shows the same yield curves, but without scaling for the size of the debt issues. As can be observed, maturities were extended significantly in 2001 and 2002. However, as credit conditions tightened in 2003, maturities shortened and yields increased dramatically. The short maturities of the placements in 2003 led to large domestic rollovers in 2004 and 2005, as can be seen from the larger bubbles in these years.

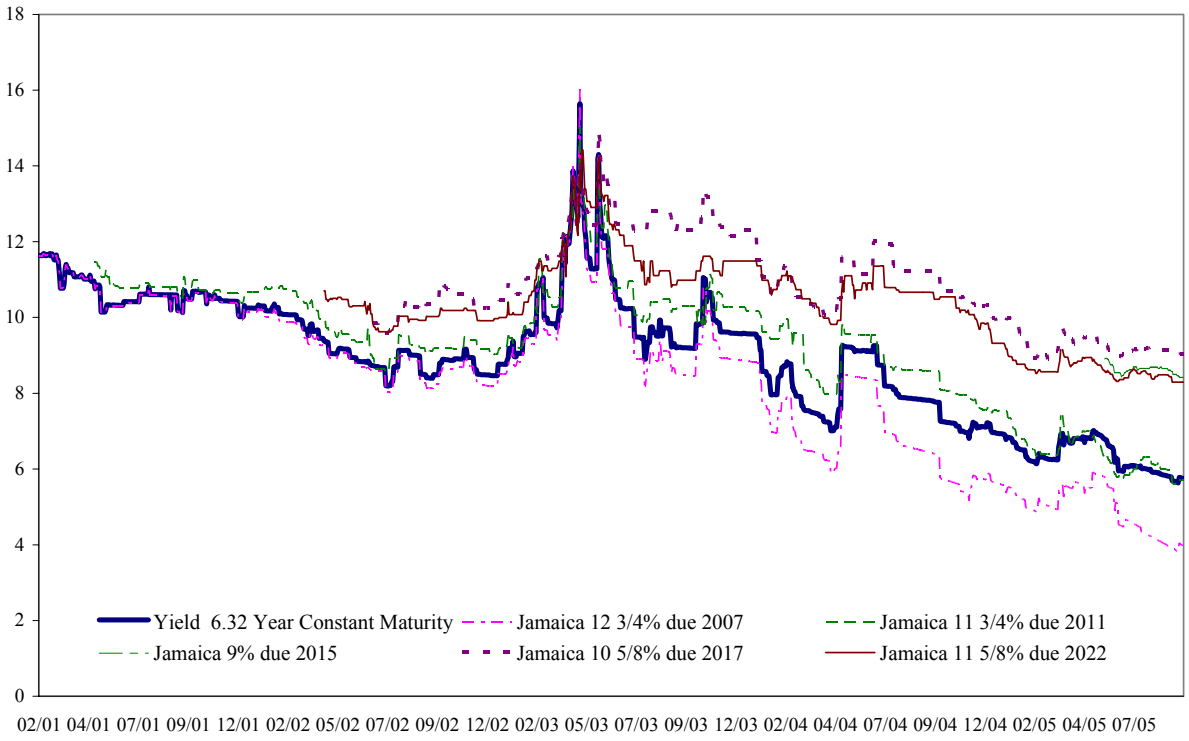
32. **Data for foreign currency debt are derived from two sources**. Global bonds have the advantage of being traded on secondary markets (New York-based), and those data are used here for foreign currency debt from 2001 onwards when such data is available**.** Earlier figures on dollar denominated yields can be proxied using Jamaica's locally issued dollar denominated bonds, which closely track other instruments (Figure 4).

Figure 3. Jamaica: Domestic Bond Yields at Issue



Sources: Jamaican authorities; and Fund staff estimates.
1/ Diameter of markers in the upper two panels are scaled by the size of the bond issue.

Figure 4. Jamaica: Global Bond Yields, Secondary Market



Sources: Jamaican authorities; and Fund staff estimates.

33. **In summary, the data set constructed for this study considers three dimensions of debt: term premium, variability of interest rates, and currency denomination**. The currency denomination trade-off is measured against the U.S. dollar. Variable interest rate debt is considered in the context of domestic currency debt that pays a premium over the weighted average Jamaican Treasury Bill rate. As regards the term premium, this study considers a one-year bond a short-term bond, and brings all other yields to constant 6.4 year maturity, to make them comparable long-term bonds. The term premium, therefore, is based on a 5.4 year differential between the long- and short-term bonds.

E. Estimation and Results

34. **The first step in estimating the optimal debt portfolio is to find the underlying parameters and variances/covariances in the first order conditions (equations (6) through (8))**. The required parameters are the elasticities of the fiscal primary balance with respect to output and inflation, and the probability of plan failure. Studies for other emerging markets have found the elasticities of the primary balance to both output and inflation to be 0.2, which is assumed at this stage to apply also to Jamaica. As regards, the probability of plan failure, a range of values (from 1 to 20 percent) are used to ensure robustness of the results. Next, the variances, which proxy the underlying economic volatility faced by investors and the government, are estimated. The variances capture the size of the shocks (in

output, inflation, and relative interest rates) relative to market expectations. The size of these shocks are proxied by the difference between the best forecast of each variable (output, the one-year fixed rate, inflation, the exchange rate, and the Treasury Bill rate), and their historical realization.[11] Figure graphs the forecast (the solid line) against the realization of these variables (the dots).

35. **The estimated variances and covariances illustrate the sources of stress that Jamaica's debt portfolio faces, and also point to how specific instruments can help manage these pressures**. These variances (and the other model parameters) are shown in Table 3.

- The short end of the yield curve on domestic currency instruments and exchange rate shocks are correlated in Jamaica, likely due to the use of interest rate action in response to exchange rate movements. Both the treasury bill and the domestic currency one-year bond are highly correlated and have large variances, similar to the variance of exchange rate shocks.[12]

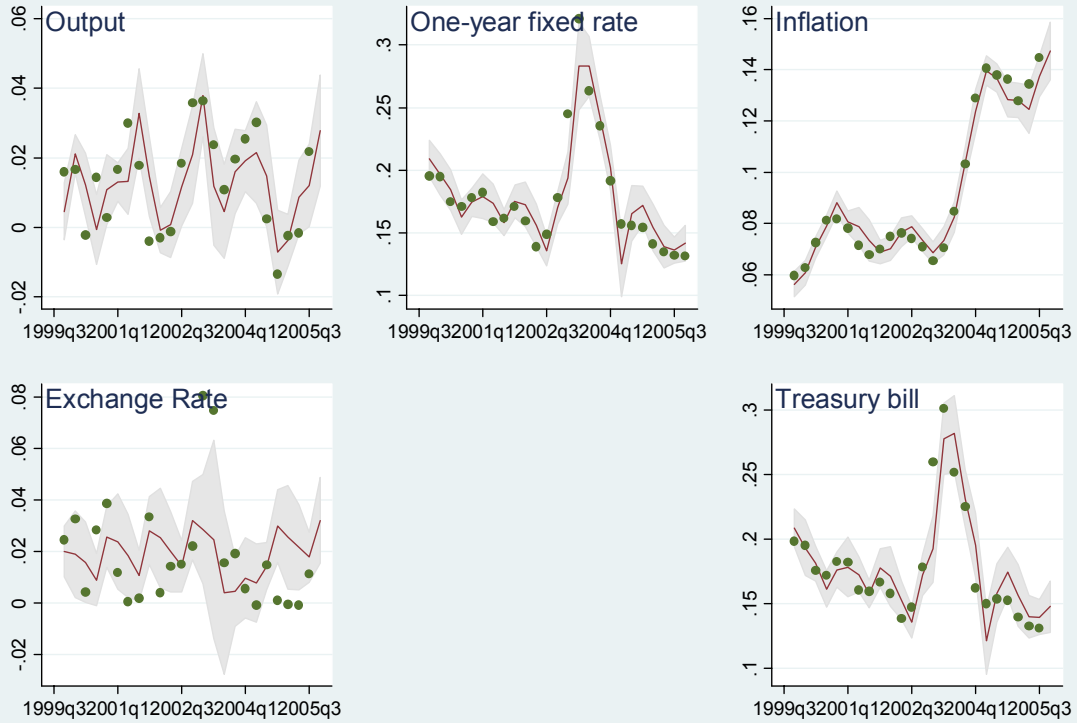
- Inflation covaries negatively with Treasury shocks, while output covaries positively with Treasury shocks—hence treasury bills help hedge inflation against output shocks. Unexpected upward movements in treasury yields are statistically correlated with unanticipated upward output movements (which improve the primary balance) and unanticipated declines in inflation (which hurt the primary balance). This allows the government's positions in Treasury bills to hedge inflation shocks against output shocks.

36. **Next, an exchange rate forecast over the 6.4 year maturity period is calculated**. These forecasts, embedded in the optimal solutions, are necessary to compare global bond rates to domestic currency rates. The use of an exchange rate forecast of this horizon can be a concern. However, the regular placement of domestic currency fixed interest rate bonds in a market where global, dollar linked, and indexed debt are available does require a pragmatic acceptance of some forecast, since a rational market must have been doing the same. In any case, the robustness of the forecasts that are actually used in this paper is addressed by considering a range of potential rates of depreciation.

[11] The "best forecast" is based on PC GeTS – shown in Table 2—and is robust to general vector auto regressions, which were also used.

[12] See Flood and Rose (2001) for evidence of the interest rate defense of exchange rates. See Calvo and Reinhart (2002) for evidence of management in floating rates using interest rates.

Figure 5. Jamaica: Macroeconomic Forecasts and Errors



Sources: Jamaican authorities; and Fund staff estimates.

37. **The final step is to put in the estimated variances and covariances, the elasticities, the probability of plan failure, and the exchange rate forecasts into equations (6) through (8), which yield the optimal portfolio**. This step is further elaborated on in the technical appendix. These solutions are then used in two ways: (i) to calculate the optimal portfolio, taking prices as given; and (ii) to back out investors' expectations in equilibrium about destabilizing fiscal shocks and exchange rate movements.

Optimal portfolio from the government's perspective, taking market prices as given (i.e., partial-equilibrium)

38. **Figure 8 shows the optimal debt portfolio solution for different probabilities of plan failure (*Pr*), and exchange rate depreciation**. Larger budget shocks are associated with higher probabilities of plan failure. Hence, the larger the probability of plan failure, the larger the deficit and thus the need to economize on the interest bill. Mathematically, the higher is (*Pr*), the more important are the last terms in equations (6) through (8). Graphically, this can be seen in the left panel of Figure 8. The right hand panel shows the analogous exercise, but with varying assumptions about exchange rate depreciation throughout the period. As the exchange rate depreciates, the costs of global bonds increases, and its usefulness erodes. Hence, the monotonic decline in global debt is compensated by across-the-

board increases in other debts (the numerical breakdowns for these exercises are given in Tables 4 and 5).

39. **The conclusion from Figure 8 is that, for the range of probabilities of plan failure and exchange rate depreciation considered, the government of Jamaica would place greater borrowing weights (in decreasing order) on short fixed-rate domestic currency debt, then global debt, then long-term fixed rate domestic debt; and it would lend in variable rate instruments**. This scenario takes prices (including the exchange rate in the first panel) as given, and assumes that the government faces no constraints on borrowing/lending. The relative ranking and weights assigned to each of the instruments changes, however, with changes in expectations. The general conclusions of the paper illustrate, therefore, a direction for the portfolio, given current prices, and how that direction changes under differing assumptions regarding exchange rates and fiscal shocks. If the authorities view future exchange rate depreciation as likely, the benefits of holding global debt are quickly overwhelmed by its increasing costs. If the authorities view a large fiscal shock as increasingly likely, they should move into cheaper debt instruments—short-term domestic currency and global debt—to lower interest costs as the primary surplus declines.

40. **Interestingly, the result stands in some contrast to trends in emerging market economies and could be driven by Jamaica's idiosyncrasies**. Most emerging market debt managers are currently moving as rapidly as possible away from foreign currency-denominated or linked bonds towards local currency issues, and are trying to build up to the extent that markets allow long term fixed rate bonds. In this regard, two observations are noteworthy. First, Jamaica, unlike many other emerging market economies, has long had market access to, and already has a large outstanding stock of, long-term fixed rate domestic currency bonds (see, for example, Section D, Figures 2 and 3 on this issue). Therefore, to the extent that other emerging market economies now have new opportunities and are moving into long term fixed rate domestic bonds simply to diversify their portfolios, Jamaica with its already large outstanding stock of domestic debt does not have the same incentives. Second, the results of the paper stem from the historical pattern of shocks and movements of variables specific to Jamaica that may not be relevant for other countries. Indeed, as underscored below, there is no assumption that even in Jamaica the same pattern of shocks will persist—going forward, the implications of the model for Jamaica will need to take this into account.

Backing out risk premia based on observed bond prices (market equilibrium)

41. **Figure 9 and Table 6 back out estimates of the market's views on exchange rates and a destabilizing fiscal shock, from observed bond premiums and the optimal portfolio**. The three points in the figure indicate the actual observed prices paid for debt under the existing portfolio (i.e. outstanding portfolio of government debt during the second half of FY 2005/06). These price points are equilibrium prices and, therefore, also incorporate the market's views about exchange rates and probabilities of destabilizing fiscal shocks. Through a process of iteration, one can therefore back out the market's views, which, according to the figure indicate a twelve-month exchange rate depreciation to J$66.5 per U.S. dollar, and a five percent chance of a destabilizing fiscal shock occurring.

F. Conclusion and Caveats Regarding Policy Implications

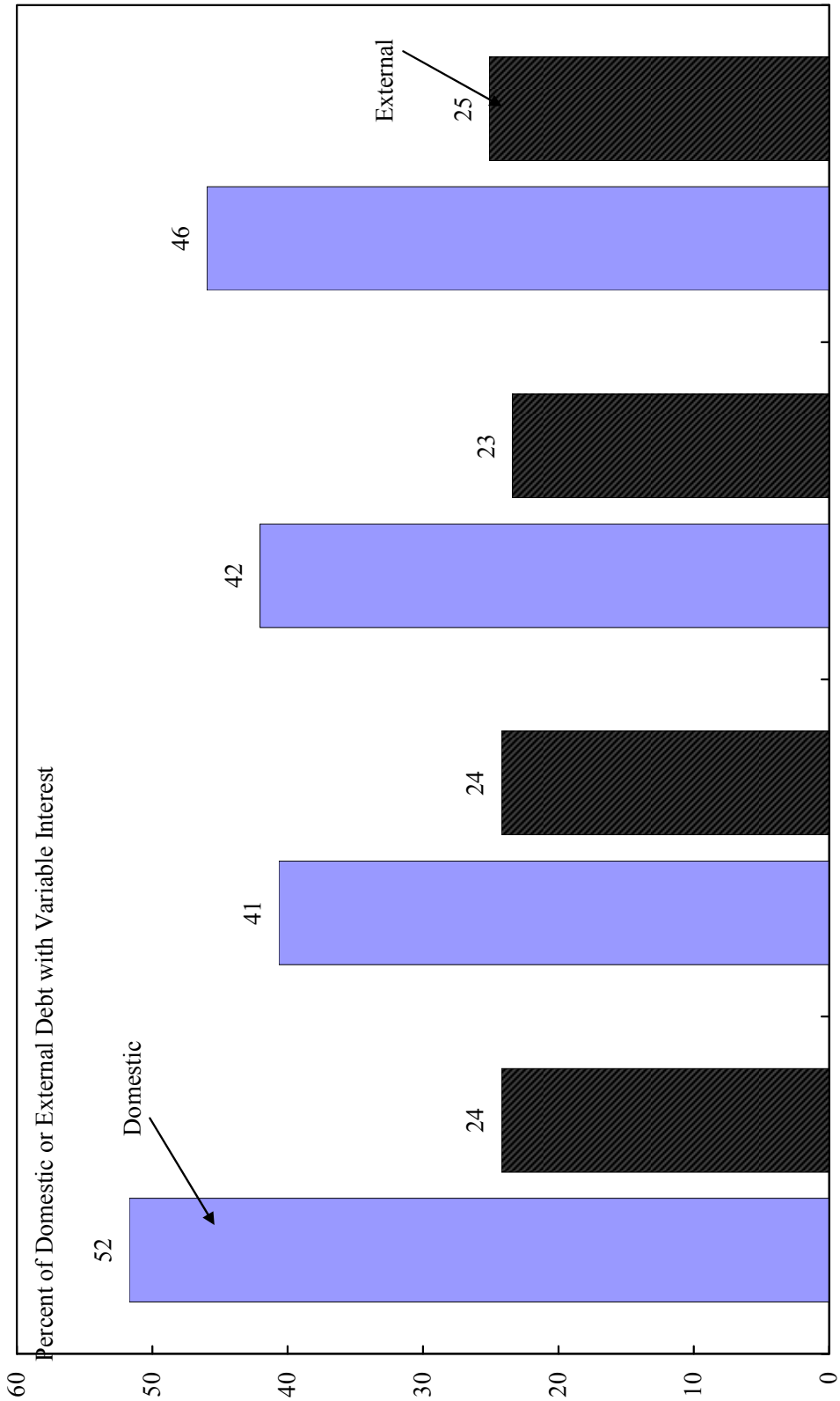
42. **This paper uses the historical pattern of shocks to study how potential interest rate, fiscal, and exchange rate shocks in Jamaica can affect the optimal debt portfolio designed to stabilize the debt-GDP ratio**. The dataset constructed consist of historical term, indexation, and foreign currency premiums that, in turn, reflect the historical distribution of market clearing prices under different economic conditions. This dataset is then used to project the (ex-ante) optimal portfolio for debt stabilization under an adjustment program. The ex-ante optimal portfolio thus calculated is based on the fact that Jamaican debt markets have, in the past, responded differently to indexed debt than to long-term and short term fixed rate domestic currency and foreign currency debt. In particular, when the Treasury bill has moved unexpectedly, GDP and inflation are seen to have moved with it. The effect on the interest bill from inflation shocks have more than compensated the effect from GDP shocks. If this persists, it should allow Treasury indexed debt to perform a hedging role in the government's portfolio. Moreover, Jamaica's debt portfolio has been very highly sensitive to exchange rate movements, and as such, in times of stability in the foreign exchange rate, foreign currency debt has appeared to be of good value. This, however, can quickly reverse itself with moderate exchange rate movements, due to the long maturities of Jamaica's debt issues.

43. **The paper also backs-out from the observed market portfolio and current prices the market's expectations regarding exchange rate movements and probabilities assigned to a destabilizing fiscal shock**. While data limitations generally limit what can be inferred from a model (particularly for emerging markets–see Section D), the framework presented here allows for some inference of market expectations. In this regard, the data suggest that during the third quarter of FY 2005/06, investors appeared to expect a 6 percent depreciation of the currency over a 12-month period (assuming spread over U.S. Treasuries of 400 basis points). In addition, the market appeared to have assigned a 5 percent probability to the event that a fiscal shock large enough to destabilize the debt to GDP ratio would emerge.

44. **While this study can suggest, on the basis of existing data and historical correlations, possible directions for debt management policy to explore, it does not provide the definitive solution to the optimal debt portfolio problem**. First and foremost, the problem in Jamaica is to reduce debt, not simply to stabilize it, so the model would need appropriate modifications to be applicable. Also, as outlined in the modeling Section C, there are alternative approaches to the framework used here for determining the optimal debt portfolio. Focusing on any one model obviously limits consideration of factors that are built into other models. For example, issues surrounding roll-over of the stock of debt are partially addressed through the inclusion of the term-premium, but not fully explored in a dynamic framework. The results presented here are also sensitive to the underlying estimated parameters. Hence, the results must be judged in the context of estimations based on a particular model, limited span of data, measurement problems in the data, incomplete information at times about market conditions, and other risks. For example, Jamaica does not trade debt in a secondary market, and therefore, for certain periods and kinds of debt, no

counterfactual can be produced beyond that which mimics information contained by yields at issuance. Also, the timing, maturity, and instruments of the debt issued are chosen by the authorities on a discretionary basis, which would, in itself, introduce biases in the observed yields. Most fundamentally, there is no assurance that the future pattern of shocks and therefore correlations will mimic those of the past. Finally, as regards backing out the market's views regarding exchange rate movements and the perceived likelihood of shocks, the results assume the existence of rational expectations and fully efficient market equilibrium—both of which are theoretical constructs that actual conditions and realities may not always adequately approximate.

Figure 6. Jamaica: Debt Variability
(In percent of Domestic or External Debt)



Sources: Jamaican authorities; and Fund staff estimates.

Figure 7. Jamaica: Domestic Bond Yields Against Maturity

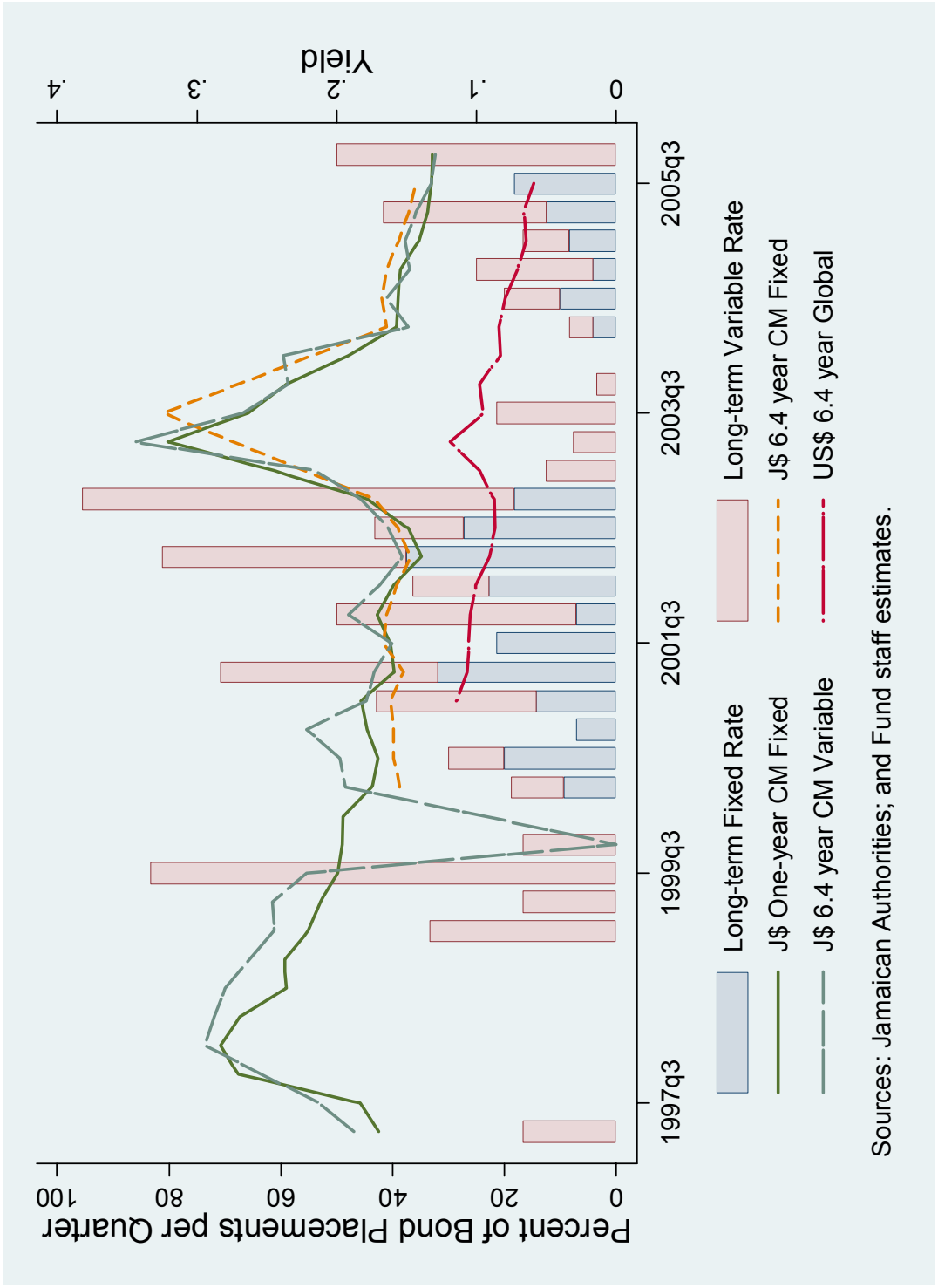
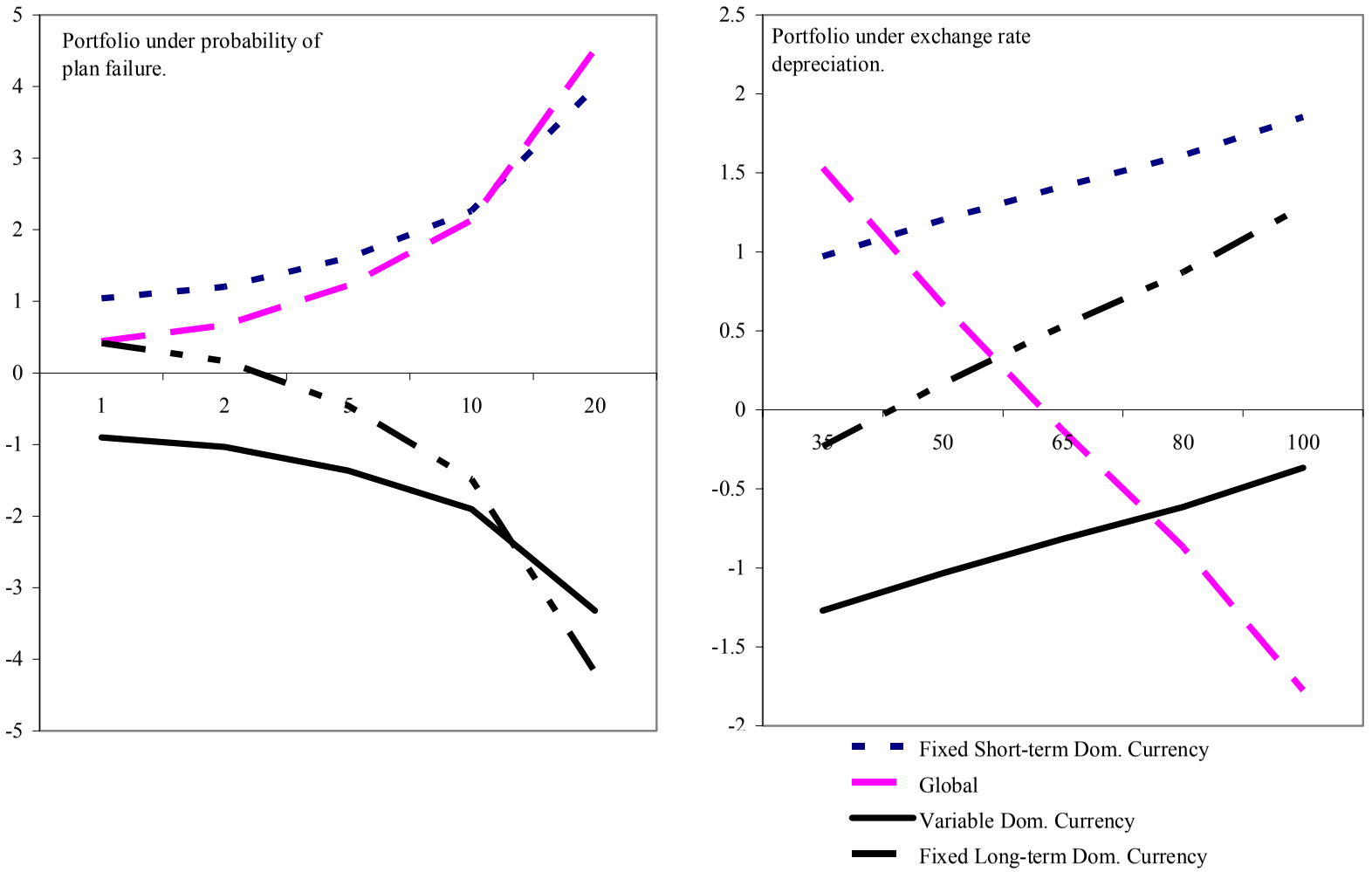
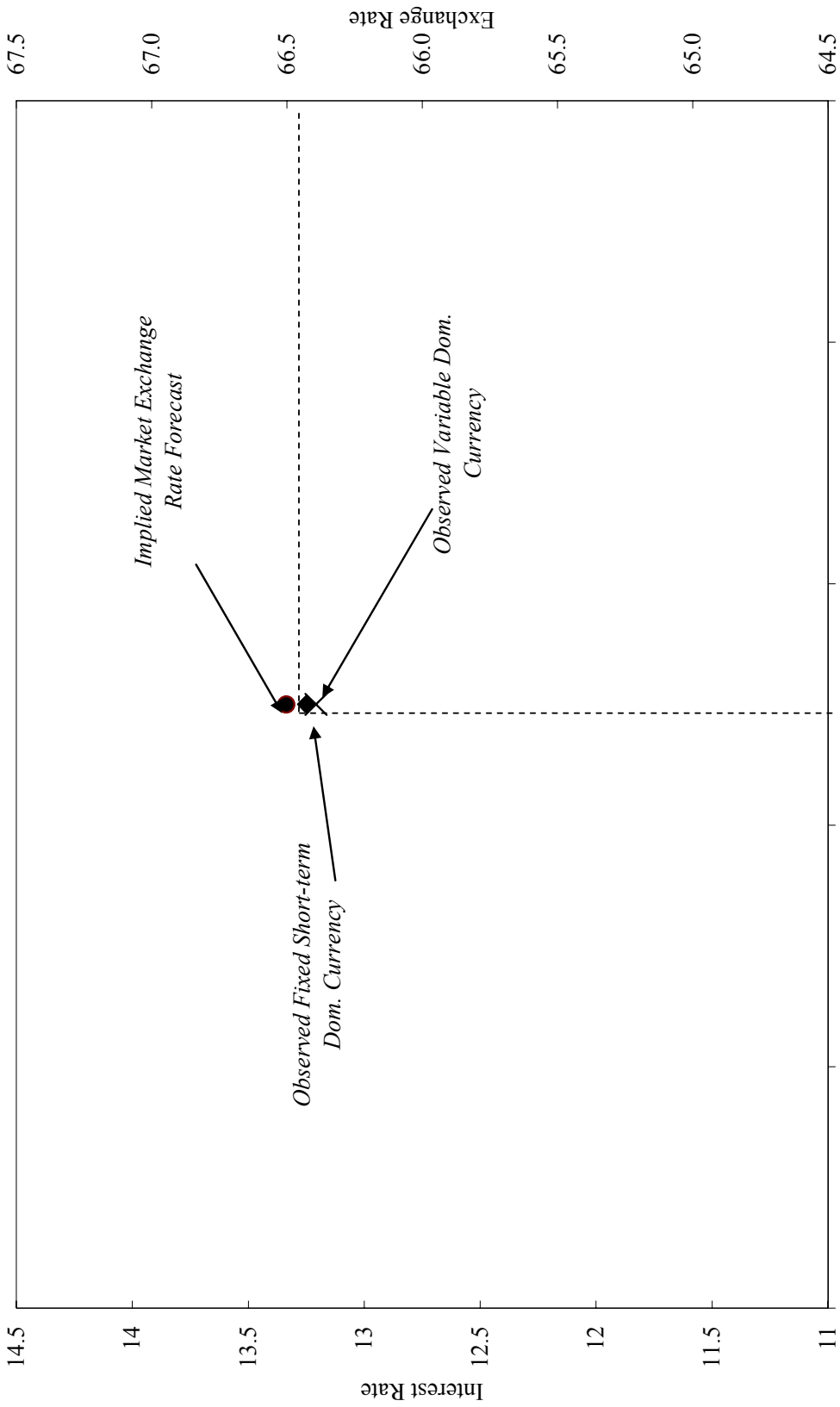


Figure 8. Jamaica: Portfolio Evolution



Source: Jamaican authorities; and Fund staff estimates.

Figure 9. Jamaica: Mapping the Market's View



Source: Jamaican authorities; and Fund staff estimates.

Table 1. Jamaica: Debt Maturity

	2002	2003	2004	2005
Domestic currency denominated debt 2/				
In percent of total debt	52.3	50.0	52.8	47.8
Shares by maturity				
One year or less	17.6	20.6	18.9	21.9
One to five years	46.5	50.6	54.1	46.9
Five to ten years	17.9	15.6	15.2	18.5
Over ten years	18.0	13.3	11.9	12.7
External and foreign currency linked debt				
In percent of total debt	47.7	50.0	47.2	52.2
Shares by maturity				
One year or less	4.8	6.5	6.0	6.3
One to five years	21.1	17.7	16.8	27.4
Five to ten years	27.5	27.5	32.8	30.3
Over ten years	46.6	48.4	44.5	36.0

Sources: Jamaican authorities; and Fund staff estimates.
1/ As of December 31 of each year.
2/ Excludes government guaranteed domestic debt.

Table 2. Jamaica: Estimation of Forecast Errors

Prediction Variables Right-hand-side	Output	One-year Rate	Inflation Rate	Exchange Rate	Treas. Bill
L.Output	0.781***				
L3.Output	-0.342**				
L.Treas. Bill	-0.247***	1.292***		0.071	1.260***
L2.Treas. Bill	0.255***	-1.599***		-0.214	-1.258**
L4.Treas. Bill	-0.124**				
I Quarter 2	-0.010*	-0.001	0.003	-0.003	-0.002
I Quarter 3	-0.011*	0.002	0.001	-0.009	0.003
I Quarter 4	-0.008	0.014	0.001	0.004	0.016
L2.One-year Rate		1.130**			0.774
L4.One-year Rate			-0.053*		
L.Inflation Rate		-0.409***	1.510***		-0.366**
L3.Inflation Rate		0.350**			0.353**
L2.Inflation Rate			-0.630***		
L4.Inflation Rate			0.122***		
L.Exchange Rate			0.084*		
L3.Exchange Rate			0.160***		
L4.Exchange Rate			0.119*		
Constant	0.036**	0.034**	0.003	0.048**	0.037**
Sample size	32	38	35	37	37
F Statistic	5.069	41.235	64.353	1.791	30.19
R-Square	0.562	0.898	0.982	0.297	0.874

Source: Fund staff estimates.

Table 3. Jamaica: Macroeconomic Covariances and Parameter Values

	Variance-Covariance of Forecast Errors 1/				
	Output	Interest Rate (1 Year)	Inflation	Exchange Rate	Treasury Bill
Output	0.94	-	-	-	-
Interest Rate (1 Year)	0.45	3.39	-	-	-
Inflation	(0.01)	(0.24)	0.19	-	-
Exchange Rate	0.29	1.86	(0.22)	3.60	-
Treasury Bill	0.29	3.49	(0.33)	2.04	4.05

Structural Parameters			
Output Elasticity	0.20	FX Premium	0.003
Inflation Elasticity	0.20	Term Premium	0.012
E[Debt Reduction]	0.07	Index Premium	0.011
Max Budget Shock	0.09	Pr{Plan Failure}	0.020
Debt to GDP	1.38		

Sources: Jamaican authorities; and Fund staff estimates.

1. Variances multiplied by 10^4.

Table 4. Jamaica: Optimal Portfolio Under Varying Probabilities of Plan Failure

(In percent of total arm's length debt 1/)

	Optimal					Current
Pr (Plan failure 2/)	1	2	5	10	20	
Fixed short-term dom. currency	104	120	160	226	399	7
Global	44	67	122	213	452	36
Variable dom. currency	(90)	(103)	(136)	(190)	(332)	36
Fixed long-term dom. currency	42	17	(46)	(149)	(418)	22
Total	100	100	100	100	100	100

Source: Fund staff estimates.

1/ Excludes 24 percent of total debt that is not arm's length debt, of which offical debt is 18 percent.

2/ Defined as growth in the debt to GDP ratio. Exchange rate depreciation by 2011 fixed at 50 percent.

Table 5. Jamaica: Optimal Portfolio Under Varying Depreciation Rates

(In percent of total arm's length debt 1/)

	Optimal					Current
Depreciation by 2011	35	50	65	80	100	
Fixed short-term dom. currency	97	120	141	161	185	7
Global	153	67	(13)	(87)	(177)	36
Variable dom. currency	(127)	(103)	(82)	(61)	(37)	36
Fixed long-term dom. currency	(23)	17	53	87	129	22
Total	100	100	100	100	100	100

Source: Fund staff estimates.

1/ Excludes 24 percent of total debt that is not arm's length debt, of which offical debt is 18 percent.

2/ Defined as growth in the debt to GDP ratio. Exchange rate depreciation by 2011 fixed at 50 percent.

Table 6. Jamaica: Ex-post Portfolio—Implied Interest Rates from Current Portfolio
(In percent)

	Optimal					Current	
Pr (Plan failure 2/)	1	2	5	10	20	Premiums	Rates
Fixed short-term dom. currency	2.3	1.5	0.8	0.5	0.2	1.2	13.2
Global	2.5	1.6	0.9	0.5	0.2	3.9	5.9
Implied depreciation	6.0	6.8	7.6	8.0	8.2	4.6	...
Variable dom. currency	3.0	1.9	1.1	0.6	0.3	1.1	13.3
Fixed long-term dom. currency							**14.4**
Fixed short-term dom. currency	12.1	12.9	13.5	13.9	14.1	...	...
Global	5.9	5.9	5.9	5.9	5.9	...	...
Implied depreciation							
Variable dom. currency	11.4	12.4	13.3	13.8	14.1	...	...
XR 3/	65.5	66.0	66.5	66.7	66.9	64.6	...

Sources: Jamaican authorities; and Fund staff estimates.

1/ Excludes 24 percent of total debt that is not arm's length debt, of which offical debt is 18 percent.

2/ Defined as growth in the debt to GDP ratio.

3/ Assumes an EMBI spread of 400.

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MODEL DEVELOPMENT

The objective of minimizing the probability of failure of the stabilization plan is modeled as minimizing the expected probability of an increase in the debt ratio. In this framework implies hedging the adjustment effort against shocks to the budget or due to revenue shortfalls or expenditure overruns. A crisis occurs if such unanticipated shocks overwhelm the adjustment effort and increase the debt-to-GDP ratio. This implies:

$$\min_{s,q,h} E_t \Pr\left[X > A_{t+1} - \Delta B^T_{t+1} \right] = \min_{l,q,h} E_t \int_{A_{t+1}-\Delta B^T_{t+1}}^{\infty} \phi(X) dx \quad (9)$$

s.t. (2), (3), and (4) hold.

The first order conditions are:

$$E_t \phi\left(A_{t+1} - \Delta B^T_{t+1} \right)\left(i_{t+1} - R_t \right) = 0 \quad (10)$$

$$E_t \phi\left(A_{t+1} - \Delta B^T_{t+1} \right)\left(R^{US}_t + RP_t + \Delta e_{t+1} \right) = 0 \quad (11)$$

$$E_t \phi\left(A_{t+1} - \Delta B^T_{t+1} \right)\left(R^I_t + i_{t+1} - R_t \right) = 0 \quad (12)$$

It is useful to express equations (10) through (12) in terms premiums paid over the long-term domestic currency fixed rate. For equation (10) this implies defining a term premium (*TP*):

$$\left(i^s_{t+1} - R_t \right) = \left(i^s_{t+1} - Ei^s_{t+1} \right) - TP_t \ \ with \ TP_t = R_t - Ei^s_{t+1}; \quad (13)$$

For equation (11) this implies defining a foreign exchange premium (*FP*):

$$\left(R^{US}_t + RP_t + \Delta e_{t+1} \right) = (e_{t+1} - Ee_{t+1}) - FP \ with \ FP = R_t - R^{US}_t - RP_t - E\Delta e_{t+1}; \quad (14)$$

And finally, for equation (12), this implies defining an indexation premium (*IP*):

$$\left(R^I_t + i_{t+1} - R_t \right) = \left(i_{t+1} - Ei_{t+1} \right) - IP_t \ with \ IP_t = \left(R_t - R^I_t - Ei_{t+1} \right) \quad (15)$$

Expressing innovations in interest rates, inflation, and the exchange rate as functions of a term premium, inflation premium, and the foreign exchange premium, the first order conditions can be re-expressed as:

$$E_t \phi\left(A_{t+1} - \Delta B^T_{t+1} \right)\left(i_{t+1} - E_t i_{t+1} \right) = TP_t E_t \phi\left(A_{t+1} - \Delta B^T_{t+1} \right) \quad (16)$$

$$E_t \phi\left(A_{t+1} - \Delta B^T_{t+1} \right)\left(e_{t+1} - E_t e_{t+1} \right) = FP_t E_t \phi\left(A_{t+1} - \Delta B^T_{t+1} \right) \quad (17)$$

$$E_t \phi\left(A_{t+1} - \Delta B^T_{t+1} \right)\left(\pi_{t+1} - E_t \pi_{t+1} \right) = IP_t E_t \phi\left(A_{t+1} - \Delta B^T_{t+1} \right) \quad (18)$$

The probability density function for X is expressed as a triangular density, which approximates any density decreasing in X (for $X>0$). The density is given by:

$$\phi(X) = \frac{\overline{X} - X}{\overline{X}^2} \tag{19}$$

Solving (16) through (18) using (19) yields the optimal debt ratios. These are:

$$s^* = \underbrace{\frac{(\eta_y + B_t)}{B_t}\frac{cov(y_{t+1}, i^s_{t+1})}{\text{var}(i^s_{t+1})}}_{\text{Term 1: Output hedge}} + \underbrace{\frac{(\eta_\pi + B_t)}{B_t}\frac{cov(\pi_{t+1}, i^s_{t+1})}{\text{var}(i^s_{t+1})}}_{\text{Term 2: Inflation hedge}} - \underbrace{q^* \frac{cov(e_{t+1}, i^s_{t+1})}{\text{var}(i^s_{t+1})}}_{\text{Term 3: Dollar debt}}$$
$$\underbrace{- h^* \frac{cov(i^s_{t+1}, i_{t+1})}{\text{var}(i^s_{t+1})}}_{\text{Term 4: Indexed debt}} + \underbrace{TP_t \frac{\sqrt{2\,\text{Pr}}}{(1-\sqrt{2\,\text{Pr}})}\frac{E_t(A_{t+1} - \Delta B^T_{t+1})}{B_t\,\text{var}(i^s_{t+1})}}_{\text{Term 5: Long term fixed rate domestic debt}} \tag{20}$$

$$q^* = \frac{(\eta_y + B_t)}{B_t}\frac{cov(y_{t+1}, e_{t+1})}{\text{var}(e_{t+1})} + \frac{(\eta_\pi + B_t)}{B_t}\frac{cov(\pi_{t+1}, e_{t+1})}{\text{var}(e_{t+1})} - s^* \frac{cov(e_{t+1}, i^s_{t+1})}{\text{var}(e_{t+1})}$$
$$- h^* \frac{cov(i_{t+1}, e_{t+1})}{\text{var}(e_{t+1})} + FP_t \frac{\sqrt{2\,\text{Pr}}}{(1-\sqrt{2\,\text{Pr}})}\frac{E_t(A_{t+1} - \Delta B^T_{t+1})}{B_t\,\text{var}(e_{t+1})} \tag{21}$$

$$h^* = \frac{(\eta_y + B_t)}{B_t}\frac{cov(y_{t+1}, i_{t+1})}{\text{var}(i_{t+1})} + \frac{(\eta_\pi + B_t)}{B_t}\frac{cov(\pi_{t+1}, i_{t+1})}{\text{var}(i_{t+1})} - q^* \frac{cov(e_{t+1}, i_{t+1})}{\text{var}(i_{t+1})}$$
$$- s^* \frac{cov(i_{t+1}, i^s_{t+1})}{\text{var}(i_{t+1})} + IP_t \frac{\sqrt{2\,\text{Pr}}}{(1-\sqrt{2\,\text{Pr}})}\frac{E_t(A_{t+1} - \Delta B^T_{t+1})}{B_t\,\text{var}(i_{t+1})} \tag{22}$$