June 2008
IMF Country Report No. 08/198

Jamaica: Selected Issues

This Selected Issues for Jamaica was prepared by a staff team of the International Monetary Fund as background documentation for the periodic consultation with the member country. It is based on the information available at the time it was completed on April 3, 2008. The views expressed in this document are those of the staff team and do not necessarily reflect the views of the government of Jamaica or the Executive Board of the IMF.

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INTERNATIONAL MONETARY FUND

JAMAICA

Selected Issues

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Approved by the Western Hemisphere Department

April 3, 2008

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INTRODUCTION

1. **Economic outcomes in Jamaica have fallen short of the authorities' objectives in recent years**. When the previous government unveiled its medium-term plan in 2004, real GDP was expected to grow by 2¾ percent annually and public debt was projected to decline to 112 percent of GDP by now. In the event, real GDP grew, on average, by just 1½ percent during the past four years, and public debt likely ended FY 2007/08 at 128 percent of GDP. Budgetary outcomes have also deviated from plans, with primary surpluses of about 8 percent of GDP in the past two years falling short of the goals of 14 percent of GDP. These outcomes reflect both exogenous shocks (such as natural disasters) and structural problems (such as ensuring that all expenditure plans are adequately budgeted for).

2. **As the government looks to reinvigorate its growth and debt reduction strategy, it is instructive to examine how exogenous shocks and other unanticipated developments can affect economic outcomes**. Statistical models are useful in this respect, although there are some limitations to such analysis: (i) no single statistical model can accurately capture all the shocks or the complex dynamic relationships between macroeconomic variables; (ii) structural changes in Jamaica and the world economy limit the statistical models' relevance, going forward; and (iii) the models' constructs do not always allow for policy changes to affect predicted outcomes. Nevertheless, by providing some insight into the direction and magnitude of impact of potential shocks, or by illustrating how temporary departures from fiscal plans can affect debt outcomes, the models can help improve the planning process. The two chapters in this volume develop and describe the results from such models.

3. **The first chapter examines the impact on Jamaica's economy of external economic slowdowns and credit crunches**. The paper derives econometric estimations of the behavior of various U.S. variables as well as of historical links between U.S. and Jamaican variables. The analysis finds that the impact of U.S. macroeconomic stress is small on Jamaica's GDP but larger on the budget, exports and capital flows.

4. **The second chapter develops a framework to assess the probabilities of successfully reducing debt below pre-specified thresholds**. It analyzes the movements of the key determinants of the debt level in response to past shocks, and with a model calibrated to replicate the patterns from the past, it simulates the behavior of the variables going forward. The model produces a wide range of debt outcomes and associated probability distributions for the outcomes. The analysis concludes that the greater the planned fiscal effort is, the higher the probability that debt eventually falls below any given threshold.

I. JAMAICA AND THE EXTERNAL ENVIRONMENT[1]

A. Introduction

1. **This chapter examines the impact on Jamaica's economy of external economic slowdowns and credit crunches**. The knock-on macroeconomic implications of the unfolding global credit crisis and slowdown in U.S. economic growth can potentially have large spillover effects for Jamaica. Jamaica's economy is highly open, with external trade amounting to almost 100 percent of GDP (Figure 1). Remittances from the diaspora (mainly in North America and the United Kingdom) amount to a further17 percent of GDP annually. Moreover, Jamaica is highly reliant on external financing, given its large current account deficit (15½ percent of GDP) and high public debt (128 percent of GDP). Jamaica is, therefore, significantly exposed to the risks of weakened external economic conditions and to deteriorating financial market sentiments.

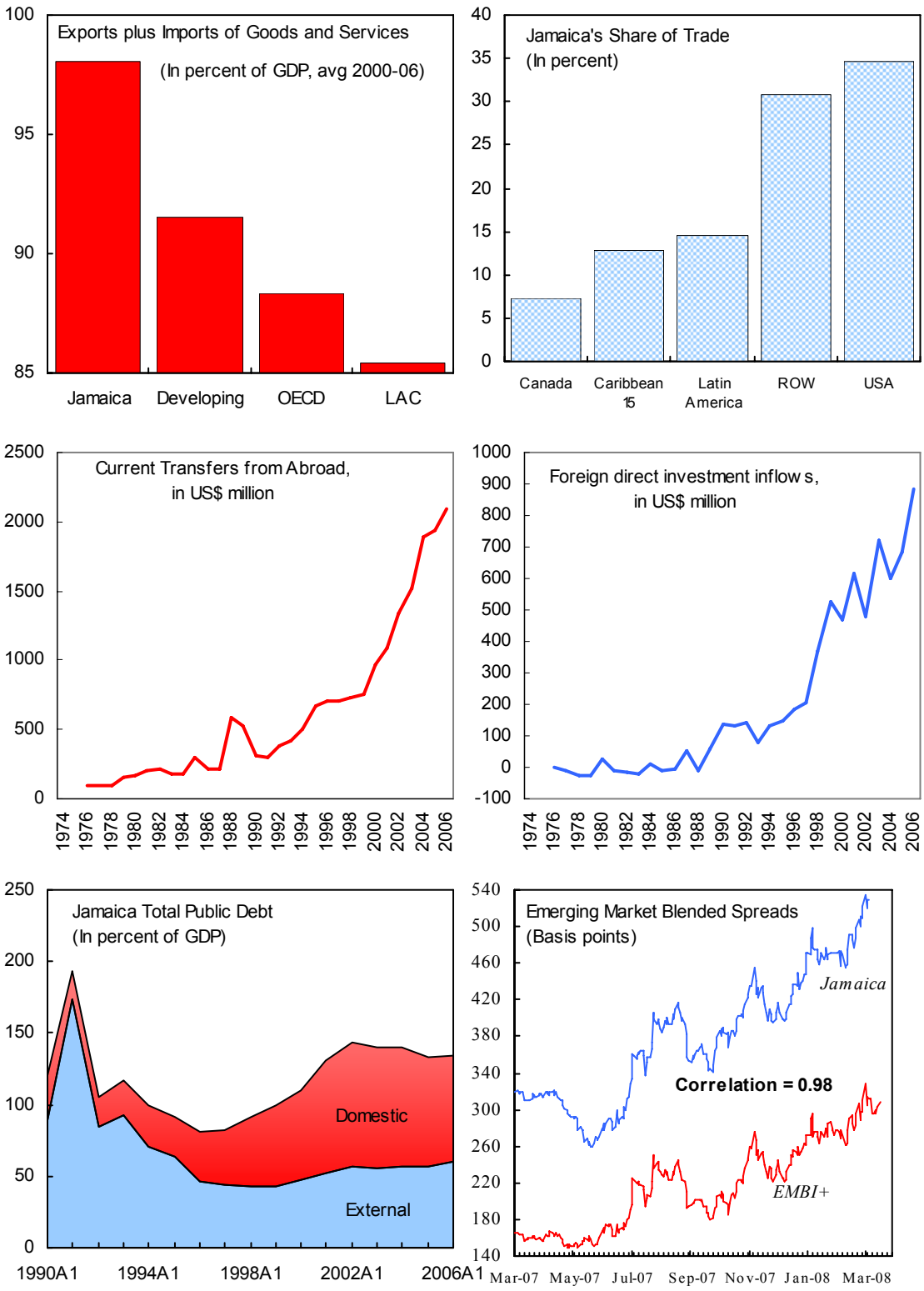
2. **The study is purely statistical and based on historical relationships between variables**. The paper derives econometric estimations of the behavior of various U.S. variables as well as of historical links between U.S. and Jamaican variables. The estimations are then used to evaluate the possible impact on Jamaica of various scenarios for the U.S. variables by shocking the latter in the estimated equations. While it identifies the direction and magnitude of the relationships between different variables, a study of this type, by itself, does not explicitly account for the economic rationale for such relationships. In most instances, the identified relationships do, however, make intuitive economic sense and the nature of the relationships are conjectured but they remain to be unambiguously established.

3. **Furthermore, the relationships that existed in the past may not hold going forward**. Jamaica is a shock-prone economy. The sheer number, variety, and frequency of shocks impacting on it make it difficult to accurately capture all the dynamic relationships between variables and, at the same time, retain econometric tractability. The possible existence of structural breaks limits the model's predictive powers. Also, it is possible that the estimated parameters are not stable. For example, with global financial integration, financial flows to Jamaica may be affected by external shocks differently than they have in the past. Indeed, the transmission of the U.S. subprime debacle to other financial systems is unprecedented and unpredictable.

4. **The study can, nevertheless, be useful in a number of ways**. First and foremost, it can provide broad indications of the possible direction and perhaps even magnitude of some potential shocks currently. It can, therefore, help policy-makers identify areas to especially watch out for. Second, by providing insight into how variables have responded in the past to

[1] Prepared by Alejandro Guerson and Christopher Faircloth.

Figure 1. Jamaica: Global Links and Vulnerabilities



Sources: Bloomberg; JP Morgan; country authorities; and Fund staff estimates.

a deterioration of the external environment, the study may help identify how the transmission mechanism to domestic variables may function, going forward.

5. T**he analysis finds that the impact of U.S. macroeconomic stress is small on Jamaica's GDP but larger on the budget, exports and capital flows**. The historical data shows that while the impact of U.S. slowdowns on Jamaican growth has been limited, they have tended to be associated with a worsening primary fiscal balance. In addition, previous episodes of external slowdowns and credit crunches have been associated with a persistent reduction in capital inflows to Jamaica. The shocks have reduced remittances and export receipts but also imports, thereby limiting the overall impact on the current account.

6. **The remainder of the chapter is organized in three sections**. The following section (B) examines the impact of U.S. economic slowdowns and credit crunches on Jamaica's balance of payments. The next section (C) extends the analysis to Jamaica's GDP and fiscal variables. Section D concludes.

B. Impact on Jamaica's Balance of Payments

7. **The empirical strategy consists of measuring the difference in value that a selected group of Jamaican variables take under two alternative scenarios for the U.S. economy**. The first scenario assumes no shocks to the U.S. variables. The second assumes negative shocks, of various pre-specified magnitudes, to specific U.S. variables. The difference in the Jamaican variables between the two scenarios provides the estimated impact on Jamaica of the change in external conditions.

Model

8. **The analysis consists of four distinct steps (Figure 2)**. These are: (i) estimating a purely U.S. economy dynamic model to generate two forecasts for U.S. variables—one with no further shocks and one with an initial negative shock to a specified U.S variable; (ii) an intermediate technical step to calculate principal components—the principal components retain the statistical information derived in (i) but overcome the problem of multicolinearity; (iii) regressing various Jamaican balance of payments variables on the principal components from the U.S. model to obtain two sets of forecasts for the Jamaican variables (one based on no shocks to the U.S. economy and one with the initial shocks); and, (iv) calculating the difference between the two sets of forecasts for the Jamaican variables derived in (iii).

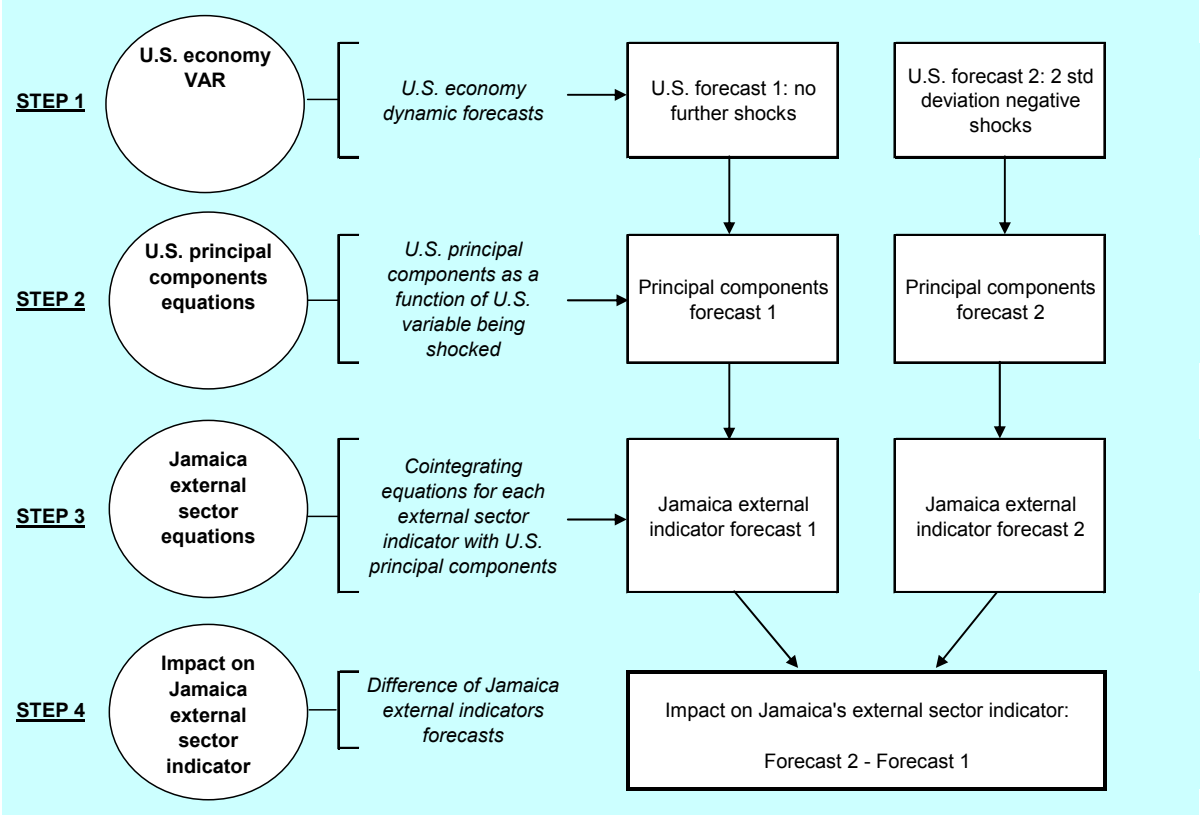
9. **In the first step, the forecasts for the U.S. economy are derived from a VAR(3) equation**. It takes the form

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \alpha_3 y_{t-3} + \varepsilon_t$$

where y_t is a vector of endogenous U.S. variables including GDP, money market interest rate, money stock, stock market index, private consumption, bank credit to the private sector,

wages, imports of goods and services, as of year *t.* All variables are in real terms and expressed in logarithms, except for the interest rate which is not in logs. α_i $(i=0,...,3)$ are matrices of coefficients. ε_t is a vector of Gaussian error terms. This set of variables was chosen according to two criteria. Either they are variables meriting particular consideration in the current global environment (measures of U.S. economic activity and of credit market conditions) or variables that are á priori likely to be the main channels of transmission of shocks to Jamaica (for example U.S. imports of goods and services and U.S, real wages, which could affect remittances to Jamaica from the diaspora). Appendix I shows tests that support the econometric specification used, which assumes the existence of a long-run relation (cointegration) among the U.S. variables.

Figure 2. Empirical Strategy



10. **The U.S. VAR model is then used to produce two five-year dynamic forecasts**. The forecasts span the period 2008–12.[2] The first forecast, assumes there are no further shocks. In the second forecast we apply a negative shock to one of the U.S. indicators for 2008 and let the shock work its way through the other variables in the dynamic model. The size of the shock is set to be equal to two-standard deviations of the growth rate of the

[2] For 2007, we use WEO estimates.

variable shocked. The VAR framework ensures that after one variable is shocked, other variables move along according to the historical patterns, including depth, persistence, and co-movement.

11. **The second step of the process produces forecasts of the U.S. principal components under both the "no shocks" and shocked scenarios**. This intermediate step is purely technical. The high degree of correlation among the U.S. variables results in a significant multicolinearity problem, which precludes using them directly as explanatory variables in equations for the Jamaican variables in step three. In particular, the multicolinearity leads to estimated coefficients being highly unstable, and therefore, rendering the estimated impact on the Jamaican variables as unreliable. To tackle this problem, we decompose the eight U.S. variables into their eight principal components. The principal components capture the common movements of the different U.S. indicators and are uncorrelated by construction, therefore avoiding the multicolinearity problem. However, critically, they still retain the information embedded in the U.S. indicators.

12. **The third step links important variables in Jamaica's balance of payments to the U.S. forecasts**. The Jamaican balance of payments variables considered are net capital inflows, the current account balance, exports of goods and services (in real terms), gross current transfers from abroad and foreign direct investment.[3] This set of indicators captures both current and capital account flows and includes specific line items that feature importantly in Jamaica's balance of payments (FDI and transfers from abroad).

13. **The link is established by estimating equations that assume the existence of long-term relationships between each Jamaican variable and the principal components of the U.S. variables**.[4] Statistically, the hypothesis of the existence of long-run relationships, or cointegration, could not be rejected, therefore, providing empirical support to our assumption. Intuitively, this finding implies that the U.S. and Jamaican indicators are not expected to drift too far apart from each other over time. Econometrically, the existence of cointegration is important to ensure that the estimated equations linking the Jamaican variables to the developments in the U.S variables are valid, i.e., the relationships are not spurious. Appendix I also presents a residual-based test that supports this specification.[5] The

[3] All Jamaican external sector indicators are measured in US$ millions except for the two measures for exports. In theory, introducing variables in U.S. dollars could introduce estimation bias, as these values tend to drift upwards with U.S. inflation. However, testing based on the same variables in real terms resulted in similar results. The decision to use variables in U.S. dollars is based on the fact that results are easier to interpret, especially when compared to the current status of the Jamaican balance of payments.

[4] Only the principal components that turn out to be statistically significant are used in the equations.

[5] The test supports the assumption of existence of a long-run relation (cointegration) between the U.S. principal components and Jamaica's external sector indicators.

existence of long-run relationships can also be rationalized on theoretical grounds. For example, if the number of Jamaican immigrants in the U.S. remains stable over the long term, then transfers should be expected to grow in line with U.S. GDP. Similarly, if the demand for tourism services in Jamaica by Americans grows along with real U.S. GDP in the long term, then FDI into the tourism sector in Jamaica can also be expected to grow in line with U.S. GDP.

14. **The cointegration equations are used to compute the two sets of forecasts for each of the Jamaican balance of payments variables of interest**. Five-year estimates of each of the Jamaican variables of interest (notionally covering 2008–13) are produced by using either the "no-shocks" or shock-based forecasts for the U.S. economy in the cointegration equations.

15. **The final step is to take the difference in the two sets of forecasts for the Jamaican variables of interest**. The impact on the Jamaican variable of interest of a shock on any given U.S. indicator is, thus, simply this difference between the two forecasts. Note however, that the forecasted *levels* of either the U.S. or Jamaican variables are not critical for the results—*only their difference is*. Furthermore, the difference reflects entirely the impact of the shock and nothing else but the shock. In other words, had the projected path for the U.S. economy been lower in the "no shock" scenario, then the deviation from that path under the shocked projection would have also been lower by the same magnitude. Thus, the realism of the projected levels is not relevant to the results as long as the difference accurately captures the shock, which the four-step process described above helps ensure.

16. **That is not to say, however, that the results do not have any limitations**. The framework is unlikely to capture completely the dynamics under the current global financial conditions and their potential impact on the real economy. This is because the model is entirely based on the average historical behavior of the various series. However, (i) the world has experienced significant changes over the sample period—in other words, there may have been structural breaks, and, therefore, the true values of the parameters may now be different from those estimated; (ii) there are other sources of fluctuations in the data than those examined here and, therefore, the dynamics of the historical data might not be representative of those generated by the specific source of current fluctuations; and (iii) there might be nonlinearities in the relations studied that are not accounted for in our estimations (for example, if the size of the shock matters for the expected response of the variables). Finally, there are the usual problems of small sample size and model specification.

Results

17. **Negative shocks to the U.S. economy are expected to reduce capital inflows, exports, and current transfers to Jamaica**. This pattern is consistent irrespective of where the initial shock occurs, whether for example to U.S. GDP growth or to credit to the private

sector in the United States. The impact on Jamaica, however, differs in magnitude from shock to shock (Figures 3–6).

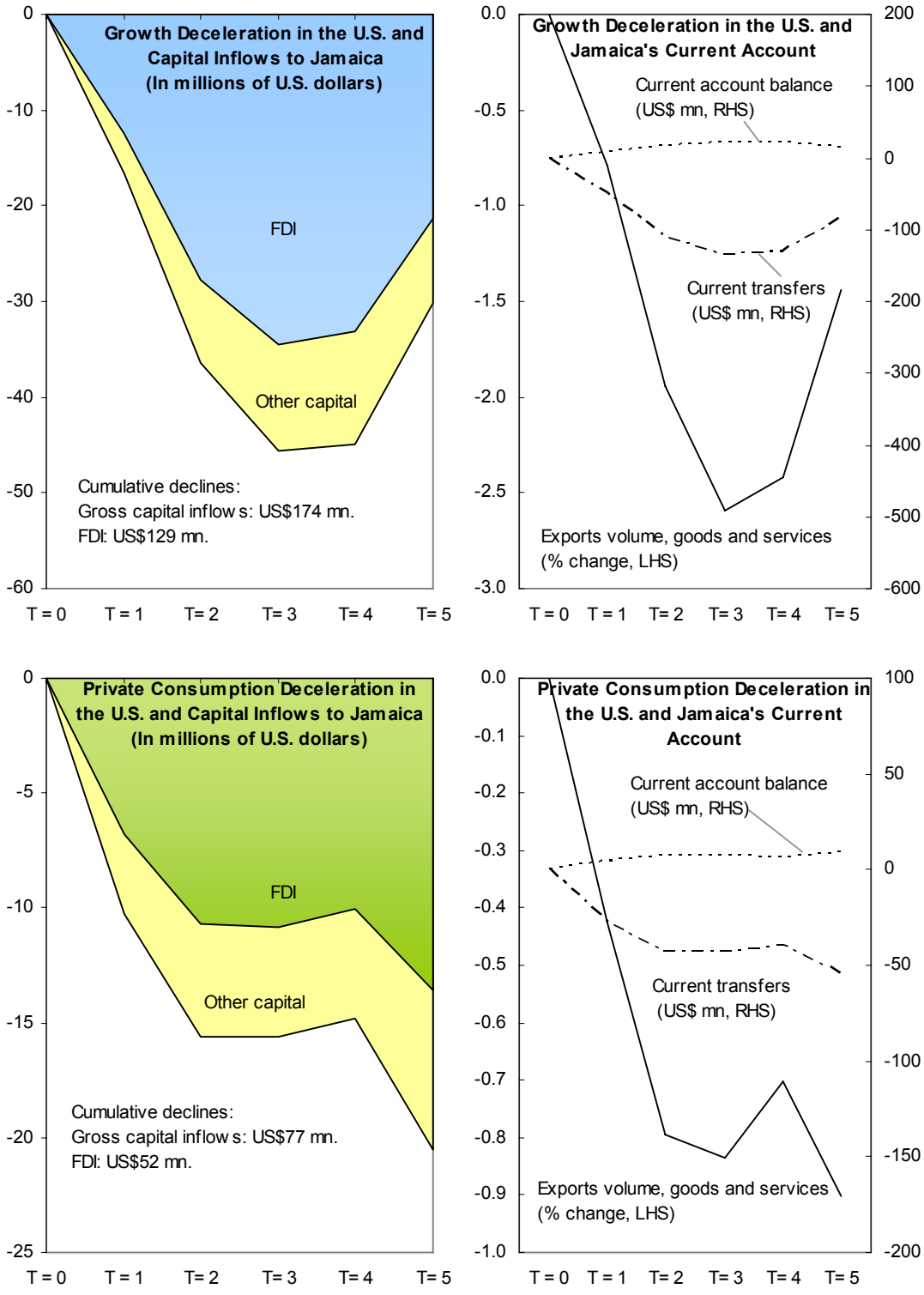
18. **Lower U.S. growth leads to lower capital inflows but the various impacts on the current account, while each significant, broadly cancel out in the aggregate**. Lower U.S. growth, by 2 standard deviations, leads capital inflows to Jamaica to decline in the model by about US$170 million cumulatively over a five-year period, mostly due to lower FDI flows. The current account, however, changes only marginally. The model does predict a sharp decline in exports as well as in current transfers from abroad. The latter, however, along with the decline in capital inflows, likely reduces available financing for imports, thereby explaining the model's prediction of a minimal impact on the current account. This is an intuitive result, as current transfers from abroad (mostly workers' remittances) can be expected to finance consumer imports, while FDI inflows to Jamaica have historically had a large import component. Furthermore, the price of oil, a major import item for Jamaica, can be expected to weaken with the U.S. slowdown, further reducing the latter's adverse impact on Jamaica's current account.

19. **Declines in U.S. private consumption and imports of goods and services have a broadly similar impact, but of a lower magnitude, on Jamaica's balance of payments**. In the case of private consumption, the lesser impact (compared to the impact of the U.S. growth slowdown) is likely due to the more stable nature of U.S. consumption along the business cycle. In the case of U.S. imports, the results may reflect factors not included in the model. For example, under the current global conditions, a decline in U.S. demand for Jamaican goods (income effect) may be counterbalanced by the depreciation of the Jamaican dollar vis-à-vis currencies other than the U.S. dollar, which has made Jamaica more competitive to tourists from Canada and Europe (substitution effect).

20. **Initial shocks applied to U.S. wages have a limited impact on Jamaica's capital account, but lead to more of a deterioration in the current account than do other shocks**. This makes intuitive sense as wage-specific U.S. shocks are most likely to affect remittances to Jamaica. On the other hand, a direct adverse impact on the capital account is unlikely. As the impulse works its way through other U.S. variables, however, some impact from those variables to capital inflows into Jamaica can also be expected.

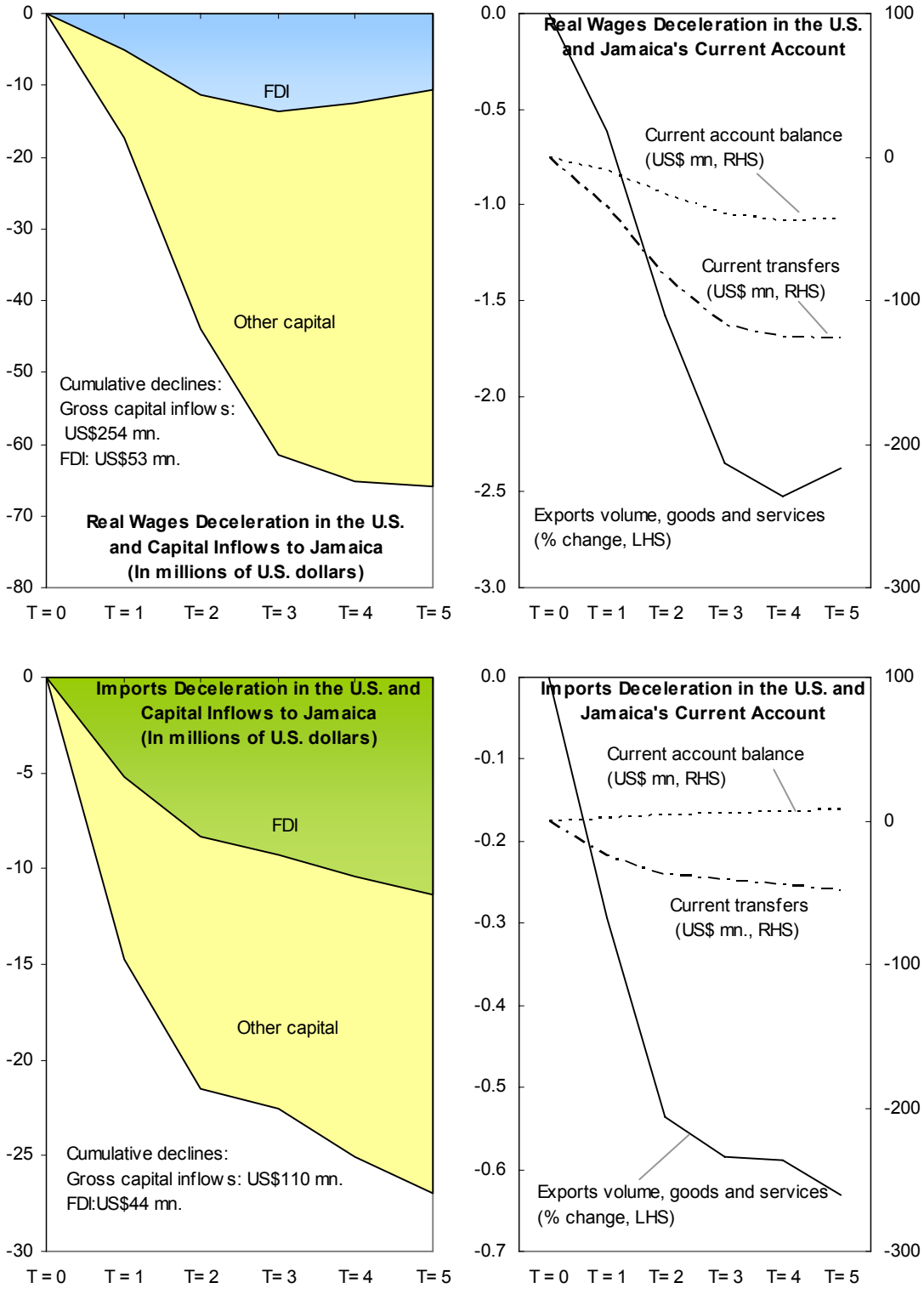
21. **When the initial shock is to credit, the decline in Jamaica's capital inflows appear larger**. Shocks to credit to the private sector in the U.S. show the largest impact, with an estimated decline in capital inflows to Jamaica by about US$500 million (roughly three times larger than the impact of GDP shock) cumulatively over five years. While significant, this figure, however, has to be compared against annual capital inflows into Jamaica in the range of US$1.5–1.9 billion in recent years. The impact on Jamaica's current account of a

Figure 3. Jamaica: Impact of Deceleration in U.S. Growth and Private Consumption



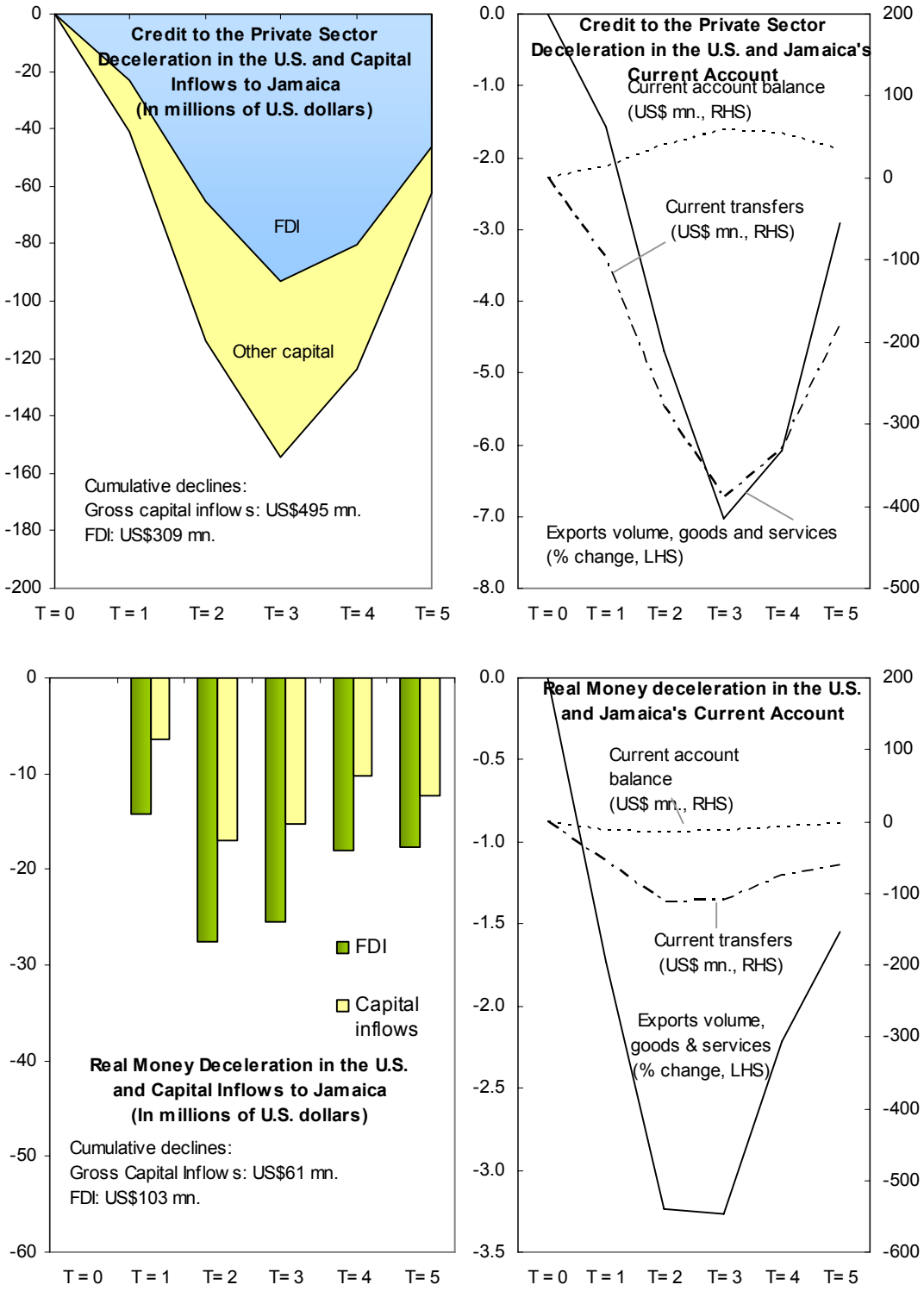
Sources: International Financial Statistics, IMF; country authorities; and Fund staff calculations and estimates.

Figure 4. Jamaica: Impact of Deceleration in U.S. Wages and Imports



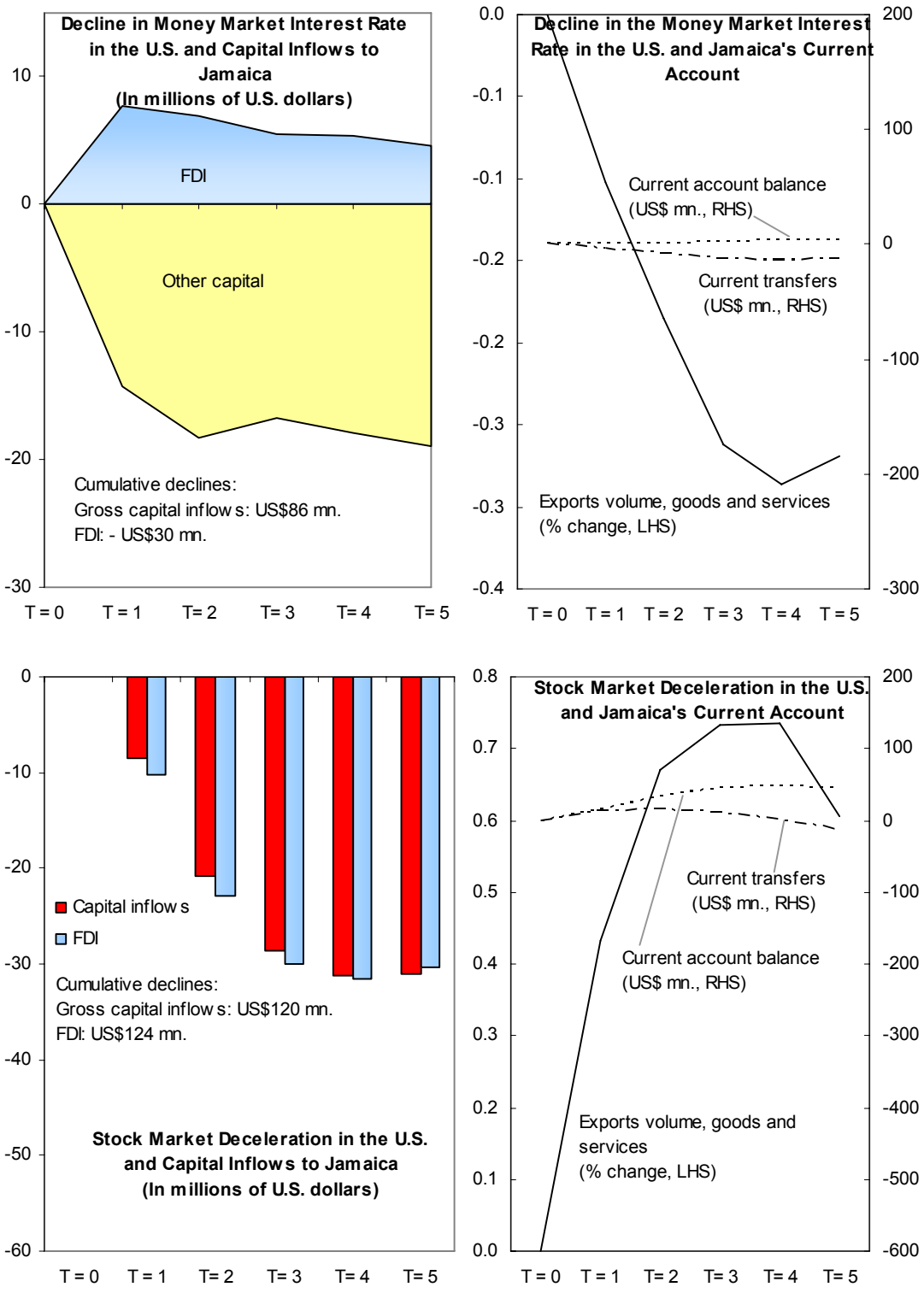
Sources: International Financial Statistics, IMF; country authorities; and Fund staff calculations and estimates.

Figure 5. Jamaica: Impact of Deceleration in U.S. Credit to the Private Sector and Money Balances



Sources: International Financial Statistics, IMF; country authorities; and Fund staff calculations and estimates.

Figure 6. Jamaica: Impact of Decline in U.S. Interest Rate and Asset Prices



Sources: International Financial Statistics, IMF; country authorities; and Fund staff calculations and estimates.

shock on credit is in the aggregate similar in magnitude to that of a shock to U.S. GDP growth. However, there are larger impacts on individual components of the current account—significantly larger declines in current transfers from abroad (of about US$1.3 billion cumulatively) and exports (with an estimated deceleration of 7 percentage points), are broadly offset by a decline in imports also of a larger magnitude.

22. **Declines in U.S. money market interest rates exhibit a relatively minor impact on Jamaica's external sector**. The results indicate a deceleration in net capital inflows of less than US$100 million over five years (the subcomponent—FDI flows—increase). The estimation also indicates almost no impact on the current account, exports and current transfers.

23. **The historical data suggests that declines in asset prices in the US do not appear to have had a strong impact on Jamaica**. Shocks to the U.S. stock market index, which can be interpreted as a proxy for asset prices in the U.S. in general, lead to a relatively low deceleration in net capital inflows to Jamaica. Specifically, capital inflows fall by an estimated US$124 million cumulatively over a five-year period, mostly due to lower FDI flows. The results also indicate that there is almost no impact on the current account, current transfers, and exports.

24. **The above-mentioned relation between U.S. asset prices and Jamaica, however, needs to be interpreted with caution**. Consumption responses to sharp asset price declines experienced by those who can afford to invest in stock markets are likely to be different from those whose only substantial asset is their home. Currently, there is an asset deflation in both the real estate and stock markets in the United States, but that has not always been the case in the sample period for this study. Thus, using the stock market index as a proxy for asset prices may not be a good predictor of the impact of the current U.S. economic stress.

C. Impact on Jamaica's GDP and Fiscal Accounts

25. **This section extends the analysis to the impact on Jamaica's GDP and government finances of changes in the external environment**. The same U.S. variables as in the preceding section are used as representative of external conditions, based on the same arguments. The external indicators to be shocked are chosen according to the same criteria. However, a richer model that also captures the dynamic relations between different Jamaican variables is used. As Jamaica's external variables are the first set of variables to be affected by external developments, it made sense above to regress each variable on external conditions separately. Developments in Jamaica's GDP and the fiscal accounts, however, reflect a complex set of interlinkages, not only with external variables but also between the Jamaican variables. The model used in this section seeks to capture that complexity.

Model

26. **The empirical strategy is to compare two forecasts for the Jamaican economy from the following VAR(1) model**:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 X_t + \varepsilon_t$$

where Y is a vector of endogenous Jamaican variables, X is a vector of exogenous variables that includes indicators of the U.S. economy as well as Jamaica's inflation, ε is an error term, and the alphas are matrices of coefficients. Sub-index t indicates year. The first set of forecasts assumes no shock to the U.S. variables whereas the second set does. The Jamaican endogenous variables included in Y are GDP, real exchange rate, the treasury bill interest rate spread over the U.S. treasury bill, government primary expenditure and government revenues, expressed in real terms and in logarithms (except for the interest rate spread that is expressed in levels). Introducing the Jamaican variables in levels requires cointegration among them, a hypothesis supported by econometric testing (see Appendix II). The lag structure of the VAR allows the endogenous variables to provide feedback to each other.

27. **The treatment of the real exchange rate, sovereign spread, and inflation merits some discussion**. The real exchange rate and the sovereign spread are included as endogenous because they are both important channels of transmission from abroad and they reflect feedback effects from GDP and the fiscal accounts; i.e., the Jamaican variables of interest. A strong argument can be made that inflation should also be treated as endogenous. However, treating it as exogenous allows the model to control for periods of above-average volatility and instability that is not related to developments in the global economy, and which introduce noise in the estimation. Two main sources of such instability in Jamaica are natural disasters (which are very frequent, lead to agricultural damage and a spike in the heavily weighted food component of inflation) and episodes of speculative pressure related to domestic, rather than external, developments.

28. **The impact on Jamaica of external shocks is the difference, one and two years forward, between the results of the two forecasts produced with the above equation**. In the first set of forecasts, the U.S. variable of interest is kept at a predetermined path and in the second, it is set at a negative two-standard deviation of its growth rate. The one-step-ahead difference provides a measure of the contemporaneous impact on Jamaica of the external shock while the two-step-ahead forecast allows for feedback effects within the Jamaican economy from one Jamaican variable to the next.[6] Note critically again that like in the preceding section, the results are not affected by either the variables' forecasted levels or by the assumed paths of exogenous variables. This is because the impact effect is estimated

[6] The fact that the Jamaican model is based on annual data implies that the feedback effect from one Jamaican variable to the next is picked up only in year two of the forecast. However, had a long time series with higher frequency been available, the feedback effect would have been observed earlier than a year after the shock.

as the *difference* between the two forecasts. Again, we take data and/or WEO estimates through 2007 as given and the forecasts are for the following two years.

Results

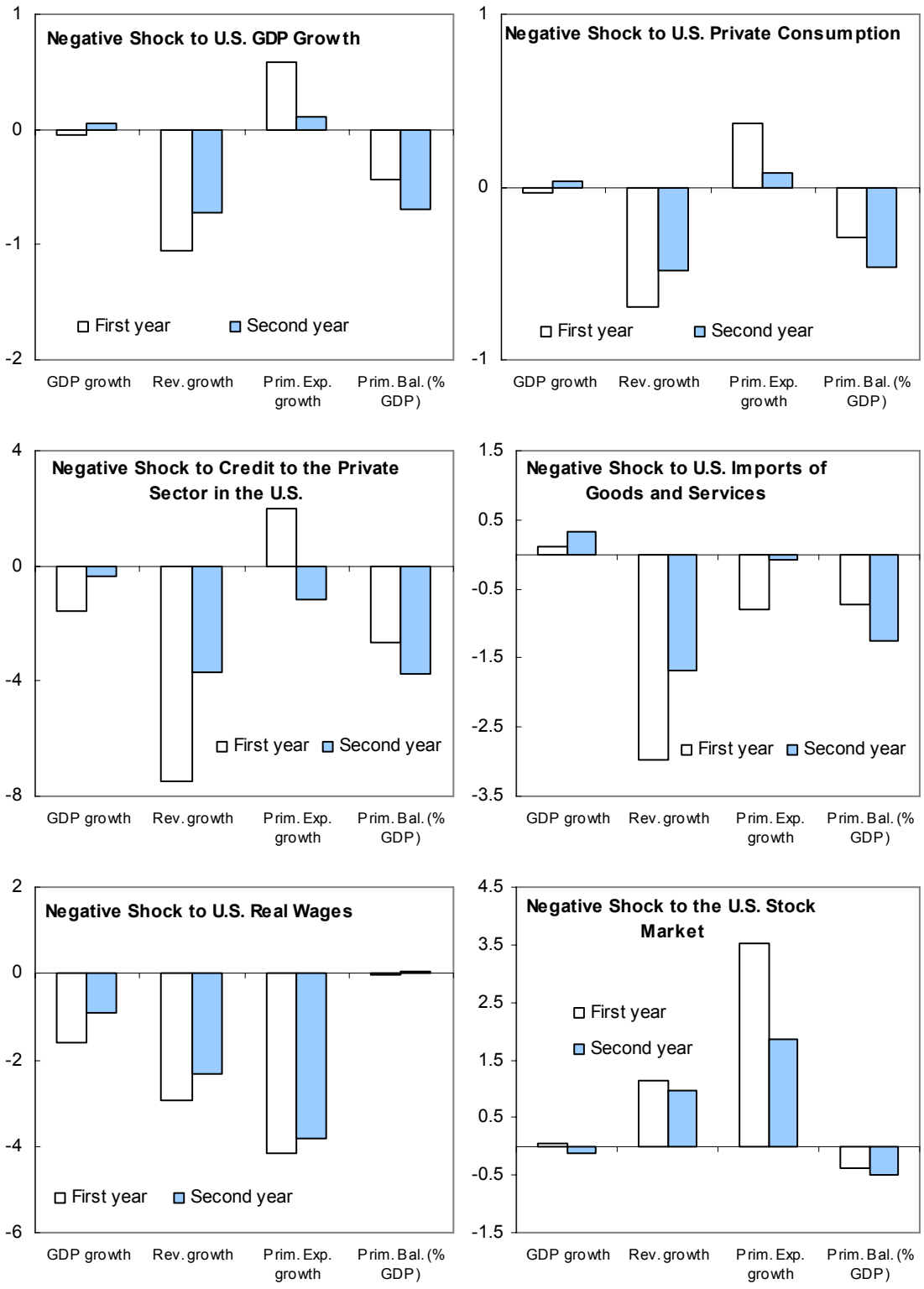
29. **The model suggests that U.S. economic stress has generally been associated with a deterioration of Jamaica's primary fiscal balance**. The primary balance worsens in almost all cases. This is the case, whether the initial shock is applied to U.S. real variables (GDP, consumption, imports) or to financial variables such as (credit to the private sector, stock market, and interest rates).[7] Figures 7 and 8 visually display the size of the deterioration in Jamaica's GDP, real revenues, real primary expenditures; and the primary balance stemming from shocks to different U.S. variables. The deterioration for GDP, real revenues and real primary expenditures are measured in terms of growth rates, in percent. For example, a bar value of -1 for real revenues indicates that it grows at a rate that is 1 percent lower in the scenario with a shock than in the one with no shock. Similarly, a value of -1 for GDP growth indicates that real GDP growth is 1 percentage point lower in Jamaica with a shock than without. The impact on the primary balance is, however, measured in terms of *percentage points of GDP*.

30. **The deterioration in the primary balance is caused in large part by lower revenues**. In all but one case (that of a shock to the stock market), revenues decline in Jamaica. The model does not explicitly account for the channels of transmission, as it relies purely on observed co-movements in the historical data. However, this result is not entirely surprising. While Jamaica's tourism sector enjoys numerous tax exemptions, the direct and indirect impact on revenues of a decline in tourism that could be caused by economic stress in the U.S. is still likely to be significant. Some of this impact could show up on taxes on imports. A quarter of tax collections in Jamaica are based on imports, which the preceding section suggests declines with macroeconomic stress in the U.S. Also, revenues from bauxite could decline if U.S. slowdowns cause global commodity prices to decline.

31. **The model generally predicts increases in primary expenditures in response to shocks, but the pattern is less clear than in the case of revenues**. The contemporaneous impact (the first year) is generally an increase in expenditures. This is, however, not true for shocks to imports and U.S. real wages. Furthermore, in some other instances, the direction of impact switches from the first year to the second. In sum, while the statistical analysis suggests that expenditure policy has generally been countercyclical, at least at the outset of an

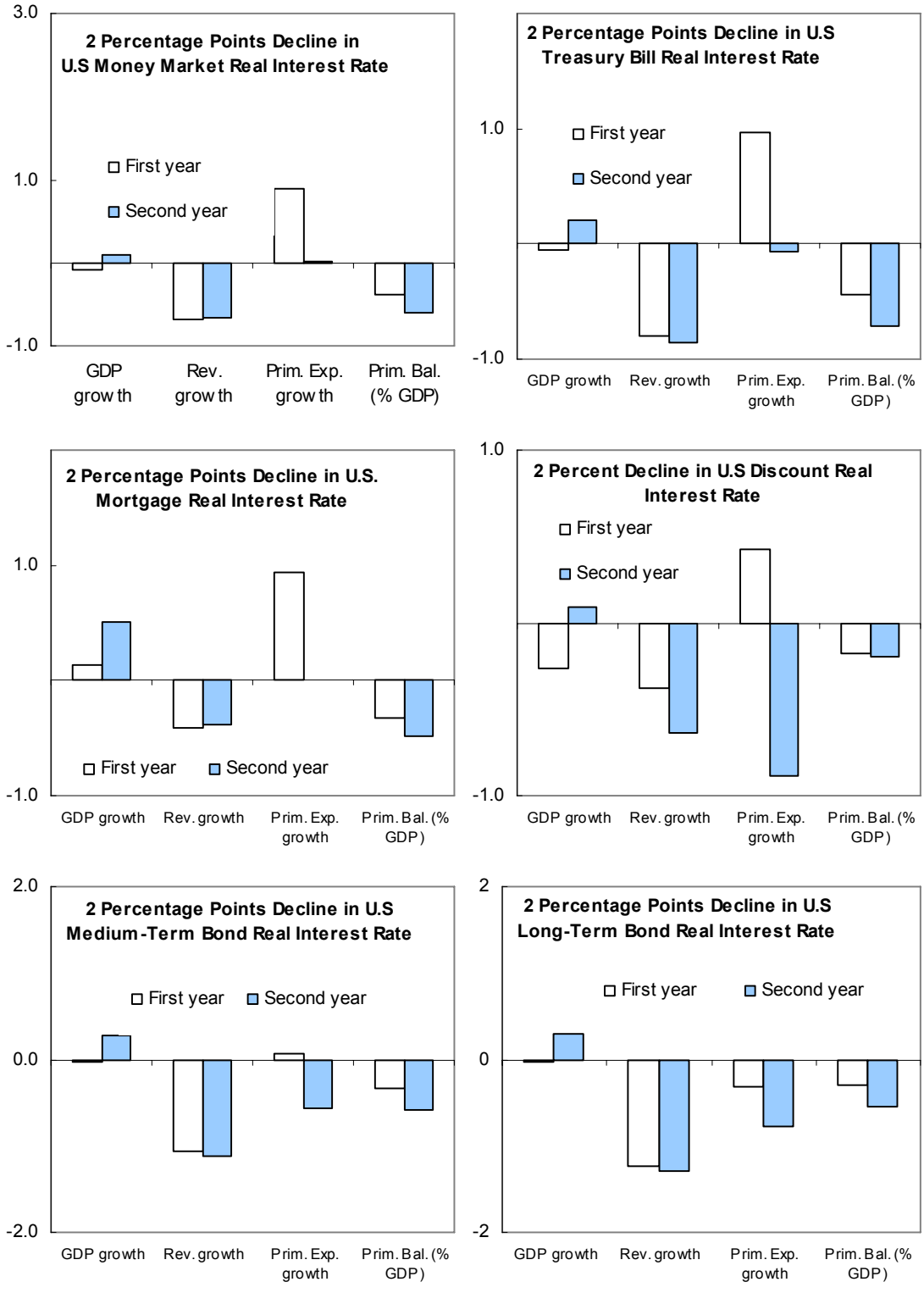
[7] Lowering of interest rates in the United States is usually associated with declining economic activity in the United States. Therefore, the impact on Jamaica should broadly be similar to that of negative shocks to U.S. GDP and consumption, which figure y generally shows to be the case.

Figure 7. Impact on Jamaican GDP and Fiscal Sectors I



Sources: Country authorities; and Fund staff calculations.

Figure 8. Impact on Jamaican GDP and Fiscal Sectors II



Sources: Country authorities; and Fund staff calculations.

external shock, it is not entirely clear why. That this has been a policy choice to limit the impact on the domestic economy of the shocks is very likely.

32. **In contrast to the fiscal position, external shocks have generally had only a limited impact on GDP growth in Jamaica**. Historically, Jamaica's GDP has shown little variability. Since 1993, Jamaica has not grown faster than 2½ percent. On the other hand, the economy has not shrunk on a year-to-year basis either, except during the banking crisis years of 1997–98 when annual contractions were limited to 1¼ percent. What variability there is in growth appears due to natural disasters. Simple growth correlations with the rest of the Caribbean, Latin America and the United States for 1991–2006 are statistically insignificant. Figures 7 and 8 show that with the exception of those cases where shocks are applied to credit to the private sector or real wages, GDP growth in Jamaica would most likely not be expected to contract very sharply in response to U.S. macroeconomic stress. The adverse effect on Jamaican growth of negative shocks to the U.S. variables may also have been limited by the countercyclical nature of Jamaica's fiscal policies, as outlined in the preceding paragraphs.

33. **A decline in credit in the U.S. economy or a decline in U.S. wages have a particularly sharp negative impact on Jamaica**. In the scenario of a credit decline (third chart in Figure 7), the model predicts lower revenue growth of more than 7 percentage points in the first year. Combined with increased expenditure, this leads to a deterioration of the primary balance by about 2 percentage points of GDP. The adverse impact on growth is also more pronounced than in other cases. As regards real wages, the model suggests that lower U.S. wage growth would result in the loss of more than 1½ percentage points of GDP growth in Jamaica and revenues lower by 4 percent. Lower U.S. wages are likely to affect Jamaica in two ways, explaining the larger magnitude of the impact. First, there is the direct impact on remittances and, hence, on aggregate demand in Jamaica. Second, lower U.S. wages will reduce U.S. demand for foreign goods and services, including from Jamaica, and thereby, adversely affect Jamaican growth.

D. Concluding Remarks

34. **The historical data show statistical relationships suggesting that U.S. economic stress and global financial turmoil can adversely affect Jamaica's balance of payments and fiscal accounts**. U.S. slowdowns have been associated with a worsening of the primary fiscal balance in Jamaica but have not had a very significant economic growth impact. However, a decline in credit to the economy in the U.S. does appear to affect growth in Jamaica in a significant way. Furthermore, credit crunches, as well as slowdowns in U.S. GDP growth, are associated with a persistent reduction in capital inflows. The results indicate that while export receipts and remittances can decline sharply, the impact on the overall current account balance is likely to be limited.

35. **There are a number of limitations to the study but the results are broadly intuitive**. As indicated above, the econometric models could be misspecified; possible nonlinear effects may not be accounted for; and, the coefficients' stability may be an issue, given the changing nature of the global financial structure and the degree of integration of Jamaica with the rest of the world. It is, therefore, important to exercise caution in interpreting the results. Importantly, the purely statistical nature of the models means that they do not explicitly account for the *economic* relationships and links among the variables (the results are based purely on observed historical co-movements in the data). In most cases, one can discern, from theoretical considerations, why the variables move in the fashion they do. This is, however, not possible in all instances, given the complexity of the real world and the limited number of variables included in the study for tractability reasons. Future research should focus on delving more deeply into why some of the variables move the way they do.

Appendix I. Section B Econometric Tables

These tables provide support to some of the assumptions in Section B. Table 1A tests for cointegration among the U.S. VAR model. Table 1B is a residual-based test for cointegration between the U.S. economy principal components and the Jamaican balance of payments indicators.

Table 1A: U.S. Economy Indicators Cointegration Tests

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability**
None *	0.84	306.61	159.53	0.00
At most 1 *	0.68	216.28	125.62	0.00
At most 2 *	0.65	160.45	95.75	0.00
At most 3 *	0.58	109.24	69.82	0.00
At most 4 *	0.50	67.16	47.86	0.00
At most 5 *	0.32	33.28	29.80	0.02
At most 6	0.23	14.24	15.49	0.08
At most 7	0.03	1.31	3.84	0.25

Trace test indicates 6 cointegrating eqn(s) at the 0.05 level.
* Denotes rejection of the hypothesis at the 0.05 level.
**MacKinnon-Haug-Michelis (1999) p-values.

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Probability**
None *	0.84	90.33	52.36	0.00
At most 1 *	0.68	55.84	46.23	0.00
At most 2 *	0.65	51.20	40.08	0.00
At most 3 *	0.58	42.09	33.88	0.00
At most 4 *	0.50	33.88	27.58	0.01
At most 5	0.32	19.04	21.13	0.10
At most 6	0.23	12.93	14.26	0.08
At most 7	0.03	1.31	3.84	0.25

Max-eigenvalue test indicates 5 cointegrating eqn(s) at the 0.05 level.
* Denotes rejection of the hypothesis at the 0.05 level.
**MacKinnon-Haug-Michelis (1999) p-values.

Notes:

Cointegration tests for the following US variables: Real GDP, stock market index, Fed Funds rate, money, credit to the private sector, imports, private consumption and wages.

All variables in real terms and expressed in logarithms, except for the interest rate which is not in logs.

Trend assumption: Linear deterministic trend.

Included observations: 49 after adjustments.

Sample (adjusted): 1958–2006.

Table 1B. Residuals-Based Tests of Jamaican External Sector Cointegration with the U.S.
ADF test statistic 1/ 2/

Capital inflows	-6.76
Current account balance	-5.72
Exports of goods and services	-4.74
FDI	-4.92
Current Transfers	-4.92

1/ Augmented Dickey-Fuller (ADF) test statistics for the residuals of the Jamaican external sector indicators on the U.S. economy principal components.

2/ All ADF test statistics indicate rejection of the hypothesis of a unit root.

Appendix II. Section C Econometric Tables

This table provides support to the assumption of cointegration between the Jamaican economy model in Section C and each of the U.S. indicators used as exogenous variables. It is a residual-based test that looks at the stationarity of the residuals of each model.

Table 2. U.S. Variables Included as Exogenous in the Jamaica VAR

	ADF test statistic 1/ 2/
U.S. GDP	-4.46
U.S. Credit to Private Sector	-4.52
Stock Market	-4.91
U.S. Imports	-4.52
U.S. Private Consumption	-4.49
U.S. Wages	-5.04
Fed Funds Rate	-4.54
Mortgage Rate	-4.49
LT Bond	-4.52
MT Bond	-4.52
T-Bill	-4.57
Discount Rate	-4.57

1/ Augmented Dickey-Fuller (ADF) test statistics for the residuals of the Jamaican economy model with U.S. indicators as exogeneous variables.

2/ All ADF test statistics indicate rejection of the hypothesis of a unit root.

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II. A Probabilistic Analysis of Debt Reduction in Jamaica[8]

A. Introduction

36. **There is broad consensus in Jamaica that public debt needs to be reduced and that fiscal effort is critical to that end**. Recognizing the severe costs on the economy of high public debt, the government adopted in 2004 an ambitious medium term plan to reduce the debt-to-GDP ratio from above 140 percent of GDP then to around 100 percent of GDP by 2009. The centerpiece of the plan was to raise and then maintain fiscal-primary-surplus-to-GDP ratios in the range of 13–14 percent of GDP throughout the medium term. In the event, while Jamaica has maintained very high primary surpluses in recent years, they have fallen short of the authorities' objectives and debt remains at 128 percent of GDP currently. As the new government that took office in late 2007 looks to reinvigorate the debt reduction strategy, the question that comes up is what level of fiscal consolidation to target? That, in turn, depends on the relationship between the fiscal effort and debt reduction.

37. **The relationship between the fiscal effort and debt reduction is not deterministic**. In a world with no uncertainty, the standard equation that relates debt to growth, the real interest and exchange rates, and the primary balance provides an unambiguous answer to the question of how much fiscal effort is required to reduce debt to the desired level. However, unanticipated shocks can impact on the first three variables and, as a result, even if the fiscal effort (measured by the primary surplus) turns out as planned, the debt outcome may be different from the one desired. Furthermore, the fiscal effort may itself deviate from the plan, due to both exogenous shocks (such as hurricanes) or to structural factors (such as weaknesses in the budget process).

38. **It is instructive to look at the relationship between the planned fiscal effort and debt reduction as probabilistic in nature**. The relevant question is then what level of the fiscal effort to target so that *on average* (i.e., after allowing for unanticipated developments, both exogenous and structural in origin), the desired debt outcome is achieved. National authorities may, however, not be satisfied with realizing the debt target only on average; they may want the assurance of a certain probability. In that case, the question is what fiscal effort to plan for so that the debt target can be achieved with the given desired probability after taking into account the possibility of unanticipated developments due to exogenous shocks as well as structural weaknesses.

39. **This chapter develops a framework to assess the probabilities of successful debt reductions**. It analyzes the movements of the key determinants of the debt level in response to past shocks. It then simulates the behavior of the variables going forward based on an econometric VAR model that is calibrated to replicate the patterns from the past. For any

[8] Prepared by Alejandro Guerson.

planned level of fiscal consolidation, the VAR model generates a very large number of simulated outcomes for GDP, the real exchange rate, revenues and expenditures, each subject to a random sequence of shocks from the same distribution as that observed in the past, to generate debt outcomes that, on average, are as desired. The large number of outcomes, however, also provide a probability distribution that can be used to answer the question of how certain the desired outcome is.

40. **The chapter demonstrates the importance of fiscal effort in achieving a lower debt level and with a greater probability of success**. The analysis concludes that the greater the planned fiscal effort is, the lower the debt level is on *average* at the end of the medium term and the higher the probability is that it is below any given threshold.

41. **The remainder of the chapter is organized as follows**. Section B places the chapter in relation to the existing literature and provides some background on Jamaica. The following section presents the methodology in some detail. Section D describes the main results and Section E concludes.

B. The Methodology in Relation to the Literature and its Applicability to Jamaica

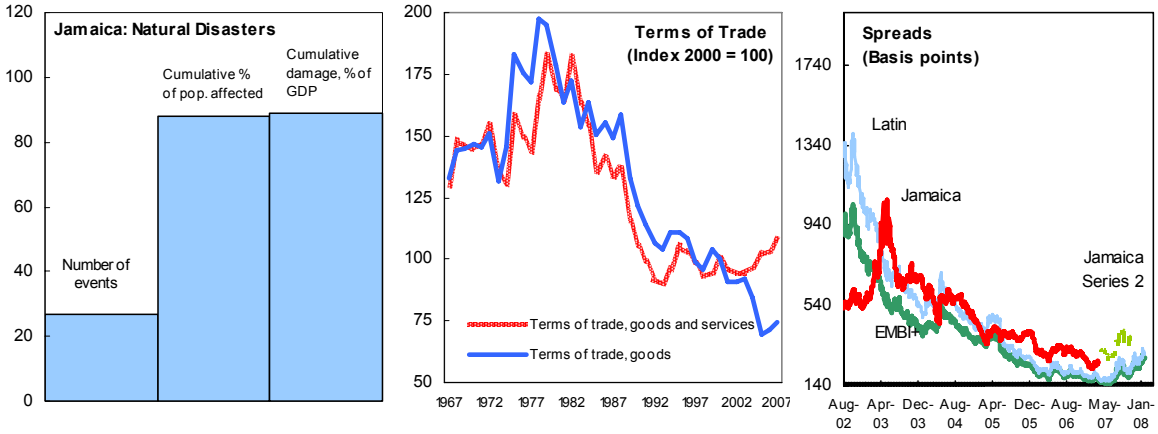
42. **The aim of this chapter is different in scope than most papers modeling stochastic debt dynamics**. While other papers have largely sought to examine whether public debt is sustainable, this chapter focuses on assessing the *dispersion* of the debt ratio at the end of the period, given the possibility of shocks. To the best of our knowledge, it is the first application of this kind of analysis to Jamaica. The results here are based on how the cyclical components of debt determinants have behaved in the past, and allows for long-term trends (to be interpreted as non-cyclical or permanent components) to be assumed exogenously. As a result, debt sustainability, as defined in the existing literature, can be imposed here by assumption, for example, by setting sufficiently low trend growth rates for primary expenditures or high growth rates for GDP. Debt sustainability is, however, not totally obscured by the model. The modeling strategy used here still allows us to calculate how the *average* debt level at the end of the period is related to the degree of fiscal effort, i.e., the trend growth rates of revenue and expenditure, or to the trend growth rate of GDP.

43. **The analytical framework in this chapter presents some disadvantages and limitations relative to the existing literature**. This includes the Lucas critique; i.e., that predicting the effect of policies based purely on historical correlations may be inaccurate as the parameters of the model may themselves change under alternative policy assumptions. There is also the potential risk that the stochastic component of the estimated model may be misspecified.

44. **The modeling technique, however also has the clear advantage of accounting for the shock-prone nature of Jamaica's small, open economy and its implications for**

successful debt reduction. Frequent natural disasters impose high costs on Jamaica (Figure 1). Other shocks stem from volatile and declining terms of trade in an environment where the export base is limited (largely tourism and bauxite based); the energy import bill is very large; and, the economy depends heavily on remittances from abroad. Developments in international financial markets can also be an important channel of shocks to Jamaica. At 98 percent, Jamaica's sovereign spreads are highly correlated with those of other emerging economies and shocks can transmit to Jamaica from developments affecting spreads in other emerging economies.

Figure 1. External Sources of Volatility in Jamaica



Sources: Rasmussen, *The Caribbean, From Vulnerability to Sustained Growth.;* JP Morgan; and Fund staff estimates.

45. **Other sources of volatility stem from debt and the financial sector**. Because of its high debt level, financial market sentiment can change quickly and abruptly in response to new developments that, in a country with a larger fiscal cushion, would be unlikely to do so.[9] This change in sentiment can impact, for example, the exchange rate, and thereby the debt dynamics. The public debt structure represents another source of volatility. Domestic debt is more than half the total and in the thin domestic money market, uneven redemption profiles, or the raising of large amounts of new financing, can have severe liquidity impacts and, thereby, affect variables such as the exchange rate. Furthermore, a large share of domestic debt is of the floating-rate variety, so interest rate shocks can significantly affect debt service costs, and therefore, overall sentiment. Furthermore, a large portion of the Jamaican financial sector comprises security dealers who finance long-term public bonds by issuing short-term repo instruments to the public. As a result, the sector is exposed to maturity and interest rate risk that can amplify shocks elsewhere in the economy.

[9] For example, Calvo (1988) shows that if public debt is sufficiently high, then expectations-based self-fulfilling deterioration of the debt dynamics is possible. The deterioration can also result from a coordination problem among debt holders in their decision to rollover debt.

C. The Model

46. **Projections of selected fundamental variables are used to compute the debt dynamics**. The variables determine the debt dynamics in accordance with the discussion in Box 1. The projections for the variables are themselves derived from econometric estimations that exploit how the variables have statistically been related to each other in the past.

47. **To obtain the projections for the fundamental variables, we calibrate the historical data to a Vector Autoregression (VAR) model of the form:**

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \beta_3 Y_{t-3} + \beta_4 X_t + u_t$$

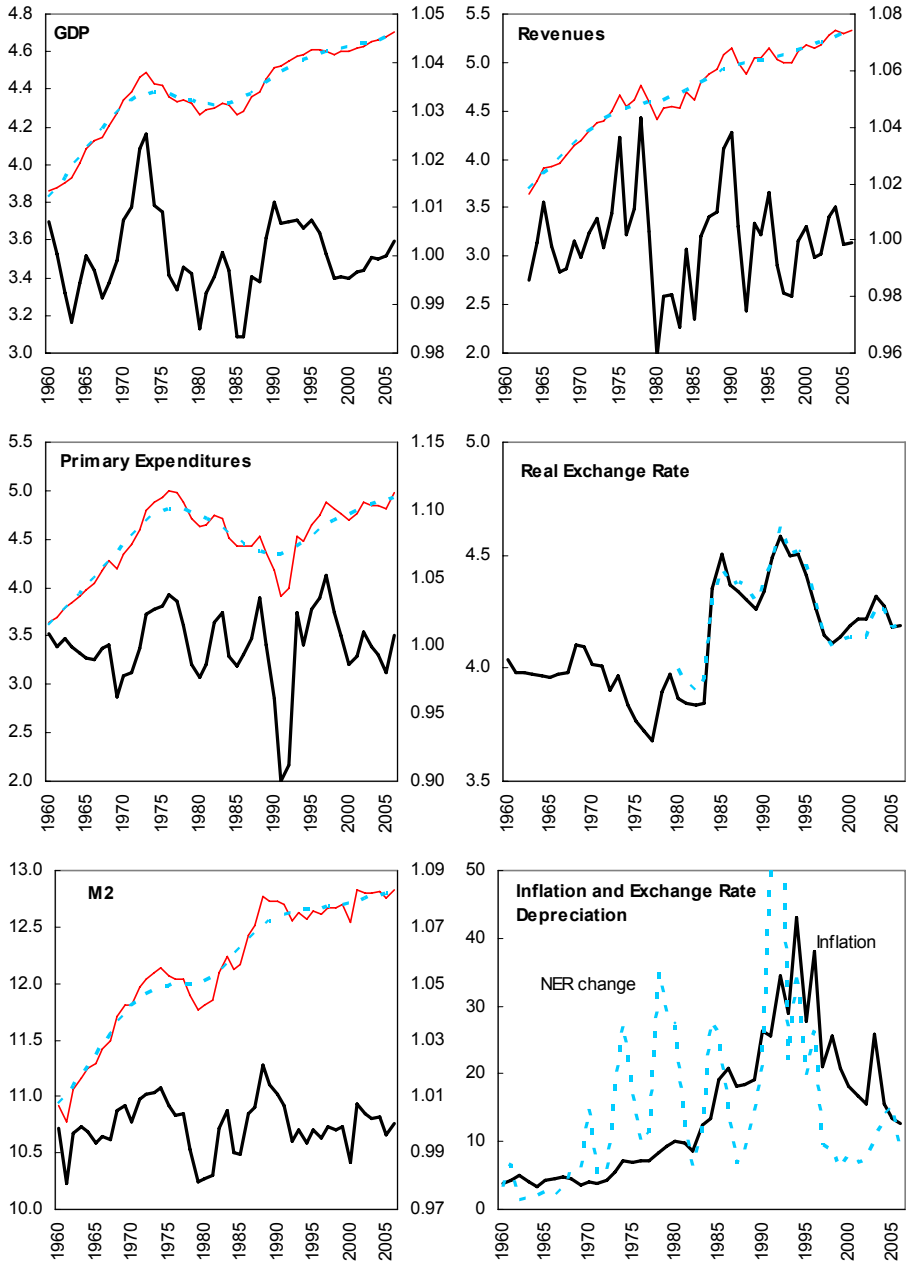
where the β are matrices of coefficients, Y is the vector of endogenous variables, X is a vector of exogenous variables and u is a Gaussian error term. There are four endogenous variables, representing: (i) the cyclical (i.e. de-trended) components of real GDP, real revenues, and real primary expenditures; and, (ii) the real exchange rate (expressed in levels because it is assumed to be stationary).[10] Historical trends of real GDP, revenues and primary expenditures were first calculated with the Hodrick-Prescott filter, on variables expressed in logarithms and the cyclical components (of real GDP, real revenues and real expenditures) are then defined as proportional deviations from the trend. The calibration includes three lags of each endogenous variable. Figure 2 shows the data series included in the simulation.

48. **The estimation also includes contemporaneous consumer inflation and three lags of the cyclical component of broad money in real terms as exogenous variables**. The cyclical component of broad money was included because it is an important determinant of the cyclical movement of the endogenous variables, possibly reflecting the monetary impulse to the economy. However, econometric testing reveals that the endogenous variables do not appear to be important in explaining the cyclical component of broad money, and hence the latter is not included as endogenous also. Inflation is included as an exogenous variable as it contributed significantly to improving the statistical qualities of the estimation. This is likely for two reasons: (i) inflation controls for excess volatility of all the variables during natural disasters, which lead to agricultural damage and a spike in the heavily weighted food component of inflation,[11] and, (ii) it controls for periods of speculative pressure characterized

[10] The real exchange rate is expressed in logarithms.

[11] Testing showed that using dummy variables in periods with natural disasters was not the best strategy because natural disasters tend to have a very wide range of effects, from mild to very severe. Inflation has the advantage of being a proxy for the intensity of the damage.

Figure 2. Series Used in the Estimation 1/



1/ All variables in real terms deflated using the Jamaica consumer price index, except for GDP, and expressed in logarithms. Inflation and exchange rate changes are annual changes of period averages, in percent.

The bolded line is the cyclical component used in the estimation, and the remaining lines show the original series (solid line) and the estimated trend (dotted line) used to infer the cyclical component. This is the case for all endogenous variables except the real exchange rate and inflation.

In the inflation chart, the dotted line is the nominal interest rate on Jamaica's Treasury Bills, which was included for reference. In the real exchange rate chart, the bolded series is the CPI-based bilateral real exchange rate vis-à-vis the United States and the dotted line is the real effective exchange rate, added for comparison purposes only.

Box 1. Debt Dynamics

The debt dynamics are calculated using the debt accumulation identity**.** Expressed in Jamaican dollars, this identity can be written as:

$$D_{t+1} + e_t D^*_{t+1} \equiv (1+r)D_t + e_t(1+r^*)D^*_t + G_t - T_t \quad (1)$$

where *D* is the stock of public debt, *e* is the nominal exchange rate, *r* is the interest rate, *G* is primary expenditures and *T* is revenues. The star supra-indexes denote foreign currency denomination, and sub-index *t* denotes years. We can rewrite the expression in real terms by dividing both sides by the price level p_t. In addition, we explicitly include the identity on gross debt issuances *I* and amortization payments *A* in year *t*:

$$\frac{D_{t+1} - D_t}{p_t} + \frac{e_t}{p_t}(D^*_{t+1} - D^*_t) \equiv \frac{r_t D_t}{p_t} + \frac{e_t}{p_t} r_t^* D^*_t + \frac{G_t}{p_t} - \frac{T_t}{p_t} \equiv \frac{I_t - A_t}{p_t} + q_t(I^*_t - A^*_t) \quad (2)$$

Let non-capital letters denote variables in real terms, so that $g_t = \frac{G_t}{p_t}, t_t = \frac{T_t}{p_t}, d_t = \frac{D_t}{p_t}$. Let also the inflation rate be $\pi_{t+1} = \frac{p_{t+1}}{p_t} - 1$.

We then decompose real revenues and primary expenditures into the permanent and the cyclical components by setting $g = g_t^p(1+\gamma_t)$ and $t_t = t_t^p(1+\tau_t)$, where supra-index *p* denotes the permanent component (trend) and $(\gamma_t; \tau_t)$ are scaling factors that capture the deviation from trend.

Furthermore, let $q_t = \frac{e_t}{p_t}$, which is a proxy for the real exchange rate. Then, (2) can be written as

$$d_{t+1}(1+\pi_{t+1}) - d_t + q_t(D^*_{t+1} - D^*_t) \equiv r_t d_t + q_t r_t^* D^*_t + g_t^p(1+\gamma_t) - t_t^p(1+\tau_t)$$
$$\equiv \frac{I_t - A_t}{p_t} + q_t(I^*_t - A^*_t) \quad (3)$$

We use identity (3) to track the evolution of the public debt stock across all debt simulations. It shows explicitly the main inputs used in our simulation exercise. Our simulation exercise provides values for the real exchange rate, inflation, the cyclical components of revenues and primary expenditures. Gross financing needs and sources are explicitly included in our analysis: we use pipeline interest and amortization payments (debt payments already contracted and coming due) and also we make assumptions on debt structure of the new debt issuances.

The fact that the cyclical component of GDP is included in the Jamaica model allows us to generate a GDP projection that is consistent with each simulation. These GDP projections are then used to compute debt stocks and debt service as a share of GDP.

by accelerated exchange rate depreciation and, given the pass-through to prices, also accelerated inflation.

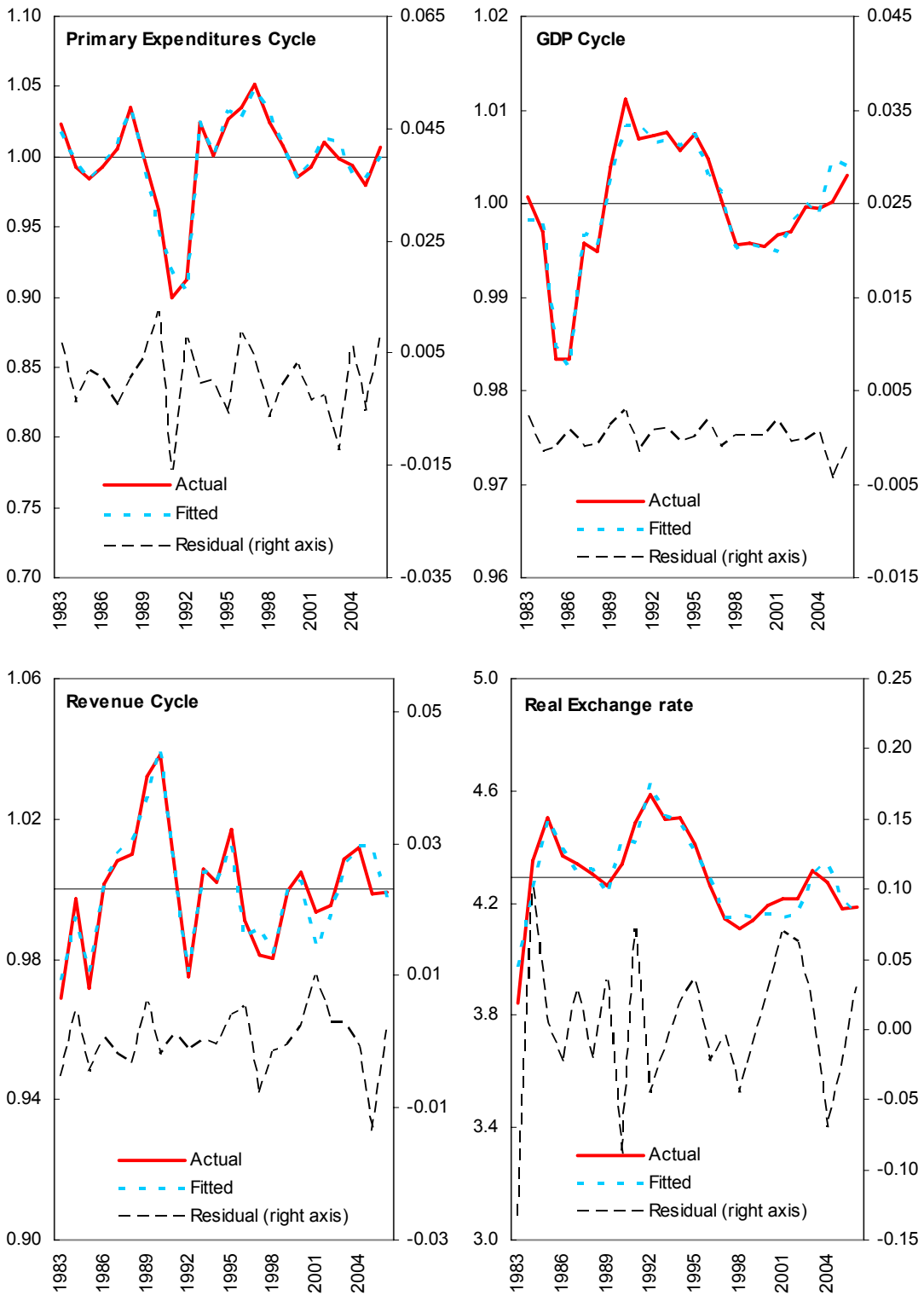
49. **Notice that the interest rate, a core determinant of debt dynamics, is not included in the VAR equations.** This is because interest payments are largely predetermined, in the sense that the current interest rate only affects interest payments in the future. This means that marginal interest rates observed in the markets can be different (sometimes very different) from average or implicit interest rates on debt. In addition, econometric testing shows that when CPI inflation is included as an exogenous regressor in the VAR then interest rates tend not to be statistically significant. This is explained by the high correlation between nominal interest rates and the rate of inflation. The result that CPI inflation performed better than nominal interest rates in the estimation was an additional reason to include it as a regressor instead of interest rates. Interest rates are introduced in the analysis in Box 1 as an exogenous parameter.

50. **The VAR model produces a good fit with the historical data, which is important to ensure that the simulated series have properties similar to those observed in the data**. All four endogenous variables are predicted with an average error of less than 1 percent for the sample period 1983–2006. Figure 3 displays the actual data and the predicted values of all endogenous variables in the VAR.[12] The high degree of fit of the cyclical component of primary expenditures is, in particular, noteworthy as one would expect spending to be a policy variable to a significant extent. The good fit implies that the endogenous response of primary expenditures to the state of the economy is well captured for the historical data with the set of variables included in the VAR.

51. **The next step is to perform a Monte Carlo experiment**. This entails generating a large number of simulated evolutions of the cyclical components of the fundamental variables (Real GDP, real revenues, etc.) To that end, we first generate disturbances u that provide impulses to the endogenous variables in the VAR, with their subsequent dynamic behavior determined according to the estimated coefficients in the VAR lag structure. The shocks u incorporate the correlation in contemporaneous co-movements in disturbances across the vector of endogenous variables. For example, if historically positive disturbances to GDP have coincided with positive disturbances in revenues, then the simulated sequence of shocks would account for this fact. The Monte-Carlo experiment generates 1000 simulated paths for the vector variables, covering four years starting from 2008 (the model takes estimates through 2007 as data).

[12] Tables with the estimated results are reported in Appendix I.

Figure 3. Predictive Power of the VAR Estimation



Sources: Country authorities; and Fund staff estimates.

52. **The output of the Monte Carlo experiment provides probability distributions for the evolution of the cyclical components**. The exercise generates a significant degree of dispersion in the simulated variables. The fan charts corresponding to the VAR (cyclical components of real determinants of public debt) and to the VEC (nominal exchange rate and level) simulations are shown in Figure 4. The cyclical components of real primary expenditures, GDP and revenues cycles are expressed relative to the projected trend. This means that for these three variables, a value of, for example, 1.02 in the chart implies that the variable is 2 percent above the trend. For the real exchange rate fan chart the values indicate the logarithm of the real exchange rate index. In the fan charts, the bolded line in the center indicates the expected value of the corresponding variable, and each subsequent pair of lines as one moves away from the expected value indicate confidence intervals of 50, 75, and 95 percent, respectively. The two bottom charts in Figure 4 are the CPI and nominal exchange rate fan charts as obtained from the decomposition exercise explained in Box 2.[13]

53. **Next, we assume trends, going forward, for the fundamental variables and apply to those trends the simulated outcomes from the Monte Carlo experiment**. The trends that we assume for real GDP, revenues and primary expenditures, to be interpreted as permanent or non-cyclical components, grow at a constant rate through the simulation period, starting from the end-of-sample point. To these trends we apply the simulated outcomes from the Monte Carlo experiment, which by construct have the same properties in terms of size, persistence and co-movement as in the sample period. The evolution of the real exchange rate comes from the VAR itself (where it is expressed in levels, unlike the other variables which are deviations from historical trend). The simulated real exchange rate series is decomposed into the nominal exchange rate, domestic prices and foreign prices (using the U.S. consumer price index as a proxy) from a parallel VEC estimation (see Box 2). The end results are 1,000 simulated paths for real GDP, real expenditures, revenues and the components of the real exchange rate, going forward into the projection period.

D. Results: Probabilities of Successful Debt Reduction

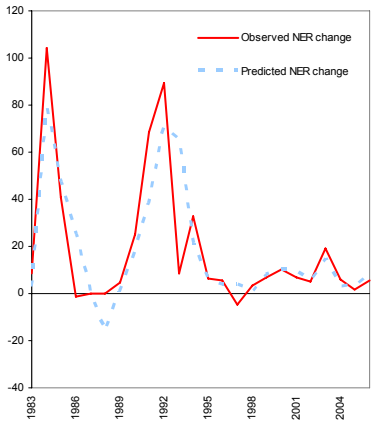
54. **Trends are imposed on the results from the Monte Carlo simulations to calculate debt dynamics and probabilities**. For illustrative purposes, two scenarios, each with a different trend for the main variables, are considered. In the first, historical trends (1986–2006) for real GDP, real revenues and real expenditures are projected forward. The trend has been of real growth of about 2.1 percent for each of these variables. Note that imposing this trend on the data means that we are imposing an improvement in the primary surplus from

[13] The confidence intervals in the fan charts are based on the Monte Carlo generated probability density functions for each indicator.

Box 2. Real Exchange Rate Decomposition

Each real exchange rate simulation is decomposed into the nominal exchange rate and the price level.

The relation between the nominal exchange rate and the price level is estimated using a Vector Error Correction (VEC) model (presented in Appendix 2). Then each simulated real exchange rate path is decomposed as follows: the real exchange rate proxy used can be written as $q = p^* e / p$, where q is the real exchange rate, p^* is the U.S. CPI index, e is the nominal exchange rate in units of Jamaican dollars per unit of U.S. dollars and p is the Jamaican CPI. Given this, one can compute the nominal exchange rate as $e = q\ p(predicted)\ / p^*$. The values for q are obtained from the VAR estimate above. The U.S. CPI inflation is assumed to take an exogenous and constant value. *p(predicted)*, indicates that the Jamaican price level is computed as a function of the lagged nominal exchange rate and price, using the equation for the consumer price index in the VEC estimate. This produces a good fit for the nominal exchange rate.



The strategy to trace the nominal exchange rate trajectory for each simulation is based on the result that, as the VEC estimation shows, consumer prices tend to have a more parsimonious behavior than the nominal exchange rate. Variance decomposition analysis shows that nominal exchange rates' variance is almost entirely explained by nominal exchange rate variability. However, in the case of consumer prices, the variance of consumer prices is mostly explained by that of the nominal exchange rate, and more so as the time horizon lengthens (Figure 4). Moreover, Granger causality tests show that changes in the nominal exchange rate cause changes in the price level, but the opposite is not true.

Variance Decomposition of the VEC Estimation of Nominal Exchange Rate and the Price Level; sample period is 1980–2006

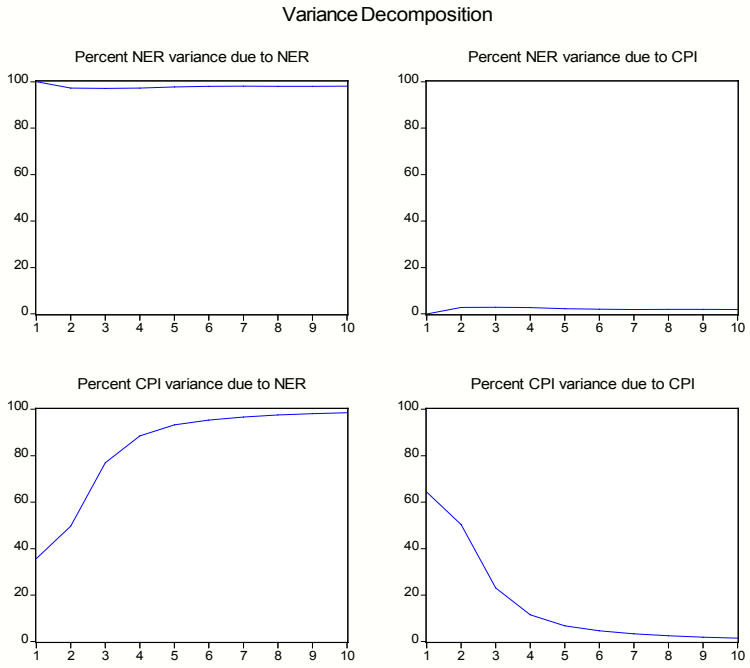
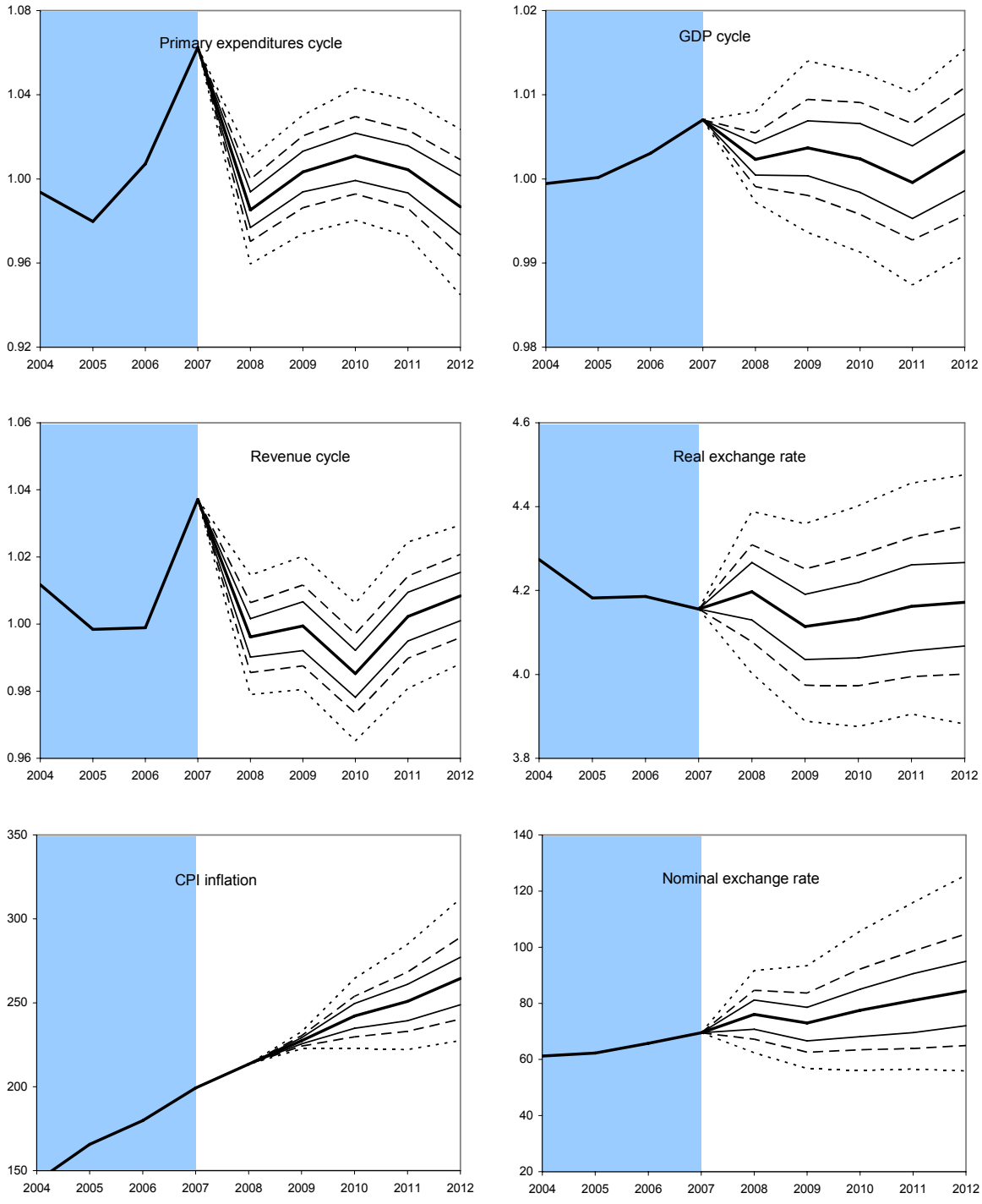


Figure 4. VAR Fan Charts

Cyclical components of GDP, revenues and expenditures, and real exchange rate

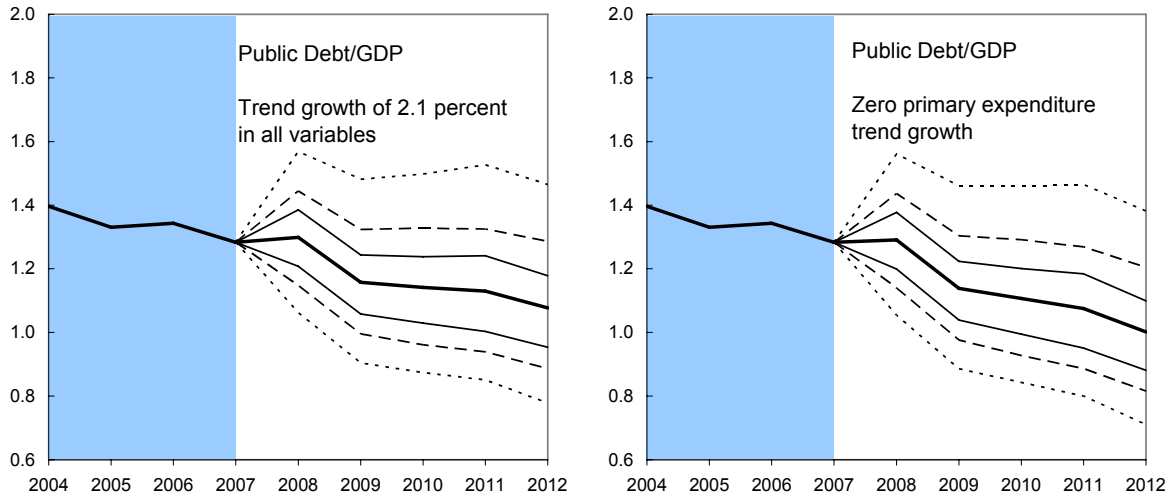


Sources: Fund staff calculations based on country authorities; and International Financial Statistics data.

the current level of 8.2 percent of GDP to 10.3 percent, *on average*, by the end of the projection period. The improvement occurs despite the continuation of the historical trend into the future because the current point is below what the long-term trend (of 2.1 percent) would suggest it should be. In the second scenario, the trends for real GDP and real revenues are the same as in the first one but real expenditures are assumed to remain flat (i.e., zero growth). Under this latter scenario, the primary surplus improves to 12.6 percent, on *average*, by 2012.

55. **Assumptions for a number of other variables are also required but are not critical to the analysis**. These include U.S. inflation; LIBOR; interest rates on different types of Jamaican debt (both domestic and foreign) and assumptions about what type of new debt is issued to finance the deficit. Given that the results mainly contrast one scenario with the other (where these variables are kept unchanged), the precise assumptions are not very relevant. In particular, they do not embody any specific policy advice, nor do they necessarily reflect the authorities' intentions. Broadly, short-term interest rates in Jamaica are assumed to decline from 2009 onwards while LIBOR is kept fixed at 5 percent over the medium term, U.S. annual inflation is kept at 2.5 percent, and the authorities are assumed to roll-over all maturing external debt and finance residual needs by issuing more domestic debt (where the share of variable rate instruments is maintained at about one-third).

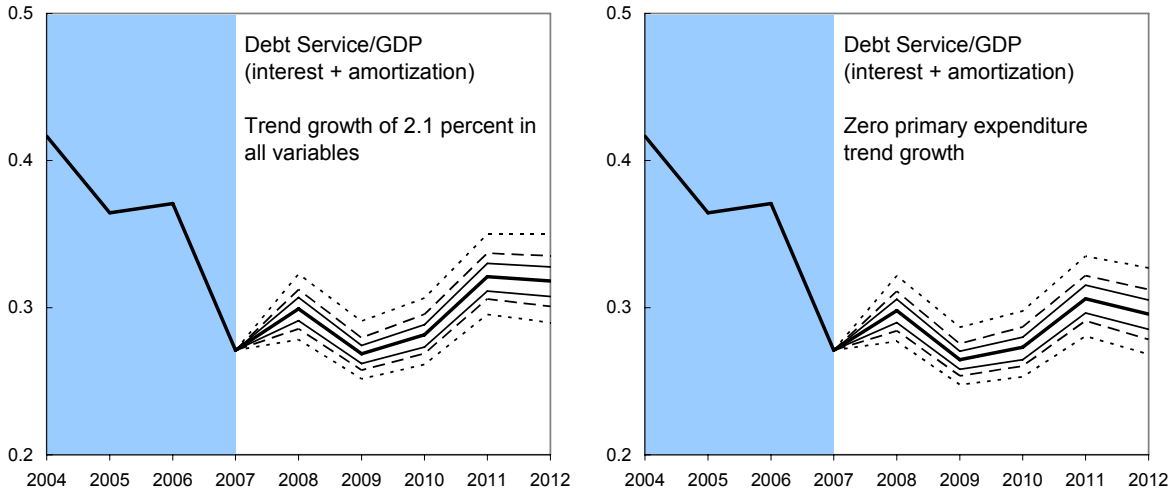
56. **As would be expected, public debt declines, on average, to a lower level in the second scenario**. On average, by 2012 debt declines to 108 percent of GDP in the first scenario and to 100 percent in the second. There is, however, a significant degree of dispersion in the outcomes for both scenarios, as indicated by the attached figures.



The bold line is the expected trajectory. Each subsequent pair of lines away from the expected trajectory represent probabilities of 50 percent, 75 percent, and 95 percent, respectively.

57. **It is noteworthy, however, that there is less dispersion in the debt service than in the debt levels in either of the two scenarios**. The reason for the relatively low variability is

that debt service is largely predetermined by the existing debt at the start of the projection period (2008 here). The slightly upward trend of debt service is an artifact of the assumption that domestic debt in local currency, which is shorter in maturity than other types of debt, is assumed to be the residual rollover instrument to fill the financing gap.



The bold line is the expected trajectory. Each subsequent pair of lines away from the expected trajectory represent probabilities of 50 percent, 75 percent, and 95 percent, respectively.

58. **Notably, greater fiscal consolidation also improves the probability of reaching any given debt target**. Given the stochastic nature of the debt dynamics in this analysis, no level of the fiscal effort will guarantee a given desired debt outcome. Shocks, which in this study are modeled from the past, could impact on growth or the real exchange rate. Furthermore, the primary surplus itself may end up being different from that planned (hence, our emphasis on the *average* primary surplus at the end of the horizon under the two scenarios). Nevertheless, the Monte Carlo simulations illustrate that the probability of reaching any given debt target are higher under the second scenario than in the first (see attached table).

Public Debt and Fiscal Consolidation

	Debt Threshold by 2012, in percent of GDP							
	130	120	110	100	90	80	70	60
	(Probability of achievement)							
2.1 percent uniform trend growth	89	78	59	36	15	4	0	0
Zero real expenditure growth 1/	95	87	75	53	30	11	2	0

1/ Assumes zero primary expenditure trend growth and 2.1 percent trend growth of revenues and expenditures annually.

59. **Growth remains critical to reducing debt**. Imposing a trend of 0.9 percent per year for growth (and hence presumably for real revenues and real spending) instead of 2.1 percent in the first scenario results in a debt-to-GDP ratio in 2012 of 118 percent in expected terms, or almost 10 percent of GDP higher. In addition, the probability of the debt ratio declining to below 100 percent of GDP declines to about 17 percent from 36 percent and the probability that the debt ratio actually increases from end-2007 goes up to 27 percent rather than 12 percent.

E. Concluding Remarks

60. **This chapter develops a framework to assess the prospects for debt reduction under uncertainty**. The analysis draws on the statistical behavior of key variables in the past to project how they can move, relative to trends, in future. The model then derives probabilities for achieving a variety of debt outcomes for any given trend growth in GDP and the fiscal effort.

61. **The past statistical behavior may, however, not persist into the future and changes in both the environment and policies can increase the probabilities of successfully reducing debt**. The behavior of the variables in the past reflect both exogenous shocks and policy weaknesses resulting in deviations of revenues and expenditures from trends. The model derived in this chapter imposes the same distribution of deviations from trend going forward as that existed in the past. However, structural changes to Jamaica and the world economy are likely to have changed the pattern of exogenous shocks. Furthermore, the policy environment itself changes over time. Such changes would affect the extent to which deviations from, say planned expenditures, occur because of weak monitoring. This, in turn, affects the probability of reducing debt going forward.

62. **The key conclusion from the analysis is, however, likely to remain valid even with changes in the environment or policies**. The conclusions are that the greater the fiscal effort or higher GDP growth is, the lower the debt level will be in the medium term on *average*; and the higher the probability that it will be below any given threshold.

Appendix I. Jamaican Economy Model

Table 1A. VAR Estimation

	Primary Expenditures	GDP	Revenues	RER
Primary expenditures (t-1)	-0.072	-0.214 ***	-0.223	1.607
(t-2)	0.423	0.098	0.187	-0.063
(t-3)	0.115	-0.043	-0.108	-1.144
GDP (t-1)	4.637 **	0.654	0.882	2.281
(t-2)	0.174	0.807 **	0.147	-17.420
(t-3)	-3.836	-0.604	0.027	10.670
Revenue (t-1)	-1.108 ***	0.116	-0.076	-1.351
(t-2)	-0.620	-0.246	-0.443	0.865
(t-3)	0.632	0.030	-0.451	0.986
RER (t-1)	0.085 *	-0.041 ***	-0.029	0.802 **
(t-2)	0.116	0.058 **	0.117	-0.363
(t-3)	-0.018	-0.013	-0.053	-0.138
Constant	3.928 **	0.249	-2.227 *	-0.176
CPI inflation	-0.001 ***	0.000 **	-0.001 ***	0.006 **
M2(t-1)	-1.144	0.256	1.567 ***	0.178
(t-2)	-1.529 **	-0.033	1.132 **	6.246
(t-3)	-1.359 **	-0.084	0.445	0.200
R-squared	0.959	0.950	0.914	0.891
Adj. R-squared	0.865	0.834	0.718	0.643
F-statistic	10.202	8.245	4.659	3.589
Mean dependent	0.998	1.000	1.000	4.293
S.D. dependent	0.035	0.007	0.017	0.163

Sample period is 1983–2006. "*" indicates significance of 90 percent, "**" of 95 percent, and "***" of 99 percent. All variables except CPI inflation and the real exchange rate (RER) are cyclical components, detrended using the Hodrick-Presscot filter.

Table 1B. Granger Causality Tests

	Dependent Variable			
Lags	Primary Expenditure	GDP	Revenue	RER
Primary Expenditure	..	20.44 ***	3.06	1.06
GDP	5.73	..	1.90	1.76
Revenue	8.11 **	7.40 **	..	0.44
RER	17.55 ***	14.90 ***	2.01	..
M2	13.05 ***	1.96	12.37 ***	1.44
All	46.95 ***	51.71 ***	49.78 ***	9.53

Numbers reported are Chi-square statistics for the null hypothesis of the lags being simultaneously equal to zero.
Sample period is 1983–2006. "**" indicates significance of 95 percent and "***" of 99 percent.
All variables except CPI inflation and the real exchange rate (RER) are cyclical components,
detrended using the Hodrick-Presscot filter.

Appendix II. Inflation and Exchange Rate Depreciation Equations

Table 2. Vector Error Correction Estimation for Nominal Exchange Rate (NER) and Consumer Prices (CPI), Sample: 1980–2006

	dNER	dCPI
Cointegrating equation		
NER (t-1)	1	
CPI (t-1)	-0.183 ***	
C	-14.673	
Error correction		
Cointegrating coefficient	0.079	0.320 ***
dNER (t-1)	0.391	0.031
dNER (t-2)	0.109	0.746 ***
dCPI (t-1)	-0.343	0.172
dCPI (t-2)	0.222	-0.170
Constant	2.156	4.699 ***
R-square	0.212	0.830
Adj. R-square	0.024	0.789
F-statistic	1.127	20.455 ***

The letter "d" indicates the variable is in first differences.
"***" indicates significance of 99 percent.

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