Growth and Distributional Effects of Fiscal Reforms in Jamaica

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Abstract

The Government of Jamaica introduced a series of fiscal reforms in 2009 and 2010 to combat the adverse effects of the global crisis. This paper offers an illustrative analysis of the potential growth and distributional impacts of these policies, as well as other potential policy changes aimed at increasing productivity and accelerating growth. The simulations are implemented with a computable general equilibrium (CGE) model for Jamaica and complemented with a micro-accounting exercise to obtain the poverty and distributional effects. The results show that future growth and poverty reduction depend critically on the ability of the government to stay the course of recent fiscal reforms. In particular, maintaining the recent fuel tax increases or replacing them with an equivalent set of fiscal measures and implementing the recently adopted Fiscal Responsibility Framework (FRF) will be key to improving growth performance and lowering the debt ratios. Despite the negative effects of increased taxation on incomes of the poorer parts of the population, the acceleration in growth and the long-term improvement in the fiscal position due to these reforms are likely to lead to lower poverty outturns in the long run.

Keywords: Jamaica, fiscal reforms, general equilibrium, poverty

JEL classification: E62, D58, D31, I32

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1. Introduction

In response to the adverse effects of the global crisis and in an effort to improve fiscal sustainability and boost revenues, the Government of Jamaica introduced a series of fiscal measures in 2009 and 2010. These measures included three sets of amendments to the existing tax schedules as well as the adoption of the Fiscal Responsibility Framework (FRF), designed to strengthen the budget process by enhancing the mechanisms for transparency and establishing clearer goals, targets, and limits for public spending, deficits, and debt. The ultimate objective of the FRF is the achievement of explicit targets for public debt, public sector wage bill, and the overall fiscal balance, while the tax packages—including significant changes to the rates and structure of income taxes, general and specific consumption taxes, license fees, customs exemptions, and import tariffs—were introduced to broaden the tax base and increase the uniformity of the tax system, therefore boosting revenues and buttressing fiscal sustainability.

This paper offers an illustrative analysis of the potential growth and distributional impacts of these recently implemented or soon to be implemented policies, as well as other potential policy changes aimed at increasing productivity and accelerating growth. The forward-looking analysis in the paper is based on linking the 2007 Jamaica household survey with a recursive dynamic computable general equilibrium (CGE) model of the same base year. The CGE model is solved recursively for each year between 2007 and 2020, and the shocks to main variables in the model are then passed on to the household survey to generate counter-factual income distributions. Comparisons across scenarios—including no policy change (business-as-usual), tax reform, adoption of the FRF, accelerated productivity growth, and changes in the composition of the investment mix and changes in the skill content of the labor force—thus allow for an assessment of the potential distributional effects of the policy actions by the government.

The paper finds that future growth and poverty reduction depend critically on the ability of the government to stay the course of recent fiscal reforms. In the no reform scenario, the public debt burden continues to rise from the current high levels, limiting fiscal space for productive expenditure, crowding out private investment through heavy borrowing on the domestic market, and consequently hampering future growth potential. However, growth is likely to improve and debt ratios are likely to return to a sustainable trajectory if the government is able to strengthen revenue collection (e.g., by maintaining the recent fuel tax increases or replacing them with an equivalent set of fiscal measures) and implement the recently adopted Fiscal Responsibility Framework (FRF). At the same time, caution is advised in the design of any fiscal rule which includes capping capital expenditure, as losses to TFP growth from a reduction in productive public investment (e.g., public infrastructure) could erase much of the gains from a stronger fiscal position. Investments in measures that accelerate productivity growth and in human capital (e.g., by improving the quality of the education system or designing incentive schemes to reduce emigration and brain-drain) can help the country make important inroads in achieving faster growth and reducing poverty.

The remainder of the paper is structured as follows: Section 2 briefly describes the data and the model, Section 3 discusses the simulation results, and Section 4 offers some caveats and concluding remarks. Annexes A and B develop the CGE and micro-simulation models, respectively, in more detail. For each scenario, the simulation results are contrasted with a hypothetical, no-reform scenario which maintains the policy variables as they were in 2007 while lining up the macro variables to the IMF/World Bank forecasts. The main objective of this paper is to inform the government of the potential consequences of

various reforms and therefore to enable the government to properly sequence such reforms and/or design policies to compensate any potential adverse impacts on vulnerable groups of society.

2. Model and data

This section develops a recursive dynamic computable general equilibrium (CGE) model as well as the micro-accounting module used to translate the CGE results into poverty and inequality outcomes. The CGE analysis is carried out by contrasting a baseline simulation with a set of alternative scenarios for the years 2007-2020. The results of these simulations are subsequently mapped to the 2007 household survey (Jamaica Survey of Living Conditions) to explore the potential impacts of changes in the macroeconomic and sectoral variables on household welfare, poverty, and the distribution of income.

The CGE model of this paper is a recursive dynamic extension of the model used by Bussolo and Medvedev (2008) to analyze labor supply dynamics and international competitiveness in Jamaica. At its core, the model is a standard World Bank single-country CGE model with a mostly neo-classical structure which is augmented by the addition of a labor-leisure tradeoff in the household utility function, therefore allowing labor supply to be determined endogenously (see Annex A for model details). As discussed in Bussolo and Medvedev (2008), the introduction of an endogenous labor supply is particularly important in the case of Jamaica where labor force participation rates have been declining, in large extent due to increased international remittances (see World Bank, 2007, and Kim, 2007).

The model has a base year of 2007, drawing on a collection of data sources. The base year data include a Social Accounting Matrix (SAM) constructed specifically for this exercise and employment by sector and skill calculated from the 2007 Jamaica Labor Force Survey (LFS).[1] The base year of 2007 was chosen in consultation with Jamaican counterparts as the most recent year that can be considered an equilibrium period for Jamaica (since 2008 and 2009 were years of large external shocks and consequent distortions to relative prices). The macro data for 2007, including national accounts, government financial statistics, and the balance of payments, were obtained from the Central Bank of Jamaica, Planning Institute of Jamaica (PIOJ), and the Statistical Institute of Jamaica (STATIN), while data on debt stocks was collected from the IMF. Sectoral data on value added and investment were also obtained from the above mentioned Jamaican sources, while the consumption vector has been estimated using data from the 2007 Jamaica Survey of Living Conditions (SLC).[2] The input-output coefficients as well as the structure of indirect taxes have been taken from the 2005 Jamaica SAM constructed by Robinson and Willenbockel (2009).[3]

The model includes three representative household groups, defined according to the sector of employment and skill level of the household primary earner from JSLC. The introduction of three representative households—unskilled rural, unskilled urban, and skilled— adds an important distributional dimension to the analysis because the sources of income, both labor and other types, vary substantially by household type.[4] For example, the two former groups receive very little income from bonds, while the latter group receives a substantial share of its income from interest paid on government bonds.

[1] See World Bank (2011) and the references therein for a description of the LFS.
[2] See World Bank (2011) and the references therein for a description of the JSLC.
[3] As is normally the case with combining multiple data sources, a final balancing procedure using a cross-entropy approach had to be applied to the input-output coefficients.
[4] Skilled primary earners are those that have some type of secondary school certificate.

Following the base year, the model is solved year-by-year through 2020. In order to generate a dynamic solution, certain assumptions have been made regarding the evolution of the model's exogenous variables. BaU (business-as-usual, or no-reform) growth has been calibrated using the near- and medium-term assumptions of the IMF; the evolution of remittances, FDI, and the overall capital account also draws on the IMF sources. For years beyond the IMF projection period (2015-2020), the assumptions extend the trends of several preceding years (2012-2014). The maximum labor supply available in each period evolves according to the World Bank population projections for the 15-64 age cohort, but the actual quantity of labor supplied in each period is determined endogenously by the model.

The CGE simulations are complemented with a micro-accounting exercise similar to the techniques described in Bussolo et al (2008) and Ravallion and Lokshin (2008). The income distribution of 2007, obtained from the 2007 JSLC, is shocked with CGE-generated changes in total household income for each representative household group, prices of consumption goods faced by each household group, and overall consumption per capita (as a consistency requirement) to produce a counter-factual income distribution in 2020 (the details of the micro-simulation approach are provided in Annex B). The process is repeated for each scenario and, although solutions for intermediate years could easily be obtained, only the 2020 results are presented and discussed in this paper.

3. Scenario analysis

This section analyzes the likely macroeconomic and distributional consequences of the fiscal reforms recently implemented and announced by the Jamaican government as well the potential impacts of other policies conducive to generating additional growth. The particular reforms chosen for analysis in this section—including an increase in fuel taxes and the adoption of the fiscal responsibility framework (FRF)—have been selected from the consolidated matrix of donor activities in Jamaica, with an eye towards selecting reform actions which are most likely to have substantial macro and distributional impacts as well as those that are quantifiable in terms of fiscal policy actions by the government. The impact of each reform is contrasted with the BaU (no-reform) scenario in order to isolate the marginal impact of each set of policy changes.

3.1. Business-as-Usual (no-reform) scenario

The BaU (no-reform) scenario incorporates the adverse impacts of the global food, fuel, and financial crises of 2008-09, and projects a smooth but gradual recovery in 2011-2020. The behavior of the main macro variables in the BaU scenario is summarized in the first few columns of Table 1. The combined impacts of the food/fuel and financial crises in 2008-10 lead to a cumulative loss of 4.6 percent of real GDP (relative to 2007). From 2011 onwards, the economy recovers gradually, achieving annual growth of 2 percent by 2012 and 2.1 percent in 2014 and each year thereafter. The baseline growth is plausible as the recent crisis created a considerable slack in the economy and per capita income grows at an average annual rate of 0.8 percent over the entire period 2007-2020. Following a sharp contraction in 2008-09, growth in exports and imports rebounds in 2010; after that, trade at constant prices grows at a rate similar to real GDP. The real exchange rate, which depreciated significantly in 2009, recovers gradually towards its 2007 level in the following years as the availability of foreign financing improves in the course of the global recovery.

Table 1: Macro Summary Indicators, 2007-2020

	No-reform						JDX + Tax Reform					FRF + JDX + Tax Reform				
	2007	2008	2009	2010	2015	2020	2008	2009	2010	2015	2020	2008	2009	2010	2015	2020
National accounts (percent change y-o-y)																
GDP at constant prices		-1.70	-2.50	-0.50	2.10	2.10	-1.70	-2.62	-0.41	2.34	2.48	-1.70	-2.62	-0.41	2.43	2.54
Private consumption		-0.7	-4.9	1.3	2.5	2.6	-0.7	-5.6	0.7	2.6	2.7	-0.7	-5.6	0.7	2.5	2.7
Public consumption		-1.7	-2.5	-0.5	2.1	2.1	-1.7	-2.6	-0.4	2.3	2.5	-1.7	-2.6	-0.4	2.4	2.5
Investment		7.5	-38.8	10.6	1.3	0.0	7.5	-37.4	16.3	2.5	2.0	7.5	-37.4	16.3	3.2	2.6
Exports		-7.8	7.2	5.2	1.8	2.0	-7.8	6.5	3.6	1.9	2.2	-7.8	6.5	3.6	2.0	2.3
Imports		0.4	-18.9	10.7	2.2	2.0	0.4	-19.3	11.0	2.5	2.5	0.4	-19.3	11.0	2.6	2.6
Balance of payments (US$ million)																
Current account balance	-1,968	-2,315	-864	-1,020	-1,328	-1,356	-2,315	-864	-1,020	-1,328	-1,356	-2,315	-864	-1,020	-1,328	-1,356
(as percent of GDP)	-14.5	-16.9	-7.1	-7.9	-9.3	-8.6	-16.9	-7.1	-7.8	-9.2	-8.3	-16.9	-7.1	-7.8	-9.1	-8.3
Balance on goods and services	-3,344	-3,776	-2,083	-2,301	-2,980	-3,292	-3,776	-2,078	-2,396	-3,194	-3,696	-3,776	-2,078	-2,396	-3,204	-3,737
(as percent of GDP)	-24.6	-27.6	-17.0	-17.7	-20.9	-21.0	-27.6	-17.0	-18.4	-22.0	-22.7	-27.6	-17.0	-18.4	-22.0	-22.9
Exchange rate	*68.95*	*68.32*	*72.11*	*69.26*	*69.20*	*69.33*	*68.32*	*71.87*	*68.87*	*68.74*	*68.79*	*68.32*	*71.87*	*68.87*	*68.72*	*68.77*
Public finance (percent of GDP)																
Overall balance	-4.1	-6.9	-8.7	-10.6	-12.5	-17.0	-6.9	-7.1	-5.3	-3.8	-3.4	-6.9	-7.1	-5.3	-2.0	-2.0
Government revenue	23.3	23.4	22.7	22.9	23.2	23.3	23.4	24.2	24.7	24.9	24.8	23.4	24.2	24.7	24.9	24.8
Total expenditure	27.4	30.3	31.4	33.5	35.7	40.2	30.3	31.3	30.0	28.7	28.2	30.3	31.3	30.0	26.9	26.8
Recurrent expenditure	24.0	26.0	27.9	28.5	32.3	36.8	26.0	27.8	25.0	25.3	24.8	26.0	27.8	25.0	24.7	23.7
Capital expenditure	3.4	4.3	3.5	5.1	3.4	3.4	4.3	3.5	5.1	3.4	3.4	4.3	3.5	5.1	2.1	3.1
Debt	115	127	141	145	168	205	127	140	139	128	120	127	140	139	119	106
Foreign	51	67	78	81	93	111	67	77	79	77	75	67	77	79	74	69
Domestic	64	60	63	64	75	95	60	63	60	51	45	60	63	60	45	36
Memo (percent change y-o-y)																
Employment		1.638	2.430	1.125	1.020	0.325	1.638	2.362	1.138	1.034	0.346	1.638	2.362	1.138	1.055	0.364
Population		0.426	0.463	0.499	0.368	0.343	0.426	0.463	0.499	0.368	0.343	0.426	0.463	0.499	0.368	0.343

The BaU path of the fiscal variables is less favorable, as both the overall deficit and the stock of public debt continue to increase through 2020.[5] In the no-reform scenario, the government maintains a fairly strong fiscal stance, with non-interest recurrent outlays remaining around 13 percent of GDP and capital expenditures stable at 3.4 percent. This enables the government to continue recording strong primary surpluses, averaging 6.1 percent of GDP between 2007 and 2020. However, the high level of existing debt and high costs of debt service push the economy on an increasing debt path. By 2012, the stock of public debt exceeds 150 percent of GDP and continues to rise to above 200 percent of GDP by 2020 (Figure 1). These debt dynamics illustrate the difficult situation and the pressing need for fiscal and debt reform faced by the government in 2009-2010. Despite the global recovery and even with strong primary surpluses, the debt trajectory would likely have been unsustainable without further, aggressive policy action.

Under the no-reform conditions, poverty and inequality are likely to continue their downward trends but at a slower rate than in the past. World Bank (2011) showed that between 1997 and 2007, poverty in Jamaica fell from 19.9 to 9.9 percent of population, while the Gini coefficient declined from 38.3 in 2003 to 36.8 in 2007. Going forward, these trends are likely to continue but at a much more moderate pace. The results of the micro-accounting exercise are summarized in Table 2, which shows that in the no-reform scenario, the moderate poverty headcount could fall by another 3.5 percentage points, while the Gini coefficient could decline by half a point. The main reason the no-reform scenario does not deliver more poverty reduction is the relatively slow rate of growth in per capita consumption. Additionally, this scenario does not incorporate the pro-poor shift in relative prices observed between 2003 and 2007 (see World Bank (2011) for a more detailed discussion). Finally, poverty reduction is more difficult when the initial headcount is lower: it takes a much higher rate of growth to halve poverty from an initial headcount of 10 percent than from an initial headcount of 20 percent.

Table 2: Micro Summary Indicators, 2007 and 2020

	2007	2020, BaU (no-reform)	2020, JDX + Tax Reform	2020, FRF + JDX + Tax Reform	2020, FRF + JDX + Tax Reform less product.
Extreme poverty headcount (%)	2.86	1.54	1.54	1.54	1.65
Poverty headcount (%)	9.91	6.41	6.11	6.09	6.89
Poverty gap (x100)	2.48	1.44	1.40	1.38	1.52
Poverty gap squared (x100)	0.95	0.53	0.52	0.51	0.55
Gini	36.78	36.32	36.03	36.05	35.80
Theil (GE1)	23.75	23.13	22.74	22.76	22.43

3.2. Tax reform and Jamaica debt exchange (JDX)

The first alternative scenario incorporates the major tax changes in fiscal years 2009 and 2010 as well as the Jamaica debt exchange (JDX) in February 2010. This scenario (JDX + tax reform) includes the largest measures (in terms of expected revenue impacts) from the series of tax amendments implemented by the Jamaican authorities in FY2009-2010, such as the increase of the SCT rate on petroleum and petroleum

[5] Public debt is defined as all public (general government), publicly guaranteed, and PetroCaribe debt—the same definition used by the IMF.

products (from J$7.36 to J$16.11 per liter of unleaded gasoline) and the subsequent re-introduction of the ad-valorem component of the SCT on petroleum, as well as the increase in the general rate of the GCT (Table 3). In addition, the scenario also takes into account the decrease in the rate of interest paid on domestic and foreign debt after the JDX.

Table 3: Revenue measures introduced during the FY2009/10

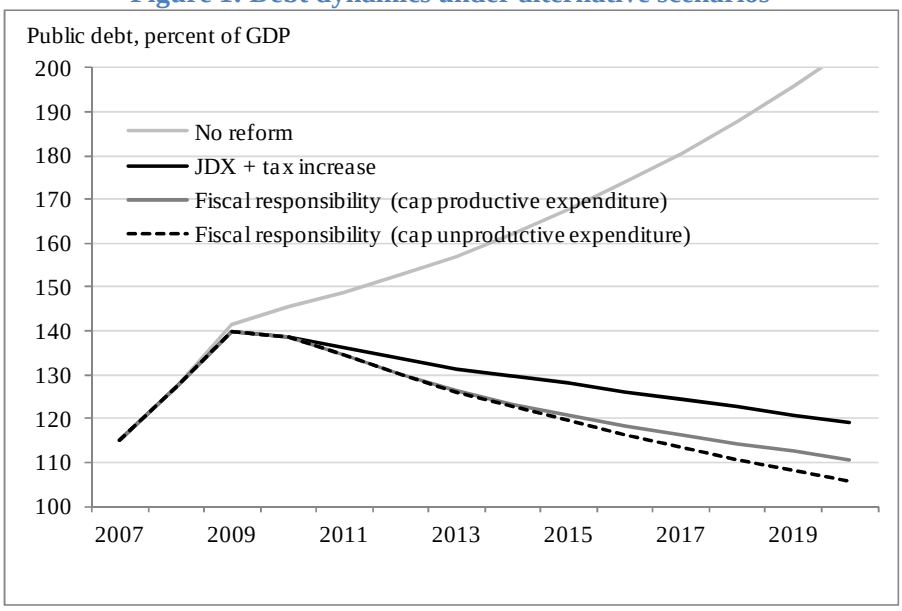
Date introduced	Description of revenue measures	Expected revenue impact (J$ million)
April 23, 2009 (Ministry Paper 26/09)	Increase in income tax threshold	-5,330
	Removal of income tax preferences	1,200
	Reduction in stamp duty and transfer tax rates	-644
	Imposition of GCT on telephone instruments	736
	Removal of GCT exemptions	7,500
	Increase of SCT on petrol and CUF on petroleum products	13,328
	Imposition of withholding tax on dividends for non-residents	1,341
	Total expected revenue impact	**18,131**
May 6, 2009 (Ministry Paper 42/09)	Increase of SCT on cigarettes	1,840
	Increase of SCT on alcoholic beverages	530
	Total expected revenue impact	**2,370**
September 29, 2009 (Ministry Paper 107/09)	Increase of departure tax	609
	Increase of GCT on telephone calls and telephone instruments	1,100
	Total expected revenue impact	**1,709**
December 23, 2009 (Ministry Paper 128/09, revised)	Increase in the standard rate of GCT	3,600
	Re-introduction of the ad valorem component of the SCT	9,400
	Increase in SCT on cigarettes	1,400
	Increase in the rate of GCT applicable to the Tourism Sector	1,200
	Electricity for commercial and industrial customers	1,453
	Pre-payment of GCT on value added merchandise at customs	2,900
	Increase in income tax for high income earners	1,317
	Increase in license fees for luxury vehicles	32
	Removal of certain customs exemptions	25
	Increase in Common External Tariff rate on luxury items	485
	Total expected revenue impact*	**21,812**

Note: GCT stands for General Consumption Tax, SCT for Special Consumption Tax, and CUF for Customs User Fees. For the first three sets of measures, estimated revenue impacts are provided for FY2009/10; for the last set, revenue impacts are annual estimates.
Source: Jamaica Ministry of Finance.

The improved fiscal outcome of this policy reform scenario makes a strong case for strengthening revenue collection as it puts Jamaica on a declining debt path. The key outcomes of the JDX + tax reform

scenario are summarized in the middle columns of Table 1. The immediate effect of the tax reform is a J$19.0 billion increase in indirect tax revenue in 2010, somewhat below the government's forecast of J$26.3 billion increase.[6] At the same time, the JDX saves the government another J$29.5 billion in interest expense in 2010. Therefore, the overall result of the policy change is a 5.3 percent of GDP improvement in the overall balance in 2010. This substantial strengthening of the fiscal position broadens the resources available to the government for making debt payments and decreases borrowing needs. Consequently, debt ratios stop rising immediately; by 2014, the debt-to-GDP ratio falls to 130 percent, and it continues declining to 120 percent of GDP by 2020 (Figure 1). The declining borrowing needs also play into the virtuous circle of lower debt and higher overall balance: compared with the no-reform scenario's interest payments of 24 percent of GDP in 2020, the interest costs in the JDX + tax reform scenario are 12 percent of GDP in the same year. The lower interest payments limit the overall deficit to 3.4 percent of GDP, compared to a projected 17.0 percent in the no-reform case.

Figure 1: Debt dynamics under alternative scenarios



The improvement in the fiscal position has important positive spillovers for real GDP growth. Although initially growth is impacted negatively by the tax increase (the contraction in 2009 is 2.6 percent rather than 2.5 percent without the tax increase), growth recovers quickly. By 2015, growth is 0.2 percentage points higher than in the no-reform and by 2020, this premium widens to 0.3 percentage points. As a result, GDP per capita in 2020 is more than two percentage points above the BaU GDP of the same year. The positive growth spillover is mainly due to the decreased borrowing needs of the government, which has a positive impact on private investment through reduced crowding-out effects.

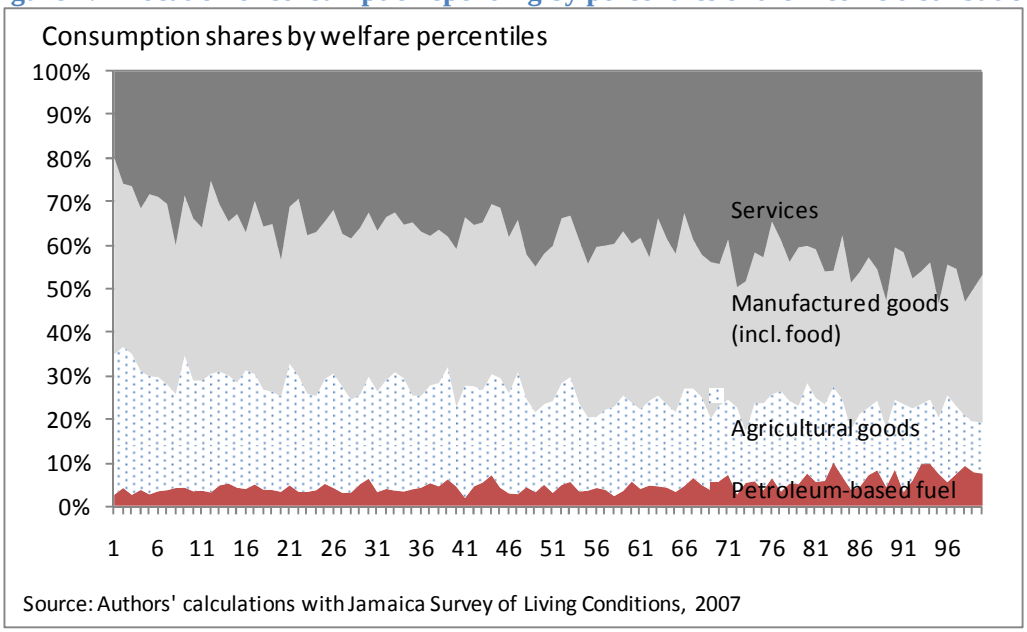
Real consumption per capita, on the other hand, remains unchanged in the first reform scenario. This is because the JDX + tax reform scenario in reality represents a transfer of resources within the economy and does not generate new income. The gains in real GDP are observed because the economy's resources

[6] The discrepancy stems to a large extent from the greater-than-expected impact of the global crisis, which resulted in a stronger than anticipated contraction in economic activity in Jamaica and consequently in lower-than-budgeted tax revenues.

are shifted towards accumulation of new capital stock, rather than financing of debt which does not create factors of production. However, the reduction in public borrowing is only made possible by taxing households and enterprises at higher rates and lowering the rate of return on their bond holdings. Therefore, initially the policy shock represents an income loss to the households, which is then compensated by increased demand for investment goods—which stimulates domestic output and increases demand for domestic factors of production—and the efficiency gains from stemming the falling capital-output ratio in the no-reform scenario. However, the efficiency gains are also limited by the choice of financing instrument, since increases in indirect taxes distort economic incentives and erode competitiveness.[7]

Although shifts into indirect taxation are usually regressive—because poor people consume a larger portion of their income—the incidence of the petrol tax is actually progressive. Even though the petrol tax increase is welfare-enhancing on average, its implementation could have adverse distributional effects if poorer parts of the population consume more gasoline (relative to their total spending) than the richer segments. This is normally why consumption taxes are considered regressive, as they affect a greater share of a poor person's income than a rich person's income. However, in the case of Jamaica raising gasoline taxes is unlikely to widen welfare disparities because gasoline is a luxury good and its consumption (as a share of total consumption spending) is an increasing function of household welfare (Figure 2). For any household, gasoline consumption is a small share of total household budget; however, a poor household normally spends approximately 3 percent of its total expenditure on gasoline while the same share for a household above the poverty line is 4.7 percent. Therefore, the increase in the petrol tax imposes a higher burden (in relative terms) on the better-off households than on the poor.

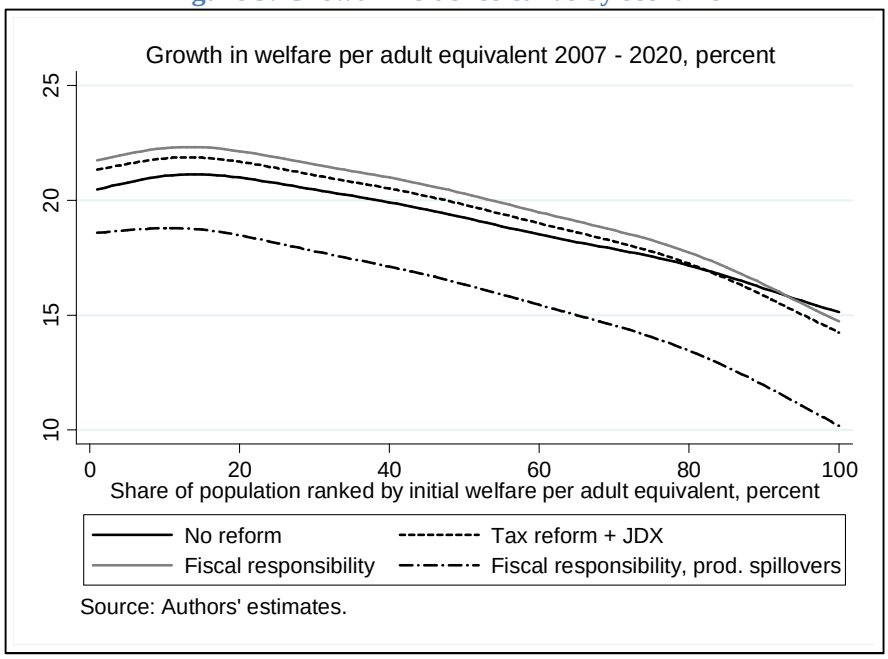
Figure 2: Allocation of consumption spending by percentiles of the income distribution



[7] This scenario is an example of a second-best outcome, when adding an extra distortion (higher taxes) may be beneficial in the presence of other distortions (high debt).

On the other hand, the incidence of a reduction of interest payments on domestic debt is quite progressive. There is no information in the JSLC or other readily available data sources on the distribution of interest income from government bonds in Jamaica. However, the JSLC does contain a question on dividend, interest, and rental income, and this information has been used to allocate the bond interest receipts across the three representative household groups in the CGE model. The data indicate that households with skilled primary earners receive approximately 84 percent of all dividend, interest, and rental income in Jamaica, while households with unskilled primary earners in urban occupations receive another 15 percent. Therefore, the distribution of interest income is heavily biased towards richer skilled households, and the poorest households—those with unskilled primary earners in rural occupations—receive less than 1 percent of total interest income. As a result, a reduction in interest earnings due to the JDX would affect rich households much more than poor households.

Figure 3: Growth incidence curve by scenario



The micro model results show that the reform scenario leads to additional poverty reduction and lower inequality, although the differences with respect to the no-reform scenario are quite small. The third column of Table 2 shows that in the JDX + tax reform scenario, the moderate poverty headcount could fall by an additional 0.3 percentage points, while the Gini coefficient could decline by more than a quarter of a point. Although these differences are very small, there are several reasons why one may not expect to observe a big boost in poverty reduction in this scenario. First, as mentioned earlier, consumption per capita does not increase in this scenario relative to no-reform, which means that poverty reduction can come only from distributional change. Second, although some distributional changes are pro-poor—as discussed earlier, the increase in the petrol tax and the reduction in bond coupon payments affect rich households more than the poor ones—other changes are biased against the poorest households. These include the overall increase in the GCT rate, which hurts poor households who spend all of their income on consumption, and the large increase in demand for investment goods, which do not require rural factors in the production process. As a result, the wages of unskilled rural households decline relative to

the labor earnings of unskilled urban and skilled households. On balance, the pro-poor distributional changes outweigh the anti-poor ones (as shown by the downward slope and greater slope, relative to the no-reform scenario, of the growth incidence curve in Figure 3), but the overall distributional change—and hence poverty reduction—is not particularly large.

3.3. Fiscal responsibility framework

The second reform scenario of this paper strengthens fiscal discipline even more through the adoption of a Fiscal Responsibility Framework (FRF), which limits fiscal deficits and further improves debt dynamics. In this scenario—in addition to implementing the tax reform and the JDX—the government adheres to a fiscal rule whereby the overall deficit is kept below 2 percent of GDP in every year after 2011, with capital expenditures bearing the brunt of adjustment. Although this fiscal rule is just an assumption and other adjustments could be made in the budget to reach a deficit target (e.g., reducing wage or non-wage recurrent expenditure), in practice capital expenditure is the most likely candidate for spending cuts in most countries (see, for example, Hauptmeier et al (2006) on successful EU fiscal reform episodes). The results of this simulation (FRF + JDX + tax reform) are shown in the last few columns of Table 1. Although towards the end of the model horizon (post-2017), the fiscal rule is no longer binding and thus the primary and overall deficits are very similar to the JDX + tax reform scenario, the slower accumulation of debt during the preceding years brings down final year debt ratios even further. Instead of more than 200 percent of GDP in the BaU scenario and 120 percent of GDP in the JDX + tax scenario, the debt-to-GDP ratio now declines to below 106 percent by 2020. As in the previous reform scenario, the reduced borrowing needs of the government lessen the crowding out of private-sector investment and yield some small growth spillovers. However, most of the debt reduction in the JDX +tax reform + FRF scenario occurs from slower debt accumulation, not faster growth. Moreover, because growth does not accelerate much and other changes are similar to the JDX + tax reform scenario, poverty reduction is only marginally larger relative to the previous simulation (Table 2).

The results of this scenario should be interpreted with caution, because the type of capital expenditure being cut can make a substantial difference in growth performance and the debt profile. The FRF + JDX + tax reform scenario discussed in the previous paragraph assumed no negative spillovers from the reduction in government capital expenditure. However, a large literature (dating back to Aschauer, 1989) has documented the positive links between public infrastructure investment and total factor productivity (TFP). The magnitude of any such productivity elasticity of public investment is an empirical question; however, in order to illustrate the importance of such spillovers, we assume a plausible value of a one percentage point reduction in the average annual rate of growth of labor productivity in manufacturing and service sectors from a ten percent reduction in the public capital stock changes the debt dynamics. Under the fiscal rule as in the scenario used in the previous paragraph, the debt-to-GDP ratio in 2020 is now 5.4 percentage points higher than it would have otherwise been, and the debt path begins to converge to the one recorded under the JDX + tax reform (and no FRF) scenario (Figure 1). This is largely an outcome of the slower GDP growth due to productivity losses, as per capita income grows nearly 50 percent slower than it would have been with no negative productivity spillovers (i.e., under the standard FRF + JDX + tax reform scenario presented in the previous paragraph). Clearly, the magnitude of the loss in productivity—and, consequently, the extent of the worsening in the debt performance—is dependent on the assumptions about the relevant elasticity. However, the aim of this scenario is not to estimate the exact losses in productivity and GDP growth due to a reduction in capital spending, but rather to illustrate

the critical point that reductions in productive public capital spending (e.g., investments in infrastructure) may not yield an improved debt performance over the long term if such expenditure cuts limit the ability of the economy to grow. Moreover, as illustrated by the last column of Table 2, the losses in per capita growth in this scenario could hamper the progress on poverty reduction, as the headcount in this scenario is 0.8 percentage points (or 13 percent) larger than in the scenario with no productivity losses, and nearly 0.5 percentage points higher than in the no-reform scenario.

3.4. Accelerated productivity growth

Low productivity growth has been documented in the literature (see World Bank (2011) for a review) as an important constraint to growth in Jamaica. In order to illustrate the importance of accelerating productivity growth for the overall growth performance in Jamaica, this section develops an alternative scenario of accelerated productivity growth and contrasts this simulation with both the no-reform scenario and the JDX + tax reform scenario.

In the BaU (no-reform) scenario, productivity grows at an average annual rate of 0.7 percent, similar to the observed TFP growth between 2000 and 2008. As described in more detail in Appendix A, the path of productivity growth in the CGE model is factor-specific. Capital productivity remains fixed throughout the model horizon (consistent with econometric evidence on long-term trends in the rate of return to capital), while labor productivity in the BaU scenario is calibrated to achieve the IMF-forecasted growth rate in real GDP. The rate of growth of (Harrod-neutral) technical change required to achieve the forecasted performance works out to a 0.8 percent annual average (2007-2020). This is somewhat above the 0.7 percent per year average rate of technical change estimated in World Bank (2011) for the period 2000-2008.[8] However, it is much faster than the 0.08 percent average annual rate for the period 2004-2008, when the real GDP grew by less than 1 percent per year. Moreover, excluding the three years of negative growth (2008-2010), labor productivity in the medium term (2010-2020) is assumed to grow at a much faster average rate of 2.7 percent per year. This high rate of labor productivity growth is required to achieve the targeted growth performance at the time of declining investment rates due to the high public debt burden and consequent crowding-out effects (see the discussion in Section 2 of this paper).

In order to reach the post-crisis (2010-2020) average real GDP growth of 3.0 percent, productivity growth would have to rise to 3.9 percent per year, or 1.8 percent per year for the entire 2007-2020 period. These implied rates of productivity growth would be high by both regional and international standards, but at the same time they underscore the challenge faced by the Jamaican economy, where high investment rates have not translated into accelerated growth, population growth is declining, and the educational system has struggled to produce a sufficient quantity of skilled workers (as evidenced by poor exam performance and other quality issues highlighted in World Bank, 2011) and high rates of skilled emigration (again, see World Bank (2011) for an-depth discussion).

In the high productivity growth scenario, poverty in 2020 falls by another 0.8 percentage points although at the same time inequality rises somewhat. Faster growth in this simulation—relative to the JDX + tax reform scenario—results in an additional 0.75 percentage point reduction in moderate poverty by 2020 (with the headcount reaching 5.36 percent) while extreme poverty declines by 0.13 percentage points to 1.41 percent of the population. However, faster economy-wide growth also shifts demand into goods and

[8] During this period, real GDP (in local currency) grew at an average annual rate of 1.56 percent.

services with higher income elasticities, which, when produced domestically, tend to be more skill-intensive and manufactured in urban areas. As a result, wages of unskilled urban and particularly skilled workers grow more rapidly, leading to a slight widening of inequality from a Gini of 36.03 in the JDX + tax reform scenario to 36.36 in the high productivity scenario.

3.5. Composition of public investment

In 2007, the capital goods purchased for both public and private investment were split roughly evenly between construction and metals, fabricated metal products, machinery and equipment. In the model specification used for this paper, all final demand agents other than the households—including the private and public investment vectors—use the Leontief demand system, which means that the base year volume shares (52 percent for metals & machinery and 48 percent for construction) remain fixed for all years in all scenarios. The composition of the investment vectors—in this case, the composition of public investment—can be changed exogenously by adjusting the demand shares while keeping the unit cost of the overall basket of capital goods fixed relative to a reference scenario.

Reducing the construction component of the public investment basket from 48 percent to 22 percent has small but positive effects on productivity, exports, and growth performance. The change in the composition of public investment—a 50 percent increase in the Leontief share of the metals and machinery component—is implemented in equal annual increments between 2011 and 2015 while keeping the unit cost of public investment the same as in the JDX + tax reform scenario (on which this scenario builds).[9] Because the metals & machinery sector is more skill-, capital-, and export-intensive, shifting resources into this sector and out of lower-productivity, lower-skilled construction results in a more efficient allocation of resources. Also because the metals & machinery sector is more productive than construction, this type of demand switching raises the overall productivity. The overall efficiency gains from the re-orientation of public investment amount to just 0.23 percent of GDP in 2020 (relative to the JDX + tax reform scenario), but there is also a dynamic component to this type of change. Due to the increased size of a higher-productivity sector, GDP growth sets out on an accelerating path: while in 2016 (the first year after the adjustment is completed) the difference in real GDP growth between this scenario and JDX + tax reform is just 0.01 percentage points, the same difference in 2020 is 0.03 percentage points.

3.6. Increased skill content of the labor force

In 2007, 28.7 percent of employed workers in Jamaica could be considered skilled, as defined by having a secondary school certificate. As discussed earlier in this paper, the skill level of the labor force in Jamaica cannot be defined simply by years of schooling due to quality and test performance issues. In acknowledgement of this difficulty, this paper defines skilled workers as those who have obtained some sort of secondary school certificate. Benchmarking against other countries in the region shows that Jamaica is not that much below the LAC average of 32.2 percent, or 29.6 percent when outliers are

[9] The metals and machinery share is increased as follows:

$$\alpha_{metals\ \&\ machinery,t} = \alpha_{metals\ \&\ machinery,0} * (1.50)^{\frac{t-2011}{5}}$$

and the construction share is adjusted by residual.

excluded.[10] However, the country could still benefit from additional investment in skill formation and retaining skilled workers.

An alternative simulation which brings the share of skilled workers in total employment to 30 percent by 2020 (relative to 28.4 percent in the JDX + tax reform scenario) improves productivity, growth, and export performance. In this scenario, the supply of skilled workers in 2020 rises by 4.7 percent relative to the JDX + tax reform scenario by means of an acceleration in the growth rate of skilled labor force between 2010 and 2015. Overall productivity increases due to higher skill content of the labor force, and higher incomes associated with higher productivity give rise to greater saving, investment, and capital accumulation. As a result, real GDP in 2020 is 0.7 percentage points higher than in the JDX + tax reform scenario, despite the fact that overall employment actually falls by approximately 6,000 workers (0.5 percent of total). [11] Furthermore, this is not only a level effect as the growth rate of real GDP accelerates due to higher skill content, and gains would likely be larger in later years. Exports in 2020 increase by 0.75 percent relative to the JDX + tax reform scenario, and become more intensive in manufacturing and less intensive in agriculture and services (sectors that, overall, use a less skill-intensive input mix). The wage dynamics also change, with the additional supply of skilled workers lessening the pressure on the skilled wage, while unskilled workers become relatively scarcer and therefore receive higher wages than in the JDX + tax reform scenario. However, these changes are quite minor and do not have a material effect on aggregate inequality. Due to higher growth, poverty falls further by 0.02 percentage points.

4. Conclusions

The forward-looking scenarios in this paper have been developed with a combination of a computable general equilibrium model and a simple micro-accounting module for modeling distributional effects. As with any *ex ante* exercise, the models' results come with a set of important caveats and qualifications. First, the results are not intended to serve as forecasts; the forecasting performance of the models used in this paper has not been validated with historical data and, in fact, CGE models tend to underperform relative to other models in forecasting macroeconomic trends. Second, standard CGE critiques of fairly restrictive functional forms and little empirical validation of elasticity values also apply here; although care has been taken to use appropriate parameter values, many estimates are simply not available for Jamaica. Third, data limitations both on the macro and micro sides have led to a number of simplifications and approximations. For example, the distribution of bond interest income across households has been approximated with a distribution of all dividend and interest income, and the welfare function in the micro data could only be defined at the level of the household, rather than the individual.

However, even with these limitations the scenario results can provide useful information to policymakers. First, the types of models used in this paper tend to do well in a simulation setting, highlighting the macro and micro marginal changes (both directions and relative magnitudes) due to shifts in policies. In particular, the comparative static version of the CGE model used in this paper was shown to yield the same policy conclusions as a forward-looking, rational-expectations dynamic-stochastic general equilibrium (DSGE) model (see Bussolo and Medvedev, 2008). Moreover, the policy conclusions of the

[10] St. Kitts and Nevis and Trinidad and Tobago each have more than 60 percent of the labor force with secondary education.
[11] This decline in the labor supply is linked to higher income and therefore higher demand for leisure, as discussed earlier in the paragraph.

same model have also been shown to be robust within a reasonable range of key elasticity values. Finally, the micro-simulation literature shows that more sophisticated modeling techniques tend to add realism and detail to the more simple micro-accounting methods, but rarely reverse their basic conclusions.

The simulations in this paper show that without the tax reforms and the debt exchange undertaken by the Government of Jamaica in FY2009-2010, the debt trajectory would have likely turned explosive and unsustainable. Under the JDX + tax reform scenario, the debt-to-GDP ratio in 2020 is estimated to be nearly half of the debt ratio in the no-reform scenario. Growth performance and poverty reduction also improve in the reform scenario, and the fiscal position is strengthened substantially. Even though the policy reform does not generate additional national income within the time horizon of the model, the transfer of resources from unproductive expenditure (debt servicing) to productive expenditure (private capital stock formation) leads to a more rapid accumulation of productive factors and faster GDP growth. Finally, although the policy reform gives rise to both progressive and regressive distributional shocks, the progressive shocks dominate and the distribution of income improves at the same time as debt ratios decline.

Additional fiscal consolidation—achieved by adhering to a fiscal deficit rule under the Fiscal Responsibility Framework—can yield further growth and debt reduction benefits, but policymakers must use caution in identifying opportunities for expenditure cuts. In the majority of cases, capital expenditure is one of the first items to be rationalized when the overall resource envelope is constrained. However, as the simulations in this paper show, cutting productive public capital expenditure may lead to lower growth (through negative productivity spillovers) and largely nullify the benefits of additional fiscal consolidation. Additionally, as over the long term per capita growth tends to be the most important determinant of poverty reduction, the fight against poverty can suffer important setbacks if productive public capital expenditure is kept below optimal levels.

Investments in accelerating labor productivity growth and raising the skill content of the labor force can pay important dividends in faster growth and improved export performance. The simulations presented in this paper do not describe the explicit channels through which these improvements may be realized. The key lesson is that these types of reforms, if successful, can have not only level but also growth effects on real GDP and export performance, and therefore should be prioritized and explored in more detail. Moreover, adjusting the composition of public investment towards more “productive” expenditure may also yield positive, if not very large, growth dividends.

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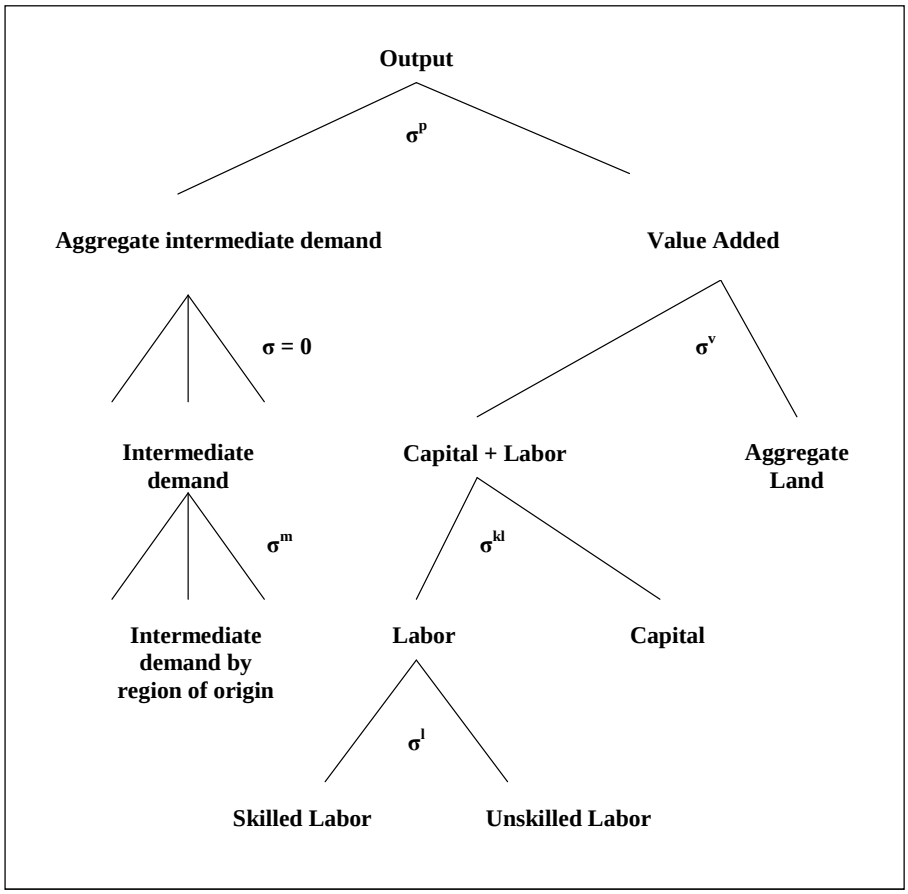
6. Annex A: Description of the CGE Model

The CGE model used in this paper has its origins in a standard neoclassical general equilibrium model and is based on the World Bank's prototype single-country model.[12] It is also a recursive dynamic extension of the CGE model in Bussolo and Medvedev (2008), who augmented the above prototype model by introducing an endogenous labor-leisure tradeoff. The main features of this model will be familiar to readers accustomed with the CGE literature and thus are summarized only briefly. The labor-leisure choice is presented in more detail, with the discussion borrowing heavily from Bussolo and Medvedev (2008).

Production. Output results from nested CES (Constant Elasticity of Substitution) functions that, at the top level, combine intermediate and value added aggregates. At the second level, the intermediate aggregates are obtained combining all products in fixed proportions (Leontief structure), and total value added is obtained by aggregating the primary factors. The nested structure of production allows for different degrees of substitutability across inputs and is a standard feature in most CGE models. The full structure of production nests is shown in Figure A.1.

Figure A.1: Production structure of the Jamaica CGE model



Note: Although the model allows substitution between Land and the other primary factors, given that the data for separating land and other factors contributions to value added was not available, the nesting structure actually active in the current model does not include Land as a separate factor.

[12] See van der Mensbrugghe (2005b) for detailed model documentation and van der Mensbrugghe (2005a) for the user's guide.

Income distribution and absorption. Labor income and capital revenues are allocated to households according to a fixed coefficient distribution matrix derived from the original SAM. Private consumption demand and labor supply decisions are obtained through maximization of household specific utility function following the Linear Expenditure System (LES). The quantity of aggregate saving behavior is determined by a fixed marginal propensity to save, calibrated using the base year consumption, income, and saving. Household utility is a function of consumption of different goods and leisure. Once total value of private consumption is determined, government and investment demand are disaggregated into sectoral demands according to fixed coefficient functions.

International trade. The model assumes imperfect substitution among goods originating in different geographical areas.[13] Import demand results from a CES aggregation function of domestic and imported goods. Export supply is symmetrically modeled as a Constant Elasticity of Transformation (CET) function. Producers allocate their output to domestic or foreign markets according to relative prices. Under the small country assumption, Jamaica is unable to influence world prices and its imports and exports prices are treated as exogenous. Assumptions of imperfect substitution and imperfect transformability grant a certain degree of autonomy of domestic prices with respect to foreign prices and prevent the model from generating corner solutions. Furthermore, they permit cross-hauling—a feature normally observed in real economies. The balance of payments equilibrium is determined by the equality of foreign savings (which are exogenous) to the value of the current account. With fixed world prices and capital inflows, all adjustments are accommodated by changes in the real exchange rates: increased import demand, due, for instance, to trade liberalization, must be financed by increased exports, and these can expand due to improved resource allocation. Import price decreases drive resources towards export sectors and contribute to falling domestic resource costs (or real exchange rate depreciation).

Factor markets. Labor is divided into two categories: skilled and unskilled. These categories are considered imperfectly substitutable inputs in the production process. The labor market skill segmentation[14] has become a standard assumption in CGE modeling and it is easily justifiable for the case of Jamaica, where inequalities in educational endowments and access to education support this assumption. Skilled and unskilled labor types are then aggregated into a composite labor bundle which is then combined with composite capital (see production nest in Figure A.1). In the standard version, composite capital and labor types are fully mobile across sectors, with the rental rate on capital and relevant wages clearing the factor markets. Capital supply in each year is fixed. Labor supply, for both the skilled and unskilled categories, is derived, as shown below, from utility maximization where individuals chose the optimal consumption level for both commodities and leisure time under their budget constraint.

Labor-leisure tradeoff. The introduction of a consumption-leisure tradeoff in the household utility function follows the approaches of Barzel and McDonald (1973), de Melo and Tarr (1992), and Annabi (2003). Consider a Stone-Geary utility function and a budget constraint of the following form:

$$u = \sum_{i=0}^{N} \mu_i \ln(C_i - \theta_i) \quad \text{s.t.} \sum_{i=0}^{N} P_i C_i = Y = WT + y \qquad \text{A.1}$$

In this utility function, C_i denotes the consumption of good i with leisure (C_0) being a normal good, θ_i are usually interpreted as consumption minima,[15] and the share parameters μ_i (including μ_0) must sum to unity. T denotes the total time a household has available for work and leisure activities, and the amount of resources available for non-leisure consumption is limited by non-labor income (y) and total wage income

[13] See Armington (1969) for details.
[14] See Taubman and Wachter (1986) for a general discussion of labor market segmentation.
[15] Note that there is no theoretical requirement for any of the θ_i to be positive.

(ignoring saving and taxes for simplicity).[16] Constrained maximization gives rise to the familiar linear expenditure system (LES) demand functions:

$$C_i = \theta_i + \frac{\mu_i}{P_i}(Y - \sum_{i=0}^{N} P_i\theta_i) \quad \text{A.2}$$

The household labor supply is the difference between total time available and the time allocated to consumption of leisure, and substituting the budget constraint into the demand function yields:

$$LS = (1-\mu_0)(T-\theta_0) - \frac{\mu_0}{W}(y - \sum_{i=1}^{N} P_i\theta_i) \quad \text{A.3}$$

Partially differentiating the labor supply equation with respect to non-labor income and the wage rate yields the following elasticities:

$$\varepsilon_y = \frac{\partial LS}{\partial y}\frac{y}{LS} = -\frac{\mu_0}{W}\frac{y}{LS} < 0 \quad \text{A.4}$$

$$\varepsilon_W = \frac{\partial LS}{\partial W}\frac{W}{LS} = \frac{\mu_0}{W * LS}(y - \sum_{i=1}^{N} P_i\theta_i) \quad \text{A.5}$$

While the labor supply is decreasing in non-labor income, the sign of the wage elasticity depends on the ratio of non-labor income to the total "committed" consumption expenditures.[17]

Model closure. The equilibrium condition on the balance of payments is combined with other closure conditions in order to obtain a unique solution. First, both current and capital government expenditures are fixed in real terms as a share of GDP. This assumption can be modified in alternative scenarios, but is appropriate in the baseline because public goods do not enter the household utility function (and therefore changes in public expenditure affect household welfare only indirectly). Tax rates are also fixed at base year levels, and the primary balance is endogenous. The composition of public borrowing (i.e., the ratio of foreign borrowing to domestic borrowing) is fixed at the base year value, and this set combination of borrowing instruments clears the fiscal accounts. Second, aggregate investment—which together with an exogenous rate of depreciation determines the next period's capital stock—is set equal to aggregate savings. The volume of available savings is determined by an exogenous level of foreign saving including foreign direct investment (which evolves according to medium-term assumptions of the IMF), endogenous government saving, and households who save a fixed share of their post-tax income. The price of absorption is the numéraire.

Dynamics. The model is solved in a recursive dynamic mode, in which a sequence of end-of period equilibria is linked with a set of equations that update the main macro variables. There are three determinants of real GDP growth in the model: labor supply growth, capital accumulation, and increases in productivity. The maximum stock of labor available in each period (which, form equation A.3, will be greater than or equal to labor supply *LS*) grows exogenously at the rate of growth of the working age population (ages 15-64), obtained from World Bank population forecasts. The capital stock in each period is the sum of depreciated capital from the period before and new investment, which, as mentioned before, is determined by the available savings in the previous period. The behavior of the third component—

[16] Note that the price of leisure is the economy-wide wage rate W (i.e. $P_0=W$).
[17] This sign ambiguity allows for a backward-bending labor supply curve.

productivity—is factor- and sector-specific. Labor and capital productivity in agriculture grow exogenously at one percent per year, broadly consistent with the econometric literature on productivity growth in developing countries. For all other sectors, capital productivity remains fixed throughout the model horizon, while growth in labor productivity (which is assumed to be Harrod-neutral, purely labor-augmenting technical change) can be exogenous or endogenous depending on the type of simulation. The evolution of skill- and sector-specific labor productivity $\lambda^{L}_{l,i,t}$ is given by the following equation:

$$\lambda^{L}_{l,i,t} = (1 + \gamma^{L}_{t} + \chi^{L}_{l,i})\lambda^{L}_{l,i,t-1} \qquad \text{A.6}$$

In the baseline scenario, also referred to as Business-as-Usual (BaU) scenario, γ^{L}_{t} is endogenous while real GDP growth is fixed. This allows the user to calibrate the model to any given GDP growth rate, which in this paper follows the near- and medium-term projections of the IMF. In scenarios other than BaU, γ^{L}_{t} is fixed in each period at the BaU solution level, and GDP growth becomes endogenous. Thus, in the absence of any shocks, the BaU GDP growth rate is reproduced exactly. In policy simulations, real GDP growth may differ from BaU due to faster/slower accumulation of labor or capital, or shocks to the sector-specific productivity shift parameters for labor or capital ($\chi^{L}_{l,i}, \chi^{K}_{k,i}$). In other words, variations in GDP growth across scenarios can be directly attributed to the simulated policy reforms, allowing for clear comparisons between the simulations.

7. Annex B: Description of the Micro-Accounting Model

The micro-accounting model used in this paper is a simple approach based on techniques described in Bussolo et al (2008) and Ravallion and Lokshin (2008). As described in much greater detail in Bourguignon et al (2008), the empirical tool is referred to as "micro-accounting" because no behavior is modeled at the micro (survey) level. Instead, the objective of the model is simply to translate the shocks observed in the macro model to the household survey in a consistent fashion, such that the resulting counter-factual distribution of income or consumption is consistent with the results at the macro level. Although this approach lacks theoretical and empirical sophistication of more complicated micro-simulation methodologies (e.g., Ferreira et al, 2008, or Robilliard et al, 2008), its advantages include simplicity, transparency, and less stringent consistency requirements (with respect to the data underpinning the macro model). Moreover, as described in the following paragraphs, more sophisticated modeling approaches could not be readily used due to data constraints.

The micro-accounting model creates a new, counter-factual distribution of welfare through shocks to link aggregate variables (LAVs). The LAVs are observed in both macro (CGE) and micro (survey) data, and therefore provide a bridge by means of which consistency between the two sides is assured. The LAVs used in this paper are a fairly standard set and include variables meant to capture the change in the overall level of welfare in the population—such as overall population growth and changes in real consumption per capita—as well as variables meant to capture any potential redistribution of welfare within the population—such as changes in population structure, changes in prices of different types of consumption goods and changes in incomes based on the sector of employment and skill level of the household primary earner. The specific LAVs used in this paper are listed in the Table below.

Table B.1: Link Aggregate Variables in the Micro-Accounting Model

Variables that affect aggregate welfare	Real consumption growth
	Overall population growth
Variables that affect the distribution of welfare	Population growth, unskilled rural household
	Population growth, unskilled urban household
	Population growth, skilled household
	Total income, unskilled rural household
	Total income, unskilled urban household
	Total income, skilled household
	Price of agricultural products consumed by unskilled rural household
	Price of petroleum products consumed by unskilled rural household
	Price of manufactured products consumed by unskilled rural household
	Price of services consumed by unskilled rural household
	Price of agricultural products consumed by unskilled urban household
	Price of petroleum products consumed by unskilled urban household
	Price of manufactured products consumed by unskilled urban household
	Price of services consumed by unskilled urban household
	Price of agricultural products consumed by skilled household
	Price of petroleum products consumed by skilled household
	Price of manufactured products consumed by skilled household
	Price of services consumed by skilled household

The LAVs above define the household welfare function in terms of initial level of household consumption and changes in household size, household income, and prices of goods and services consumed by the household. Thus, we can express the economy-wide average household per capita (or adult equivalent) welfare at time *t* as follows:

$$welfare_t = \frac{1}{\sum_{h,i}\left(hhsize_h * I_{h,i}\frac{pop_{i,t}}{pop_{i,0}}\right)} \sum_h \frac{\sum_i \left(cons_h * I_{h,i}\frac{y_{i,t}}{y_{i,0}}\right)}{\sum_{c,i}\left(\frac{cons_{h,c}}{cons_h} * I_{h,i}\frac{p_{c,i,t}}{p_{c,i,0}}\right)} \quad \text{B.1}$$

where

$i \in [unskilled\ rural, unskilled\ urban, skilled]$, defined at the level of household primary earner

$c \in [agricultural\ products, petroleum\ products, manufactured\ products, services\ ]$

$I_{h,i}$ is an identity operator equal to 1 when household *h* belongs to group *i* and 0 otherwise

$cons_h$ is the total value of goods and services consumed by household *h*

$cons_{h,c}$ is the total value of good *c* consumed by household *h*

$hhsize_h$ is the size of household *h* (either in terms of persons or adult equivalents)

$pop_i$is the size of population group composed of *i*-type households

y_i is the total post-tax income (labor, capital, and transfers) of an *i*-type household

$p_{c,i}$ is the price of good *c* consumed by an *i*-type household

Note that equation B.1 defines the income-generation process at the household, rather than individual level. This distinction underpins the choice of micro-simulation methodology in this paper: rather than being defined as the sum of incomes of each working member (conditional on the characteristics of each worker), household income is defined as an inseparable total, conditional only on the characteristics of the primary earner. As mentioned in the first paragraph of this annex, this modeling choice was determined largely by data constraints: due to a large number of missing or zero labor income reported by employed individuals in the Labor Force Survey (LFS), more than half of all households (57 percent) in the Survey of Living Conditions (JSLC) did not have any labor income despite having multiple working members. As a result, it was not possible to specify a model of individual earnings and labor supply—such as the one developed by Bourguignon and Ferreira (2005)—for these households, and using only households for which this information was available would have substantially distorted the original survey design and, consequently, the poverty and inequality statistics. Therefore, the classification of households into unskilled rural, unskilled urban, and skilled groups was done according to the characteristics of the household primary earner, as reported in the JSLC.

The model operates on total household income, rather than labor income only. This distinction is important because many models of the type used in this paper pass on only labor earnings from the macro model down to the micro. In this case, however, we use total income because of the critical importance of income sources other than labor to the simulation results. For example, the debt exchange leads to a large decrease in bond earnings for households which hold bonds. Consequently, ignoring this important channel would have introduced a substantial distributional bias towards richer (skilled) households who capture nearly all of the bond income (because less-wealthy unskilled households hold few bonds). Due to these considerations, the household income generation process—taking into account all income sources—was modeled at the macro level for three representative household groups—unskilled rural, unskilled urban, and skilled—and shocks to total income were transmitted to the household survey.

The impacts of changes in prices of consumer goods on household welfare are modeled as first-order effects without allowing households to re-optimize their consumption bundle. In other words,

households in the survey continue to devote the same share of their consumption budget to each consumption category *c* in time *t* as they did in time *0*, meaning that only price (and not quantity) effects are taken into account. However, because the macro model does include three representative households (depending on the source of income of the primary earner) and the macro model allows for a re-optimization of the consumption bundle, price changes faced by the households in the survey do vary across the representative groups (but not within them). This approximation is consistent with other approaches taken in the majority of studies in the macro-micro simulation literature (e.g., Bourguignon et al, 2008), and avoids the difficulties of specifying and calibrating a household-specific demand system while still capturing a substantial share of the impact of price changes on household welfare.

The simulation approach developed above is implemented sequentially, with no feedbacks to the macro model. Consistent with other micro-accounting applications, the results of the micro exercise do not have any feedbacks to the macro model. Incorporating this type of feedback effects requires a much more complicated modeling structure and a near full-reconciliation of macro and micro data through cross-entropy or other numerical techniques (see Robilliard et al, 2008, for an application and a discussion of advantages and limitations of such approaches). Furthermore, the simulation is implemented as a sequence of individual steps as described in the table below.

Table B.2: Sequential nature of the micro model

Step	Action
1	Households are re-weighted to match the new population structure given by the macro model
2	Overall population growth is constrained to match that of the macro model
3	The welfare of each household is scaled up or down depending on changes in the total income of its corresponding representative household group (e.g., unskilled urban) in the macro model
4	The welfare of each household from step 3 above is scaled up or down depending on changes in the consumption prices faced by its corresponding representative household group (e.g., unskilled urban) in the macro model and the share of each good in each household's consumption bundle.
5	Overall change in real consumption per capita is constrained to match that of the macro model