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Martin Cicowiez
Agustín Filippo

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1. Introduction

Undoubtedly, Haiti has endured incredible hardship, and, despite its resilience, the country's social and economic structures have not created an environment for prosperity. Consequently, statistics are usually grim, starting with Haiti's GDP per capita of US$761 for 2017. Of Haiti's population of 10.8 million, 58.6 percent are considered poor based on the national poverty line and the most recent estimate. Haiti is also extremely unequal; based on the 2012 household survey data, Haiti has a Gini coefficient of 0.610, which has remained constant since 2001 (ECVMAS, 2012).

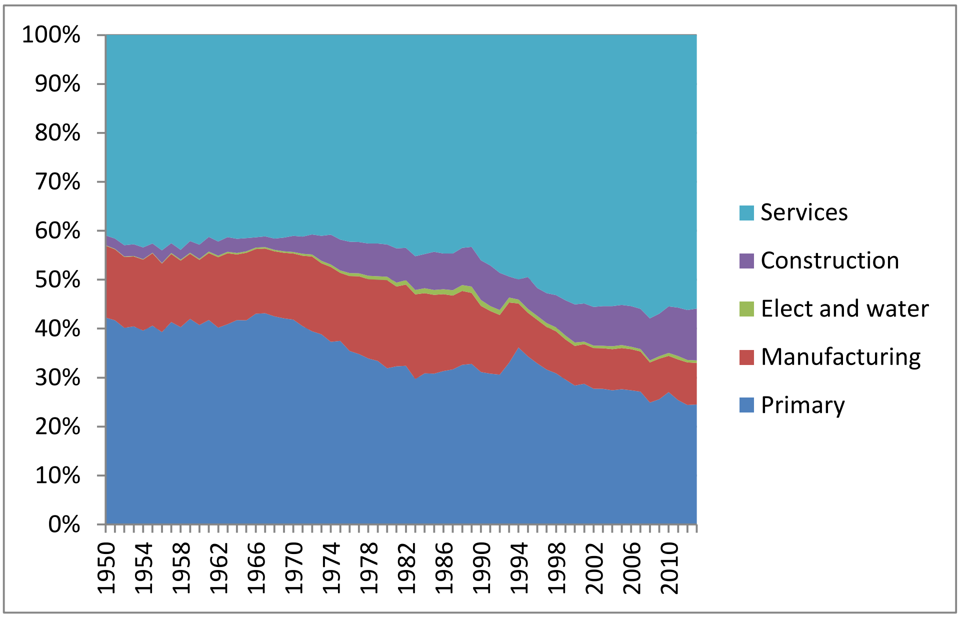
In this paper, we assess the impact of various scenarios related to accelerating growth and structural change in Haiti. The analysis is based on simulations with a relatively standard recursive dynamic computable general equilibrium (CGE) model designed for development policy analysis. For the purpose of this paper, the model was adapted to the Haitian context and calibrated to a database for 2013, the most recent year with sufficiently detailed information. The simulations cover the period 2013-2030 and consider alternative policies and shocks starting from 2019.

In outline, we proceed as follows. In Section 2, we provide context and assess the long-term (1950-2013) structural changes of Haiti. Section 3 describes the model and its database. Section 4 presents and analyzes CGE simulations designed to assess the impact – in terms of macro and sectoral variables -- of alternative patterns of sectoral productivity growth. Finally, Section 5 summarizes our main findings. More details on the model structure, data, and additional simulation results are presented in two appendices.

2. Historical Trends in Structural Change

In the period 1950-2013, Haiti's economy experienced a change in its sectoral structure against tradable sectors such as agriculture and manufacturing (Figure 2.1). Currently, agriculture and manufacturing account for 24.5 and 8.5 percent of GDP, respectively. In the 1970s, the corresponding figures were 37.3 and 15.1, respectively. On the other hand, the service sector grew to represent 55.9 percent of GDP in 2013.

Figure 2.1: sectoral structure (percent)



Source: Haitian Institute of Statistics; see data table in annex.

Productivity Gains and Structural Constraints

Here, we start by estimating the value added (VA) per worker across economic sectors. To that end, we used information from the national accounts. Table 2.1 shows the sectoral structure of the Haitian economy in terms of employment (column 1-2) and VA at current (columns 3-4) and constant (columns 4-5) prices. For instance, in 2013, 39.6 and 2.2 percent of workers were employed in the primary sector and manufacturing, respectively. Besides, Table 2.1 shows that VA per worker was higher in manufacturing than in primary sectors. In turn, this translates into wage differentials across sectors. For example, for unskilled labor, wages are 490 percent higher in manufacturing than in agriculture. Generally speaking, urban industries (i.e., manufacturing and services) show higher VA per worker than (typically) rural industries such as agriculture. Indeed, such disparity in VA per worker is related to differences in wages and poverty rates between rural and urban areas. In 2012, the extreme poverty rates were 38 and 12 in rural and urban areas, respectively. Moreover, population statistics show that population migrates from rural to urban areas.

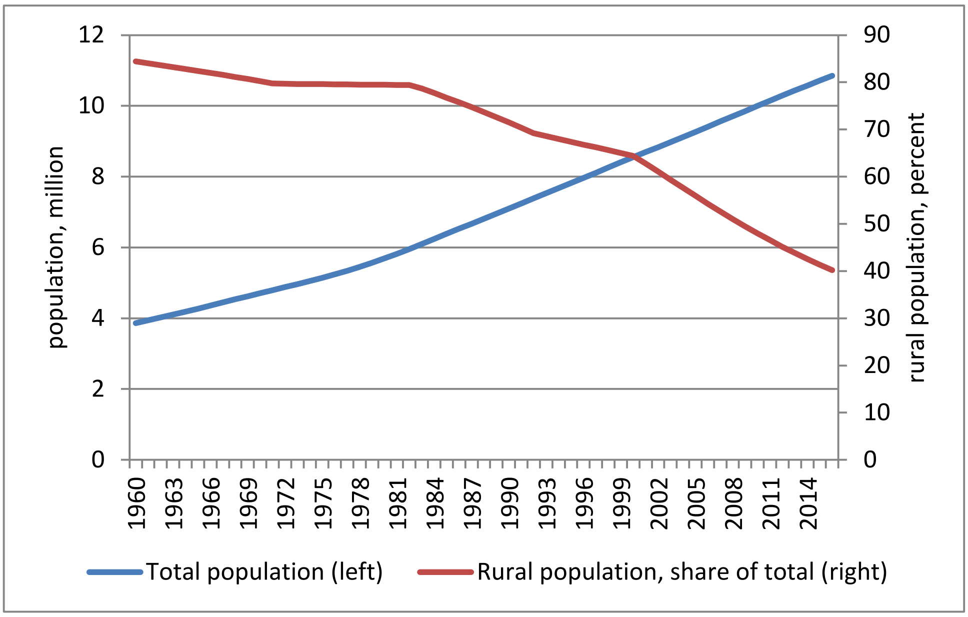
Interestingly, we find large differences between sectoral VA measured at current and constant prices. For example, construction VA represents 23.9 and 10.6 percent of GDP at current and constant prices, respectively. Certainly, part of that difference may be explained by higher prices for construction services after the 2010 earthquake. In turn, construction accounts for 5.8 percent of total employment.

Table 2.1: employment and value added per worker 2013

	Employment		Value Added, current pr		Value Added, constant pr	
	share (%)	number (#)	share (%)	VA per worker	share (%)	VA per worker
	(1)	(2)	(3)	(4)	(5)	(6)
Agriculture, forestry, fishing and mining	39.6	1,240,306	19.6	1,391	24.5	1,738
Manufacturing	2.2	69,747	7.1	8,958	8.5	10,724
Electricity and water	0.3	8,194	1.8	19,331	0.5	5,370
Construction	5.8	180,819	23.9	11,631	10.6	5,159
Services	52.1	1,633,227	47.6	2,565	55.9	3,012
Total	100	3,132,292	100	2,809	100	2,809

Source: Haiti CGE model dataset except VA at constant prices from IHSI.

Figure 2.2: total and rural population, 1960-2016



Based on Table 2.1, we can conduct a (partial equilibrium) thought experiment in which workers move from primary to manufacturing activities under the assumption that wages remain constant. Thus, moving one worker from agriculture to manufacturing would cause the economy to gain $7,567 ($8,958 - $1,391). Then, under the assumption that the workforce remains constant, increasing the share of manufacturing employment to 15 percent would increase VA per worker from $2,809 to $3,776, an increase of 34.4% (see Table 2.2). Certainly, this is a simple partial equilibrium computation that did not consider the economic interrelation of agents in the economy – e.g., we assume that output per worker remained constant. In the next section, we use a computable general equilibrium model to conduct similar, but more realistic, experiments. In fact, the estimations reported here suggest that promoting the manufacturing industries may have strong growth potential. In this regard, the African Development Bank has recently released a report stating that "Africa must industrialize to end poverty and to generate employment for the 10-12 million young people who join its labor force every year" (AfDB, 2017). Also, Rodrik (2016) makes a similar argument in favor of manufacturing.

Table 2.2: thought experiment, increasing the share of manufacturing employment to 15 percent

	Employment		Value Added	
	number (#)	share (%)	VA per worker	share (%)
Agriculture, forestry, fishing and mining	840,209	26.8	1,391	9.90
Manufacturing	469,844	15.0	8,958	35.60
Electricity and water	8,194	0.3	19,331	1.40
Construction	180,819	5.8	11,631	17.80
Services	1,633,227	52.1	2,565	35.40
Total	3,132,292	100.0	3,776	100.00

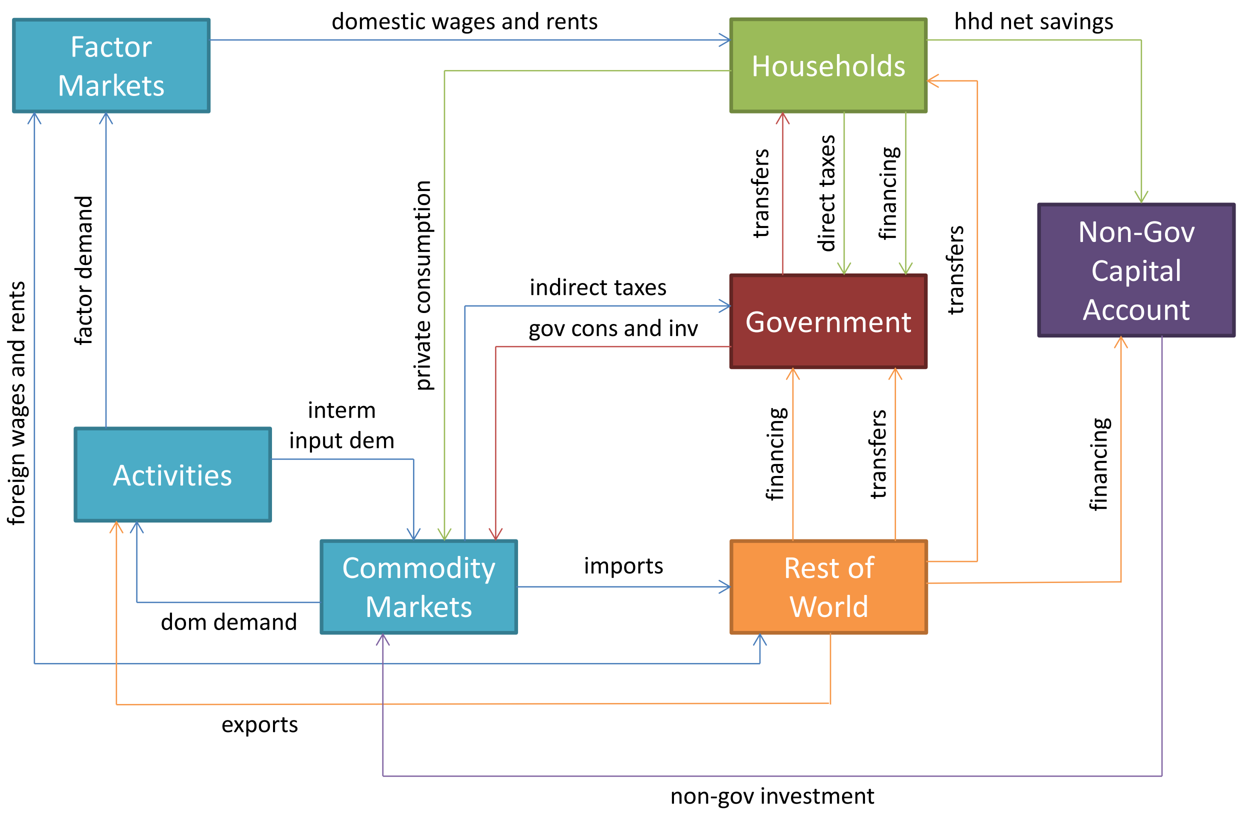
3. Haiti CGE Model and Dataset

CGE Model

The fact that many policies and external shocks induce complex interactions between numerous agents makes it difficult to predict what effects they will have, including who will win and who will lose. CGE modelling offers a systematic method for predicting both the direction and approximate sizes for the impacts of policies and external shocks on different agents. This study employs a single-country recursive dynamic CGE model to evaluate the impact of alternative scenarios on the Haitian economy.[1] The mathematical statement of the model is provided in Appendix A.

The model integrates a relatively standard recursive dynamic computable general equilibrium model with additional equations and variables that single out: (a) the impact of public capital investment in infrastructure on sectoral productivity, (b) the workers migration between rural/informal and urban/formal sectors, and (c) the foreign tourism demand. Thus, this CGE model offers a combination of policy-relevant features for the study of various policy counterfactual scenarios for Haiti. Figure 3.1 depicts, for each simulation period, the circular flow of income within the economy and between the economy and the rest of the world.

Figure 3.1: circular income flow in the Haiti computable general equilibrium; within-period module



[1] In Banerjee et al. (2015), a similar model was used to assess the impact of a tourism-related investment in the Sud department of Haiti.

Source: Author's own elaboration.

In any single year, the Haiti CGE has the structure summarized in the above figure. Activities produce, selling their output at home or abroad (i.e., the rest of the world), and using their revenues to cover their costs (of intermediate inputs, factor hiring and taxes). Their decisions to pursue particular activities with certain levels of factor use are driven by profit maximization. The shares exported and sold domestically depend on the relative prices of their output in world and domestic markets.

The model identifies four types of institutions: households, government, the rest of the world, and foreign tourists. Households earn incomes from factors and transfers. These are used for consumption, direct taxes, and savings. Their consumption decisions change in response to income and price changes. By construction (and as required by the household budget constraints), the consumption value of the households equals their income net of direct taxes and savings. The government gets its receipts from taxes and transfers from abroad; it uses these for consumption, transfers to households, and investment, drawing on the loanable funds market for supplementary funding. To remain within its budget constraint, it either adjusts some part(s) of its spending on the basis of available receipts or mobilizes additional receipts in order to finance its spending plans. The rest of the world (which appears in the balance of payments) sends foreign currency to Haiti in the form of transfers to its government and households. In turn, Haiti uses these inflows to finance its imports. The balance of payments clears (inflows and outflows are equalized) via adjustments in the real exchange rate (the ratio between the international and domestic price levels), influencing export and import quantities and values in foreign currency. Investment financing is provided from savings by households, government, and the rest of the world. Tourism demand from rest of the world (exports) is modeled as an exogenous volume. In turn, total tourism demand is disaggregated across locally produced commodities using fixed coefficients.

In domestic commodity markets, flexible prices ensure balance between demands for domestic output from domestic demanders and supplies to the domestic market from domestic suppliers. The part of domestic demands that is for imports from the rest of the world faces exogenous prices – Haiti is viewed as small in world markets, without any impact on the import and export prices that it faces. Domestic demanders decide on import and domestic shares in their demands on the basis of the relative prices of commodities from these two sources. Similarly, domestic suppliers (the activities) decide on the shares for exports to the rest of the world and domestic supplies on the basis of the relative prices received in these two markets.

Factor markets reach balance between demands and supplies via wage (or rent) adjustments. Across all factors, the factor demand curves are downward-sloping reflecting the responses of production activities to changes in factor wages. In the case of labor, unemployment is endogenous. For each labor type, the model includes a wage curve that imposes a negative relationship between the real wage and the unemployment rate (Blanchflower and Oswald, 2004). This type of wage equation can be derived from trade union wage models, as well as from efficiency wage models (see, for example, Devarajan et al. (1999) and Cicowiez and Sánchez (2010)). For non-labor factors, the supply curves are vertical in any single year.

Model Dynamics

In our CGE model, growth over time is largely endogenous. The economy grows due to accumulation of capital determined by investment and depreciation, labor (determined by exogenously imposed projections), as well as because of improvements in total factor productivity (TFP) which have both endogenous and exogenous components. Apart from an exogenous component, TFP of any production activity potentially depends (usually, positively) on the levels of government capital stocks and economic openness. The accumulation of capital is through investment financed by domestic savings and foreign inflows. Increased capital is allocated across sectors according to their relative profitability. Once installed, capital becomes sector-specific and can only by adjusted through exogenously-determined depreciation and the attraction of new investments.

Social Accounting Matrix and Other Data

The basic accounting structure and much of the underlying data required to implement our Haiti CGE model is derived from a Social Accounting Matrix (SAM) for Haiti. A SAM is a comprehensive, economy-wide statistical representation of the modeled economy at a specific point in time. It is a square matrix with identical row and column accounts where each cell in the matrix shows a payment from its column account to its row account. It can be used for descriptive purposes and is the key data input for a CGE model. Major accounts in Haiti SAM are: activities that carry out production; commodities (goods and services) which are produced and/or imported and sold domestically and/or exported; factors used in production which include labor, capital, land, and other natural resources; and institutions such as households, government, and the rest of the world. Generally speaking, most features of the SAM are familiar from social accounting matrices used in other models.[2]

As is usually done, we use the SAM to define base-year values for the bulk of the model parameters, including production technologies, sources of commodity supplies (domestic output or imports), demand patterns (for household and government consumption, investment and exports), transfers between different institutions, and tax rates. A stylized (macro-)SAM for Haiti is provided in Table 3.1. Haiti GDP reached 367,215 million gourdes in 2013, based on data from the supply and use table.[3] In 2013, the government current account surplus was around 1.1% of GDP and government current consumption was 8.5 of GDP. Regarding international trade, Haiti exported 12.2 percent of GDP and imported 46.7 percent of GDP (Table 3.2). Remittances (transfers) are the single largest source of earnings in the current account balance of Haiti, equivalent to 21.1 percent of GDP in 2013.

[2] See Pyatt and Round (1985) or King (1981) for a more detailed introduction to SAM construction and interpretation.

[3] GDP in 2013 was 364,526 million gourdes according to the latest IHSI report on national accounts.

Table 3.1: macro-SAM for Haiti 2013
(percent of GDP)

	a-agr	a-nagr	c-agr	c-nagr	f-lab	f-cap	tax-act	tax-com	tax-imp	tax-dir	marg-d	marg-m	marg-e	h-rur	h-urb	gov	row	sav	invng	invg	dstk	total
a-agr			31.0	0.0																		31.0
a-nagr			0.6	118.6																		119.2
c-agr	9.1	4.7												13.1	15.6		0.9		0.0	0.0	0.0	43.3
c-nagr	4.0	34.9									12.1	19.2	1.8	22.0	45.3	8.5	11.3		13.8	16.0	0.0	189.0
f-lab	7.5	43.8																				51.4
f-cap	10.4	32.8															0.8					44.1
tax-act	0.0	3.0																				3.1
tax-com			0.0	-0.9																		-0.9
tax-imp			0.3	3.0																		3.3
tax-dir														0.4	2.1							2.6
marg-d			3.4	8.8																		12.1
marg-m			0.8	18.5																		19.2
marg-e			0.1	1.7																		1.8
h-rur					18.4	7.6										0.1	4.9					31.0
h-urb					32.9	36.3										0.2	16.2					85.6
gov							3.1	-0.9	3.3	2.6				0.1	0.7		8.9					17.7
row			7.2	39.4		0.2								0.5	2.4	0.0						49.8
sav														-5.2	19.5	8.9	6.7					29.8
invng																		13.8				13.8
invg																		16.0				16.0
dstk																		0.0				0.0
total	31.0	119.2	43.3	189.0	51.4	44.1	3.1	-0.9	3.3	2.6	12.1	19.2	1.8	31.0	85.6	17.7	49.8	29.8	13.8	16.0	0.0	762.9

where a/c-agr: agriculture activities and commodities; a/c-nagr: non-agriculture activities and commodities; f-lab: labor; f-cap: capital; tax-ind: domestic indirect taxes; tax-imp: import tariffs; tax-dir: direct taxes; marg: trade and transport margins; h-rur and h-urb: rural and urban

representative households, respectively; gov: government; row: rest of the world; sav: savings; inv and invg: private and government investment, respectively.
Source: Author’s elaboration.

As explained, the Haiti CGE was calibrated to a 2013 SAM and other data for Haiti. The main sources of information for the construction of the Haiti 2013 SAM were the supply and use tables for the same year, complemented by data on the balance of payments and government finance statistics as well as the ECVMAS 2012. Table 3.2 shows the accounts in the SAM, which determine the size (i.e., disaggregation) of the model. Thus, the SAM/model identifies 22 activities and commodities. The factors of production include two types of labor, each of which is linked to a level of education (unskilled is less than completed secondary, and skilled is completed secondary or above). The growth in the labor force and changes in its composition are exogenous, allowing us to consider alternative counterfactual scenarios. The non-labor factors include public capital stocks (i.e., one for each government sector), a private capital stock, land, and a natural resource used/extracted in mining. The SAM also includes current and capital accounts for institutions (household, government, rest of world, and foreign tourists), investment accounts (one per capital stock), and auxiliary accounts for taxes and trade and transport margins.

Table 3.2: accounts in the Haiti 2013 Social Accounting Matrix

Category (#)		Item	Category (#)	Item
Sectors (activities and comm) (22)	**Primary (2)**	Agr, hunting and forestry; Fishing	**Factors (5)**	Labor, unskilled
		Mining and quarrying		Labor, skilled
	Manufact (10)	Food prod and beverages		Capital
		Tobacco prod		Land
		Textiles, wearing apparel and leather		Natural resource, extractive
		Wood and of prod of wood and cork	**Trade and transport margins (3)**	Dist marg, domestic
		Paper and paper prod; Publishing		Dist marg, imports
		Chemicals; Rubber and plastics		Dist marg, exports
		Other non-metallic mineral prod	**Taxes and subsidies (5)**	Taxes on activities
		Basic metals		Taxes on commodities
		Fabricated metal prod; Mach and equip		Subsidies on commodities
		Other manufactures		Tariffs
	Services (10)	Electricity and water supply		Taxes on income
		Construction	**Institutions (13)**	Household, rural, quintiles (5)
		Wholesale and retail trade		Household, urban, quintiles (5)
		Hotels and restaurants		Government
		Transport, storage and comm		Rest of world
		Financial intermediation		Foreign tourists
		Other services	**Investment (8)**	Savings
		Education, government		Investment, private
		Helath, government		Investment, government agriculture infra
		Public administration		Investment, government transport infra
				Investment, government education
				Investment, government health
				Investment, government other
				Stock change

Source: Author’s elaboration.

On the basis of SAM data, Table 3.3 summarizes the sectoral structure of Haiti’s economy in 2013: sectoral shares in value-added, production, employment, exports and imports, as well as the split of domestic sectoral supplies between exports and domestic sales, and domestic sectoral demands between imports and domestic output. For instance, while (primary) agriculture represents a significant share of employment (around 41 percent), its shares of value added, production, and exports are much smaller (in the range of 7.5-20 percent). The share of its output that is exported is around 2.5 percent while 19.6 percent of domestic demands are met via imports. On the other hand, textiles, wearing apparel and leather products represent a significant share of export revenue (around 48.1%), while their share in total value added is about 2.8% (column VAshr). The Haiti 2013 SAM also reports taxes paid by institutions, commodity sales, value added, activities, exports, and tariffs; total tax revenue reached 9% of GDP in 2013, a relatively low figure when compared to other LDCs (see WDI (2018)).

Table 3.3: sectoral structure of Haiti's economy in 2013
(percent)

Sector	VAshr	PRDshr	EMPshr	EXPshr	EXP-OUTshr	IMPshr	IMP-DEMshr
Agr, hunting and forestry; Fishing	19.4	21.0	41.0	7.3	2.5	15.5	19.6
Mining and quarrying	0.2	0.2	0.0	0.0	0.0	0.1	12.0
Food prod and beverages	1.9	4.6	0.5	2.0	2.5	14.2	52.0
Tobacco prod	0.0	0.1	0.0	0.0	0.0	0.3	58.2
Textiles, wearing apparel and leather	2.8	4.4	1.2	48.1	81.1	17.0	87.3
Wood and of prod of wood and cork	0.4	0.5	0.1	2.0	12.4	1.5	51.0
Paper and paper prod; Publishing	0.5	0.9	0.1	0.0	0.0	1.3	31.0
Chemicals; Rubber and plastics	0.2	0.5	0.0	1.3	13.0	15.0	92.0
Other non-metallic mineral prod	0.4	0.6	0.1	0.0	0.1	1.2	39.7
Basic metals	0.1	0.2	0.0	0.0	0.0	2.2	76.0
Fabricated metal prod; Mach and equip	0.1	0.1	0.0	1.1	45.0	11.4	98.7
Other manufactures	0.7	1.5	0.2	18.2	66.7	0.7	33.0
Electricity and water supply	1.8	2.7	0.3	0.0	0.0	0.0	0.0
Construction	23.9	19.0	5.9	0.0	0.0	0.0	0.0
Wholesale and retail trade	26.0	22.0	28.6	0.0	0.0	0.0	0.0
Hotels and restaurants	0.3	0.8	0.3	10.2	100.0	1.2	100.0
Transport, storage and comm	14.2	13.9	3.7	8.5	5.0	15.8	27.1
Financial intermediation	2.0	2.0	2.1	1.3	5.0	1.7	21.1
Other services	3.3	3.5	11.0	0.0	0.0	0.9	7.1
Government services	1.6	1.4	4.8	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	7.0	100.0	31.3

where VAshr: value-added share (%); PRDshr: production share (%); EMPshr: share in total employment (%); EXPshr: sector share in total exports (%); EXP-OUTshr: exports as share in sector output (%); IMPshr: sector share in total imports (%); IMP-DEMshr: imports as share of domestic demand (%).
Source: Author's calculations based on 2013 Haiti SAM and employment data.

Table 3.4 shows the factor shares in total sectoral value added. For example, the table shows that agriculture is relatively intensive in the use of unskilled labor and labor; this information will be useful to analyze the results from the Haiti CGE simulations. In turn, Government services (i.e., education, health and public administration) and Financial intermediation are relatively intensive in the use of skilled labor.

Table 3.4: sectoral factor intensity, Haiti 2013
(percent)

Sector	Labor, unskilled	Labor, skilled	Capital	Nat Res	Total
Agr, hunting and forestry; Fishing	40.3	3.8	9.5	46.4	100.0
Mining and quarrying	14.0	31.6	31.5	23.0	100.0
Food prod and beverages	18.6	41.9	39.6	0.0	100.0
Tobacco prod	21.9	49.4	28.7	0.0	100.0
Textiles, wearing apparel and leather	27.4	61.7	10.9	0.0	100.0
Wood and of prod of wood and cork	17.2	38.8	44.1	0.0	100.0
Paper and paper prod; Publishing	18.3	41.3	40.3	0.0	100.0
Chemicals; Rubber and plastics	13.1	29.6	57.3	0.0	100.0
Other non-metallic mineral prod	11.8	26.7	61.5	0.0	100.0
Basic metals	21.7	48.9	29.4	0.0	100.0
Fabricated metal prod; Mach and equip	13.6	30.8	55.6	0.0	100.0
Other manufactures	15.4	34.8	49.8	0.0	100.0
Electricity and water supply	10.1	22.7	67.2	0.0	100.0
Construction	18.1	19.4	62.5	0.0	100.0
Wholesale and retail trade	44.0	25.3	30.7	0.0	100.0
Hotels and restaurants	40.4	23.2	36.4	0.0	100.0
Transport, storage and comm	21.5	36.4	42.1	0.0	100.0
Financial intermediation	13.2	66.1	20.8	0.0	100.0
Other services	18.6	20.3	61.1	0.0	100.0
Government services	5.3	85.1	9.6	0.0	100.0
Total	29.3	24.9	37.0	8.8	100.0

Source: Author's calculations based on 2013 Haiti SAM.

In addition to the SAM, our Haiti CGE model requires (a) base year estimates for capital stocks and sectoral employment levels and unemployment estimates for the different labor types, (b) a set of elasticities (for production, consumption, and trade), (c) population projections by household group (i.e., rural and urban), and (d) a baseline projection for growth in GDP at factor cost (see below). In order to estimate sectoral employment, we combined population data from UN with estimates for the unemployment rate computed from the ECVMAS (2012). In turn, elasticities were given a value based on the available evidence for comparable countries; given the implied uncertainty, we performed a systematic sensitivity analysis of the results with respect to their value.

For elasticities, the following values were used: (a) the elasticity of substitution among factors is in the 0.2–1.15 range, relatively low for primary sectors and relatively high for manufacturing and services (see Narayanan et al. (2015)); (b) the wage curve has an unemployment-elasticity of -0.1 (see Blanchflower and Oswald (2005)); and (c) based on Sadoulet and de Janvry (1995), trade elasticities are in the 0.5-2 range. Finally, note that for each set of simulations we conducted a systematic sensitivity analysis of our CGE model results with respect to their value.[4]

4. Results and Analysis

Scenarios

The simulations consist of a base simulation and a set of non-base simulations that quantitatively explore alternative growth options for Haiti. The Haiti CGE simulations cover the period 2013-2030. The initial year, 2013, was selected in light of data availability (see Section 3).

Base Scenario

The base run is designed to replicate trends since 2013 at the macro and sectoral levels. From 2018 on, this first simulation assumes that past trends will continue into the period from 2018 to 2030. More specifically, the model's base-run scenario simulates a Haitian economy that grows at an average annual growth rate of 1.5 percent for the period 2018-2030, based on recently observed growth rates and consistent with the long-run growth rate estimated by Katz (2016). Thus, relative to IMF World Economic Outlook projections (IMF, 2017), our baseline scenario is pessimistic in terms of expected growth. In contrast, our non-base simulations are designed to assess alternative options to bring about an increase in the Haiti's growth rate, closer to the estimations by the IMF. In the base scenario, GDP growth is imposed by endogenously adjusting (overall) total factor productivity.[5] Besides, we assume that government demand for government services, transfers from government to households, and domestic and foreign government net borrowing are all maintained at their base-year shares of GDP. In turn, taxes are fixed at

[4] The results from the sensitivity analysis are available from the authors upon request.

[5] In the non-base simulations, TFP is invariably exogenous.

their base-year rates, which means that they will grow roughly at the same pace as the overall economy.

Figures 4.1-4.4 show key macroeconomic results for the base. (Tables B.1-B.5 show additional results for base and non-base scenarios, covering macro and sector indicators as well as the government budget and the balance of payments.) Given that it is intended to be a business-as-usual scenario, the base is set up to maintain the observed macroeconomic structure. Figures 4.1 and 4.2 show the evolution of the levels of GDP, foreign trade, and domestic final demand aggregates. In Figure 4.3, this information is translated into average annual growth rates. As shown, most macro aggregates grow at 1.5-1.7 percent yearly, with exports growing at 2.2 percent yearly. Figure 4.4 simply reflects our baseline assumption that sectoral TFP grows at the same pace for all sectors. In fact, the baseline TFP growth of about 0.2 is consistent with the annual GDP growth rate of 1.5 percent for the period 2018-2030.[6] Thus, based on Katz (2016), the computed TFP is below the one estimated for the 70s but above the one estimated for recent periods. The real wage grows slightly at a rate of 0.1 percent per year on average. For the base scenario, the growth rates in household consumption per-capita for rural and urban households are 1.3 and -0.2 percent, respectively, yielding a national average of 0.4 percent (Figure 4.5). In turn, these changes in per-capita consumption are reflected in changes in headcount poverty. In fact, the extreme poverty rate falls from 26.6 in 2013 to 17.4 in 2030 (Figure 4.6)

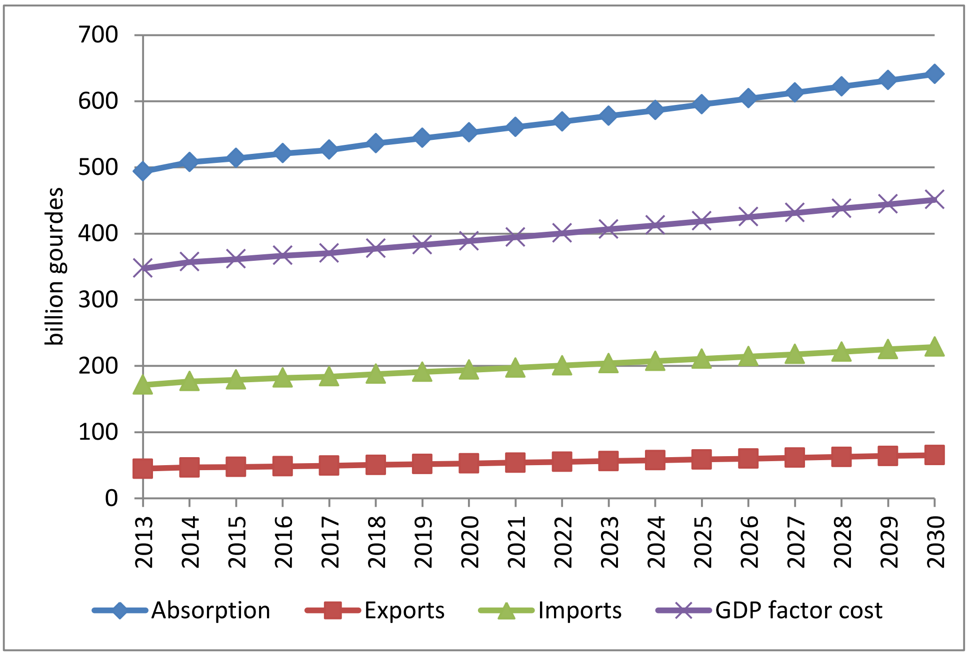
At the sector level, growth for agriculture – 0.8 percent yearly -- is constrained by the land supply, which is assumed to grow only 0.1 percent annually. On the other hand, textiles – which is the most export-oriented sector -- grows at 2.5 per year during the period 2018-2030 (Figure 4.7 and Table B.3 in Appendix B). GDP grows at 1.5 percent yearly is not strong enough to reduce the unemployment rate, which stays relatively constant at 31.7 percent (see Table B.1). Figure 4.8 shows output per worker in four (aggregated) sectors: agriculture, manufacturing, other industries (i.e., mining, construction, and electricity and water supply), and services. As discussed, output per worker is lower for agricultural activities. In the base, we see that sectoral output per worker and the sectoral structure of the economy remains relatively constant for the whole simulation period. For example, the share of non-

[6] In a companion paper, we consider long-run scenarios that are also consistent with a 1.5 percent annual GDP growth rate.

agricultural VA increases by 1.6 percentage points – from 60 to 61.6 percent -- at the expense of agricultural VA (Figure 4.9).

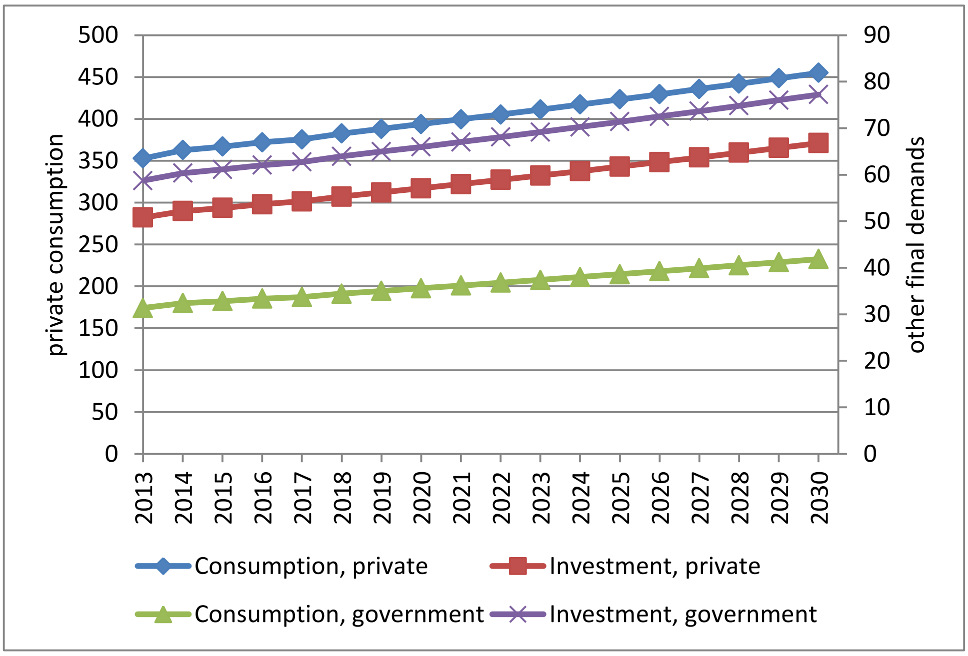
Finally, the base scenario replicates the trend in population migration from rural to urban areas described above (Figure 4.10).

Figure 4.1: base scenario; selected macroeconomic indicators (2013 prices, billion gourdes)



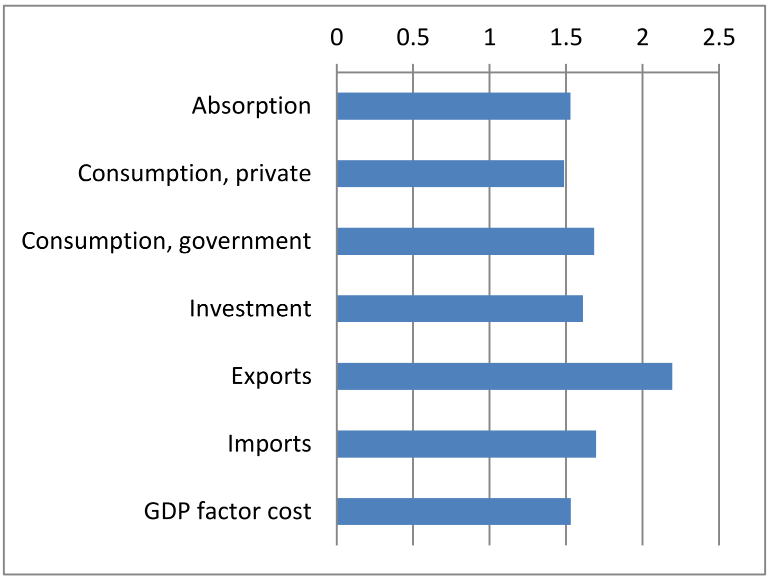
Source: Authors’ calculations based on simulation results.

Figure 4.2: base scenario; domestic final demands (2013 prices, billion gourdes)



Source: Authors' calculations based on simulation results.

Figure 4.3: base scenario; real annual macroeconomic growth 2018-2030 (%)



Source: Authors' calculations based on simulation results.

Figure 4.4: base scenario; TFP annual growth 2018-2030 (%)

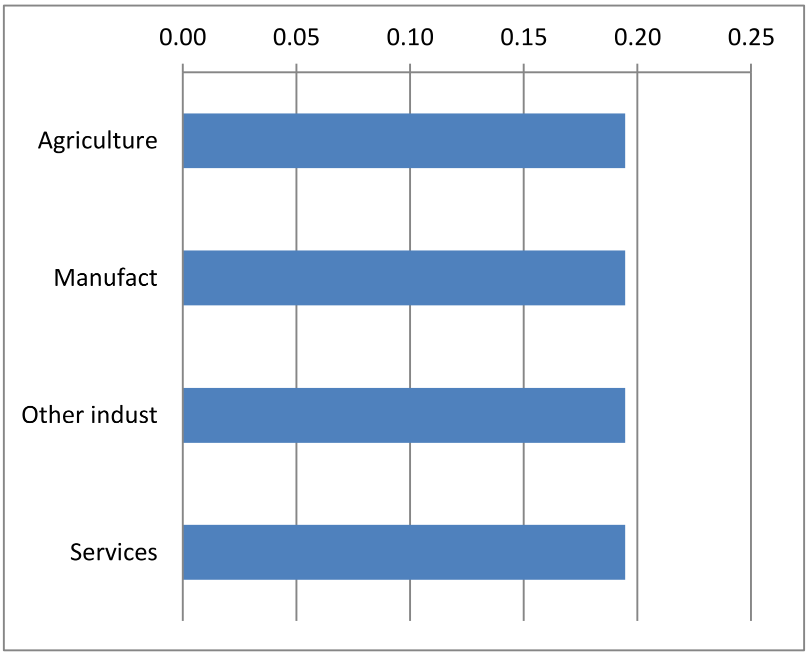
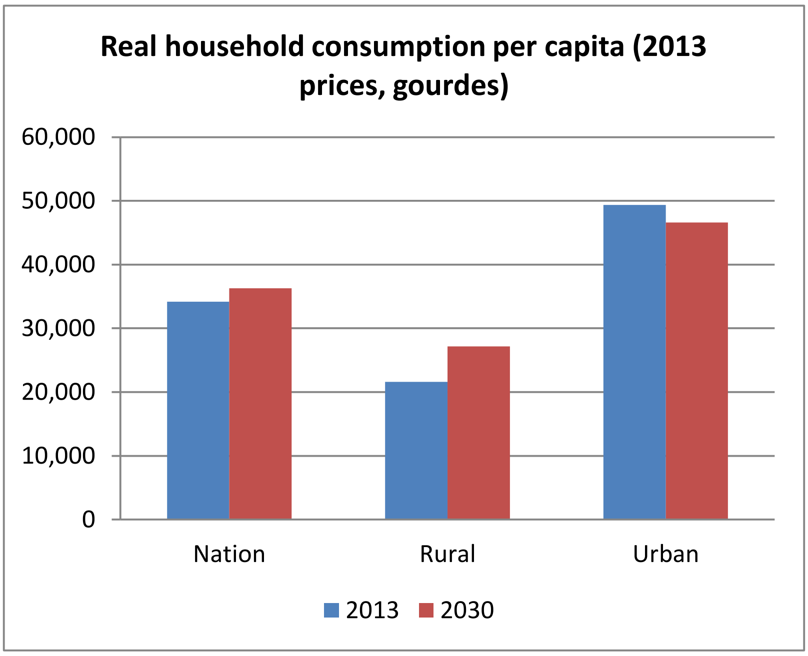


Figure 4.5: base scenario; real household consumption per capita by region



Source: Authors' calculations based on simulation results.

Figure 4.6: base scenario; headcount extreme poverty by region

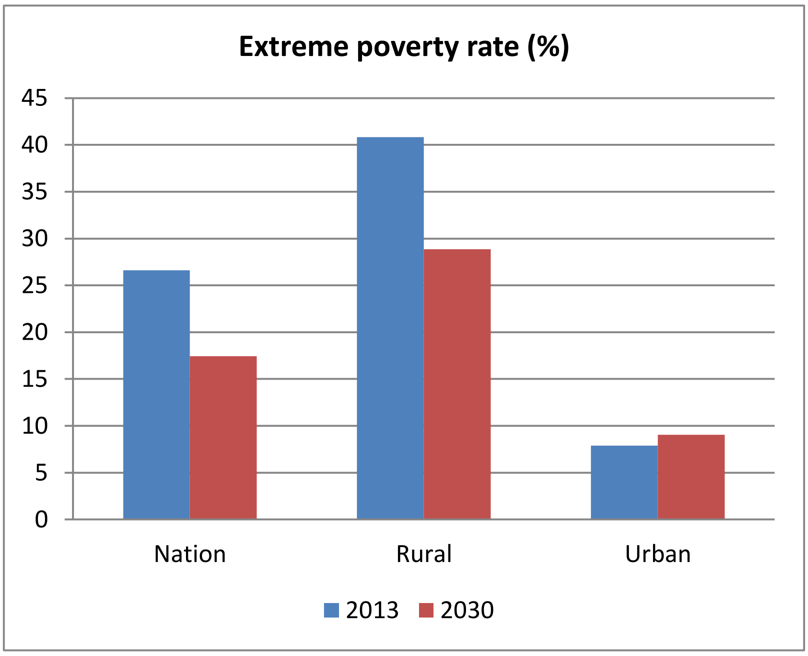
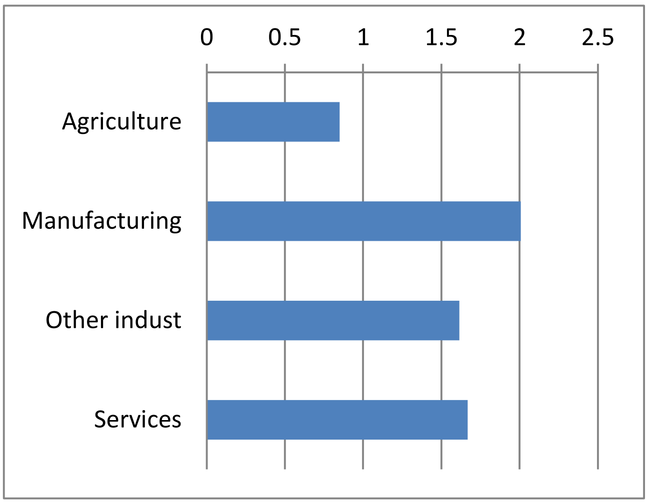
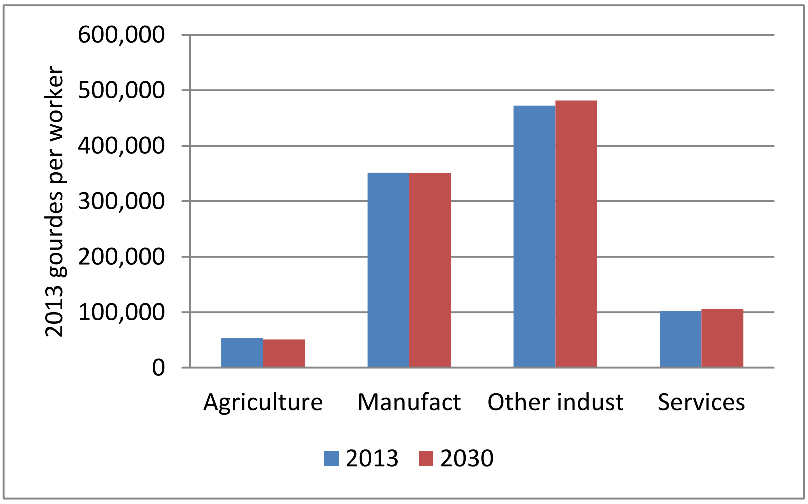


Figure 4.7: base scenario; real annual sector growth 2018-2030 (%)



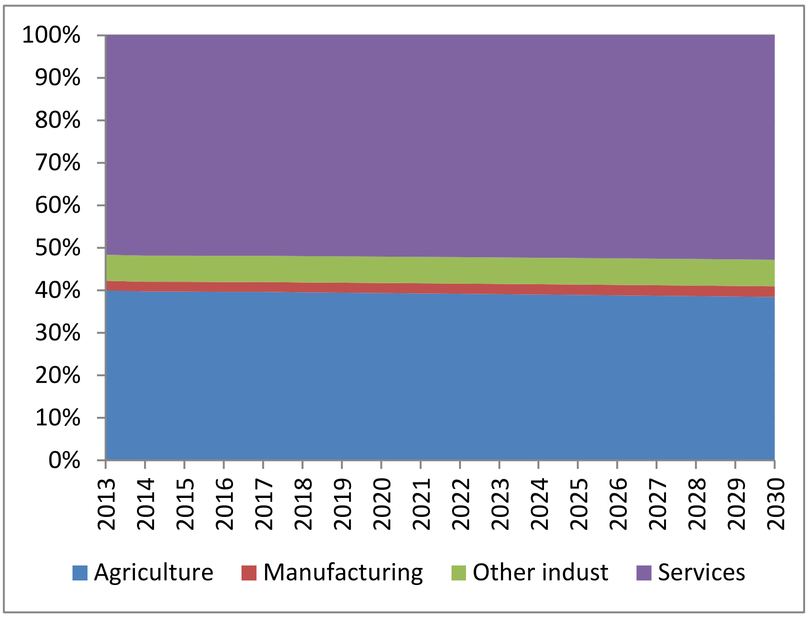
Source: Authors' calculations based on simulation results.

Figure 4.8: output (VA) per worker (2013 prices, gourdes per capita)



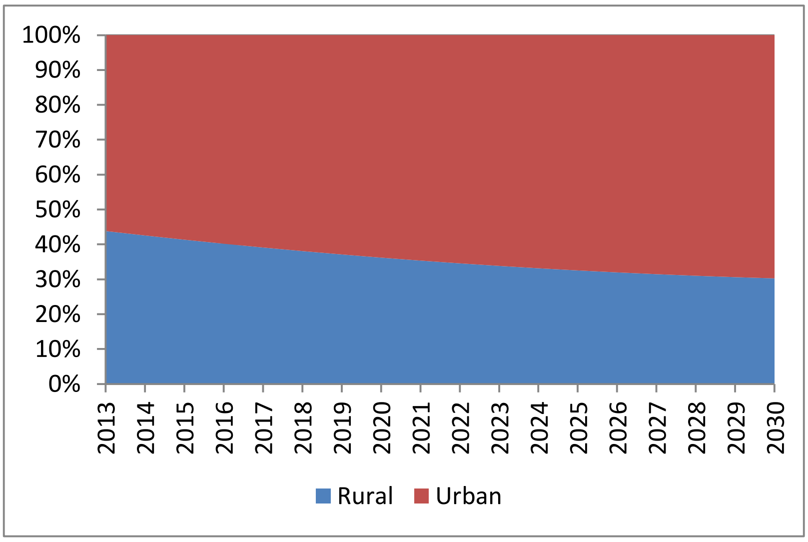
Source: Authors' calculations based on simulation results.

Figure 4.9: base scenario; employment structure (%)



Source: Authors' calculations based on simulation results.

Figure 4.10: base scenario; rural and urban population (%)



Source: Authors' calculations based on simulation results.

Non-Base Scenarios

The non-base scenarios are defined in Table 4.1. As shown, and based on the experiences of other successful developing countries[7], we simulate the effects of rapid growth in agriculture, export-oriented manufacturing such as textiles and apparel, and logistic services such as trade and transport. Specifically, the non-base scenarios assume increases in labor productivity, increases in land productivity – used in agriculture --, and increases in foreign direct investment (FDI).

[7] For example, countries such as Brazil, Malaysia, Thailand, China, India, and Vietnam have reached MIC status within a span of approximately 10 years. In none of these countries rapid growth was driven by booms in (extractive) natural resources. Instead, in all six countries the share of agriculture in total GDP declined in favor of manufacturing.

*Table 4.1: definitions of non-base scenarios**

Name	Description
agr	25 percent increase in labor and land productivity in agriculture during 2018-2030
agr+fdi	same as agr combined with increase in FDI equivalent to 2.7 percent of base GDP
mnfc	increased labor productivity in manufacturing during 2018-2030; overall TFP increase same as agr
mnfc+fdi	same as mnfc combined with increase in FDI equivalent to 2.7 percent of base GDP
svc	increased labor productivity in services during 2018-2030; overall TFP increase same as agr
svc+fdi	same as svc combined with increase in FDI equivalent to 2.7 percent of base GDP

*Note: Except for the changes indicated in the description, the scenarios are otherwise identical to the base scenario. By assumption, the overall (economy-wide) TFP growth is 0.5 percent in all non-base scenarios (see text). Hence, the increase in FDI does not increase TFP.
Source: Authors' elaboration.

For agriculture, the non-base increase in agriculture productivity is justified because yields per hectare cultivated in Haiti are low when compared to the average for least developed countries in 2014; i.e., there is room for significant improvement. For example, the average yield of the areas cultivated with corn was 9.2 and 16.4 tons per hectare in Haiti and in least developed countries, respectively (FAO, 2017) (see Table B.1 in Appendix B).

In turn, the selection of manufacturing industries in the mnfc and mnfc+fdi scenarios is based on (a) the current sectoral export pattern of Haiti, highly concentrated in textiles (Figure 4.11); (b) the labor intensity of textiles, based on the Leamer product classification (Leamer, 1984); and (c) the current location of Haiti in the Product Space as developed by Hidalgo et al. (2007, 2011) (Figure 4.12) (The Product Space is a network representation of the relatedness or proximity between products traded in the global market. The product space is a network connecting products that are likely to be co-exported and can be used to predict the evolution of a country's export structure.)

In all cases, the increase in FDI is determined such that the FDI in Haiti increases to the same FDI-to-GDP ratio as the average for low income countries in 2016. (In 2016, FDI in Haiti and in low income countries was 1.3 and 4 percent of GDP, respectively.). Implicitly, we assume that the increase in FDI would bring about an increase TFP; for example, through a better organization of production and an improvement in the business climate. In all cases, shocks are introduced during the period 2018-2030; i.e., the non-base simulations deviate from the base for the period 2018-2030; thus, base and non-base scenarios are the same for the period 2013-2017.

Figure 4.11a: exports Haiti 2015 (%)

Figure 4.11b: imports Haiti 2015 (%)

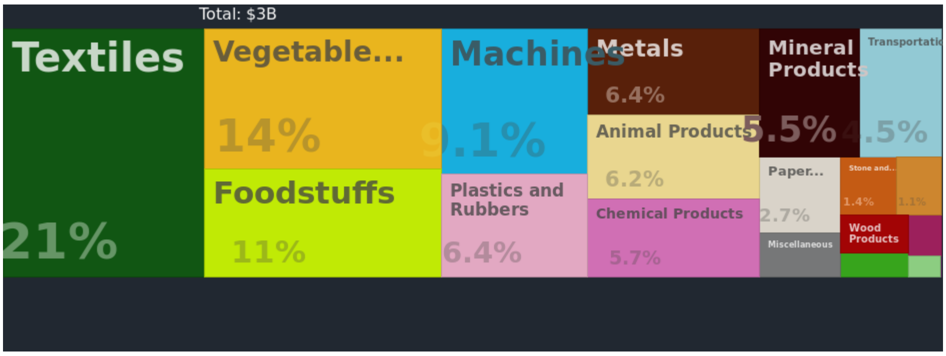
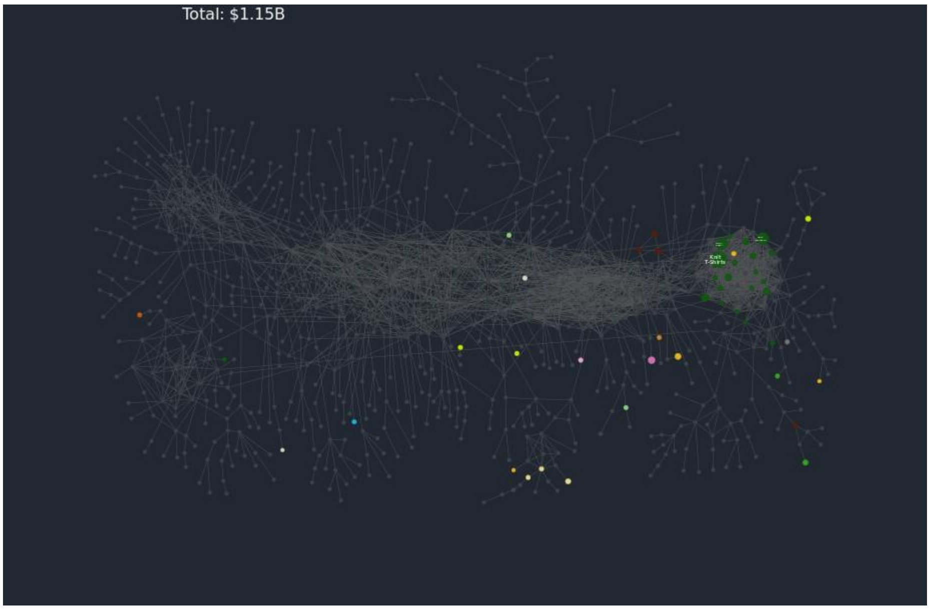


Figure 4.12: Product Space Haiti 2015



To facilitate comparisons across the different scenarios, all shocks are imposed during the same period (2018-2030) and are of the same size in terms of their impact on overall Total Factor Productivity. In other words, in all non-base scenarios factor-specific productivity in the target sector is increased up to a point where aggregate TFP growth rate reaches 0.5 percent annually. In turn, the non-promoted sectors maintain their baseline productivity level. In fact, our simulation design takes into account the differences in size between the productive sectors. For example, agriculture and manufacturing represent 40 and 2.2 percent of total employment, respectively. Thus, in order to obtain the same increase in overall TFP, the required increase in factor-specific productivity is smaller for agriculture than for manufacturing. In other words, the different simulations are comparable even though the increase in factor-specific productivity is applied to different sectors (see Figure 4.20). Specifically, in scenarios mnfc and svc, labor productivity in manufacturing and services increases by 3.1 and 1 percent annually, respectively.[8]

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[8] Mathematically, the VA production function can be written as $QVA_{a,t} = tfp_{a,t} \cdot \varphi_a^{va} \left(\sum_{f\in F} \delta_{f,a}^{va} \cdot \left(fprda_{f,a,t} \cdot QF_{f,a,t}\right)^{-\rho_a^{va}}\right)^{\frac{-1}{\rho_a^{va}}}$, where $QVA_{a,t}$ is value added, $QF_{f,a,t}$ is factor demand, $tfp_{a,t}$ is an an index of

Figure 4.13 summarizes the main transmission channels in the agricultural productivity scenarios agr and agr+fdi. For the other labor productivity scenarios, the main transmission channels are similar, although the targeted sector differs. In all scenarios, increased factor productivity results in increased output of the promoted sector. Thus, real GDP and household income rise in all scenarios. Consequently, household consumption per capita also rises while poverty declines when compared to the base scenario. For instance, in the agriculture scenarios, yearly GDP growth gains between 0.5 (agr) and 1 (agr+fdi) percentage points. As expected, the increase in GDP is accompanied by expansion in private consumption and private investment as additional output permit private incomes and savings to grow more rapidly with a positive feedback into the growth process. In turn, the increase in supply of the sector's goods (or services) results in a decline in its price since demand increases (brought about by increases in household incomes and investment demand) are in general less than the increase in supply. In other words, domestic markets clear at a lower price level. However, the higher the exports-to-output ratio, the lower is the decrease in the domestic price. In all scenarios, overall TFP growth increases from about 0.2 percent in the base to about 0.5 in the non-base simulations. The size of the change in real GDP, the changes in output quantities and prices, and changes in incomes of various household groups all vary according to which sector is shocked (see Figures 4.14 and 4.15). Needless to say, GDP growth also depends on capital accumulation and the employment level.

The income sources of rural and urban households are distinct, with rural households depending more on unskilled labor while urban households rely more on skilled labor and (private) capital. The scenarios differ in terms of their impact on different sectors and, thereby, on the distribution of factor incomes, household incomes, and household consumption. Figure 4.16 shows the deviations of the per-capita consumption growth rates from the base rates reported in Figure 4.5, both at the national level and for rural and urban households separately. The scenarios that promote the agricultural and manufacturing

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sectoral total factor productivity, $fprd_{f,a,t}$ is an index of sectoral factor-specific productivity, and $\delta_{f,a}^{va}$, φ_a^{va}, and ρ_a^{va} are parameters. In the simulation, we increase $fprda_{f,a,t}$ in selected sectors so that the change in overall TFP is the same in all non-base scenarios. In turn, overall TFP in year t is defined as the ratio between $\sum_{a \in A} QVA_{a,t}$ and $\sum_{a \in A} QVA_{a,t}^{*}$, where $QVA_{a,t}^{*} = tfp_a^{00} \cdot \varphi_a^{va} \left(\sum_{f \in F} \delta_{f,a}^{va} \cdot \left(fprda_{f,a}^{00} \cdot QF_{f,a,t} \right)^{-\rho_a^{va}} \right)^{\frac{-1}{\rho_a^{va}}}$.

sectors are more advantageous for rural households, since agricultural and manufacturing sectors are relatively intensive in the use of unskilled labor. For the services scenarios, the consumption growth gains favor the urban households. In all cases, the gap between rural and urban household per capita incomes is reduced when the increase in factor productivity is combined with FDI. Interestingly, and due to its positive impact on the (unskilled-intensive) construction sector, FDI has a stronger positive impact on the wages of unskilled workers. These changes in per-capita consumption are reflected in changes in headcount poverty. Figure 4.17 shows the deviations of the extreme poverty rates in 2030 from the base rates reported in Figure 4.6. In all scenarios, we observe a reduction in poverty at the national level. For the scenarios that favor agriculture and manufacturing, the declines in the poverty rate are stronger for rural households where poverty is most severe. By 2030, in the mnfc+fdi scenario, rural and urban extreme (moderate) poverty rates are 7.4 and 3.4 (11.8 and 14.1) percentage points lower than in the base, respectively.

Generally speaking, the most favored sectors are those with a higher ratio between exports and output -- i.e., the most export-orientated sectors. Specifically, textiles, wearing apparel and leather show the largest increases in sectoral value added (VA). For all other sectors, the ratio between exports and output is relatively small (see Table 3.3 in Section 3). As explained, Haiti is assumed to be a price taker in world markets. Therefore, the said sectors are the ones that can expand production and increase sales with a relatively minor decrease in domestic prices. In other words, the increase in TFP favors the current pattern of sectoral specialization for exports. Overall, exports (and imports) increase the most under the manufacturing scenarios. As expected (Figure 4.8)[9], the higher VA per worker and the higher export orientation of manufacturing leads to higher GDP growth rate.

Interestingly, growth in the manufacturing sector does not spill over the agriculture sector. For instance, in the mnfc scenario, the increase in agriculture GDP growth is insignificant (Figure 4.18). However, this is due to poor integration of local agriculture into manufacturing supply chains and high import shares of consumer and industrial goods (again, see Table 3.3 in Section 3). Besides, when FDI also increases we see a similar growth rate for manufacturing sectors combined with higher growth rates for services such as

[9] Also, see the discussion at the end of Section 2.

electricity, construction, trade, and transport. Therefore, our results indicate that, once manufacturing increases its growth rate, bottlenecks in (non-tradable) infrastructure- and logistic-related services emerge. In turn, the increase in the relative profitability of these sectors attracts new investments with the consequent increase in their respective capital stocks.

In the agr and agr+fdi scenarios, the agricultural real VA share increases relative to the base (Figure 4.19). At the same time, employment share in agriculture decreases, from 38.4 to 36.9 percent in 2030. In turn, manufacturing scenarios mnfc and mnfc+fdi show a decrease in agriculture real VA share from 17.3 to 14.8 in 2030 combined with an increase in manufacturing real VA share from 7.7 to 14.1 percentage points.

To explain changes in overall labor productivity (Figure 4.20), we implement a decomposition procedure based on McMillan and Rodrik (2011). Specifically, we decompose the changes in labor productivity relative to the base scenario in two components: (a) the within-sector component that captures how much of overall labor productivity growth can be attributed to changes within sectors; and (b) the structural change component that captures how much of overall labor productivity growth can be attributed to movements of workers across sectors. Mathematically,

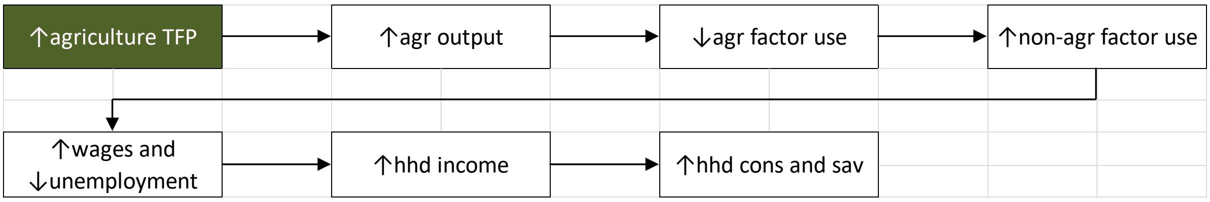
$$\Delta lprd_{t,sim} = \sum_{a \in A} wgth_{a,t,base} \left(lprda_{a,t,sim} - lprda_{a,t,base}\right) + \sum_{a \in A} lprda_{a,t,sim}\left(wgth_{a,t,sim} - wgth_{a,t,base}\right)$$

where $a(\in A)$ are activities, $t(\in T)$ are time periods, $sim(\in SIM)$ are simulations/scenarios, $lprd_{t,sim}$ is overall labor productivity, $lprda_{a,t,sim}$ is activity-specific labor productivity, and $wght_{a,t,sim}$ is the weight of activity *a* in base-year employment. Figure 4.21 shows the results.

In the agr scenario, structural change does not play a significant role to explain the overall increase in labor productivity. In fact, the structural change in favoring agricultural activities has a negative impact on overall labor productivity. On the other hand, once FDI is increased (see scenario agr+fdi), the structural change favoring industrial and service activities also has a positive impact on overall labor productivity. In turn, all manufacturing and services scenarios show that structural change has a positive impact on overall labor productivity.

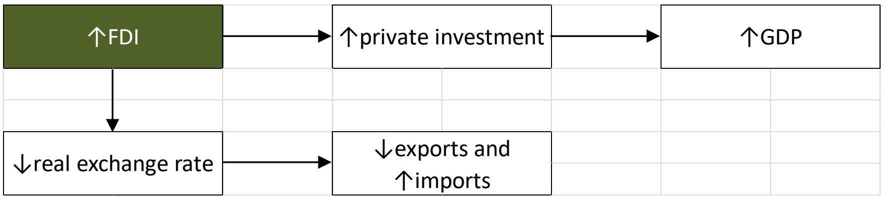
Hence, our results are consistent with the evidence that suggest that structural change and higher growth go hand in hand (Rodrik, 2016). At any rate, both the increase in sector-specific productivity and the sectoral composition effect have a positive impact on VA per worker, wages, and household income.

Figure 4.13a: main transmission channels for an increase in agriculture TFP



Source: Author's elaboration.

Figure 4.13b: main transmission channels for an increase in FDI

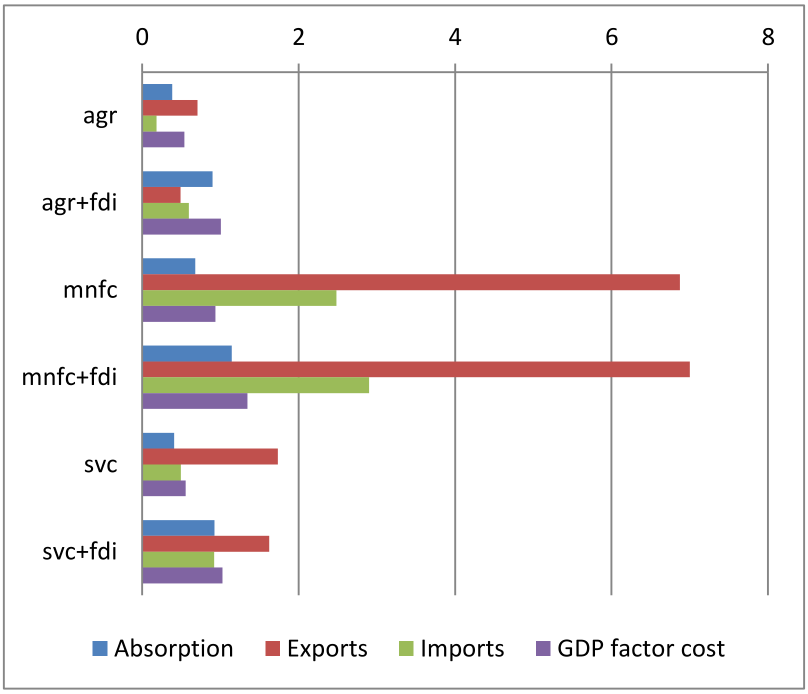


Source: Author's elaboration.

Needless to say, our CGE model for Haiti has some limitations worth mentioning. It does not fully capture all the issues involved in bringing about structural changes. For instance, our scenario design does not consider expenditures related to skill upgrading that would likely complement the increase in factor productivity and FDI. Also, we are assuming that government investment in infrastructure remains constant at its baseline values. However, we should expect that public investment in infrastructure will have to increase to support the increase in GDP.

Certainly, it is difficult to select one development path over the other. In fact, the identification of the exact causes of growth is notoriously difficult, and although our approach may have some advantages, it does not solve completely the problem of identifying of the more efficient drivers of growth. However, we should note that manufacturing (and perhaps some services) have some initial advantages over agriculture in Haiti's context. On the one hand, manufacturing requires less land space per unit of output. On the other hand, an increase in agriculture output would likely require a fundamental revamping of the Haiti's property rights system regarding land tenure (see for example CIRAD, 2017, chapter 7). Currently, land tenure is a contentious issue, that would require political consensus to be resolved but remains a key issue in countries at similar stages of development (World Bank, 2008).[10]

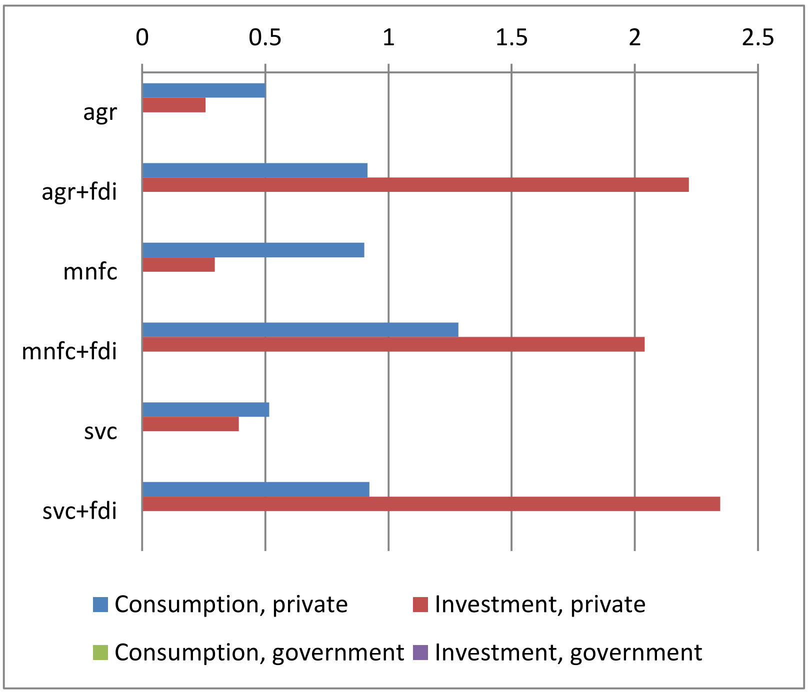
Figure 4.14 macro growth by simulation (%-age point deviation for average annual growth from base)



Source: Authors' calculations based on simulation results.

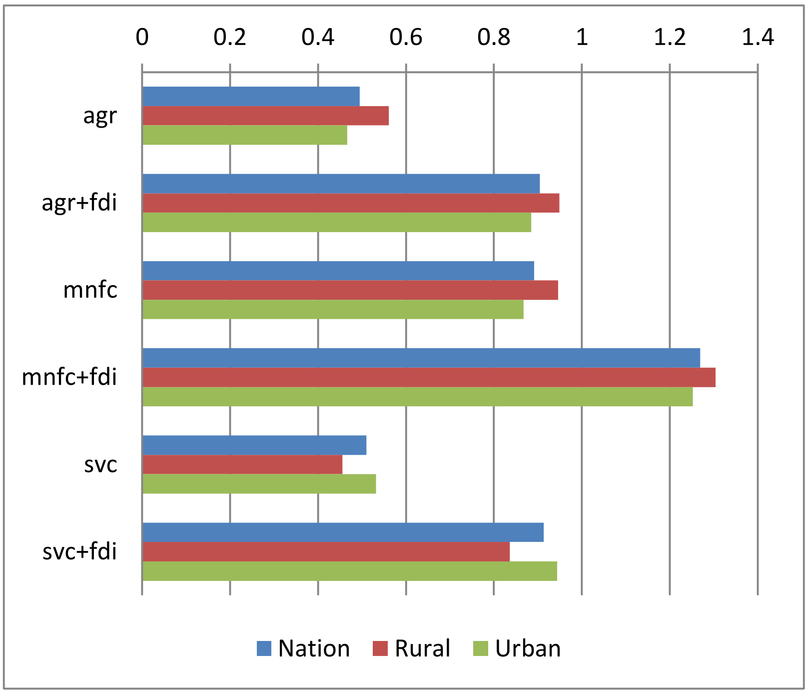
[10] In +++, we focus on the (very) long-run impacts of the TFP increases discussed here.

Figure 4.15: consumption and investment growth by simulation (%-age point deviation for average annual growth from base)



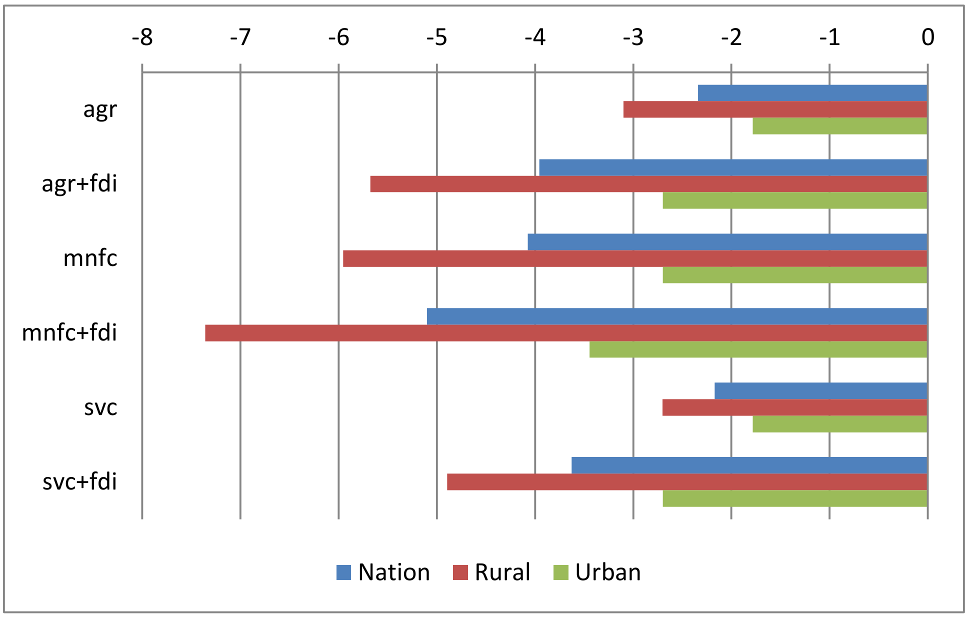
Source: Authors' calculations based on simulation results.

Figure 4.16: real household consumption per capita growth by simulation (%-age point deviation for average annual growth from base)



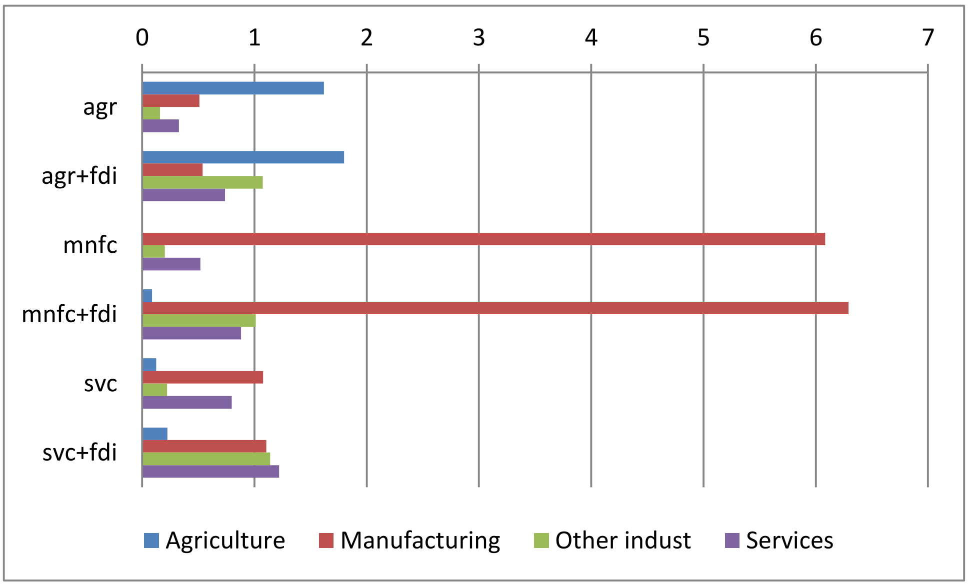
Source: Authors' calculations based on simulation results.

Figure 4.17: headcount poverty by simulation in 2030 (%-age point deviation from base)



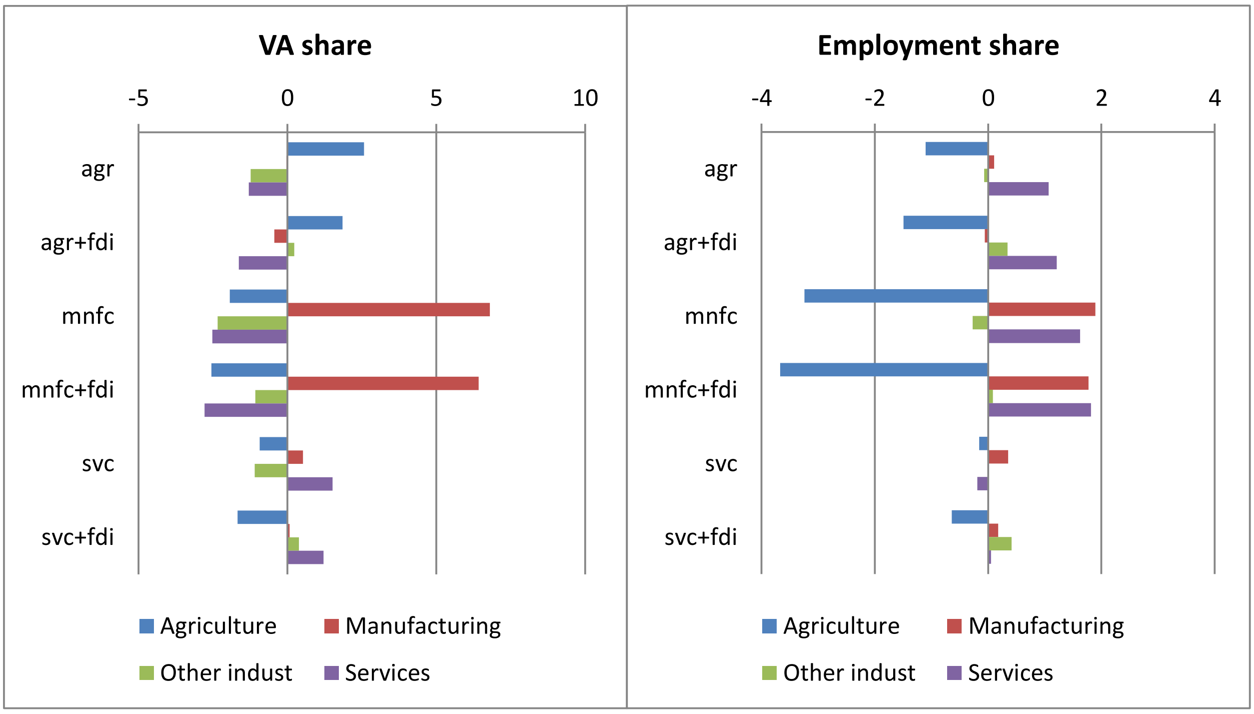
Source: Authors' calculations based on simulation results.

Figure 4.18: sectoral GDP growth by simulation (%-age point deviation from base)



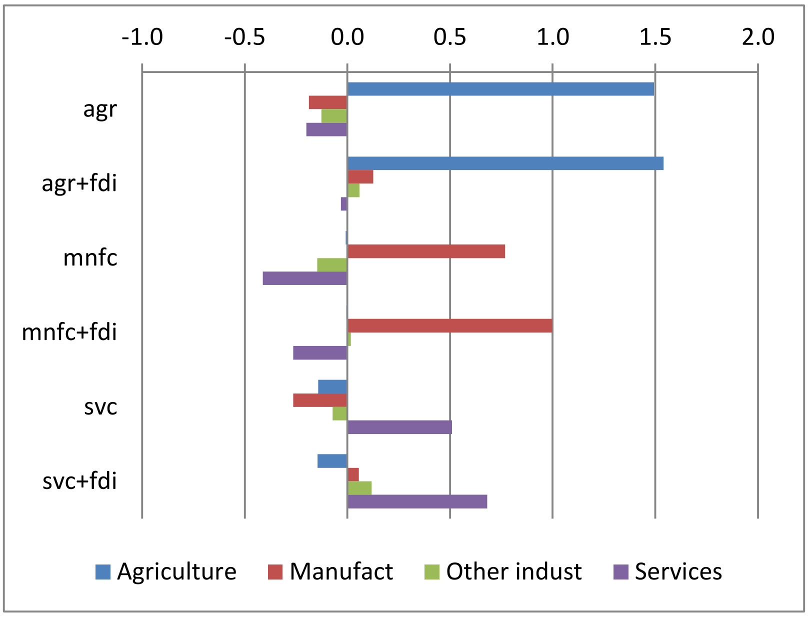
Source: Authors' calculations based on simulation results.

Figure 4.19: sectoral structure by simulation in 2030 (%-age point deviation from base)



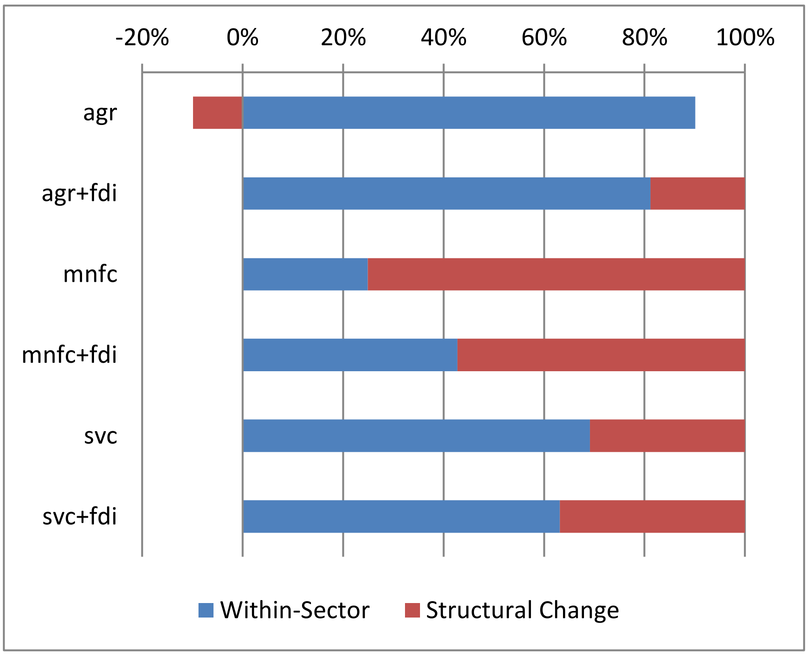
Source: Authors' calculations based on simulation results.

Figure 4.20: sectoral labor productivity growth by simulation (%-age point deviation from base)



Source: Authors' calculations based on simulation results.

Figure 4.21: decomposition of change in labor productivity by simulation in 2030 (%)



Source: Authors' calculations based on simulation results.

5. Concluding Remarks

In this paper, we analyzed the structure of Haiti's economy and its capacity to generate accelerated rates of growth and structural change. To that end, we implemented both partial and general equilibrium approaches. In general, our results show that shifting employment from agriculture to manufacturing increases the economy-wide product per worker. Naturally, better production techniques in agriculture and in manufacturing raise aggregate TFP.

In sum, our analysis concludes that agriculture-led growth provides weak overall benefits relative to the manufacturing-led growth and is also less effective at reducing rural poverty. Besides, Haiti's economic structure shows weak linkages from manufacturing growth to agriculture. However, manufacturing has higher value added per worker and higher export orientation – textiles in particular. Thus, developing the manufacturing sector leads to higher GDP growth rates and poverty reduction. Interestingly, as a result of indirect effects transmitted through the labor market, manufacturing-based growth induces higher poverty reduction in rural areas as well. Therefore, our results emphasize the relevance of promoting the development of industries oriented to the export market. In other words, and consistent with the literature, our study finds that structural change favoring manufacturing is correlated with the higher GDP growth rates. Moreover, we also showed how an increase in FDI can contribute to promote growth.

In a recent study, Cavallo and Powell (2018) find that countries in Latin America and the Caribbean should focus on factors that accelerate investment and enhance productivity growth. By doing so, countries in the region will achieve a more encouraging economic outlook in the medium and long term. More specifically, the authors suggest that the reduction of economic frictions and distortions, tax reforms that promote growth of more productive economic units, and emphasis on efficient and sustained public capital expenditures are key ingredients of the appropriate growth policy.

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Appendix A: Haiti CGE Model Mathematical Statement

In order to simplify the model presentation, in what follows assumptions are made in order to simplify the mathematical statement of the model. For example, we assume that all tax rates are exogenous, one trade partner, no enterprises as separate institutions, no value added tax, no tax on factor use, no consumption subsidies, among others. Of course, all this elements are available in the GAMS (General Algebraic Modeling System) model code. In addition, the model presentation assumes the macroeconomic closure rule used for model simulations in Section 4.

In the mathematical statement of the model we use the following sets:

ac = all accounts in the social accounting matrix and other elements

a(ac) = activities

c(ac) = commodities

f(ac) = factors

i(ac) = institutions (i.e., households, enterprises, government, rest of the world)

h(i) = households

gov(i) = government

row(i) = rest of the world

inv = investment accounts

invg = government investment accounts

invng = government investment accounts (i.e., private/public enterprises)

where the notation i(j) implies that j is a subset of i. Besides, the following notation is used:

- endogenous variables = upper-case Latin letters;
- exogenous variables = upper-case Latin letters with a bar on top – usually as part of the model “closure rule” (see below);
- parameters = lower-case Latin letters or lower case Greek letters;
- set indices = lower-case Latin letters as subscripts to variables and parameters; and
- variable names for quantities and prices start with Q and P, respectively.

Variables and Parameters

Endogenous Variables

$WFAVG_{f,t}$ = average remuneration of factor f

$CALTFP_t$ = TFP in calibration run

CAB_t = current account balance

$CON_{h,t}$ = household consumption expenditure

CPI_t = consumer price index

DPI_t = index for domestic producer prices (PDS-based)

EG_t = total current government expenditure

EXR_t = exchange rate (dom. currency per unit of for. currency)

$FD_{f,a,t}$ = quantity demanded of factor f from activity a

$FPRD_{f,a,t}$ = productivity term for factor f in act a

$FS_{f,t}$ = supply of factor f

$GDAJ_t$ = government demand scaling factor

$GFCF_t^{GOV}$ = government gross fixed capital formation

$GFCF_t^{NGOV}$ = non-government gross fixed capital formation

$IADJ_{invg,t}^{GOV}$ = government investment scaling factor

$IADJ_t^{NGOV}$ = non-government investment scaling factor

$IND_{a,t}$ = non-gov investment by destination

$INDG_{invg,t}$ = gov investment by destination

IT_t^{GOV} = gov total investment

IT_t^{NGOV} = non-gov total investment

$KG_{invg,t}$ = government capital stock

$MPS_{h,t}$ = marginal propensity to save for domestic non-gov inst insdng

$MPSADJ_t$ = savings rate scaling factor

$PA_{a,t}$ = output price of activity a

$PDD_{c,t}$ = demand price for commodity c produced and sold domestically

$PDS_{c,t}$ = supply price for commodity c produced and sold domestically

$PE_{c,t}$ = export price for c

$PINTA_{a,t}$ = price of intermediate aggregate

$PK_{invg,t}^{GOV}$ = replacement cost of gov capital

$PK_{invng,t}^{NGOV}$ = replacement cost of non-gov capital

$PM_{c,t}$ = import price for c

$PQD_{c,ac,t}$ = composite commodity demand price for c demanded by ac

$PQS_{c,t}$ = composite commodity supply price for c

$PVA_{a,t}$ = value-added price for activity a

$PX_{c,t}$ = producer price for commodity c

$QA_{a,t}$ = level of activity a

$QD_{c,t}$ = quantity sold domestically of domestic output c

$QE_{c,t}$ = quantity of exports for commodity c

$QG_{c,t}$ = quantity of government demand for commodity c

$QH_{c,h,t}$ = quantity consumed of commodity c by household h

$QINT_{c,a,t}$ = quantity of commodity c as intermediate input to activity a

$QINTA_{a,t}$ = quantity of aggregate intermediate input

$QINV_{c,t}$ = quantity of investment demand for commodity c

$QM_{c,t}$ = quantity of imports of commodity c

$QQ_{c,t}$ = quantity of goods supplied domestically (composite supply)

$QT_{c,t}$ = quantity of trade and transport demand for commodity c

$QVA_{a,t}$ = quantity of aggregate value added

QX_{c} = quantity of domestic output of commodity c

$REXR_{t}$ = real exchange rate

$RGFCF^{GOV}$ = real gross fixed capital formation gov

$RGFCF_{invng}^{NGOV}$ = real gross fixed capital formation non-gov

SG_{t} = government savings

SH_{h} = savings of household h

$SROW_{t}$ = foreign savings (foreign currency)

TFP_{a} = sectoral TFP index

$TR_{ac,ins,t}$ = transfers from ins to ac

$TRADJ_{ac,t}$ = scaling factor for transfers

$UERAT_{f,t}$ = unemployment rate for factor f

$WALRAS_{t}$ = dummy variable (zero at equilibrium)

$WF_{f,t}$ = average price of factor f

$WFDIST_{f,a,t}$ = wage distortion factor for factor f in activity a

$YF_{f,t}$ = factor income

YG_{t} = government income

$YH_{h,t}$ = income household h

$YIF_{i,f,t}$ = income of institution ins from factor f

Exogenous Variables and Parameters

iva_a = aggregate value added coefficient

$inta_a$ = aggregate intermediate input coefficient

$\delta_{f,a}^{VA}$ = share parameter for CES activity VA production function

ϕ_a^{VA} = shift parameter for CES activity VA production function

σ_a^{VA} = elasticity of substitution between factors

ρ_a^{VA} = exponent in the value added production function for a

$ica_{c,a}$ = intermediate input c per unit of aggregate intermediate

$\theta_{a,c}$ = yield of output c per unit of activity a

pwe_c = export price for c (foreign currency)

pwm_c = import price for c (foreign currency)

$icd_{c',c}$ = trade and transport input of c per unit of commodity c' produced and sold domestically

$ice_{c',c}$ = trade and transport input of c per unit of commodity c' exported

$icm_{c',c}$ = trade and transport input of c per unit of commodity c' imported

$sh_{i,f}^{F}$ = share for institution i in the income of factor f

$\overline{mps}_h$ = marginal propensity to save household h

$sh_{i,i'}^{TR}$ = share of institution i in post-tax post-savings income of institution i'; $i' \in \{h,e\}$

$ta_{a,t}$ = rate of tax on producer gross output value

$te_{c,t}$ = export tax rate for commodity c

$tf_{f,t}$ = rate of direct tax on factor income

$tm_{c,t}$ = import tariff rate for commodity c

$tq_{c,t}$ = rate of sales tax

$ty_{i,t}$ = rate of income tax for household h

$\overline{tr}_{ac,i}$ = exogenous component of transfers from ins i to ac; $i \in \{gov, row\}$

δ_c^M = Armington function share parameter for imports commodity c

δ_c^{DD} = Armington function share parameter for domestic commodity c

ϕ_c^Q = Armington function shift parameter for commodity c

σ_c^Q = elasticity of substitution between domestic goods and imports for c

$\rho_c^Q = \left(1 - \sigma_c^Q\right) / \sigma_c^Q$

δ_c^E = CET function share parameter for exports commodity c

δ_c^{DS} = CET function share parameter for domestic commodity c

ϕ_c^X = CET function shift parameter for commodity c

σ_c^X = elasticity of transformation between domestic sales and exports for c

$\rho_c^X = \left(1 + \sigma_c^X\right) / \sigma_c^X$

$\overline{qg}_c$ = quantity of government demand for commodity c

$qhmin_{c,h}$ = subsist cons of commodity c for household h

$\delta_{c,h}^{LES}$ = marginal share of household consumption on commodity c

cc_i^{NGOV} = quantity of commodity c per unit of non-gov investment in invng

cc_i^{GOV} = quantity of commodity c per unit of gov investment in invg

$phillips_f$ = elasticity of real wage with respect to unemployment rate

$qdstk_c^{NGOV}$ = changes in inventories non-government

$qdstk_c^{GOV}$ = changes in inventories government

$cwts_c$ = weight of commodity c in the CPI

$dwts_c$ = domestic sales price weights

δ^{GOV} = depreciation rate public capital

δ^{NGOV} = depreciation rate private capital

$\overline{qinvg}_{invg,t}$ = government investment in sector invg

$\overline{qinvng}_{invng,t}$ = non-government investment in sector invng

Equations

The model equations are organized in the following eight groups: production, incomes and savings, prices, international trade, final consumption, equilibrium conditions, miscellaneous, and investment by destination (i.e., dynamics).

Production

In the first place, we describe the production function, which is organized in two levels (see Figure A.1). As shown in the figure, we use nested Leontief (i.e., fixed coefficients) and CES (Constant Elasticity of Substitution) production functions. Equations (PF1) and (PF2) show that value added ($QVA_{a,t}$) and the aggregate of intermediate inputs ($QINTA_{a,t}$) are a fixed proportion of the activity production level ($QA_{a,t}$), respectively.

$$QVA_{a,t} = iva_a \cdot QA_{a,t} \qquad \text{(PF1)}$$

$$QINTA_a = inta_a QA_a \qquad \text{(PF2)}$$

Equations (PF3) and (PF4) represent the first order conditions of the optimization problem solved by the representative firm in each industry or activity (i.e., cost minimization/profit maximization). The value added production technology is a CES function. The remuneration to factor *f* paid by the activity *a* is computed as $WF_{f,t} \cdot WFDIST_{f,a,t}$, where $WFDIST_{f,a,t}$ is a "distortion" factor that allows modeling cases in which the factor remuneration differs across activities.[11] As we will see, this method to compute the remuneration of factor f in

[11] In this presentation we assume that its value is exogenous for labor and exogenous for capital; its value can be computed by combining the social accounting matrix with employment data by activity.

each activity allows to easily selecting among alternative closures (i.e., mechanisms to equalize supply and demand) in the factor markets.[12]

$$QVA_{a,t} = \varphi_a^{va} \cdot TFP_{a,t} \left(\sum_f \delta_{f,a}^{va} \left(fprda_{f,a,t} \cdot QF_{f,a,t} \right)^{-\rho_a^{va}} \right)^{\frac{-1}{\rho_a^{va}}} \qquad \text{(PF3)}$$

$$FD_{f,a,t} = \left(\frac{PVA_{a,t}}{WF_{f,t} \cdot WFDIST_{f,a,t}} \right)^{\sigma_a^{va}} \left(\delta_{f,a}^{va} \right)^{\sigma_a^{va}} \left(\varphi_a^{va} \cdot TFP_{a,t} \cdot fprda_{f,a,t} \right)^{\sigma_a^{va}-1} QVA_{a,t} \qquad \text{(PF4)}$$

Individual intermediate inputs are also a fixed share of output. However, note that in equation (PF5) intermediate inputs are a fixed share of the aggregate intermediate input which, in turn, is a fixed proportion of output (equation (PF2)).[13]

$$QINT_{c,a} = ica_{c,a} QINTA_a \qquad \text{(PF5)}$$

Equation (PF6) computes the production of each product on the basis of the $\theta_{a,c}$ parameter, which represents the production of product *c* per unit produced of activity *a*. Thus, following the supply and use tables, our model differentiates between activities and commodities/products. In addition, an activity can produce more than commodity and the same commodity may be produced by more than one activity.

$$QX_c = \sum_a \theta_{a,c} QA_a \qquad \text{(PF6)}$$

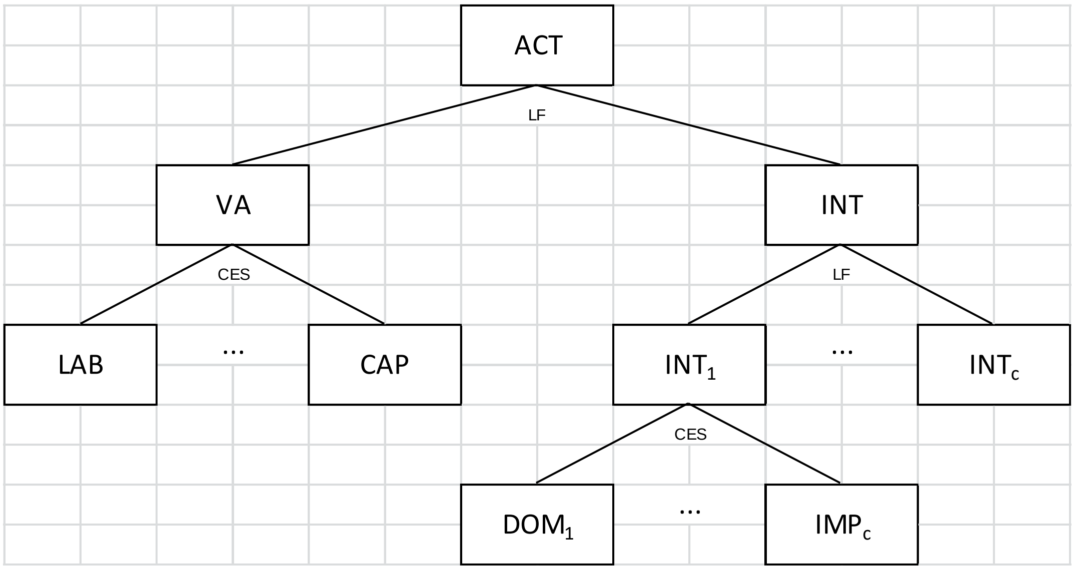
Equation (FP7) computes sectoral total factor productivity (TFP) as a function of (a) an exogenous component, and (b) the size of the public infrastructure capital stocks. Thus, an increase in the provision of public infrastructure of type *invginf* (e.g., roads) would have positive impacts on sectoral TFP, more or less strong depending on the value assigned to the $tfpelas_{a,invg}$ elasticity parameter. In equation (FP7), variable KG_{invg}^{00} refers to the public capital stock in sector *invg* in the base year. In other words, our model assumes that, based on available empirical evidence, that public infrastructure has positive externalities on sectoral TFP. For model calibration, the initial public capital stock can be estimated through alternative methods; for example, based on recent data for public investments.

[12] Besides, for the factors considered as specific, equation (PF4) is interpreted as an equilibrium condition between factor supply and demand.

[13] Note that, unlike the $ica_{c,a}$ parameters, the Leontief technical coefficients are expressed as share of output.

$$TFP_{a,t} = tfpexog_{a,t} CALTFP_t \prod_{invg \in invginf} \left(\frac{KG_{invg,t}}{KG^{00}_{invg}} \right)^{tfpelas_{a,invg}} \tag{PF7}$$

Figure A.1: production function



where ACT=activities, VA=value added, INTA=aggregate of intermediate inputs, LAB=labor, CAP=capital, INT=intermediate consumption, DOM=domestic, and IMP=imported.

Source: Author's own elaboration.

Prices

Equation (PR1) implicitly defines the price of value added, as all other variables in that equation are determined elsewhere in the model. For each activity, the price of its intermediate input composite ($QINTA_a$) is a weighted average of the prices of each of the commodities that is demanded as an intermediate input (equation (PR2)), with $ica_{c,a}$ as weights. As we have seen, $ica_{c,a}$ is the quantity of commodity *c* used as an intermediate input in activity *a* per unit of $QINTA_a$. The price of each activity is a weighted average of the prices of the commodities it produces (equation (PR3)).

$$PVA_a QVA_a = PA_a (1 - ta_a) QA_a - PINTA_a QINTA_a \tag{PR1}$$

$$PINTA_a = \sum_{c \in cenerg} PQD_{c,a} ica_{c,a} \tag{PR2}$$

$$PA_a = \sum_c \theta_{a,c} PX_c \tag{PR3}$$

Equations (PR4) and (PR5) define domestic prices of exports (PE_c) and imports (PM_c), respectively. It is assumed that the modeled economy is small; thus, world prices for exports and imports are given (pwe_c and pwm_c ; also, see below). The government can collect tariffs on imports and taxes on exports, at rates tm_c and te_c , respectively. Besides, the model also considers trade and transport margins applied to exports and imports; i.e., $ice_{c',c}$ and $icm_{c',c}$ represent the quantity of trade/transport commodity *ct* per unit of exports and imports of commodity *c*, respectively.

$$PE_c = (1 - te_c) EXR.pwe_c - \sum_{c' \in ct} PQD_{c',tace} ice_{c',c} \tag{PR4}$$

$$PM_c = (1 + tm_c) EXR.pwm_c + \sum_{c' \in ct} PQD_{c',tacm} icm_{c',c} \tag{PR5}$$

Equation (PR6) computes the demand price of the domestic product, by adding to its supply price the corresponding trade and transport margin. Thus, parameter $icd_{c',c}$ refers to the quantity of commodity *c'* (i.e., trade and transport; distribution services) that is required to move one unit of domestic product *c* from the producer to the consumer.

$$PDD_c = PDS_c + \sum_{c' \in ct} PQD_{c',tacd} icd_{c',c} \tag{PR6}$$

Incomes and Savings

Factors. Equation (YF1) computes the total income of factor *f*. The first term on the right hand side corresponds to total factor payments from activities. Besides, factor *f* can receive transfers from the rest of the world. In turn, equation (YF2) computes the income received by each institution for being the owner of factor *f*, net of the applicable (direct) tax on factor income.

$$YF_f = \sum_a WF_f WFDIST_{f,a} FD_{f,a} + TR_{f,row} \tag{YF1}$$

$$YIF_{i,f} = sh^F_{i,f} YF_f (1 - tf_f) \tag{YF2}$$

Households. The income of (representative) household h is the sum of two elements: (1) factor income, and (2) transfers from other institutions (see equation (H1)). Equation (H2) computes the marginal propensity to save for the households. Initially, variable $MPSADJ$ is equal to one.[14] Equation (H3) computes the value of savings for each household in the model, as a linear function of disposable income. Equation (H4) computes the consumption spending by households as their income net of transfers to other institutions, savings, and direct taxes.

$$YH_h = \sum_f YIF_f + \sum_i TR_{h,i} \tag{H1}$$

$$MPS_h = \overline{mps}_h \overline{MPSADJ} \tag{H2}$$

$$SH_h = \alpha_h^{SAV} CPI + MPS_h YH_h (1 - ty_h) \tag{H3}$$

$$CON_h = YH_h (1 - ty_h) - SH_h - \sum_i TR_{i,h} \tag{H4}$$

Government. Equation (G1) computes government income as the sum of three elements: (1) tax collection, (2) transfers from other institutions, and (3) factor income. Note that transfers from the rest of the world are multiplied by the exchange rate so that they are expressed in local currency. The government uses its income to provide goods and services and make transfers to other institutions (equation (G2)). Equation (G3) computes government savings as the difference between current income (YG) and current spending (EG).

$$\begin{aligned} YG = & \sum_{i \in insdng} ty_i YH_i \\ & + \sum_c tq_c \left(PDD_c QD_c + PM_c QM_c \right) \\ & + \sum_c tm_c EXR.pwm_c QM_c \\ & + \sum_c te_c EXR.pwe_c QE_c \\ & + \sum_a ta_a PA_a QA_a \\ & + \sum_f tf_f YF_f \\ & + \sum_i TR_{gov,i} \\ & + \sum_f YIF_{gov,f} \end{aligned} \tag{G1}$$

[14] Besides, in this presentation it is assumed that $MPSADJ$ is an exogenous variable.

$$EG = \sum_c PQ_c QG_c + \sum_i TR_{i,gov} \tag{G2}$$

$$SG = YG - EG \tag{G3}$$

Rest of the World. The rest of the world is represented through the current account of the balance of payments, expressed in foreign currency (equation (RW1)). The left (right) hand side shows the inflows (outflows) of foreign exchange. The current account balance of the balance of payments is the negative of foreign savings (equation (RW2)).

$$\begin{aligned} &\sum_c pwe_c QE_c + \frac{\sum_{ac} TR_{ac,row}}{EXR} + \overline{SROW} = \\ &\sum_c pwm_c QM_c + \frac{\sum_i TR_{row,i}}{EXR} + \sum_f \frac{YIF_{row,f}}{EXR} \end{aligned} \tag{RW1}$$

$$CAB = -\overline{SROW} \tag{RW2}$$

Transfers. The model provides a detailed treatment for transfers. Specifically, transfers from domestic non-government institution *i* (e.g., households, enterprises, others) to institution *i*' are modeled as an exogenous share of the income of institution *i* net of savings and direct taxes (equation (TR1)).[15] In turn, government transfers to domestic institutions are indexed to consumer price index (equation (TR2)), so that their value is constant in real terms. On the other hand, transfers from government to the rest of the world and from the rest to domestic institutions are indexed to the nominal exchange rate – see equations (TR3) and (TR4), respectively. Thus, their value in foreign currency is kept constant.[16] Equation (TR5) refers to the factor income from abroad, also expressed in foreign currency.

$$TR_{i,h} = sh_{i,h}^{TR}\left(YH_h\left(1 - ty_h\right) - SH_h\right) \tag{TR1}$$

$$TR_{insdng,gov} = \overline{tr}_{insdng,gov} CPI \tag{TR2}$$

$$TR_{row,gov} = \overline{tr}_{row,gov} EXR \tag{TR3}$$

[15] In case enterprises are present in the SAM as an institution, it is assumed that they can save and pay direct taxes, but do not demand commodities. In practice, enterprises usually receive most of the capital income to distribute it among the other institutions, such as households and the rest of the world.

[16] In equations (TR3)-(TR5) the trbar parameter is expressed in foreign currency units.

$$TR_{insd,row} = \overline{tr}_{insd,row} EXR \qquad \text{(TR4)}$$

$$TR_{f,row} = \overline{tr}_{f,row} EXR \qquad \text{(TR5)}$$

International Trade

Imports. On the consumption side, and following the Armington (1969) assumption, we assume that products are differentiated based on their country of origin (i.e., Haitian textiles are different from Italian textiles). Consequently, it is possible to consider two-way trade (i.e., the same product is exported and imported simultaneously). To model the imperfect substitution between domestic and imported products, we use a CES function (equation (IM1)).[17] Equation (IM2) is the tangency condition that determines the domestic/imported mix of total supply/demand for each product. Equation (IM3) computes the supply price of the composite product QQ_c as a weighted average of the domestic and imported varieties of commodity c. Equation (IM4) computes the demand price of the composite product QQ_c. The sales tax is imposed on the composite product. For products that are only bought domestically or that are only imported, equation (IM1) is replaced with equation (IM1') at the same time that equation (IM2) is excluded from the model.

$$QQ_c = \phi_c^Q \left(\delta_c^M QM_c^{-\rho_c^Q} + \delta_c^{DD} QD_c^{-\rho_c^Q} \right)^{-\frac{1}{\rho_c^Q}} \qquad \text{(IM1)}$$

$$QQ_c = QM_c + QD_c \qquad \text{(IM1')}$$

$$\frac{QM_c}{QD_c} = \left(\frac{PDD_c}{PM_c} \frac{\delta_c^M}{\delta_c^{DD}} \right)^{\frac{1}{1+\rho_c^Q}} \qquad \text{(IM2)}$$

$$PQS_c QQ_c = PDD_c QD_c + PM_c QM_c \qquad \text{(IM3)}$$

$$PQD_{c,ac} = PQS_c \left(1 + tq_c\right) \qquad \text{(IM4)}$$

Exports. On the production side, production can be sold in the domestic market and/or exported to the rest of the world. In terms of modeling, we use a CET (Constant Elasticity of Transformation) function (equation (EX1)).[18] Equation (EX2) corresponds to the first order

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[17] The elasticity of substitution between domestic purchases and imports is $\sigma_c^Q = 1/\left(1+\rho_c^Q\right)$.

[18] The elasticity of transformation between domestic sales and exports is $\sigma_c^X = 1/\left(\rho_c^X - 1\right)$.

conditions of the profit maximization problem solved by the producer. Equation (EX3) is the zero profit condition for the production of commodity *c*, from where price PX_c is obtained. For products that are only sold domestically or are only exported, equation (EX1) is replaced by equation (EX1') and equation (EX2) is excluded from the model.

$$QX_c = \phi_c^X \left(\delta_c^E QE_c^{\rho_c^X} + \delta_c^{DS} QD_c^{\rho_c^X}\right)^{\frac{1}{\rho_c^X}} \quad \text{(EX1)}$$

$$QX_c = QE_c + QD_c \quad \text{(EX1')}$$

$$\frac{QE_c}{QD_c} = \left(\frac{PE_c}{PDS_c}\frac{\delta_c^{DS}}{\delta_c^E}\right)^{\frac{1}{\rho_c^X - 1}} \quad \text{(EX2)}$$

$$PX_c QX_c = PDS_c QD_c + PE_c QE_c \quad \text{(EX3)}$$

Final Consumption

Household consumption expenditure is distributed across commodities according to a Stone-Geary utility function, from which a linear expenditure system is derived (equation (FC1)). Equation (FC2) computes the investment demand of commodity *c*. It is assumed that the commodity composition of investment is exogenous – see parameters $cc_{invng,c}^{NGOV}$ and $cc_{invng,c}^{NGOV}$. Thus, if there is an increase in investment, investment demand for all goods and services will increase in the same proportion.[19] Initially, variable $IADJ$ is equal to one. Equation (FC3) computes the government consumption/provision of commodity *c*. It is assumed that the commodity composition of government consumption is also fixed at its initial values. Initially, variable $GADJ$ is equal to one. Equation (FC4) is the total demand for commodities that provide trade and transport margins; the demand for such commodities is linked to domestic products, imports and exports.

$$QH_{c,h} = qhmin_{c,h} + \frac{\delta_{c,h}^{LES}}{PQD_{c,h}}\left(CON_h - \sum_{c'} PQD_{c',h} qhmin_{c',h}\right) \quad \text{(FC1)}$$

$$QINV_c = \sum_{invng} cc_{invng,c}^{NGOV} RGFCF_{invng}^{NGOV} + \sum_{invg} cc_{invg,c}^{GOV} RGFCF_{invg}^{GOV} \quad \text{(FC2)}$$

[19] This presentation assumes that investment is considered as an endogenous variable; see below the discussion of macroeconomic closure rule.

$$QG_c = \overline{qg}_c \overline{GADJ} \tag{FC3}$$

$$QT_c = \sum_{c'} \left(icm_{c,c'} QM_{c'} + ice_{c,c'} QE_{c'} + icd_{c,c'} QD_{c'} \right) \tag{FC4}$$

Unemployment

Equation (U1) is the wage curve for factor f (see Blanchflower and Oswald (1994)). It is assumed that there is a negative relation between the real wage and the unemployment rate, as the value of the phillips parameter is negative. In fact, Blanchflower and Oswald (2005) report a value for the unemployment-elasticity of wage close to -0.1 for a large number of countries. Note that the wage curve is consistent with several stories to explain the presence of unemployment for the labor market, such as efficiency wages, unions with bargaining power, among others.

$$\frac{WF_f}{CPI} = \frac{WF_f^{00}}{CPI^{00}} \left(\frac{UERAT_f}{UERAT_f^{00}} \right)^{phillips_f} \tag{U1}$$

Equilibrium Conditions

Equation (EQ1) is the equilibrium condition in the market for factor f. As will be shown, this model presentation assumes that all factor supplies are exogenous. However, the supply of each factor (FS_f) can be exogenous or endogenous depending on the selected closure rule.

Equation (EQ2) is the equilibrium condition between supply and demand for each commodity. Total supply, composed of domestic and imported varieties, is used for household consumption, intermediate consumption, investment, government consumption and changes in inventories. Equation (EQ3) is the savings-investment balance; three are the institutions that contribute to total savings: domestic non-government institutions (i.e., households and enterprises), government, and the rest of the world. The variable $WALRAS$ must be zero in equilibrium.

$$FS_{f,t}(1 - UERAT_{f,t}) = \sum_a FD_{f,a} \tag{EQ1}$$

$$\sum_h QH_{c,h} + \sum_a QINT_{c,a} + QINV_c + QG_c + qdstk_c^{NGOV} + qdstk_c^{GOV} + QT_c = QQ_c \tag{EQ2}$$

$$IT^{NGOV} + IT^{GOV} + WALRAS = \sum_{h} SH_h + SG + EXR.SROW \tag{EQ3}$$

Miscellaneous

Equation (MIS1) defines the consumer price index as a weighted average of the composite commodity prices for households ($PQD_{c,h}$); the weights are the shares of each commodity in private (i.e., household) consumption. In this presentation CPI is the model numeraire (see below). Equation (MIS2) defines the producer domestic price index as a weighted average of the prices of domestic output sold in the domestic market. Equation (MIS3) defines the real exchange rate, as the ratio between the nominal exchange rate and the producer domestic price index.

$$\sum_{c,h} PQD_{c,h} cwts_{c,h} = CPI \tag{MIS1}$$

$$\sum_{c} PDS_c dwts_c = DPI \tag{MIS2}$$

$$REXR = \frac{EXR}{DPI} \tag{MIS3}$$

Investment by Destination – Dynamics

Lastly, this group of equations presents the model dynamics. Specifically, the mechanisms used to assign each period private and public investment among sectors are presented. As will be shown, a distinction is made between private and public capital stocks; this is particularly relevant given our interest in simulating increases in the government investment of public infrastructure.

Non-Government Sector. In this case, investment in each period increases the capital stock available in the next period. Then, we need to determine how the new capital is distributed among industries. In our model, for private investment (i.e., households and/or enterprises) we assume that the new capital is distributed across activities based on sectoral differences in capital rates of return. Thus, sectors with a relatively higher (lower) capital rate of return receive a relatively larger (smaller) share of the new capital.

Equation (DP1) computes the price of one unit of private capital; the new capital is assembled using a fixed coefficient production function. Equation (DP2) defines total private investment as the sum of private gross fixed capital formation and the value of change in stocks. Equation (DP3) computes the real gross fixed capital formation, which refers to the quantity of new units of the capital good that will be available to produce the next period. Equation (DP4) can be used to impose an exogenous path for private investment in one or more sectors included in the set *invng* (see above). Equation (DP5) computes the average capital rate of return, as the ratio between total capital income and total capital stock. Equation (DP6) computes the share of each activity in the new capital stock, following the explanation on the previous paragraph. The κ parameter, which varies between zero and one, measures the degree of capital mobility among productive sectors. When κ is zero, investment is distributed among sectors only based on the initial share of each sector in the total capital stock. When κ is positive, investment is distributed among sectors also based on the relative capital returns. Finally, equation (DP8) shows how sectoral capital stocks are updated.

$$PK_{invng}^{NGOV} = \sum_{c} cc_{invng,c}^{NGOV} PQD_{c,invng} \tag{DP1}$$

$$IT^{NGOV} = GFCF^{NGOV} + \sum_{c} PQD_{c,dstk} qdstk_{c}^{NGOV} \tag{DP2}$$

$$GFCF^{NGOV} = \sum_{invng} RGFCF_{invng}^{NGOV} PK_{invng}^{NGOV} \tag{DP3}$$

$$RGFCF_{invng}^{NGOV} = \overline{qinvng}_{invng}\left(1 + IADJ^{NGOV}\right) \tag{DP4}$$

$$AWF_{f} = \frac{\sum_{a} FD_{f,a} WF_{f} WFDIST_{f,a}}{\sum_{a} FD_{f,a}} \tag{DP5}$$

$$IND_{fcap,a} = \sum_{invng \in mfcapinv} RGFCF_{invng}^{NGOV} \frac{FD_{fcap,a}}{\sum_{a'} FD_{fcap,a'}} \left[1 + \kappa\left(\frac{WF_{fcap} WFDIST_{fcap,a}}{AWF_{fcap}} - 1\right)\right] \tag{DP6}$$

$$FD_{fcap,a} = \left(1 - \delta^{NGOV}\right) FD_{fcap,t-1} + IND_{fcap,a,t-1} \tag{DP7}$$

Government Sector. For the government, investment can be determined in two alternatives ways: (1) as a policy variable (i.e., exogenously), or (2) as a residual to balance the government budget. Equations (DG1), (DG2), (DG3) and (DG4) are similar to equations

(DP1), (DP2), (DP3) and (DP4), respectively. Finally, equation (DG6) updates the public capital stocks of period t using public investment from period t-1. For example, an increase in public investment in infrastructure would be modeled as an increase in the value of the relevant element of the $\overline{qinvg}_{invg}$ parameter. Then, an increase in KG_{invg} would be obtained that, in turn, would positively impact on the sectoral TFP (see equation (PF7) above). As mentioned, the model allows identifying more than one type of public capital; for example, different infrastructure sectors such as roads, communications, energy, among others.

$$PK_{invg}^{GOV} = \sum_{c} cc_{invg,c}^{GOV} PQD_{c,invg} \tag{DG1}$$

$$IT^{GOV} = GFCF^{GOV} + \sum_{c} PQD_{c,dstkg} qdstk_{c}^{GOV} \tag{DG2}$$

$$GFCF^{GOV} = \sum_{invg} PK_{invg}^{GOV} RGFCF_{invg}^{GOV} \tag{DG3}$$

$$RGFCF_{invg}^{GOV} = \overline{qinvg}_{invg}\left(1 + IADJ_{invg}^{GOV}\right) \tag{DG4}$$

$$INDG_{invg} = RGFCF_{invg}^{GOV} \tag{DG5}$$

$$KG_{invg,t} = \left(1 - \delta^{GOV}\right) KG_{invg,t-1} + INDG_{invg,t-1} \tag{DG6}$$

In addition, model dynamics require the imposition of growth rate for the other factor endowments, the minimum consumption of households, and transfers model through the $\overline{tr}_{ac,i}$ parameter.

Appendix B: Additional Results

Table B.1: yields (hg/ha) in agriculture; Haiti and average for least developed countries, 2014*

Product	Haiti	Least Developed Countries
Cereals (Rice Milled Eqv)	9,263	16,443
Cereals,Total	10,085	20,009
Citrus Fruit,Total	47,397	77,367
Coarse Grain, Total	8,438	12,199
Fruit excl Melons,Total	66,701	68,908
Jute & Jute-like Fibres		19,530
Oilcakes Equivalent	2,678	3,541
Oilcrops Primary	2,375	2,740
Pulses,Total	7,152	8,240
Roots and Tubers,Total	57,232	90,579
Treenuts,Total		5,295
Vegetables Primary	52,761	84,399
Vegetables&Melons, Total	52,761	84,399

*hg/ha is hectogramme (100 grammes) per hectare
Source: FAOSTAT.

Table B.1. Real macro indicators for base and non-base simulations (% annual growth 2018-2030)

Item	2013	base	agr	agr+fdi	mnfc	mnfc+fdi	svc	svc+fdi
Absorption	493,643	1.5	1.9	2.4	2.2	2.7	1.9	2.5
Consumption, private	352,731	1.5	2.0	2.4	2.4	2.8	2.0	2.4
Investment, private	50,796	1.6	1.9	3.8	1.9	3.7	2.0	4.0
Investment, government	58,732	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Consumption, government	31,327	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Exports	44,879	2.2	2.9	2.7	9.1	9.2	3.9	3.8
Imports	171,307	1.7	1.9	2.3	4.2	4.6	2.2	2.6
GDP factor cost	347,308	1.5	2.1	2.5	2.5	2.9	2.1	2.6
Real exchange rate (index)	1	0.0	0.1	0.1	-1.0	-1.0	0.1	0.1
Average wage	1	0.1	0.3	0.5	0.9	1.1	0.4	0.5
Average capital return	1	0.1	0.6	0.3	0.9	0.7	0.5	0.2
Unemployment rate (%)	32	31.9	28.5	26.5	25.5	23.7	29.2	27.3

Note: Except for unemployment, the 2013 column shows levels in million gourdes, while the simulation columns show annual growth rates 2018-2030. For unemployment, the 2013 and simulation columns show the rates in 2013 and 2030, respectively.
Source: Authors' calculations based on simulation results.

Table B.2. Macro indicators in 2017 and for simulations in 2030 (% of nominal GDP)

Item	2013	base	agr	agr+fdi	mnfc	mnfc+fdi	svc	svc+fdi
Absorption	134.4	134.3	132.2	133.0	126.4	127.2	132.2	133.0
Consumption, private	96.1	95.9	94.9	94.2	91.4	91.0	95.2	94.6
Investment	29.8	29.8	29.1	31.0	27.4	29.1	29.0	30.9
Investment, private	13.8	13.8	13.7	16.5	13.0	15.4	13.8	16.6
Investment, government	16.0	16.0	15.4	14.4	14.5	13.7	15.2	14.3
Consumption, government	8.5	8.5	8.2	7.8	7.5	7.2	8.0	7.6
Exports	12.2	13.7	14.1	12.9	25.1	24.1	16.0	14.9
Imports	46.7	48.0	46.3	45.9	51.5	51.4	48.2	47.9
GDP factor cost	94.6	94.6	94.7	94.7	94.3	94.3	94.4	94.5

Source: Authors' calculations based on simulation results.

Table B.3. Real sectoral value added for base and non-base simulations (% annual growth 2018-2030)

Commodity	2013	base	agr	agr+fdi	mnfc	mnfc+fdi	svc	svc+fdi
Agr, hunting and forestry; Fishing	67,345	0.8	2.5	2.6	0.9	0.9	1.0	1.1
Mining and quarrying	560	1.6	2.0	2.7	2.1	2.7	2.4	3.0
Food prod and beverages	6,639	1.4	1.8	2.1	1.6	1.9	1.9	2.2
Tobacco prod	118	1.6	1.9	2.3	1.8	2.1	2.0	2.3
Textiles, wearing apparel and leather	9,609	2.5	3.5	2.9	13.4	13.6	3.7	3.1
Wood and of prod of wood and cork	1,227	1.8	2.2	2.7	0.9	1.3	3.1	3.6
Paper and paper prod; Publishing	1,856	1.8	2.2	2.8	2.3	2.8	2.7	3.3
Chemicals; Rubber and plastics	839	1.8	1.9	2.5	0.5	0.9	2.9	3.5
Other non-metallic mineral prod	1,426	1.7	1.8	2.6	1.3	2.0	2.2	3.0
Basic metals	204	1.9	1.9	2.7	0.7	1.4	3.0	3.8
Fabricated metal prod; Mach and equip	208	2.1	1.5	2.1	-1.4	-0.9	4.2	4.8
Other manufactures	2,449	2.2	1.5	2.1	-2.1	-1.7	4.2	4.8
Electricity and water supply	6,366	1.8	2.1	2.5	2.6	3.0	2.2	2.7
Construction	83,021	1.6	1.8	2.7	1.8	2.6	1.8	2.8
Wholesale and retail trade	90,090	1.6	2.1	2.5	2.7	3.2	2.4	2.8
Hotels and restaurants	1,134	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Transport, storage and comm	34,190	1.7	1.9	2.4	1.1	1.5	3.0	3.5
Financial intermediation	6,990	1.9	2.0	2.4	1.1	1.5	3.5	3.9
Other services	11,490	1.6	2.1	2.7	2.2	2.7	2.4	3.0
Education, government	894	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Helath, government	2,584	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Public administration	18,071	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Total	347,308	1.5	2.1	2.5	2.5	2.9	2.1	2.6

Note: The 2013 column shows levels in million gourdes, while the simulation columns show annual growth rates 2018-2030.
Source: Authors' calculations based on simulation results.

Table B.4. Government receipts and spending in 2017 and for simulations in 2030 (% of nominal GDP)

Item	2013	base	agr	agr+fdi	mnfc	mnfc+fdi	svc	svc+fdi
IncCur-DirTax	2.6	2.6	2.6	2.2	2.9	2.6	2.0	1.6
IncCur-ActTax	3.1	3.1	3.1	3.0	3.4	3.4	3.2	3.1
IncCur-ComTax	-0.9	-0.9	-0.9	-0.9	-1.0	-1.0	-0.9	-0.9
IncCur-ImpTax	3.3	3.3	3.2	3.2	3.3	3.3	3.4	3.3
IncCur-TrnsfrDom	0.8	0.9	0.9	0.8	0.8	0.8	0.9	0.9
IncCur-TrnsfrFor	8.9	8.9	8.4	7.9	7.0	6.6	8.4	7.9
IncCur-Total	17.7	17.7	17.2	16.2	16.5	15.7	16.8	15.9
SpndCur-Con	8.5	8.5	8.2	7.8	7.5	7.2	8.0	7.6
SpndCur-TrnsfrDom	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.2
SpndCur-TrnsfrFor	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SpndCur-Total	8.8	8.8	8.5	8.1	7.8	7.4	8.3	7.9
GovSav	8.9	8.9	8.7	8.2	8.7	8.3	8.5	8.0
SpndCap-Inv	16.0	16.0	15.4	14.4	14.5	13.7	15.2	14.3
GovSurp	-7.1	-7.1	-6.7	-6.3	-5.7	-5.4	-6.7	-6.3
IncCap-NetDomFin	2.6	2.6	2.4	2.2	2.2	2.1	2.4	2.2
IncCap-NetForFin	4.5	4.5	4.3	4.0	3.6	3.4	4.3	4.0
Inc-Total	24.8	24.8	23.8	22.5	22.2	21.1	23.4	22.1
Spnd-Total	24.8	24.8	23.8	22.5	22.2	21.1	23.4	22.1

Source: Authors' calculations based on simulation results.

Table B.5. Balance of payments in 2017 and for simulations in 2030 (% of nominal GDP)

Item	2013	base	agr	agr+fdi	mnfc	mnfc+fdi	svc	svc+fdi
InCur-Exports	11.0	12.4	13.0	11.8	24.1	23.1	14.9	13.8
InCur-Tourism	1.2	1.2	1.2	1.1	1.1	1.0	1.1	1.1
InCur-Trnsfr-NoGov	21.1	21.1	19.9	18.7	16.6	15.7	19.9	18.7
InCur-Trnsfr-Gov	8.9	8.9	8.4	7.9	7.0	6.6	8.4	7.9
InCur-FacInc	0.6	0.6	0.5	0.5	0.4	0.4	0.5	0.5
InCur-RowSav	7.0	7.0	6.6	9.1	5.5	7.6	6.6	9.1
InCur-Total	49.8	51.2	49.5	49.1	54.6	54.5	51.5	51.2
OutCur-Imports	46.7	48.0	46.3	45.9	51.5	51.4	48.2	47.9
OutCur-Trnsfr-NoGov	2.9	3.1	3.1	3.0	2.9	2.9	3.1	3.1
OutCur-Trnsfr-Gov	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OutCur-FacInc	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
OutCur-Total	49.8	51.2	49.5	49.1	54.6	54.5	51.5	51.2
InCap-NetForFin-NoGov	0.6	0.6	0.6	0.5	0.5	0.4	0.6	0.5
InCap-NetForFin-Gov	4.5	4.5	4.3	4.0	3.6	3.4	4.3	4.0
InCap-NetTotal	5.1	5.1	4.8	4.5	4.0	3.8	4.8	4.5

Source: Authors' calculations based on simulation results.