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Analysis of Evidence

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Boosting Tourism's Contribution to Growth and Development: Analysis of Evidence

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Abstract

In this study we develop an evidence-based tool to help to guide policy and investment choices, to maximize developmental returns from tourism. Specifically, we develop a tourism-extended social accounting matrix and computable general equilibrium and microsimulation models customized for tourism investment analysis. To demonstrate the approach, we develop these data structures for Belize, at both national and regional levels. The framework developed herein can be used to quantify the direct and indirect, and short- and long-run impacts of tourism investments. Anticipating application of the approach to tourism investment analysis in the Central American Region, we provide a stock take of the availability of data to develop a similar suite of models for other countries in the region.

Keywords: ex-ante economic impact analysis; tourism investment analysis; tourism development; economy-wide model; microsimulation model; Belize; Central America.

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1.0. Introduction

Belize boasts diverse natural resources as well as rich cultural heritage, which provide a range of attractions for tourists. For the past 15 years tourism has grown to be an important sector of Belize's economy, with around 340,000 overnight visitors in 2015 and a further 960,000 cruise arrivals. The World Travel and Tourism Council (WTTC) estimates that the industry's direct contribution to GDP grew from 8.5 percent in 2000 to 13.9 percent in 2016 (WTTC, 2016). As noted by the government (GOB, 2012 and 2015), tourism has strong potential for further expansion in Belize, and is therefore a priority sector for Belize's strategy for economic development, as it is for the IDB's Country Strategy for Belize (IDB, 2013).

The tourism supply chain involves a wide range of sectors of the society and economy. The industry's contribution to growth, poverty reduction and long term development depends upon complex economic, social, environmental and institutional linkages, spillovers and externalities. To maximize the positive effects and minimize the negative, policy-makers need to understand what types of tourism, and kinds of policies, are associated with the most beneficial results, and how to stimulate the types of private sector innovation and investment (domestic and international, large and small) that foster them.

In this study we develop an evidence-based tool to help to guide policy and investment choices, to maximize developmental returns from tourism. Specifically, we develop tourism-extended social accounting matrices and computable general equilibrium and microsimulation models for Belize, at both national and regional levels.

The computable general equilibrium (CGE) model of Belize's national economy (and of its six regions) presented here is ready to be applied. Hence, where estimates related to specific tourism-related investments are available, the model can be used to quantify the direct and indirect, and short- and long-run impacts. For instance, it could be used to estimate the impacts of building a port for cruise ships and/or improving the road to Caracol, a world renowned Mayan archeological site. To that end, the analyst implementing the model would need access to: (i) investment projections and (ii) an estimate of the expected impact on gross tourist arrivals and/or tourist spending.

This report is structured as follows. Section 2 describes the model and its dataset. Section 3 describes the baseline and a set of scenarios to identify the impact of investment policy decisions related to the development of the tourism sector of Belize under different tourism demand assumptions. Specifically, we focus on Belize's Cayo District as an illustrative case study. Section 4 presents the model results. The study closes with a stock take of the available data to implement our modeling approach more broadly, both in Belize and in the other Central American countries. A detailed description of the model and data is provided in the Appendix to the study.

2.0. Methods and Data

The tourism industry is far from being an isolated sector: indeed, it is an important component of many sectors, ranging from the hotels and restaurants sector where it is dominant, to food and beverages and transport, where its influence is also strong. Similarly, investments in diverse sectors contribute to the development of tourism, from infrastructure development, the provision of basic public services such as water and sanitation, and capacity building in the services sector, to institutional strengthening in terms of tourism-sector governance. Thus, in order to assess the impact of any of the many types of policy interventions, investments and external shocks that might affect the tourism sector, a framework that considers all economic sectors and their inter-linkages is essential (see, for example, Dwyer (2015)). The CGE model provides a systematic method for predicting both the direction and approximate magnitudes of impacts of policies and external shocks on different agents. In this study, a national/regional, tourism-extended recursive dynamic computable CGE model for Belize is developed and applied.

The modeling framework developed here can be used in different contexts, such as other countries in the CID region. In fact, our model was developed as a "standard" (flexible structural) model. Thus, there is a complete separation between model code and database. Specifically, the model comprises the following files: (a) a generic set of model files in GAMS (General Algebraic Modeling System)[1], and (b) application-specific files in Excel for data and simulations. Thus, anything that is not specific to an application dataset for the particular country or regional case appears in the model code. Finally, note that the model code is written and customized to capture whatever data is available in each case.

The modelling framework is not only designed to be applicable to different countries or regions, but also to be sufficiently flexible to allow customizable versions. Users can therefore select from: a national or regional model version; a static or dynamic model

[1] https://www.gams.com/

version; flexible (dis)aggregation (e.g., sectors and/or factors) options; alternatives specified for selected assumptions; the application of a special treatment for the (domestic and foreign) tourism sector; macro closures[2]; rules for government receipts and spending; rules for non-government payments; presence/absence of (endogenous) unemployment; and various other features.

2.1. The Computable General Equilibrium Model

In essence, the CGE model combines a relatively standard recursive dynamic computable general equilibrium model (see, for example, Lofgren et al. (2002) and Robinson (1989)) with additional equations and variables that, depending on data availability, can single out: (a) the domestic and foreign tourism demand, (b) different modalities of tourism supply and demand, and (c) the impact of public capital investment in infrastructure on sectoral productivity. Moreover, the regional (that is, sub-national) variant of the model can handle (a) trade between the modeled region and the rest of the country and the rest of the world, and (b) local and central government operations in the modeled region (i.e., tax collection and current and capital spending)[3]. Thus, compared to other CGE models, the one developed here provides a combination of policy-relevant features for the study of tourism investment or policy counterfactual scenarios in a national/regional economy.

The regional variant of the model is similar to the national variant, but with additional elements to capture transactions between the modeled regional economy and the rest of the country. Figure 1 depicts, for each simulation period, the circular flow of income within the regional (subnational) economy and between this regional economy and the rest of the country and the rest of the world.

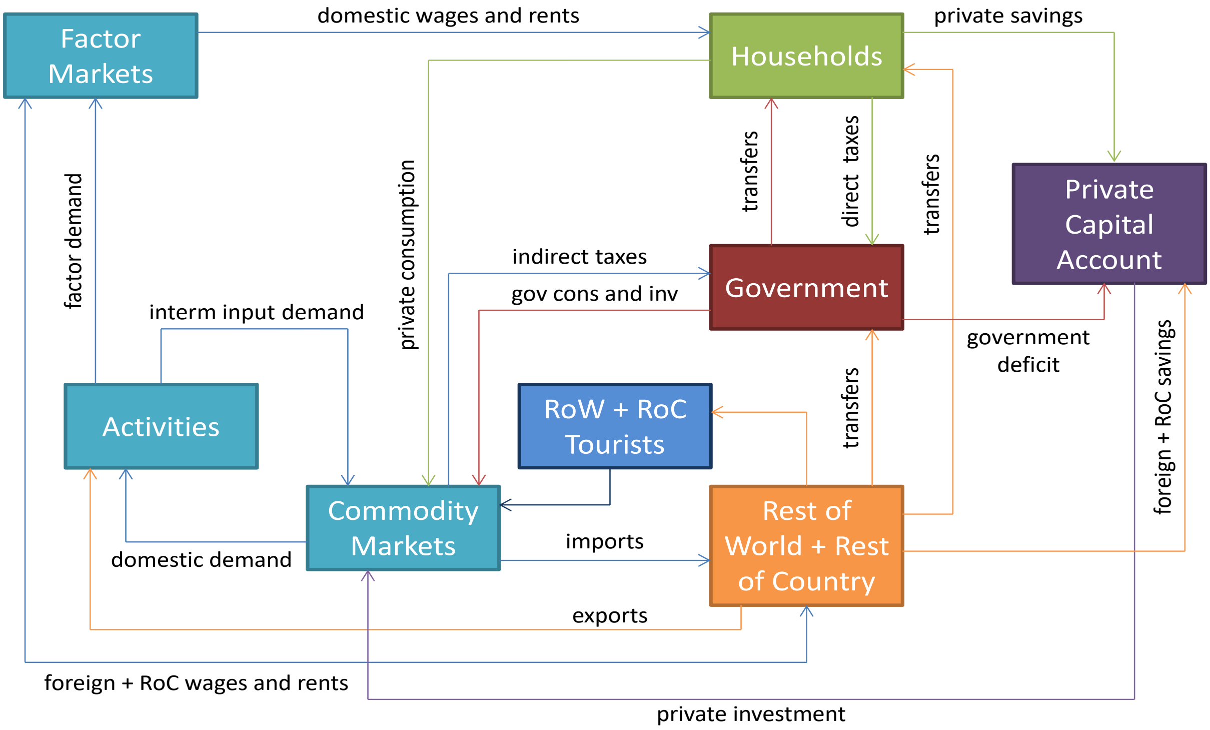
For the national economy as a whole, the major building blocks of our CGE model may be divided into: activities (producers of commodities), markets for commodities (goods and services); markets for factors (labor, land and capital stock) and private capital, and four

[2] In a CGE model, the macro closure refers to the rules on the basis of which a market (quantity demanded = quantity supplied) or a macro balance (income = expenditure) clears. In any application, the model macro closure comprises three elements: (a) government (adjustment of one or more receipt or spending items), (b) balance of payments (adjustment of the real exchange rate -- more common -- or of a non-trade foreign exchange flow), and (c) savings-investment balance (investment clears -- investment is savings driven -- or one or more savings flows adjust -- savings is investment driven).

[3] In fact, our starting point for model development was our previous work as published in Banerjee et al. (2015) and Banerjee et al. (2016). In addition, a multi-regional variant of the model has been developed. Again, the application of the multi-regional model depends on the availability of regional data such as regional employment and/or GDP by sector. In practice, such data is required to build a multi-regional dataset, starting from a national dataset.

institutions: households, government, the rest of the world, and tourists (both domestic and foreign). As shown, foreign and domestic tourism are sources of income for the modeled region. Specifically, foreign tourism is a source of foreign exchange. In any application (and database) of our CGE model, most blocks in Figure 1 are disaggregated – the disaggregation in the Belize Cayo District regional CGE (RCGE) application is shown in Table 2 below.

Figure 1. Circular income flow in the RCGE; within-period module



Source: Author's own elaboration.

In any single year, the (regional) CGE model has the structure summarized in the above figure.

Activities produce, selling their output at home or abroad (i.e., the rest of Belize and/or the rest of the world), and use their revenues to cover their costs (of intermediate inputs, factor hiring and taxes) and provide a return to investors. Their decisions to pursue particular activities with certain levels of factor use are driven by profit maximization. The shares of output that are exported and sold domestically depend on the relative prices of the output in world, national, and domestic markets. For any exported commodity, exporters face either (a) export prices (here we refer to free on board prices) that are exogenously determined, in which case export demand is infinitely price-elastic; or (b) price-sensitive export demands (defined by constant-elasticity functions) with the free on board export prices linked to domestic conditions (e.g., the costs of production) and the real exchange rate.

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 design (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 (income flows to and from which appear in the balance of payments) sends foreign currency to the modeled region (or country if using the national version of the model) in the form of transfers to its government and households. The region uses these inflows to finance its imports. It is assumed that the balance of payments clears (inflows and outflows are equalized) via adjustments in the (local) real exchange rate (the ratio between the international and domestic price levels), influencing export and import quantities and values in foreign currency.

The private capital account provides investment financing from savings by households, government, the rest of the world and the rest of Belize.

For the regional model, the relation between the modeled region of Belize (e.g., Cayo District) and the rest of Belize is also taken into account. Here, tourism demand from the rest of the world and the rest of Belize can be modeled as an exogenous volume or using constant elasticity of demand functions. In the latter case, the modeled region of Belize faces a downward-sloping demand curve for its tourism exports. In both cases, total tourism demand is disaggregated across locally produced commodities using fixed coefficients. For concreteness, equations (1) and (2) show the demand functions used to model tourism export demand from the rest of the world and the rest of Belize, respectively. Naturally, in the national variant of the model, only tourism export demand from the rest of the world is considered.

The relationships in the model are described by the following equations:

(1) $$QTROW_{c,i} = \overline{qtrow}_{c,i} \left(\frac{PQ_c / EXR}{PQ_c^0 / EXR^0} \right)^{\eta_{rowt,i}}$$

(2) $$QTROC_{c,i} = \overline{qtroc}_{c,i} \left(\frac{PQ_c / CPI}{PQ_c^0 / CPI^0} \right)^{\eta_{roct,i}}$$

where

c = tourism-related *commodities* such as hotels and restaurants

i = tourism demand *modalities* such as tourist and business visitors

$QTROW_{c,i}$ = Rest of the *World* (RoW) tourism type i demand quantity of commodity c

$QTROC_{c,i}$ = Rest of *Country* (RoC) tourism type i demand quantity of commodity c

PQ_c = composite commodity price for c

CPI = consumer price index

EXR = exchange rate

$\overline{qtroc}_{c,i}$ = baseline RoC tourism type i demand quantity of commodity c

$\overline{qtroc}_{c,i}$ = baseline RoW tourism type i demand quantity of commodity c

$\eta_{roct,i}$ = constant price elasticity of RoC tourism demand (< 0)

$\eta_{row,i}$ = constant price elasticity of RoW tourism demand (< 0)

As shown, we use constant elasticity of demand functions to model tourism export demand from RoW and RoC. In addition, note that, within domestic and foreign tourism demand, the model allows for the identification of one or more tourism demand modalities (i.e., see index i in equations (1) and (2)).[4] In equation (1), foreign tourists' demand is a function of local (tourism-related) prices relative to the exchange rate EXR. In equation (2), national tourists' demand is a function of local (tourism-related) prices relative to the consumer price index CPI. Note that although tourists from the rest of Belize do not need to change currencies, a real exchange rate exists between any specific region of Belize that is being modeled and the rest of the country, defined as the ratio between regionally tradable and non-tradable commodities such as housing.

On the supply side, the modeling of alternative tourism modalities – for example, all-inclusive beach resorts, boutique hotels, eco-lodges – is straightforward. Provided data is

[4] For example, index i in equation (1) can refer to tourists from different countries.

available, the model can consider different cost structures for the different tourism modalities on the supply side.

In domestic commodity markets, flexible prices ensure balance between demand and supply. Import prices in most cases would be exogenous, but the assumptions of the model can be adjusted for cases where their prices are endogenous (for example, in the case of the regional model, where a large increase in imports from a specific region could push up the price). The share of imports in the national market is determined by their prices relative to domestic prices.

In factor markets, demand curves are downward-sloping reflecting the responses of production activities to changes in factor prices. In the case of labor, unemployment is endogenous. For each labor type, the model assumes an inverse relationship between the real wage and the unemployment rate[5] (Blanchflower and Oswald, 1994 and 2005). The model allows for the input of assumptions for labor mobility in response to wage differentials between Belize and outside, and (in the regional version) between one region and another within Belize. For non-labor factors, the supply curves are vertical in any single year: that is, their quantity is fixed, but price adjusts according to the level of demand.

In our CGE, national income growth over time is largely endogenous. The economy grows due to the expansion of capacity determined by net fixed capital formation (investment minus depreciation) and the availability of labor (determined by exogenously imposed projections), as well as improvements in total factor productivity (TFP) which have both endogenous and exogenous components. Endogenous determinants of TFP include the levels of government capital stock (public goods) and economic openness. The accumulation of private and government capital is through investment financed by local and external savings. Increased private 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.

2.2. Social Accounting Matrix

The basic accounting structure and much of the underlying data required to implement our Belize RCGE model is derived from a Social Accounting Matrix (SAM) for Belize or one of

[5] In this case, the unemployment elasticity of the real wage is assumed to be -0.1, which is consistent with estimates derived from the literature. That is, a 1% increase in the unemployment rate is assumed to reduce wages by 0.1%.

its regions. A SAM is a comprehensive, economy-wide statistical representation of the 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.

Major accounts in a standard SAM match the main building blocks of the CGE as described above: activities, commodities, factors used in production, and institutions such as households, government, and the rest of the world. Most features of the Belize SAM are familiar from SAMs used in other models,[6] but the Belize SAM has non-conventional features related to the explicit treatment of foreign tourism-related spending, together with the corresponding inflow of foreign exchange.[7] In turn, the regional SAMs built for the six districts of Belize (see below) single out trade with the rest of the country and domestic (i.e., from the rest Belize) tourism-related spending.

In most cases, a (national) SAM is built using supply-use tables as the starting point. However, in the case of Belize, where the necessary national accounts data are not available, we built the Belize national SAM using: (i) as much data as possible from the Statistical Institute of Belize (SIB) and other government agencies; i.e., recent national accounts on GDP by Activity and GDP by expenditure, balance of payments, fiscal data, among others, and; (ii) input-output data for a similar country within the region (i.e., Ecuador), as conducted by the GTAP (Global Trade Analysis Project) (Aguiar et al., 2016) team to build the "rest of Central America" input-output table used in the GTAP database (see Banerjee et al. (2016) for a discussion on constructing a SAM in data scarce environments). To disaggregate households and regions in the SAM, we used the 2008 Household Income and Expenditure Survey (HES).

In what follows we first focus on the Belize national (Macro-) SAM. Then, we describe the regional SAM built for the Cayo District of Belize. Cayo is a district in western Belize with several parks and ecological reserves. In addition, Cayo district is known especially for the ruins of Caracol, the country's largest Mayan archaeological site. In Appendix B Table B.6 we show the main data from the HES 2008 that was used to regionalize the national Belize SAM. Using the HES 2008, we also developed regional SAMs for the six departments of

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

[7] In addition, depending on data availability, a (multi-)regional SAM can be used to implement the multi-regional model developed, but not presented here.

Belize; in Tables 6 and 7 below we show some of the regional data that was used to disaggregate the national SAM. In Appendix B we describe the steps that were followed to build the national and regional SAMs for Belize. A similar procedure can be followed to build (national and regional) SAMs for other countries in the region.

A stylized (Macro-)SAM for Belize is provided in Table 1. In 2013 for example, Belize's GDP was BZ$3,252 million, the government current account surplus was around 3.1 percent of GDP and government current consumption (spending on wages, salaries, goods and services) was 15.1 percent of GDP. Regarding international trade (goods and services), Belize exported 60.8 percent of GDP and imported 66.3 percent of GDP. Remittances (transfers) inflows were equivalent to 6.4 percent of GDP and capital income outflow to the rest of world was 7.2 percent of GDP.

For the application in this study, the Belize RCGE was calibrated twice: (i) to a 2013 Social Accounting Matrix (SAM) and other data for the whole of Belize, as shown above, and; (ii) to a 2013 Regional Social Accounting Matrix (RSAM) and other data for the Cayo District of Belize. In what follows we focus on the latter.

Table 1. Macro-SAM for Belize 2013, percent GDP.

	act	com	f-lab	f-cap	tax-act	tax-imp	tax-com	tax-dir	hhd	gov	row	sav-inv	dstk	to
act		86.3												86.3
com									71.5	15.1	60.8	17.8	1.0	166.3
f-lab	46.2										0.1			46.4
f-cap	39.8										0.2			40.1
tax-act	0.2													0.2
tax-imp		6.0												6.0
tax-com		7.7												7.7
tax-dir									7.7					7.7
hhd			46.0	30.0						6.0	6.4			88.3
gov				2.9	0.2	6.0	7.7	7.7			0.0			24.5
row		66.3	0.4	7.2					1.6	0.3				75.8
sav-inv									7.5	3.1	8.2			18.8
dstk												1.0		1.0
total	86.3	166.3	46.4	40.1	0.2	6.0	7.7	7.7	88.3	24.5	75.8	18.8	1.0	

Notes:
Rows show income flows received by the respective building blocks of the model; columns indicate the source of income.
Abbreviations: act = activities; com = commodities; f-lab = labor; f-cap = capital; tax-act = activity taxes; tax-imp = import tariffs; tax-dir = direct taxes; hhd=households; gov = government; row = rest of the world; sav-inv = saving-investment; dstk = change in stocks.
Source: Author's elaboration.

Table 2 shows the accounts in the Cayo District RSAM, which determine the size (i.e., disaggregation) of the model. Thus, the RSAM/model identifies 18 activities and commodities. The factors of production include two types of labor, defined by level of education (those who have completed less than lower secondary, and those who have completed lower 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 of production include data for public capital stock, private capital stock, land, and natural resources used/extracted in forestry, fishing, and mining.[8] The RSAM also includes current transactions (inflows and outflows) for institutions (household, government, rest of the country, rest of world, and domestic and foreign tourists), investment flows (one entry per type of capital stock), and auxiliary accounts for taxes and trade and transport margins.

[8] In fact, the model can handle more than one input for government capital stock (i.e., one for each government sector). However, the Belize 2013 SAMs do not provide the sectoral detail that would be needed to consider such disaggregation of the government sector.

Table 2. Accounts in the Cayo District RSAM, 2013.

Category (#)	Item	Category (#)	Item
Sectors (activities and commodities) (18)	Crops	**Factors (7)**	Labor, unskilled
	Livestock		Labor, skilled
	Forestry		Capital
	Fishing		Land
	Mining		Natural res in Forestry
	Food and beverages		Natural res in Fishing
	Textiles		Extractive res in Mining
	Other manufacturing	**Institutions (5)**	Households
	Electricity and water		Government
	Construction		Rest of the country
	Trade		Rest of the world
	Hotel and restaurants		Foreign Tourism
	Transport	**Taxes (4)**	Taxes on production
	Post and telecommunications		Taxes on sales
	Financial intermediation		Taxes on imports
	Real estate, renting and bus svc		Taxes on income
	Community, social and pers svc	**Savings and Investment (4)**	Savings
	General government services		Investment, non-government
Dist marg (3)	Trade and transp marg, dom		Investment, government
	Trade and transp marg, imp		Stock change
	Trade and transp marg, exp		

Source: Authors' own elaboration.

According to our estimates in the RSAM, the Cayo District's Gross Regional Product (GRP) reached BZ$696.7 million in 2013 (see Table 3), equivalent to 21.5 percent of the national Gross Domestic Product (GDP). In 2013, local and central government current consumption in Cayo District was 16.4 percent of gross regional product (GRP), and total fixed capital formation and remittances from abroad accounted for 19 and 6.9 percent of GRP, respectively.

Table 3. Gross Regional Product (GRP), Belize Cayo District 2013.

Item	mill BZ$	GRP%
Total Demand		
Private consumption	531.9	76.3
Fixed investment	132.7	19.0
Stock change	-4.7	-0.7
Government consumption	114.4	16.4
Exports to RoW	263.7	37.9
Exports to RoC	162.2	23.3
Tourism demand RoC	0.0	0.0
Tourism demand RoW	154.6	22.2
Total	1,354.9	194.5
Total Supply		
GRP at market prices	696.7	100.0
Imports from RoW	479.5	68.8
Imports from RoC	178.7	25.7
Total	1,354.9	194.5
GRP = gross regional product		

Source: Author's own calculations based on 2013 Belize Cayo District SAM.

On the basis of RSAM data, Table 4 summarizes the sectoral structure of the Cayo District'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. In terms of trade with the rest of Belize, columns (EXP-RoCshr) and (IMP-RoCshr) of Table 4 show the share of each sector in total exports and imports to/from the rest of the country, respectively. For instance, while hotels and restaurants represent a significant share of employment (around 5.8 percent), its share of exports is much larger (around 26.4 percent). The 2013 Belize Cayo District SAM also reports taxes paid by institutions, commodity sales, value added, activities, and tariffs; total tax revenue reached 22.3 percent of GRP in 2013.

Table 4. Sectoral structure of GRP, Belize Cayo District 2013, percent share.

Sector	VAshr	PRDshr	EMPshr	EXPshr	EXP-OUTshr	IMPshr	IMP-DEMshr
Crops	7.4	4.8	8.5	9.8	65.0	1.6	25.2
Livestock	2.1	5.1	2.7	0.0	0.1	0.2	1.3
Forestry	0.7	0.4	2.3	0.1	7.4	0.0	2.2
Fishing	2.7	2.4	1.6	0.1	1.1	0.0	0.0
Mining	0.8	5.6	1.0	17.8	99.9	0.3	14.1
Food and beverages	6.8	10.4	3.9	32.9	100.0	11.6	84.5
Textiles	0.0	0.0	1.0	0.0	5.8	1.9	85.1
Other manufacturing	7.2	10.6	6.2	1.7	5.0	67.5	76.9
Electricity and water	4.4	6.7	1.4	0.0	0.0	0.0	0.0
Construction	3.9	3.2	9.8	0.0	0.0	0.0	0.0
Trade	17.2	12.2	16.6	0.0	0.0	0.0	0.0
Hotel and restaurants	4.3	8.4	5.8	26.4	99.9	2.9	10.7
Transport	3.5	3.4	4.3	1.7	15.8	6.9	35.2
Post and telecommunications	3.4	3.2	0.5	0.4	4.4	0.6	3.0
Financial intermediation	2.7	2.9	0.7	0.1	1.5	2.4	12.8
Real estate, renting and bus svc	7.1	4.4	4.8	3.4	24.0	2.8	29.1
Community, social and pers svc	8.2	5.2	19.8	5.6	34.3	1.2	7.2
General government services	17.7	11.2	9.2	0.0	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	31.6	100.0	31.2

Source: Authors' own elaboration.

Table 4 continued. Sectoral structure of GRP, Belize Cayo District 2013, percent share.

Sector	EXP-RoCshr	EXP-RoC-OUTshr	IMP-RoCshr	IMP-RoC-DEMshr
Crops	0.1	0.2	0.8	4.0
Livestock	1.3	3.1	11.8	23.6
Forestry	0.9	31.2	0.1	4.2
Fishing	0.6	3.4	5.9	25.4
Mining	0.0	0.0	5.0	80.4
Food and beverages	4.6	5.5	0.4	1.0
Textiles	0.0	29.7	0.0	0.0
Other manufacturing	32.9	38.0	3.0	1.2
Electricity and water	5.9	10.7	0.5	1.2
Construction	3.8	14.6	0.3	1.5
Trade	0.1	0.1	0.5	0.6
Hotel and restaurants	0.3	0.4	2.8	3.8
Transport	1.0	3.6	9.0	17.3
Post and telecommunications	3.6	14.0	32.9	59.3
Financial intermediation	2.5	10.5	22.7	45.5
Real estate, renting and bus svc	10.8	29.8	1.0	3.8
Community, social and pers svc	0.0	0.1	0.4	0.9
General government services	31.5	34.5	2.9	5.0
Total	100.0	12.3	100.0	31.2

Glossary: 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 (%); EXP-RoCshr = sector share in total exports to RoC (%); EXP-RoC-OUTshr = exports to RoC as share in sector output (%); IMP-RoCshr = sector share in total imports from RoC (%); IMP-RoC-DEMshr = imports from RoC as share of domestic demand (%). Source: Authors' calculations based on 2013 Belize Cayo District SAM and employment data.

Table 5 shows the factor shares in total sectoral value added. For example, the table shows that agriculture (Crops and Livestock) is relatively intensive in the use of unskilled labor and land; this information will be useful to analyze the results from the Belize Cayo District RCGE simulations. In turn, General government services and Financial intermediation sectors are relatively intensive in the use of skilled labor.

Table 5. Sectoral factor intensity, Belize Cayo District 2013, percent sectoral value added at factor cost.

Sector	Labor, unskilled	Labor, skilled	Capital	Nat Res	Total
Crops	52.3	5.7	19.8	22.2	100.0
Livestock	58.0	6.3	16.8	18.9	100.0
Forestry	28.8	22.1	44.3	4.8	100.0
Fishing	45.9	3.9	20.1	30.1	100.0
Mining	6.4	1.8	46.7	45.1	100.0
Food and beverages	16.0	22.4	61.6	0.0	100.0
Textiles	38.2	21.8	40.0	0.0	100.0
Other manufacturing	23.5	22.6	53.9	0.0	100.0
Electricity and water	8.3	35.4	56.3	0.0	100.0
Construction	46.0	15.4	38.6	0.0	100.0
Trade	34.7	38.5	26.8	0.0	100.0
Hotel and restaurants	27.5	31.5	41.0	0.0	100.0
Transport	17.0	36.5	46.6	0.0	100.0
Post and telecommunications	5.3	49.7	45.0	0.0	100.0
Financial intermediation	7.7	61.5	30.8	0.0	100.0
Real estate, renting and bus sv	5.6	36.3	58.2	0.0	100.0
Community, social and pers sv	21.3	60.9	17.8	0.0	100.0
General government services	15.6	63.3	21.1	0.0	100.0
Total	24.5	37.5	34.8	3.2	100.0

Source: Author's calculations based on 2013 Belize SAM and employment data.

In Tables 6 and 7 we present regional data computed from the HES 2008. As previously discussed, this data was used to estimate regional social accounting matrices for the six departments of Belize.

Table 6. Household per capita expenditures by district, Belize 2008, BZ$

Department	Mean	Median	S.d.
Corozal	3,654	2,694	3,907
Orange Walk	4,895	3,367	6,822
Belize	7,183	4,041	12,537
Cayo	5,258	2,764	10,607
Stann Creek	4,902	2,322	13,007
Toledo	2,274	1,413	3,566
Total	5,284	2,905	10,190

Source: Author’s calculations based on HES 2008.

Table 7. Poverty headcount ratio by district, Belize 2008, 2.5 and 4 PPP US dollars-a-day poverty lines.

Department	2.5 USD	4 USD
Corozal	33.3	52.2
Orange Walk	26.5	44.7
Belize	23.3	34.5
Cayo	36.7	53.9
Stann Creek	47.0	62.5
Toledo	66.2	76.8
Total	34.7	49.6

Source: Author’s calculations based on HES 2008.

Different supply modalities of tourism sector output can be considered in the RSAM. As an example taken from other work in Nicaragua, table 8 shows the data that would be required to differentiate between different types of hotels. Of course, matching estimates from the demand side would also be needed. In the case of Belize (and Cayo District), we do not have access to such data. Thus, our RSAM considers a single tourism supply and demand modality. In addition, and again due to the lack of data, we cannot distinguish between domestic and foreign tourists.

Table 8. Cost structure, supply modalities for the Municipality of Granada in 2013, percent.

Item	Hotel, 1 Star	Hotel, 2 Stars	Hotel, 3 Stars	Hotel, 4 Stars	Hotel, 5 Stars	Restaurants and
Intermediate consumption, goods	23.1	14.9	22.7	11.8	15.8	25.6
Intermediate consumption, service	10.0	23.6	13.8	18.1	13.6	8.0
Wages	31.4	20.8	38.8	23.0	41.7	17.9
Capital and other (*)	35.4	40.8	24.8	47.1	28.9	48.5
Total	100	100	100	100	100	100
(*) includes tax payments						

Source: Authors' own elaboration.

2.3. Non-SAM Data

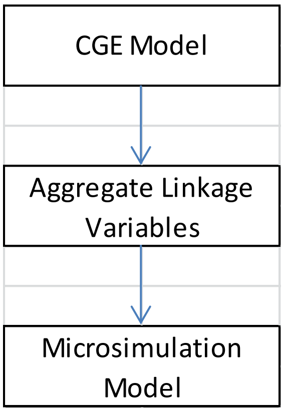
In addition to the SAM, our Belize RCGE model requires: (a) base year estimates for capital stocks, and sectoral employment levels and unemployment estimates for the different labor types; (b) a set of elasticities (for production, consumption and trade); (c) population projections by household group (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 the United Nations with estimates for the unemployment rate computed from the 2013 labor force survey. In turn, elasticities were given values based on the available evidence for comparable countries. Specifically, 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 manufactures and services (see Aguiar et al. (2016)); (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 in Section 4 we conduct a systematic sensitivity analysis of our CGE model results with respect to the values of these parameters.

2.4. Microsimulation Model and Data

As discussed, CGE models are effective in capturing macro and meso (i.e., for 30-35 sectors) responses to shocks such as an improvement in the terms of trade. However, the standard configuration of a CGE model is not well suited for analysis of questions related to poverty and income inequality. This is due to the fact that most CGE models use a representative household (RH) formulation where all households in an economy are aggregated into one or a few households to represent household and consumer behavior. The main limitation of the RH formulation is that intra-household income distribution does not respond to shocks introduced into the model.

Consequently, in order to provide greater resolution with regard to household-level impacts, we generate results in terms of poverty and inequality at the micro level by linking the CGE model with a microsimulation model (see Figure 2). The two models interact in a sequential “top-down” fashion (i.e., without feedback): the CGE communicates with the microsimulation model by generating a vector of (real) wages[9], aggregate employment variables such as labor demand by sector and the unemployment rate, and non-labor income. The functioning of the labor market thus plays an important role, and the CGE model determines the changes in employment by factor type and sector, and changes in factor and product prices that are then used for the microsimulations.

Figure 2. The Macro-Micro approach.



Source: Authors’ own elaboration.

To build the microsimulation model, the Belize HES for 2008, conducted by the Statistical Institute of Belize (SIB), was used.[10] These data cover 11,438 individuals in 3,023 households in all of Belize. The HES 2008 is the latest available household survey in Belize that covers both income and spending. No attempt was made to reconcile the household survey data with the national accounts. Instead, the results from the CGE model are transmitted to the microsimulation model as percentage deviations from base values.[11] To estimate poverty, we used the US$ 4 and US$ 2 dollars-a-day poverty lines for 2008; the US$ 2 and 4 national poverty rates are calculated as 49.6% and 34.7%, respectively.

[9] The real wage is defined in terms of the CPI; see the RCGE model mathematical statement in the Appendix A.

[10] In Appendix C we provide additional details regarding the processing of the HES 2008.

[11] The HES 2008 was processed as part of the Socio-Economic Database for Latin America and the Caribbean (CEDLAS and The World Bank, 2012); see <http://sedlac.econo.unlp.edu.ar/eng/index.php>.

The microsimulation model follows the non-parametric method described in Vos and Sanchez (2010) but was extended to consider changes in non-labor income.[12] First, the labor market structure is defined in terms of rates of unemployment *U* among different segments of the population of working age (in this case, defined according to skill), the structure of employment *S* (in this case, defined according to sector of activity *S*) and (relative) remuneration *W1*, as well as overall level of remuneration *W2*. The labor-market structure can thus be written as:

$$\lambda = (U, S, W1, W2)$$

The effect of altering each of its four parameters on poverty and inequality can then be analyzed by simulating counterfactual individual earnings and family incomes. Briefly, the model selects at random (with multiple repetitions) from the corresponding labor groups the individuals who will change labor market status (i.e., employment/unemployment and sector) and assigns wages to new workers according to parameters for the average groups. Then, the new wage and employment levels for each individual result in new household per capita incomes that are then used to determine the new poverty and income distribution results. Analytically, we can write

$$yl_i = f(\lambda, X_i)$$

where

yl_i = individual labor income

X_i = individual characteristics; e.g., skill level

In each counterfactual scenario, labor market conditions might change and in turn affect the individual labor income; i.e.,

$$yl_i^* = f(\lambda^*, X_i)$$

where λ^* refers to the simulated labor market structure parameters.

The labor market variables and procedures that link the CGE model with the microsimulations are as follows. This "unemployment effect" is simulated by changing the labor status of the active population in the HES 2008 sample, based on the results from the

[12] In turn, this approach is an extension of the earnings inequality method developed by Almeida dos Reis and Paes de Barros (1991).

CGE model. For instance, if according to the CGE simulations, unemployment decreases at the same time that employment increases for skilled workers in sector A, the microsimulation model "hires" randomly from the HES 2008 sample among the unemployed skilled workers. As explained above, individual incomes for the newly employed are assigned based on their characteristics (e.g., educational level) by looking at similar individuals that were originally employed. If the CGE simulations indicate a decrease in employment for a specific labor category and sector, the microsimulation program "fires" the equivalent percentage from the type of labor and sector, and the counterfactual income for those newly unemployed is zero.

The "sectoral structure effect" is simulated by changing the sectoral composition of employment. For those individuals that move from one sector to another, we simulate a counterfactual labor income based on their characteristics and on their new sector of employment, again by looking at individuals that were originally employed in the sector of destination.

To model the change in relative wages, the wage level for a given labor category (e.g., skilled workers in sector A) are adjusted according to the changes from the CGE simulations but keeping the aggregate average wage for the economy constant. The impact of the change in the aggregate average wage for the economy is simulated by changing all labor incomes in all sectors by the same proportion, based on the changes from the CGE simulations. Next, all the previous steps are repeated several times and averaged.

For non-labor incomes, government transfers and remittances from abroad are proportionally scaled up or down using changes taken from the CGE model. The final step in the microsimulation model is to adjust the micro data such that the percentage change in the household per capita income matches the change in the level of household per capita income – for each representative household in the CGE simulations. Thus, this residual effect implicitly accounts for changes in all items not previously considered (i.e., non-labor and non-transfer incomes) such as natural resource and capital rents.

Finally, we should note that our CGE model can only solve for the relative prices and the real variables of the economy. Thus, in order to anchor the absolute price level, a normalization rule has been applied. Specifically, the consumer price index (CPI) is chosen as the numéraire, so all changes in nominal prices and incomes in simulations are relative to the weighted unit price of households' initial consumption bundle (i.e., a fixed CPI). The model is also homogenous of degree zero in prices. In macro terminology, the model displays neutrality of money.

3.0. Scenario Design

This section presents the simulations and analyzes the results. To illustrate the use of the model and dataset we have developed, the following four scenarios were simulated and analyzed:

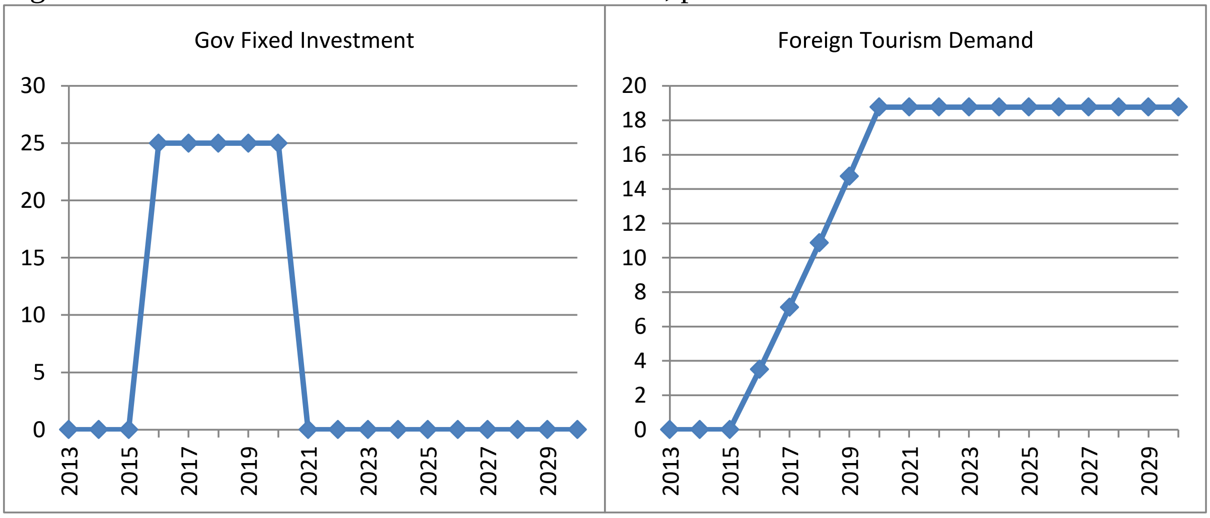
- **Base:** the baseline or reference scenario is the “business-as-usual” scenario;
- **Invest:** 25 percent increase during 2016-2020 in government investment in tourism-related infrastructure; financed with transfers from the rest of the country. These transfers implicitly represent transfers from the central government[13].
- **Dem:** 3.5 percent yearly increase in foreign tourism demand and arrivals during 2016-2020; afterwards (i.e., 2021-2030) foreign tourism demand is around 20% higher than in the baseline; and
- **Combi:** scenarios **invest** and **dem** combined.

In the **base**, we assume that average past trends will continue from 2013 to 2030. In fact, in the absence of better projections, it is assumed that Belize’s Cayo District is on a balanced growth path, which means that real or volume variables, including tourism demand, grow at the same rate while relative prices do not change.

The three non-base simulations only deviate from the base beginning in 2016 to 2030. Certainly, the non-base shocks we are considering are arbitrary, but are designed to illustrate the mechanics of the model. In fact, is likely that any tourism-related scenario will contain some of the elements present in this set of simulations.

[13] It should be noted that in this application, no additional government spending on operations and maintenance of the new capital stock was included. The model does, however, allow for this additional spending to be included in the simulation.

Figure 3. Definition of scenarios ‘invest’ and ‘dem’, percent deviation from base.



Source: Authors’ elaboration.

At the macro level, our RCGE, as any other CGE model, requires the specification of the equilibrating mechanism for three macroeconomic balances. For the non-base scenarios these are:

(i) The impact on the government fiscal balance is cleared via changes in income tax rates on households. This assumption ensures that the simulations are budget neutral; that is, there is no additional domestic and/or foreign financing beyond baseline values.

(ii) Private investment in the Cayo District follows an exogenously imposed path; given this path, adjustments in savings from the rest of Belize clear the savings-investment balance; and

(iii) The real exchange rate adjusts to equilibrate inflows and outflows of foreign exchange, by influencing export and import quantities. That is, the simulations are neutral in terms of changes in region net foreign assets. The non-trade-related payments of the (local) balance of payments (transfers and foreign investment) are non-clearing, following exogenously imposed paths.

In addition, given the regional character of the model, a mechanism is required to clear the current account of the balance of payments between the local economy and the rest of the country. Specifically, it is assumed that the real exchange rate is flexible with respect to the RoC, with equilibrium achieved through changes in the price of local non-tradable commodities. In other words, prices for non-tradable commodities are region-specific, while for tradable commodities the local price is a weighted average of the price of three different varieties: local, from the RoC, and from the RoW.

4.0. Results

4.1. Macro Results

The base year of the model as presented here is 2013. For the baseline scenario, which serves as a benchmark for comparisons, we impose an average growth of 2.5 percent, based on projections from the April 2016 International Monetary Fund World Economic Outlook (IMF, 2016).[14] In addition, due to the assumption of a balanced growth path, the following assumptions were also imposed: (i) macro aggregates are kept fixed as a share of the gross regional product at base year values; (ii) transfers to/from government/RoC/RoW to households are also kept fixed as a share of GRP; and (iii) tax rates are fixed over time.

In Table 9 and Figures 4a and 4b, we show key macroeconomic results for the baseline and other scenarios for the year 2020 (i.e., the year when the simulated tourism-related infrastructure investment is completed) and 2030. In Table 9, all indicators are for the Cayo District alone. As the table shows, the increase in government tourism-related investment has, in the medium- long-run, a positive impact on the activity level (simulation **invest**). On the other hand, the inflow of foreign resources -- both from RoC to finance investment and from RoW due to increased tourist arrivals -- gives rise to slower non-tourism (goods and services) export growth and faster import growth, both of which were induced by an appreciation of the regional real exchange rate.[15] In turn, the expansion of tourism demand tends to expand domestic absorption more rapidly than it expands GRP, also causing deterioration in the non-tourism trade balance (scenario **dem**). In other words, the increase in “tourism exports” also generates an appreciation of the real exchange rate that hurts the other tradable (mainly goods) sectors. Slower export growth here is a function of increasing domestic demand and prices in Cayo District due to the investment. Where factor supply constraints exist (labor/capital/land/natural resources), increased domestic prices relative to world prices result in a reallocation of resources toward domestic production to meet more rapid growth in domestic demand.

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[14] The exogenous part of total factor productivity growth is adjusted to generate such a growth path. In non-base scenarios, GRP growth is endogenous.

[15] Notice that “exports” do not include tourism-related spending made by foreigners. Certainly, the latest correspond to tourism exports, but the two are treated differently in the model and Table 3.1.

Figure 4a. Change in real private consumption 2015-2030, percent deviation from base.

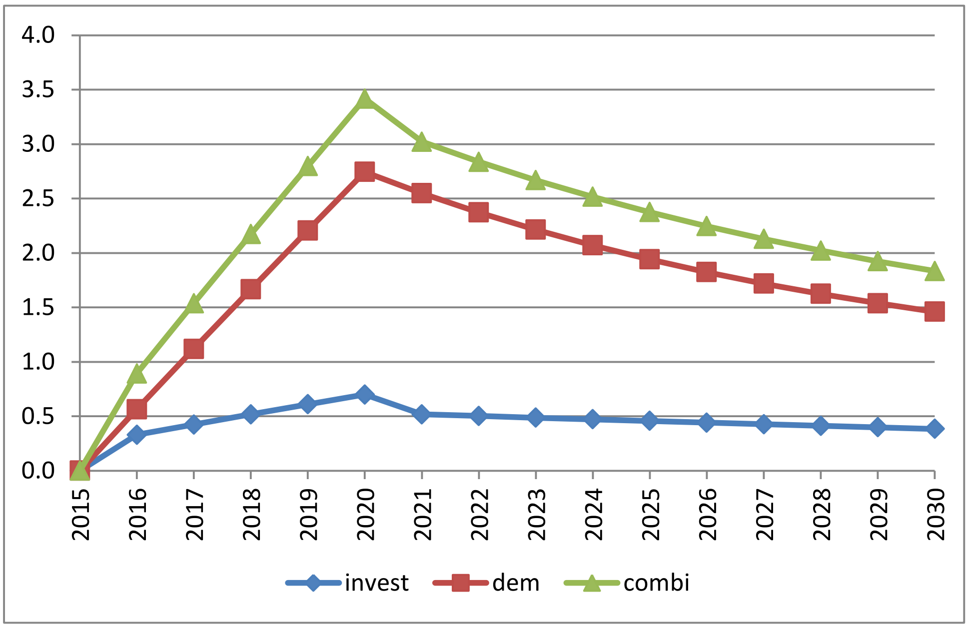
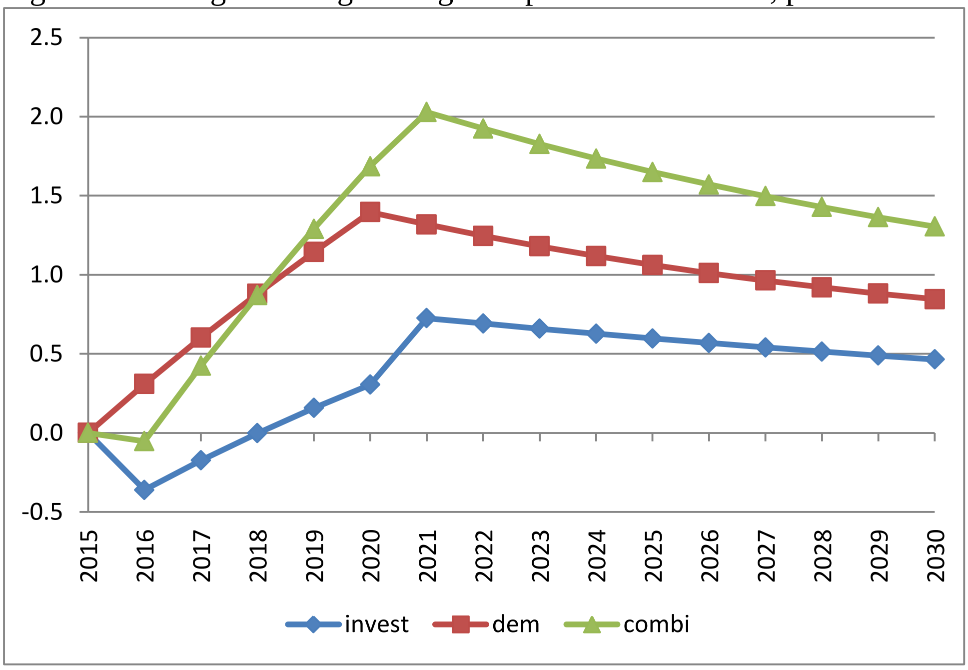


Figure 4b. Change in real gross regional product 2015-2030, percent deviation from base.



Source: Authors' own elaboration.

Table 9. Change in real macro indicators, percent deviation from base.

	base (LCU)	invest		dem		combi		combi-BE	
Item	2013	2020	2030	2020	2030	2020	2030	0	0
Absorption	912	0.2	0.3	4.8	4.1	5.0	4.4	0.0	0.0
Private consumption	532	0.7	0.4	2.7	1.5	3.4	1.8	0.0	0.0
Government consumption	114	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exports to rest of world	264	1.1	0.8	-4.8	-6.6	-3.7	-5.7	0.0	0.0
Imports from rest of world	479	0.5	0.4	4.5	2.9	5.0	3.3	0.0	0.0
Exports to rest of Belize	162	-5.1	0.8	0.8	0.0	-4.3	0.8	0.0	0.0
Imports from rest of Belize	179	2.7	0.2	0.4	-0.3	3.2	-0.1	0.0	0.0
GRP at market prices	697	0.3	0.5	1.4	0.8	1.7	1.3	0.0	0.0
RER wrt rest of world	1	-0.1	0.1	-3.4	-1.8	-3.5	-1.7	0.0	0.0
RER wrt rest of Belize	1	-2.4	0.3	-0.2	-0.1	-2.5	0.2	0.0	0.0
Wage, average	1	0.7	0.1	1.8	1.2	2.6	1.3	0.0	0.0
Capital return, average	1	0.5	0.4	2.8	1.0	3.2	1.4	0.0	0.0
Unemployment rate	14.3	13.0	14.2	12.2	12.9	10.9	12.8	0.0	0.0
LCU = million BZ$									

Source: Authors' elaboration.

4.2. Sectoral Results

Unsurprisingly at the sectoral level, service industries catering directly to tourists, including Hotels and restaurants, are strongly stimulated by the expansion in tourism (simulation **dem**). On the other hand, the upward pressure on prices and the real exchange rate leads to reduced competitiveness of traditional (non-tourism) export sectors. Specifically, Table 10 shows a decrease in value added in food products (i.e., primary agriculture and food processing) and Mining, two of the most export-oriented sectors (see Table 4). To some extent, this result changes when labor and capital are in greater supply (i.e., more elastic supply curves). In other words, if there is a surplus of labor (i.e., underemployment) available to increase supply in response to the demand stimulus, so that wage increases are constrained, these types of crowding out effects are weaker. In the case of Belize, where the level of underemployment is persistently high and porous borders allow labor supply to grow in response to stronger demand, we would expect wage-cost pressures to be low. As expected, changes in sectoral employment follow those of sectoral value added (not shown).

Table 10. Change in sectoral real value added, exports, and imports, percent deviation from base.

	base (LCU)	invest		dem		combi	
Commodity	2013	2020	2030	2020	2030	2020	2030
Value Added							
Crops	44	-0.3	0.7	-2.8	-2.7	-3.3	-2.0
Livestock	12	-1.0	0.2	0.1	-0.5	-0.9	-0.3
Forestry	4	0.9	1.0	0.0	-0.4	0.8	0.6
Fishing	16	-0.8	0.4	-0.3	-1.0	-1.1	-0.6
Mining	5	2.6	1.2	-5.3	-9.3	-2.3	-8.0
Food and beverages	41	0.6	0.8	-4.5	-6.6	-4.0	-5.8
Textiles	0	-1.7	0.9	5.9	4.8	4.1	5.7
Other manufacturing	43	-1.8	0.2	1.4	1.1	-0.5	1.4
Electricity and water	26	-0.6	0.2	0.8	0.5	0.3	0.7
Construction	23	18.4	1.2	0.6	0.3	19.0	1.5
Trade	103	0.4	0.4	1.3	0.6	1.6	1.0
Hotel and restaurants	25	0.0	0.2	15.3	15.8	15.3	15.9
Transport	21	-0.1	0.5	0.5	0.0	0.4	0.5
Post and telecommunications	20	-1.3	0.2	0.5	0.3	-0.8	0.5
Financial intermediation	16	-1.5	0.5	0.2	-0.2	-1.2	0.3
Real estate, renting and bus svc	43	-0.7	0.6	-0.2	-0.5	-0.9	0.1
Community, social and pers svc	49	0.3	0.4	6.0	5.9	6.3	6.3
General government services	106	-2.1	0.4	-0.1	-0.4	-2.2	0.0
Exports							
Crops	41	-0.4	0.7	-3.9	-3.1	-4.4	-2.4
Livestock	0	-0.7	0.3	-2.8	-1.9	-3.6	-1.6
Forestry	0	0.1	1.0	-4.2	-2.6	-4.2	-1.6
Fishing	0	-0.1	0.4	-3.3	-2.1	-3.4	-1.6
Mining	74	2.6	1.2	-5.3	-9.3	-2.3	-8.0
Food and beverages	126	0.8	0.8	-4.9	-6.9	-4.2	-6.1
Textiles	0	-1.2	0.7	0.7	2.9	-0.4	3.6
Other manufacturing	3	-0.8	0.1	-1.9	-0.4	-2.7	-0.3
Transport	2	0.4	0.5	-3.2	-1.8	-2.9	-1.3
Post and telecommunications	1	0.1	0.0	-3.9	-2.1	-3.8	-2.0
Financial intermediation	1	-0.3	0.4	-4.0	-2.5	-4.3	-2.1
Real estate, renting and bus svc	14	0.5	0.3	-4.4	-2.8	-4.0	-2.5
Imports							
Crops	8	0.0	0.7	1.4	-1.1	1.3	-0.5
Livestock	1	-0.5	0.1	1.8	0.3	1.4	0.4
Forestry	0	6.7	0.7	4.4	2.1	11.4	2.7
Fishing	0	-0.7	0.3	1.6	-0.5	0.9	-0.3
Mining	2	2.7	2.9	-7.5	-17.2	-3.6	-14.3
Food and beverages	56	0.2	0.6	11.6	9.5	11.7	10.0
Textiles	9	0.6	1.1	11.9	6.2	12.5	7.3
Other manufacturing	324	0.7	0.3	2.4	1.3	3.1	1.6
Hotel and restaurants	14	-0.1	0.1	20.8	18.0	20.7	18.2
Transport	33	0.2	0.5	3.6	1.5	3.8	1.9
Post and telecommunications	3	-0.9	0.2	4.4	2.6	3.5	2.8
Financial intermediation	11	-1.1	0.4	3.7	1.8	2.6	2.2
Real estate, renting and bus svc	14	0.1	1.3	7.8	4.3	8.0	5.7
Community, social and pers svc	6	0.2	0.2	10.3	8.1	10.6	8.4
LCU = million BZ$							

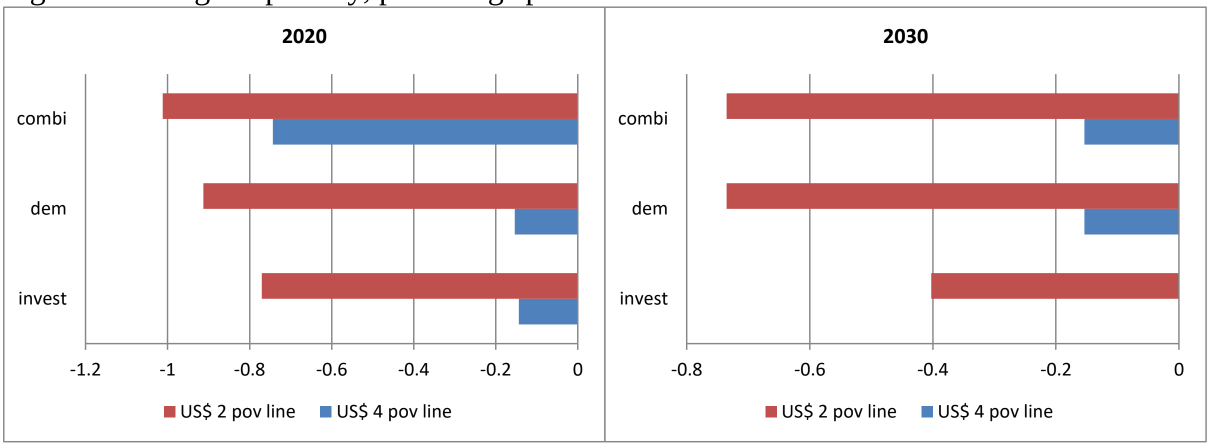
Source: Authors' own elaboration.

The model shows how the size of the economic impacts resulting from increased tourism demand is determined by key factors: factor supply constraints, real effective exchange rate appreciation, and current government economic policy (Dwyer et al., 2000).

4.3. Poverty Results

In terms of poverty, our results show, for example, that the 2 dollars-a-day poverty headcount ratio in the Cayo District falls by 0.7 percentage points in the last year of the simulation period in the **combi** scenario (Figure 5). The main drivers of this result are a decrease in unemployment, a higher average wage, and an increase in non-labor income. In terms of inequality, we find a slight increase, driven by the decrease in the unemployment rate (because those with the very lowest incomes are under-represented among the newly employed) and the change in the sectoral structure of employment in favor of the services sector.

Figure 5. Change in poverty, percentage points from base.



Source: Authors' elaboration.

4.4. Sensitivity Analysis

As usual, the results from the RCGE model are a function of (i) the model structure (e.g., functional forms used to model production and consumption decisions, macroeconomic closure rule, among other elements); (ii) the base year data used for model calibration (i.e., the RSAM); and (iii) the values assigned to the model elasticities or, more generally, to the model's free parameters.

Certainly, the elasticities used in this study implicitly carry an estimation error, as in any similar model. Consequently, we have performed a systematic sensitivity analysis of the results with respect to the value assigned to the model elasticities. Hence, if the conclusions of the analysis are robust to changes in the set of elasticities used for model calibration, we will have greater confidence in the results presented above.

In order to perform the systematic sensitivity analysis, it is assumed that each of the model elasticities is uniformly distributed around the central value used to obtain the results. The range of variation allowed for each elasticity is +/- 85%; that is, a wide range of variation for each model elasticity is considered. Then, a variant of the method originally proposed by Harrison and Vinod (1992) is implemented, which allows for performing a systematic sensitivity analysis. In short, the aim is to solve the model iteratively with different sets of elasticities. Thus, a distribution of results is obtained to build confidence intervals for each of the model results. The steps for implementing the systematic sensitivity analysis are as follows.

Step 1. In the first step, the distribution (i.e., lower and upper bound) for each of the model parameter that will be modified as part of the systematic sensitivity analysis is computed: elasticities of substitution between primary factor of production, trade-related elasticities, expenditure elasticities, and unemployment elasticities for the wage curves.

Step 2. In the second step, the model is solved repeatedly, each time employing a different set of elasticities; it is, therefore, a Monte Carlo type of simulation. First, the value for each model elasticity is randomly selected. Second, the model is calibrated using the selected elasticities. Third, the same counterfactual scenarios as previously described are conducted. Then, the preceding steps are repeated several times, 1,000 in this case, with sampling with replacement for the value assigned to the elasticities.

Table 11 shows the percentage change in private consumption estimated (i) under the central elasticities, and; (ii) as the average of the 1,000 observations generated by the sensitivity analysis. For the second case, the upper and lower bounds under the normality assumption were also computed; notice that all runs from the Monte Carlo experiment receive the same weight. As can be seen, the results reported above are significant, while estimates presented in Table 9 are within the confidence intervals reported in Table 11. For example, there is virtual certainty that the **combi** scenario has a positive effect on private consumption in the Cayo District of Belize.

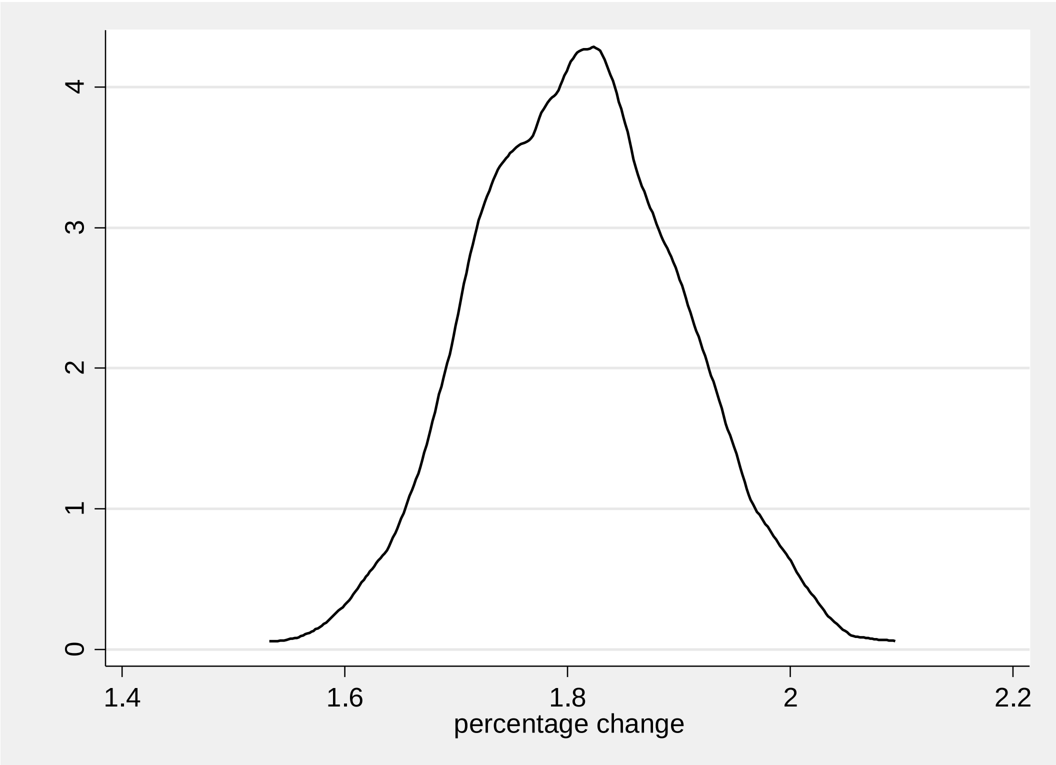
Table 11. Sensitivity analysis; real private consumption percent deviation from base; year 2030; 95% confidence interval under normality assumption

Scenario	Central Elast	Mean	Standard Dev	Lower Bound	Upper Bound
invest	0.3835	0.3800	0.0303	0.3206	0.4394
dem	1.4596	1.4391	0.0927	1.2575	1.6207
combi	1.8333	1.8100	0.0916	1.6305	1.9895

Source: Authors' own elaboration.

Figure 6 shows non-parametric estimates of the density function for the percentage change in 2030 in private consumption in the **combi** scenario. Again, the sign of the results (i.e., positive) is not changed when model elasticities are allowed to differ in +/- 80% of their "central" value.

Figure 6. Sensitivity analysis, real private consumption deviation from base in 2030.



Source: Authors' own elaboration.

5.0. Assessment of Data Availability in CID Region

In this section, we assess the availability of the data required to implement our tourism-extended CGE model for the countries in IDB's Country Department for Central America. Specifically, we discuss the availability and latest year of the following data:

- (a) supply and use tables[16],
- (b) other national accounts data such as integrated economic accounts and regionally disaggregated national accounts[17],
- (c) tourism satellite account, and
- (d) household surveys capturing household income and expenditure.

In Table 12 we summarize the availability of the required data to build national and sub-national SAMs for the CID countries. Also, we should note that Mexico is the only country in the region that, as part of its national accounts data, generates a set of regional accounts at the state level. For the other countries, one would need to combine the national supply-use tables with regional data typically obtained from a household and/or enterprise survey in order to estimate a sub-national social accounting matrix. Specifically, in order to build a regional (i.e., sub-national) SAM, information on regional sectoral employment and/or GDP would be required. Then, depending on the required level of geographical disaggregation, information from an existing household survey can be used, as implemented here for the Departments of Belize and in Banerjee et al. (2015) for the South Department of Haiti.

However, if the aim is to build a local SAM for a city or municipality, it is usually the case that the regularly conducted household surveys do not contain enough observations at the local level to build a local SAM. Thus, a special-purpose household and/or enterprise survey would be required. In addition, conducting surveys to domestic and foreign tourists is required to single them out in the SAM. Furthermore, note that all countries considered in Table 12 regularly produce aggregated national accounts data.

[16] "The supply and use tables are in the form of matrices that record how supplies of different kinds of goods and services originate from domestic industries and imports and how those supplies are allocated between various intermediate or final uses, including exports". (OECD Glossary of Statistical Terms).

[17] "The integrated economic accounts comprise the full set of accounts of institutional sectors and the rest of the world, together with the accounts for transactions (and other flows) and the accounts for assets and liabilities." (OECD Glossary of Statistical Terms).

Table 12. Availability of data required to build a recent (i.e., circa 2014) social accounting matrix

País	Supply and Use Tables	Integrated Economic Acc	National Acc Sectoral Data	HHD Survey	Institution
Belize	n.a.	n.a.	2013	2008	SIB
Costa Rica	2012	2013	2013	2014	BCCR / INEC
Dominican Republic	2010	n.a.	2014	2014	BCRP / ONE
El Salvador	2006	n.a.	2014	2014	BCR / DIGESTYC
Guatemala	2012	2012	2012	2011	BG / INE
Honduras	2013	2013	2013	2014	BCH / INE
Mexico	2008	2008; desag	2014	2014	INEGI
Nicaragua	2010	2010	2010	2014	BCN / INIDE
Panama	2012	2012; total	2014	2015	INEC

Source: Author's own elaboration based on information from the following institutions:

- Belize = Statistical Institute of Belize (SIB);
- Costa Rica = Banco Central de Costa Rica and Instituto Nacional de Estadística y Censos (INEC);
- Dominican Republic = Banco Central de la República Dominicana and Oficina Nacional de Estadística (INEC);
- El Salvador = Banco Central de Reserva de El Salvador and Dirección General de Estadística y Censos (DIGESTYC);
- Guatemala = Banco de Guatemala and Instituto Nacional de Estadística (INE);
- Honduras = Banco Central de Honduras and Instituto Nacional de Estadística (INE);
- Mexico = Instituto Nacional de Estadística y Geografía (INEGI);
- Nicaragua = Banco Central de Nicaragua (BCN) and Instituto Nacional de Información de Desarrollo (INIDE); and
- Panama = Instituto Nacional de Estadística y Censo (INEC).

Finally, it is noteworthy that not all the information reviewed above is currently publicly available through the corresponding institutional web pages. For example, Nicaragua and Costa Rica are currently in the process of publishing their recently updated national accounts data. However, it is expected that the said data would be made available to conduct economic analysis by any government agency, even if it is not publicly available yet.

6.0. Concluding Remarks

This framework has the potential to be applied at the national level, where national level tourism policies and investments are the subject of analysis, or at the regional level as in the

Belize illustration in assessing the impacts of a localized investment. The indicators generated shed light on income and expenditure impacts, employment, poverty, sectoral output, as well as trade relations.

Where the analyst is concerned with the net present value (NPV) of the investment, the model can report changes in private consumption or equivalent variation which can be used as measures of wellbeing and therefore benefits. The series of benefits generated by the model may then be used in a cost benefit framework or the entire NPV analysis may be conducted within the model as described in Banerjee et al (2017). The coupling of the CGE model with the microsimulation model presents a powerful approach to estimating localized poverty impacts of investments. This information is particularly important where investments aim to target the more marginalized segments of the population. Finally, the sensitivity analysis demonstrates that the model is robust and key model assumptions are reasonable.

The stock take of required data in the Central American Region confirms that similar frameworks could be developed for each of the countries reviewed. Furthermore, given the availability of household income and expenditure survey data in those countries, regional models such as the Cayo District model developed in this study could also be developed where localized investment impacts are of concern. Where municipal-level analysis of is interest, specialized surveys may be applied to gather the required information from firms, households and tourists. Given the need to conduct primary research for the development of these localized models, the expense is greater than that of generating national or regional models. Nonetheless, focused case studies of this nature can shed light on the mechanics of tourism investments and tourism value chains, details of which may have been missed when evaluated at the national or regional level.

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Appendix A: RCGE Model Mathematical Statement

The mathematical presentation of the RCGE uses some notational conventions: capital letters for endogenous variables, lowercase letters for exogenous variables, and Greek letters for behavioral parameters. The endogenous variables with bar on top are assumed to be exogenous as part of the "closure rule" of the model.[18] Besides, all variables at time (t-1) are exogenous at time t. The following set names also apply:

- a = activities
- c = commodities
- i = institutions (i.e., households, enterprises, government, rest of the country, and rest of the world)
- insdng = domestic non-government institutions
- h = households
- e = enterprises
- gov = government
- roc = rest of the country (i.e., rest of Belize)
- row = rest of the world
- inv = investment
- invg = government investment
- invng = non-government investment

Endogenous Variables

$AWF_{f,t}$	average remuneration of factor f
$CALTFP_{f,t}$	tfp in calibration run
$CON_{h,t}$	household consumption expenditure
CPI_t	consumer price index
DPI_t	index for domestic producer prices (PDS-based)
EG_t	government expenditure

[18] The closure rule determines the mechanisms equalizing demand and supply in all markets featuring the model.

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

$GADJ_t$ government demand scaling factor

$GFCF_{inv,t}$ gross fixed capital formation

$IND_{f,a,t}$ non-government investment by destination

$KG_{invg,t}$ government capital stocks

$MPS_{i,t}$ marginal propensity to save for dom non-government 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

$PDER_{c,t}$ price for composite QD-QER

$PDMR_{c,t}$ price for composite QD-QMR

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

$PE_{c,t}$ export price for c (domestic currency)

$PER_{c,t}$ RoC export price for c (domestic currency)

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

$PK_{inv,t}$ replacement cost of capital

$PM_{c,t}$ import price for c (domestic currency)

$PMR_{c,t}$ RoC import price for c (domestic currency)

$PQ_{c,t}$ composite commodity 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

$QDER_{c,t}$ QD-QER aggregate for comm c

$QDMR_{c,t}$ QD-QMR aggregate of comm c

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

$QER_{c,t}$ quantity of exports to RoC for commodity c

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

$QFS_{f,t}$ supply of factor f

$QG_{c,t}$ 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

$QMR_{c,t}$ quantity of imports from RoC of commodity c

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

$QTROC_{c,t}$ RoC tourism demand quantity of comm c

$QTROW_{c,t}$ RoW tourism demand quantity of comm c

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

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

$QX_{c,t}$ quantity of domestic output of commodity c

$REXR_t$	real exchange rate
$RGDPFC_{c,t}$	real GDP at factor cost (at constant base-year prices)
$RGFCF_{inv,t}$	real gross fixed capital formation
RSG_t	real government savings
SG_t	government savings
$SH_{i,t}$	savings domestic non-government institution i
$SROC_t$	RoC savings (foreign currency)
$SROW_t$	foreign savings (foreign currency)
$TFP_{a,t}$	total factor productivity index
$TR_{i,i',t}$	transfers from dom inst insdng to inst ins
$UERAT_{f,t}$	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 revenue
$YH_{i,t}$	income of (domestic non-government) institution insdng
$YIF_{i,f,t}$	income of institution ins from factor f

Parameters and Exogenous Variables

$sh^F_{i,f}$	share for inst ins in the income of factor f
$\overline{mps}_{i,t}$	marginal propensity to save for dom non-gov inst insdng
$\overline{qg}_{c,t}$	quantity of government demand for commodity c

$\overline{rgfcf}_{inv,t}$	real gross fixed capital formation
$ta_{a,t}$	rate of tax on producer gross output value
$tq_{c,t}$	rate of sales tax
$ty_{i,t}$	rate of direct tax on dom inst ins
$tf_{f,t}$	rate of direct tax on factor income
$tfact_{f,a,t}$	rate of factor use tax
$te_{c,t}$	export tax rate for commodity c
$tm_{c,t}$	import tariff rate for commodity c
$trnsfr_{ac,i,t}$	transfers from insp to ins or factor
$sh^{TR}_{i,i',f}$	share of inst ins in post-tax post-sav income of inst insp
$pwe_{c,t}$	export price for c (foreign currency)
$pwm_{c,t}$	import price for c (foreign currency)
$pwer_{c,t}$	export price for c to RoC (foreign currency)
$pwmr_{c,t}$	import price for c from RoC (foreign currency)
$qdstk_{c,t}$	changes in inventories
$icd_{c,c'}$	trade and transport input of c per unit of comm cp produced and sold domest
$ice_{c,c'}$	trade and transport input of c per unit of comm cp exported
$icm_{c,c'}$	trade and transport input of c per unit of comm cp imported
$icer_{c,c'}$	trade and transport input of c per unit of comm cp exported to RoC
$icmr_{c,c'}$	trade and transport input of c per unit of comm cp imported from RoC

$\overline{qtroc}_{c,t}$	RoC tourism demand quantity of comm c
$\overline{qtrow}_{c,t}$	RoW tourism demand quantity of comm c
$\delta_{f,a}^{VA}$	share parameter for CES activity production fn
ϕ_a^{VA}	efficiency parameter in the value added production fn for a
σ_a^{VA}	elasticity of substitution between factors
ρ_a^{VA}	exponent in the value added production fn for a
$tfpexog_{a,t}$	exogenous component of sectoral TFP
$\theta_{a,c}$	yield of output c per unit of activity a
$ica_{c,a}$	intermediate input c per unit of aggregate intermediate
iva_a	aggregate value added coefficient for act a
$inta_a$	aggregate intermediate input coefficient for act a
$\delta_{c,h}^{LES}$	marg shr of hhd cons on commodity c
$qhmin_c$	subsist cons of com c for hhd h
δ_c^M	Armington function share parameter for imports commodity c
δ_c^{DMR}	Armington function share parameter for composite QDMR commodity c
ϕ_c^Q	Armington function shift parameter for commodity c
σ_c^Q	elasticity of substitution between dom goods and imports for c
ρ_c^Q	Armington function exponent for commodity c
δ_c^E	CET function share parameter for exports commodity c
δ_c^{DER}	CET function share parameter for composite QDER commodity c
ϕ_c^X	CET function shift parameter for commodity c

σ_c^X	elasticity of transformation between dom sales and exports for c
ρ_c^X	CET function exponent for commodity c
δ_c^{MR}	Armington function share parameter for RoC imports commodity c
δ_c^{DD}	Armington function share parameter for domestic commodity c
ϕ_c^{DMR}	Armington function shift parameter for commodity c
σ_c^{DMR}	elasticity of substitution between dom goods and imports for c
ρ_c^{DMR}	Armington function exponent for commodity c
δ_c^{ER}	CET function share parameter for RoC exports commodity c
δ_c^{DS}	CET function share parameter for domestic commodity c
ϕ_c^{DER}	CET function shift parameter for commodity c
σ_c^{DER}	elasticity of transformation between dom sales and exports for c
ρ_c^{DER}	CET function exponent for commodity c
η^{roct}	constant price elasticity of RoC tourism demand (< 0)
η^{rowt}	constant price elasticity of RoW tourism demand (< 0)
$cwts_c$	consumer price index weights
$dwts_c$	domestic sales price weights
$phillips_f$	elasticidad-desempleo del salario factor f
$fprd_{f,a,t}$	productivity term for factor f in act a
κ	velocidad movilidad del capital entre actividades
$capcomp_{c,inv}$	quantity of commodity c per unit of investment inv
δ^{ng}	depreciation rate for non-government capital
δ^{g}	depreciation rate for government capital

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 Function

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) and the aggregate of intermediate inputs ($QINTA_a$) are a fixed proportion of the activity production level (QA_a), respectively.

$$QVA_a = iva_a QA_a \quad \text{(PF1)}$$

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

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 $WF_f WFDIST_{f,a}$, where $WFDIST_{f,a}$ is a "distortion" factor that allows modeling cases in which the factor remuneration differs across activities.[19] As we will see, this method to compute the remuneration of factor f in each activity allows to easily selecting among alternative closures (i.e., mechanisms to equalize supply and demand) in the factor markets.[20]

Equation (PF5) 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 (PF5), 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

[19] 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.

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

TFP. For model calibration, the initial public capital stock can be estimated through alternative methods; for example, based on recent data for public investments.

$$QA_a = TFP_a \phi_a^{VA} \left(\sum_f \delta_{f,a}^{VA} \left(fprd_{f,a} FD_{f,a} \right)^{-\rho_a^{VA}} \right)^{\frac{-1}{\rho_a^{VA}}} \quad \text{(PF3)}$$

$$FD_{f,a} = \left(\frac{PVA_a}{WF_f WFDIST_{f,a} \left(1 + tfact_{f,a}\right)} \right)^{\sigma_a^{VA}} \left(\delta_{f,a}^{VA}\right)^{\sigma_a^{VA}} \left(TFP_a \phi_a^{VA}\right)^{\sigma_a^{VA}-1} QVA_a \, fprd_{f,a}^{\sigma_a^{VA}-1} \quad \text{(PF4)}$$

$$TFP_{a,t} = tfpexog_{a,t} CALTFP_t \prod_{invg \in invginf} \left(\frac{KG_{invg,t}}{KG_{invg}^{00}} \right)^{tfpelas_{a,invg}} \quad \text{(PF5)}$$

Individual intermediate inputs are also a fixed share of output. However, note that in equation (PF6) intermediate inputs are a fixed share of the aggregate intermediate input which, in turn, is a fixed proportion of output (equation (PF2)).[21]

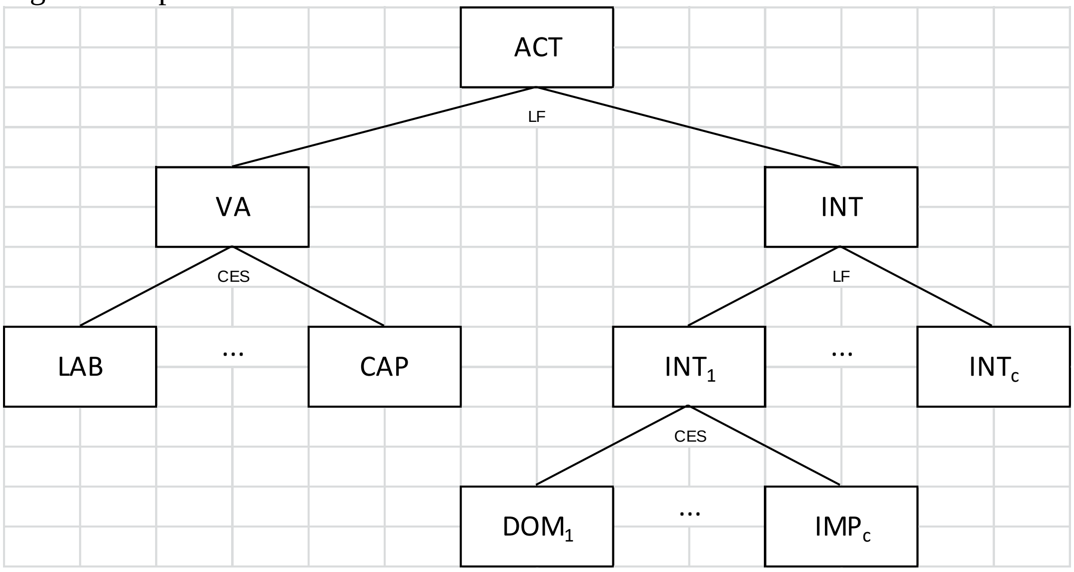
$$QINT_{c,a} = ica_{c,a} QINTA_a \quad \text{(PF6)}$$

Equation (PF7) 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.

$$QX_c = \sum_a \theta_{a,c} QA_a \quad \text{(PF7)}$$

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

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)).

$$PVA_aQVA_a = PA_a(1-ta_a)QA_a - PINTA_aQINTA_a \quad \text{(PR1)}$$

$$PINTA_a = \sum_c PQ_c ica_{c,a} \quad \text{(PR2)}$$

$$PA_a = \sum_c \theta_{a,c} PX_c \quad \text{(PR3)}$$

Trade with Rest of the Country

RoC Prices

$$PMR_c = pwmr_c + \sum_{ct} PQ_{ct} icmr_{ct,c} \quad \text{(TC1)}$$

$$PER_c = pwer_c - \sum_{ct} PQ_{ct} icer_{ct,c} \tag{TC2}$$

QDD + QMR

$$QDMR_c = \phi_c^{DMR} \left(\delta_c^{MR} QMR_c^{-\rho_c^{DMR}} + \delta_c^{DD} QD_c^{-\rho_c^{DMR}} \right)^{-\frac{1}{\rho_c^{DMR}}} \tag{TC3}$$

$$\frac{QMR_c}{QD_c} = \left(\frac{PDD_c}{PMR_c} \frac{\delta_c^{MR}}{\delta_c^{DD}} \right)^{\frac{1}{1+\rho_c^{DMR}}} \tag{TC4}$$

$$PDMR_c QDMR_c = PDD_c QD_c + PMR_c QMR_c \tag{TC5}$$

QDS + QER

$$QDER_c = \phi_c^{DER} \left(\delta_c^{ER} QER_c^{\rho_c^{DER}} + \delta_c^{DS} QD_c^{\rho_c^{DER}} \right)^{\frac{1}{\rho_c^{DER}}} \tag{TC6}$$

$$\frac{QER_c}{QD_c} = \left(\frac{PER_c}{PDS_c} \frac{\delta_c^{DS}}{\delta_c^{ER}} \right)^{\frac{1}{\rho_c^{DER}-1}} \tag{TC7}$$

$$PDER_c QDER_c = PDS_c QD_c + PER_c QER_c \tag{TC8}$$

Trade with Rest of the World

Equations (TW1) and (TW2) 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.

$$PM_c = (1 + tm_c) EXR.pwm_c + \sum_{ct} PQ_{ct} icm_{ct,c} \tag{TW1}$$

$$PE_c = (1 - te_c) EXR.pwe_c - \sum_{ct} PQ_{ct} ice_{ct,c} \tag{TW2}$$

Equation (TW3) 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.

$$PDD_c = PDS_c + \sum_{ct} PQ_{ct} icd_{ct,c} \tag{TW3}$$

$$QQ_c = \phi_c^Q \left(\delta_c^M QM_c^{-\rho_c^Q} + \delta_c^{DMR} QDMR_c^{-\rho_c^Q} \right)^{-\frac{1}{\rho_c^Q}} \tag{TW4}$$

$$\frac{QM_c}{QDMR_c} = \left(\frac{PDMR_c}{PM_c} \frac{\delta_c^M}{\delta_c^{DMR}} \right)^{\frac{1}{1+\rho_c^Q}} \tag{TW5}$$

$$PQ_c QQ_c = \left(PDMR_c QDMR_c + PM_c QM_c \right)\left(1 + tq_c\right) \tag{TW6}$$

Demand of Products -- Dom + Exp

$$QX_c = \phi_c^X \left(\delta_c^E QE_c^{\rho_c^X} + \delta_c^{DER} QDER_c^{\rho_c^X} \right)^{\frac{1}{\rho_c^X}} \tag{TW7}$$

$$\frac{QE_c}{QDER_c} = \left(\frac{PE_c}{PDER_c} \frac{\delta_c^{DER}}{\delta_c^E} \right)^{\frac{1}{\rho_c^X - 1}} \tag{TW8}$$

$$PX_c QX_c = PDER_c QDER_c + PE_c QE_c \tag{TW9}$$

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.

$$YF_f = \sum_a WF_f WFDIST_{f,a} FD_{f,a} + trnsfr_{f,row} EXR + trnsfr_{f,roc} \tag{Y1}$$

$$YIF_{i,f} = sh_{i,f}^F YF_f \left(1 - tf_f\right) \tag{Y2}$$

Domestic Non-Government Institutions; $i \in insdng$. Households. The income of the domestic non-government institution i(insdng) (i.e., households and enterprises) is the sum of two elements: (1) factor income, and (2) transfers from other institutions (see equation (Y1)). Equation (Y2) computes the marginal propensity to save for the domestic non-government institutions. Initially, variable $MPSADJ$ is equal to one.[22] Equation (Y3) computes the value of savings for each domestic non-government institution in the model, as a linear function of disposable income.

$$YH_i = \sum_f YIF_{i,f} + trnsfr_{i,gov}CPI + \sum_{i' \in insdng} TR_{i,i'} + trnsfr_{i,row}EXR + trnsfr_{i,roc} \qquad \text{(Y3)}$$

$$MPS_i = \overline{mps}_i MPSADJ \qquad \text{(Y4)}$$

$$SH_i = mps_i YH_i (1 - ty_i) \qquad \text{(Y5)}$$

$$TR_{i',i} = sh_{i',i}^{TR}(1 - MPS_i)(1 - ty_i)YH_i \qquad \text{(Y6)}$$

Households. Equation (H1) computes the consumption spending by households as their income net of transfers to other institutions, savings, and direct taxes.

$$CON_h = \left(1 - \sum_i sh_{i,h}^{TR}\right)(1 - MPS_h)(1 - ty_h)YH_h \qquad \text{(H1)}$$

Local 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).

$$\begin{aligned} YG = & \sum_h ty_h YH_h \\ & + \sum_c tm_c EXR.pwm_c QM_c \\ & + \sum_c te_c EXR.pwe_c QE_c \\ & + \sum_a ta_a PA_a QA_a \\ & + tq_c (PDMR_c QDMR_c + PM_c QM_c) \\ & + \sum_f tf_f YF_f + \sum_{f,a} WF_f WFDIST_{f,a} FD_{f,a} tfact_{f,a} \\ & + trnsfr_{gov,row}EXR + trnsfr_{gov,roc} + \sum_{insdng} TR_{gov,insdng} \\ & + \sum_f YIF_{gov,f} \end{aligned} \qquad \text{(G1)}$$

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

$$EG = \sum_{c} PQ_c QG_c + \sum_{i \in insdng} trnsfr_{i,gov} CPI + trnsfr_{row,gov} EXR + trnsfr_{roc,gov} \quad \text{(G2)}$$

$$SG = YG - EG \quad \text{(G3)}$$

Central Government. Equations (G4)-(G6) are similar to equations (G1)-(G3) but refer to the central government. As we see, both levels of government tax the same tax base. Consequently, the model captures the interaction between the tax policies of the various levels of government.

$$\begin{aligned} YGC = & \sum_{h} tcy_h YI_h \\ & + \sum_{c} tcm_c EXR.pwm_c QM_c \\ & + \sum_{c} tce_c EXR.pwe_c QE_c \\ & + \sum_{a} tca_a PA_a QA_a \\ & + tcq_c \left(PDMR_c QDMR_c + PM_c QM_c \right) \\ & + \sum_{f} tcf_f YF_f + \sum_{f,a} WF_f WFDIST_{f,a} QF_{f,a} tcfact_{f,a} \\ & + trnsfr_{govc,roc} + \sum_{insdng} TRII_{govc,insdng} + trnsfr_{govc,gov} \\ & + \sum_{f} YIF_{govc,f} \end{aligned} \quad \text{(G4)}$$

$$EGC = \sum_{c} PQ_c QGC_c + \sum_{i \in insdng} trnsfr_{i,gov} CPI + trnsfr_{gov,govc} \quad \text{(G5)}$$

$$GCSAV = YGC - EGC \quad \text{(G6)}$$

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)).

$$\begin{aligned} & \sum_{c} pwe_c QE_c + \sum_{ac} trnsfr_{ac,row} + \frac{\sum_{c} PQ_c QTROW_c}{EXR} + SROW = \\ & \sum_{c} pwm_c QM_c + trnsfr_{row,gov} + \frac{\sum_{i \in insdng} TR_{row,i}}{\overline{EXR}} + \frac{\sum_{f} YIF_{row,f}}{\overline{EXR}} \end{aligned} \quad \text{(RW1)}$$

Rest of the Country

$$\sum_c pwee_c QER_c + \sum_{ac} trnsfr_{ac,roc} + \sum_c PQ_c QTROC_c + SROC = \sum_c pwmr_c QMR_c + trnsfr_{roc,gov} + \sum_{i \in insdng} TR_{roc,i} + \sum_f YIF_{roc,f} \quad \text{(Y13)}$$

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 (FD1)). Equation (FD2) computes the investment demand of commodity *c*. It is assumed that the commodity composition of investment is exogenous – see parameter $cc_{c,inv}$. Thus, if there is an increase in investment, investment demand for all goods and services will increase in the same proportion.[23] 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 (FD4) 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.

$$QH_{c,h} = qhmin_{c,h} + \frac{\delta_{c,h}^{LES}}{PQ_c}\left(CON_h - \sum_{c'} PQ_{c'} qhmin_{c',h} \right) \quad \text{(FD1)}$$

$$QINV_c = \sum_{inv} cc_{c,inv} RGFCF_{inv} \quad \text{(FD2)}$$

$$QG_c = \overline{qg}_c GADJ \quad \text{(FD3)}$$

$$QT_c = \sum_{c'} \left(icm_{c,c'} QM_{c'} + ice_{c,c'} QE_{c'} + icd_{c,c'} QD_{c'} + icmr_{c,c'} QMR_{c'} + icer_{c,c'} QER_{c'} \right) \quad \text{(FD4)}$$

Tourism Demand (RoC and RoW); exogenous if eta_roct = 0 and eta_rowt = 0. Note that although tourists from the rest of the Belize do not need to change currencies, a real exchange rate exists between the modeled region of Belize and the rest of the Belize.

$$QTROC_c = \overline{qtroc}_c \left(\frac{PQ_c}{PQ_c^0} \right)^{\eta^{roct}} \quad \text{(FD5)}$$

$$QTROW_c = \overline{qtrow}_c \left(\frac{PQ_c / EXR}{PQ_c^0 / EXR^0} \right)^{\eta^{rowt}} \quad \text{(FD6)}$$

Unemployment

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

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.

$$\frac{WF_f}{CPI} = \frac{WF_f^0}{CPI^0}\left(\frac{UERAT_f}{UERAT_f^0}\right)^{phillips_f} \qquad \text{(U1)}$$

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, local and central 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.

$$FS_f\left(1-UERAT_f\right)=\sum_a FD_{f,a} \qquad \text{(EQ1)}$$

$$\sum_h QH_{c,h} + \sum_a QINT_{c,a} + QINV_c + QG_c + QGC_c + QT_c + qdstk_c + QTROC_c + QTROW_c = QQ_c \qquad \text{(EQ2)}$$

$$\sum_c PQ_c qdstk_c + \sum_{inv} GFCF_{inv} = \sum_{i \in insdng} SH_i + SG + EXR.SROW + SROC \qquad \text{(EQ3)}$$

Miscellaneous

Equation (MIS1) defines the consumer price index as a weighted average of the composite commodity prices; 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. Finally, equation (MIS4) computes the real GDP at factor cost.

$$\sum_c PQ_c cwts_c = CPI$$

$$\sum_c PDS_c dwts_c = DPI$$

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

$$RGDP = \sum_a PVA_a^{00} QVA_a$$

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 the rates of return on capital. 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 capital type "inv"; the new capital is assembled using a fixed coefficient production function. Equation (DP2) 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 (DP3) computes the average rate of return for private capital, as the ratio between total capital income and total capital stock. Equation (DP4) 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 (DP5) shows how sectoral capital stocks are updated.

$$PK_{inv} = \sum_c capcomp_{c,inv} PQ_c \qquad \text{(DP1)}$$

$$RGFCF_{inv} = \frac{GFCF_{inv}}{PK_{inv}} \qquad \text{(DP2)}$$

$$AWF_f = \frac{\sum_a FD_{f,a} WF_f WFDIST_{f,a}}{\sum_a FD_{f,a}} \qquad \text{(DP3)}$$

$$IND_{k,a} = RGFCF_{invng} \frac{FD_{k,a}}{\sum_{a'} FD_{k,a'}} \left[1 + \kappa \left(\frac{WF_k WFDIST_{k,a}}{AWF_k} - 1 \right) \right] \qquad \text{(DP4)}$$

$$FD_{k,a} = \left(1 - \delta_k^{ng}\right) FD_{k,-1} + IND_{k,a,-1} \qquad \text{(DP5)}$$

Government Sector. For the government, investment can be determined in two alternative ways: (1) as a policy variable (i.e., exogenously) (equation (DG6)), or (2) as a residual to balance the government budget. 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 $\overline{rgfcf}_{invg}$ 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 for the identification of more than one type of public capital; for example, different infrastructure sectors such as roads, communications, energy, among others.

$$RGFCF_{inv} = rgfcf_{invg} \qquad \text{(DG6)}$$

$$KG_{invg,a} = \left(1 - \delta^g\right) KG_{invg,-1} + RGFCF_{invg,-1} \qquad \text{(DG7)}$$

Appendix B: Technical Note on the Construction of the RSAM for Belize Cayo District

B.1. Introduction

The aim of this technical appendix is to document in detail the steps that have been followed to build the Regional Social Accounting Matrices (RSAM) for the Belize Cayo District that was used to calibrate our Regional Computable General Equilibrium (RCGE) model[24], an extended version of the (recursive) dynamic computable general equilibrium model developed for the IDB for tourism development strategy analysis. For a comprehensive description of the RCGE, see Appendix A.

In outline, we proceed as follows. The basic concepts that define the RSAM are introduced in Section B.2. The data requirements to construct the RSAM for the Belize Cayo District are identified and described in Section B.3. The next section spells out the steps that have been followed to construct the RSAM, starting from a national SAM.

B.2. A Regional Social Accounting Matrix

A SAM (and a RSAM) is a matrix representation of the interrelationships existent on an economy at the level of individual production sectors, factors, and institutions. As stated in Round (2003), "it is a comprehensive, flexible, and disaggregated framework which elaborates and articulates the generation of income by activities of production and the distribution and redistribution of income between social and institutional groups".

The SAM is composed of accounts. For each of these, a cell represents a payment column-wise and a receipt row-wise. Hence, columns represent expenditures for each account whereas rows record the matching incomes. Due to the accounting consistency of the SAM, total expenditure of every account must be equal to its total income. In other words, the total of every row must be equal to the corresponding total of the column. The basic structure of a RSAM is presented in Table B.1.

[24] Of course, the procedure described here can be used to build a RSAM for other regions of Belize.

Table B.1: stylized regional social accounting matrix

	spending									
income	activities	com	factors	households	gov local	gov central	RoC	RoW	sav-inv	total
activities		dom-prod								inc firms
com	IO			C	G	G	E	E	I	demand
factors	VA						INC-F	INC-F		inc fac
households			VA		TR	TR	TR	TR		inc hhd
gov local	T	T		T			TR	TR		inc gov loc
gov central	T	T								inc gov cent
RoC		M	INC-F	TR	TR					out LCU
RoW		M	INC-F	TR	TR					out forex
sav-inv				SH	SG local	SG central	SROC	SROW		sav
total	spnd firms	supply	spnd fac	spnd hhd	spnd gov loc	spnd gov cent	in LCU	in forex	inv	

where com = commodities, dom-prod = domestic production, gov = government, RoC = rest of the country, RoW = rest of the world, IO = intermediate consumption, VA = value added, T = taxes, M = imports, INC-F = factor income to/from abroad, TR = transfers, C = private consumption, G = government consumption, E = exports, I = investment, SH = households savings, SG = government savings, and SF = foreign savings.
Source: Authors' own elaboration.

The logic behind the SAM transactions is the following. Activities buy intermediate inputs; pay for factors of production, thus generating the value added at factor prices; and pay indirect taxes. All these expenditures are financed with the payments that each activity receives for the sale of its output.

Aggregate supply and demand are both recorded in the commodities accounts. For each commodity, the corresponding account records for the sales of the aggregate supply (domestic output plus imports from the rest of the country and the rest of the world, and related taxes) as follows: to activities as these demand intermediate goods; to households, government and investment as these demand final goods; and to the rest of the country and the rest of the world as this demands the region's exports.

Factors earn returns from their involvement in domestic and foreign (including the RoC) production, and they distribute them, net of taxes, to their owners (generally, households and enterprises).

Institutions (households, enterprises[25], government, rest of the country, and rest of the world) receive incomes from production factors and (net) transfers that can be either spent in purchasing commodities or saved.

Savings from household, the local and central governments (that is, the current account balance), the rest of the country, and the rest of the world (that is, the current account balance with opposite sign) add to aggregate savings and these, in turn, are equal to the level of investment of the regional economy.

Regional gross domestic product (RGDP) at factor cost builds as activities remunerate factors of production (that is, value added). RGDP at market prices equals RGDP at factor cost plus indirect taxes and tariffs, which should also be equal to total final demand plus exports minus imports, both from RoC and RoW.

B.3. Data

The main sources of information when constructing a national/regional SAM tend to be national supply and use tables, and other databases such as regional accounts, fiscal data, and the balance of payments. The supply and use table provides information on production, intermediate consumption, final demand (i.e., household and government consumption), exports, and value added. In our case, we first built a national SAM that was later on regionalized using non-survey techniques. In doing so, the national supply and use table was combined with regional data on sectoral employment from the most recent household income and expenditure survey, the Belize Household Expenditure Survey 2008-2009.

In our case, the SAM and RSAM base year was selected based on the available information. Specifically, the more recent year with a complete set of national accounts data was selected as the base year, 2013. As will be discussed, in the case of Belize, the national accounts do not provide a supply and use table.

B.4. Steps in Building the RSAM

[25] The SAM and RSAM built do not separate enterprises from the households. A single account, named hhd, is taken as representative of the domestic private sector.

Typically, we start with a relatively aggregate SAM that, in a stepwise fashion is disaggregated, drawing on additional data in different areas.[26] Specifically, the process followed has a top-down structure, entailing three steps: (i) construction of an aggregate national SAM (hereafter, Macro SAM), (ii) disaggregation of the Macro SAM into a matrix with a relatively large sectoral breakdown (hereafter, SAM), and (iii) regionalization of the SAM to make it suitable for the calibration of our regional CGE model (hereafter RSAM).

B.4.1. Macro SAM

In the first step of the RSAM building, a very schematic representation of the national economy was generated, using macroeconomic aggregates from the national accounts. In case needed, information from other sources, adjusted to keep the consistency, was next used to improve the representation of the economy. In particular, data on public finances and balance of payment were factored in to complete the construction of the national Macro SAM; especially to adjust the current account balances of the government and the rest of the world, among others. Specifically, the data sources are:

- national accounts data at current prices from the Statistical Institute of Belize (SIB), including gross domestic product by activity and expenditure on gross domestic product;
- data on tax collection and government revenues and expenditures from Belize Ministry of Finance, Belize Department of General Sales Tax, the IDB (2016), and IMF 2015 Article IV Consultation;
- balance of payments from the Central Bank of Belize; and
- supply and use table for Ecuador 2007 and 2013 (see below).

The estimated Macro SAM is presented in Table B.2, where the following abbreviations are used:

- act = activities
- com = commodities
- f-lab = labor
- f-cap = capital
- tax-act = activity taxes
- tax-com = commodity taxes
- sub-com = commodity subsidies

[26] The top-down approach for the SAM-building process is described with more detail in Reinert and Roland-Holst (1997).

- tax-imp = import tariffs
- tax-dir = direct taxes
- hhd = households
- gov = government
- row = rest of the world
- sav = savings
- invng = non-government investment
- invg = government investment
- dstk = stock change

Table B.2: Macro SAM for Belize 2013 (BZ$ million)

	act	com	f-lab	f-cap	tax-act	tax-imp	tax-com	tax-dir	hhd	gov	row	sav	invng	invg	dstk	to
act		2,806														2,806
com									2,325	492	1,977		388	192	33	5,406
f-lab	1,504										5					1,509
f-cap	1,295										7					1,303
tax-act	7															7
tax-imp		160														160
tax-com		286														286
tax-dir									249							249
hhd			1,496	974						194	208					2,872
gov				93	7	160	286	249			1					796
row		2,154	13	236					53	9						2,465
sav									244	101	268					613
invng												388				388
invg												192				192
dstk												33				33
total	2,806	5,406	1,509	1,303	7	160	286	249	2,872	796	2,465	613	388	192	33	

Source: Authors' own elaboration.

In building the Macro SAM, and due to the lack of Belizean data, the 2013 Ecuadorian supply and use table was used to split total value added net of "other taxes on production" between payments to labor and capital.[27] In Table B.2, capital payments comprise gross operating surplus and mixed income.

B.4.2. National SAM

At this stage, the aim became to build more disaggregated SAM, which would be as large as the data available would allow it. Specifically, the main inputs to initiate the disaggregation for activities and commodities of the Macro SAM were

[27] In the main text we discuss the reason for using the Ecuadorian supply and use table to build the Belize SAM.

- sectoral output (i.e., value added at basic prices) information from national accounts provided by the SIB;
- sectoral exports and imports of goods provided by the SIB and COMTRADE (United Nations Commodity Trade Statistics Database);
- sectoral exports and imports of services from the balance of payments;
- sectoral tariff rates from TRAINS (UNCTAD - Trade Analysis Information System); and
- Ecuador 2013 supply and use table.

In Table B.3, we list the 18 activities and commodities identified in the Belize (national/regional) SAM. Certainly, the number of sectors could be increased once additional sectoral output data becomes available.

Table B.3: activities and commodities in the Belize (national) SAM 2013

Crops
Livestock
Forestry
Fishing
Mining
Food and beverages
Textiles
Other manufacturing
Electricity and water
Construction
Trade
Hotel and restaurants
Transport
Post and telecommunications
Financial intermediation
Real estate, renting and bus svc
Community, social and pers svc
General government services

Source: Authors' own elaboration.

In addition, various other complementary adjustments were implemented during the building process of the SAM:

- non-profit final consumption was added to be part of the private sector account, hhd;
- financial intermediation services indirectly measured were distributed across sectors based on their estimated intermediate consumption of financial services;

- direct purchases were consolidated with the relevant sectors[28];
- imports, exports and cif/fob adjustments are all accounted for in the single SAM account pertaining to the rest of the world, “row”;
- split of gross operating surplus/mixed income into its two components using the 2007 Ecuador supply and use table; mixed income was associated with non-salaried workers;
- GTAP (Global Trade Analysis Project) data was used to split the sectoral gross operating surplus among payments to capital, land, and natural resources used in forestry, fishing, and mining (coal, petroleum and gas, metals, and other);
- trade and transport margins were split between domestic products, imports, and exports; we assumed that the distribution margins requirements are proportional to the corresponding transactions; and
- the stock variation is a component of the total gross investment; this is expressed in the SAM as a payment done by the savings-investment account, savings (“sav") to the stock variation account, “dstk”; and
- in the current version of the SAM, the stock variation account was used to balance the commodity accounts of the SAM.

Disaggregation of Gross Fixed Capital Formation

Typically, a SAM specifies the investment in a slightly different setup to that of the RSAM for our model. The RSAM for our RCGE includes, at least, two investment accounts: one for the private sector, and one for the services that are provided by the government. This disaggregation implies that investment by sector of origin and by sector of destination had to be specified. As a first step, we assumed that the composition of the capital good is the same independently of the sector of destination by keeping the disaggregation of investment by sector of origin as this is initially accounted for in the national SAM. Next, based on regional evidence, we assumed that public investment demand is biased towards construction services. On the other hand, private investment demand is biased towards machinery and equipment (see Table B.4).

[28] Direct purchases usually represent the expenditure on transport and communication services of the governmental and private sector abroad and from foreign individuals in the country.

Table B.4: investment demand sectoral composition

Commodity	Private	Public	Total
Machinery and equipment	38.4	11.0	31.8
Construction services	61.6	89.0	68.2
Total	100	100	100

Source: Authors' own elaboration based on national accounts data for Costa Rica, Ecuador, Guatemala, and Mexico.

Disaggregation of Labor Payments

In the SAM used to calibrate our RCGE model, each labor category (i.e., salaried and non-salaried) was disaggregated into two types according to the educational level as follows: (i) unskilled, for workers with less than nine years of education (i.e., less than lower secondary); and (ii) skilled, for individuals who have nine or more years of education (i.e., completed lower secondary, with or without [incomplete/complete] tertiary education). In order to conduct such disaggregation, we used information on labor payments by sector, labor category (salaried/non-salaried) and skill level from the Household Expenditure Survey for the year 2008-2009, conducted by the SIB (see Table B.5). The HES 2008-2009 is the latest available household income and expenditure survey in Belize; it covers 11,442 individuals in 3,023 households in all of Belize. The HES 2008-2009 was processed following the SEDLAC (Socio-Economic Database for Latin America and the Caribbean) guidelines (World Bank and CEDLAS, 2012). Not surprisingly, the HES 2008-2009 does not provide enough information for all labor categories and activities in the SAM. Thus, two or more sectors in the national accounts were linked to the same activity in Table B.5.

Table B.5: share of each labor skill level in total labor payments by sector and labor category (salaried/non-salaried), (percent)

Sector	Salaried, unskilled	Salaried, skilled	Salaried, total	Non-salaried, unskilled	Non-salaried, skilled	Non-salaried, total
Crops + Livestock	88.7	11.3	100.0	92.0	8.0	100.0
Forestry	50.4	49.6	100.0	100.0	0.0	100.0
Fishing	85.7	14.3	100.0	96.8	3.2	100.0
Mining	64.3	35.7	100.0	97.9	2.1	100.0
Food and beverages	40.4	59.6	100.0	42.9	57.1	100.0
Textiles	58.1	41.9	100.0	81.4	18.6	100.0
Other manufacturing	45.0	55.0	100.0	66.2	33.8	100.0
Electricity and water	20.0	80.0	100.0	3.6	96.4	100.0
Construction	72.3	27.7	100.0	83.1	16.9	100.0
Trade	31.8	68.2	100.0	62.0	38.0	100.0
Hotel and restaurants	41.9	58.1	100.0	69.5	30.5	100.0
Transport	62.9	37.1	100.0	18.4	81.6	100.0
Post and telecommunications	9.6	90.4	100.0	0.0	100.0	100.0
Financial intermediation	11.2	88.8	100.0	.	.	.
Real estate, renting and bus svc	15.9	84.1	100.0	3.7	96.3	100.0
Community, social and pers svc	24.6	75.4	100.0	34.6	65.4	100.0
General government services	19.8	80.2	100.0	.	.	.
Total	41.4	58.6	100.0	57.6	42.4	100.0

Source: Authors' own elaboration based on HES 2008-2009.

B.4.3. Regional SAM for the Cayo District

The standard national SAM was regionalized to reflect the productive structure of the Belize Cayo District, in order to make it suitable to calibrate our RCGE model. The regional SAM for a single-region will have exactly the same aspect as the national SAM, but imports will also include inflows coming from other regions within Belize and final demand will also comprise of exports to other regions within Belize. Ideally, the RSAM would have dedicated accounts for the local and the central government levels (see below).

In estimating our non-survey RSAM, the technical coefficients matrix was assumed to be equal to its national counterpart, which is called the "national technology assumption". It is convenient to mention what these technical coefficients mean: they express the amount of input of commodity c per unit of output of activity a, regardless of the geographic origin of input of commodity c. This means that the national inter-industry transactions matrix to be used as a starting point has to be a total flow matrix, thus including both nationally produced and imported inputs (i.e., the cell IO in Table B.1). So, the implicit hypothesis is that technology, in the production function sense, is spatially invariant within Belize (Lahr, 1993).

In our case, the regionalization of production was carried using the regional proportion of industrial's employment (see Table B.6). Thus, our key assumption is that labor productivity (i.e., output per worker) is the same at the regional and at the national levels. Specifically, the

Household Expenditure Survey 2008-2009 identifies the following 17 activities or industries: Crops and Livestock; Forestry; Fishing; Mining; Food and beverages; Textiles; Other manufacturing; Electricity and water; Construction; Trade; Hotel and restaurants; Transport; Post and telecommunications; Financial intermediation; Real estate, renting and business services; Community, social and personal services; and General government services.

Table B.6: share of sectoral employment by district (percent)

Sector	Corozal	Orange-Walk	Belize	Cayo	Stann-Creek	Toledo	Total
Crops + Livestock	19.2	20.4	5.7	17.5	21.0	16.2	100.0
Forestry	10.6	16.7	16.3	53.3	3.2	0.0	100.0
Fishing	18.1	1.0	27.6	16.7	32.1	4.5	100.0
Mining	3.6	0.0	7.7	31.1	0.0	57.6	100.0
Food and beverages	5.3	24.3	34.8	21.4	12.9	1.3	100.0
Textiles	14.1	7.6	28.8	31.2	15.7	2.7	100.0
Other manufacturing	4.9	30.2	18.0	35.8	5.6	5.5	100.0
Electricity and water	4.0	8.8	49.6	25.7	6.6	5.3	100.0
Construction	12.8	16.8	31.8	26.1	9.0	3.5	100.0
Trade	19.6	18.8	31.5	21.6	3.8	4.6	100.0
Hotel and restaurants	12.3	3.1	51.6	16.8	10.7	5.5	100.0
Transport	10.2	10.2	48.4	16.5	11.7	3.1	100.0
Post and telecommunications	0.0	19.8	68.9	9.4	1.9	0.0	100.0
Financial intermediation	9.8	10.3	65.5	9.8	3.6	1.1	100.0
Real estate, renting and bus svc	4.0	3.0	62.4	22.4	4.4	3.8	100.0
Community, social and pers svc	10.3	11.5	39.4	22.9	8.4	7.5	100.0
General government services	8.4	5.6	42.9	33.5	4.6	5.0	100.0
Total	12.6	14.0	34.5	22.3	9.7	6.8	100.0

Source: Authors' own elaboration based on HES 2008-2009.

For final demand components, the following assumptions were made:

- regional household consumption and private investment estimated based on the regional income share (i.e., regional income in national income);
- regional government current and capital spending based on population share (i.e., regional population in national population);
- the share of exports in total sectoral output at the regional level is assumed equal to the share of exports in total sectoral output at the national level;
- the share of imports in total sectoral consumption (intermediate and final) at the regional level is assumed equal to the share of imports in total sectoral consumption at the national level;

- the regional share of factor income to/from the rest of the world is equal to the national share of factor income to/from the rest of the world;
- the inter-regional imports and exports were estimated using commodity balance method (see below);
- regional household and government savings are estimated as residuals, once corresponding current incomes and expenditures are known;

The commodity balance method used for estimating the inter-regional imports and exports can be explained as follows (see Sargento, 2009). Let us define regional demand of commodity c by $d_{c,r}$. For any region, the following balance must hold:

$$d_{c,r} = q_{c,r} + m_{c,row,r} + m_{c,roc,r} - ex_{c,r,row} - ex_{c,r,roc}$$

where

$q_{c,r}$ = regional output

$m_{c,row,r}$ and $m_{c,roc,r}$ = imports from rest of the world and rest of the country, respectively

$e_{c,r,row}$ and $e_{c,r,roc}$ = exports to rest of the world and rest of the country, respectively

This means that regional demand of commodity c is satisfied with regional output to which are added regional imports and from which regional exports are subtracted. Based on this balance, the commodity balance method is applied as follows:

- If $q_{c,r} \geq d_{c,r}$, then it is assumed that the region has the capacity to provide all the requirements of c in region r.
- If $q_{c,r} < d_{c,r}$, it is assumed that the self-sufficiency of the region is limited to the proportion $q_{c,r} / d_{c,r}$. Thus, the remaining regional demand will have to be fulfilled by imports coming from outside the region; in our case, given that imports from RoW were estimated, from the remaining regions.

Foreign Tourism Demand

In order to single out foreign tourism demand, we combined information from (a) national balance of payments, (b) tourist arrivals from SIB, (c) the sectoral information for the Hotels and restaurants sector in the national accounts, and (d) the Tourist Exit Survey conducted in Belize during February-March 2016. Specifically, from the last source of information we extracted the commodity composition of foreign tourist demand that visit the Cayo District as their primary destination. In Table B.7 we show the average per capita and per day spending by commodity in the RSAM. In this version of the RSAM, due to the lack of data, we were no able to also single out domestic tourism demand.[29]

Table B.7: average foreign tourists' daily expenditure by commodity in the RSAM (US$ and percent share)

Sector	US$	share%
Food and beverages	8.1	4.1
Other manufacturing	5.3	2.6
Hotel and restaurants	80.4	40.1
Transport	54.6	27.3
Post and telecommunications	2.9	1.4
Other services (e.g., recreation)	49.0	24.5
Total	200.3	100.0

Source: Authors' own elaboration

In Section 3 of the main text, some statistics that were obtained from the national 2013 Belize and 2013 Cayo District SAMs are presented.

[29] However, the model can handle – as separate entities -- both foreign and domestic tourism demand.

Appendix C: Processing of HES 2008-2009

The database presents a wide format, so each line should identify one household (variable HHID). Nevertheless, we found 14 cases with repeated HHID numbers, so we omitted these (duplicated) ids. The wide format implies that we have to reshape the database to match the individual questions of the different sections of the survey.

Merging of Section

As usual, the HES 2008 data is organized in several files that we had to merge. Specifically, we found out that the only way to connect the different sections of the HES 2008 is by using the person number inferred from the variable names. For example, consider the variable Q16A11, where Q16 refers to the Section itself (Section 16 - Income), A refers to subsection (in this example, the income section has four parts), then 1 refers to person number, and the last 1 denotes the question number. Of course, we repeated this procedure in each of the sections in order to merge the whole database.

Expenditure Sections

In the HES 2008, there are two different sources for expenditure variables. According to BIS, the most complete and reliably source is the general survey, with 11 sections devoted to capture the different expenses incurred by households. However, this source does not include food expenses, consumed at home or at a restaurant. Therefore, we turn to the second source of information available: the household record of daily expenditure. It includes (especially) food and many other items. Specifically, this file contains a list that includes all expenditures incurred by each household during the last two weeks. Then, after merging both databases, we have a matching of 91.92% -- 281 household ids in the diaries survey are not present in the general survey.

In all cases, we always select the variable "value" or "cost" reported in the questionnaire, without taking into account the quantities purchased. Implicitly, we assume that households tend to report the total expense in each category/product. In most cases, expenditure items are reported on an annual basis. Thus, we annualized those that are not. In particular, we had to annualize food and beverages (category 1) and restaurant and catering services (category 10). As we mentioned, both categories were estimated from the household record of daily expenditure. Thus, given that it captures expenditures incurred by each household during the last two weeks, to annualize those categories we multiplied every single purchase by 24.

Based on a general classification, we define the following 12 expenditure categories.

1. Food and beverages: this group is the only one based on information taken from the household record of daily expenditure. It includes food and beverages consumed at the household. COICOP product classification is used so we can classify food products and calculate food expenses.

2. Clothing and footwear: purchases of ready-made clothes, tailoring and dressmaking costs, repairs and alterations costs.

3. Housing, water, electricity, gas and other fuels: rents paid by renters, electricity bills, water bills, cable TV bills, internet bills, garbage collection bills and cooking fuel purchases.

4. Furnishing, household equipment and routine household maintenance: repairs and maintenance to the rental unit, costs for houses under construction, addition and improvements for houses, fumigation costs, domestic helper costs, childcare costs, cutting/yard cleaning costs, other regular household services, furniture, appliances and textiles purchased for the household.

5. Health: premium payments (not covered by health insurance) for accidents, hospitalization, maternity, surgery, x-ray, lab fees, anesthesia, ambulance, physician's fees, dental care, and purchases of medicines and medical supplies. In this case, we noticed that the questionnaire does not include a question to know the amount paid for health insurance when it is paid directly by the user.

6. Transport: operating expenses (gasoline, insurance, vehicle rental, etc.), servicing and repairs (including parts and supplies costs) for private transport, public transportation (other than vacation and business travel) including air, sea, bus and taxi transportation.

7. Communication: telephone bills, internet bills, phone cards purchases and internet coffee usage.

8. Recreation and culture: expenditures on entrance fee for cinema concerts and sports games, night clubs (entrance fee, drinks, etc.), casino, newspapers, books (other than school books), magazines, hobbies, fairs/shows, weddings, funerals, baby showers, gifts/greeting cards, parties (other than food), flowers, veterinary expenses (for pets), pet food, other pet expenses, boledo/lottery/lotto tickets, postage, stationery (exclude school-related items), courier service, church contributions and other charitable contributions. It also comprises local travel expenses; including air fare, sea fare, bus fare, taxi, travel in personal vehicle, gasoline, hotel, meals, tips, entertainment (tours, nightclubs, museums, sports events, etc.), package tours and excursions and other travel expenses (rentals, souvenirs, etc.).

9. Education: expenditures on tuition, exam fees, other educational fees, books/supplies/equipment, special lessons, boarding/lodge, uniforms and others.

10. Restaurant and catering services: we had to estimate food expenses outside the household. Specifically, the diaries database provides a "business type" variable, that indicates the type of business or place from which the item was bought, e.g., supermarket. Therefore, we selected bars, restaurants, fast food outlets, coffee shops and caterings to estimate expense on those places.

11. Miscellaneous goods and services: expenses on haircuts, perms/relax, manicure, laundry service, spa services, music lessons, fitness classes, life insurance and other expenditures, not classified previously and declared in section 19.

12. Purchases in the rest of the world: foreign travel expenses; including air fare, sea fare, bus fare, taxi, travel in personal vehicle, gasoline, hotel, meals, tips, entertainment (tours, nightclubs, museums, sports events, etc.), package tours and excursions and other travel expenses (rentals, souvenirs, etc.).

Finally, total household expenditure is the sum of all categories. In order to obtain household per capita expenditure, we computed the ratio between this total amount and the number of individuals that compose each (primary) household.