A National CGE Model with a Focus Tourism Analysis

Onil Banerjee (IDB) and Martin Cicowiez (CEDLAS-UNLP)

# Non-Technical Overview of Model and Data

## Model

In a nutshell, our model integrates a relatively standard recursive dynamic CGE model (see, for example, Lofgren et al. (2002) and Robinson (1989)) with additional equations and variables that single out: (a) the foreign tourism demand as the product of the number of foreign tourists and their spending per capita, and (b) the impact of private investments in the tourism sector. More precisely, our starting point for model development was our previous work as published in Banerjee et al. (2015, 2016). Thus, compared to other CGE models, the CGE that was developed for this particular application offers relevant features for the study of tourism investment and/or tourist arrivals and expenditure scenarios in a national economy.

Figure 3.1 depicts, for each simulation period, the circular flow of income within the economy and between the economy and the rest of the world. The major building blocks of our CGE model may be divided into: (a) activities (the entities that carry out production); (b) commodities (activity outputs or, exceptionally, imports without domestic production; linked to markets); (c) factors (also linked to markets); and (d) institutions (households, the government, the rest of the world, and foreign tourists). In any application (and database) of our CGE model, most blocks in Figure 3.1 are disaggregated based on the available data.

Figure 3.1: Circular income flow in the CGE; within-period module



Source: Author’s own elaboration.

In any single year, our CGE model has the structure summarized in the above figure. Activities produce, selling their output at home – to both residents and foreign tourists -- or abroad to the trading partners of the modeled economy. The activities use their revenues to cover costs (of intermediate inputs, factor hiring, and taxes). Their decisions regarding factor employment, which determines the output level, are driven by profit maximization. The shares of their outputs that are exported and sold domestically depend on relative sales prices in these two destinations.

Figure 3.2 provides additional detail on the production technology of production activities. The level (or quantity) of any activity and its output quantities (via yield coefficients) are a Constant Elasticity of Substitution (CES) function of the quantities of factors employed (in this example labor and capital). Intermediate input use is a Leontief (LEO) function of the activity levels.

*Figure 3.2: Production function -- factor and intermediate input demand*



Note: CES and LEO refer to constant elasticity of substitution and Leontief production functions, respectively, and there are N commodities used as intermediate inputs.

Source: Authors’ elaboration.

Returning to Figure 3.1, our CGE model includes four types of institutions: households, enterprises, the government, foreign tourists, and the rest of the world. As shown, households earn incomes from factors, transfers from the government, and transfers from the rest of the world. These incomes are used for direct taxes, savings, and consumption. After deducting net financing of the government (which in the real world equals household lending to the government minus household interest earnings) and resources needed for changes in foreign reserves, household savings are used to finance private investment. Household consumption decisions change in response to income and price changes. By construction (and as required by the household budget constraints), the consumption value of the households equals their income net of direct taxes and savings.

The government gets its receipts from taxes, transfers from abroad, and net financing (borrowing net of interest payments) from households and the rest of the world. It uses these receipts for transfers to households, consumption, and investment (to provide the capital stocks required for government services).[[1]](#footnote-1) 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 of one or more types in order to finance its spending plans.

Foreign wages and rents is the only non-trade payment to the rest of the world; it is typically an exogenous projection. The non-trade payments received from the rest of the world consist of tourism expenditures, net transfers to households, foreign borrowing, and foreign investment, net of changes in foreign reserves. Total financing from the rest of the world (to the government and to the non-government capital account) is positive (negative) if the model country has a deficit (surplus) in its non-borrowing payments. The balance of payments clears (inflows and outflows are equalized) via adjustments in the real exchange rate (the ratio between the international and domestic price levels), influencing export and import quantities and values.

To model tourism demand, the model offers two alternatives. On the one hand, international tourism receipts may be modeled as the product between per capita tourism expenditures and the number of tourists arriving in the modeled country (see equation 1). On the other hand, the model allows modeling foreign tourism demand using a constant elasticity demand function (see equation 2). In the latter case, the modeled country would face a downward-sloping demand curve for its tourism exports. In both cases, total tourism demand is disaggregated across domestically produced commodities in fixed proportions.[[2]](#footnote-2) In equation 2, foreign tourists’ demand is a function of local (tourism-related) prices relative to the exchange rate .

(1)

(2)

where

 *t*: time

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

 : rest of the world tourism demand quantity of commodity *c*

 : the price for commodity *c*

 : exchange rate

 : demand quantity of commodity *c* per foreign tourist

 : number of foreign tourists arriving in the modeled economy

 : (constant) price elasticity of foreign tourism demand (< 0)

On the supply side, the modeling of alternative tourism modalities – for example, all-inclusive beach resorts, boutique hotels, eco-lodges – is straightforward, provided the required data is available. In fact, if data is available, the model can consider different cost structures for the different tourism modalities on the supply side.

In commodity markets, flexible prices ensure balance between demands for domestic output from domestic demanders and supplies to the domestic market from domestic suppliers. The parts of domestic demands that are for imports face exogenous world prices; under the common small-country assumption, prices in foreign currency are fixed. On the basis of relative prices, domestic demanders decide on the split between domestic purchases and imports (see Figure 3.3). Similarly, domestic suppliers (the activities) also consider relative prices when deciding on the allocation of their output between domestic supplies and exports (see Figure 3.4). For exports, we also assume that the modeled economy faces exogenous world prices.

Figure 3.3: Allocation of domestic demands across alternative sources



Note: The demand structure in the figure applies to each of the commodities singled out in the SAM and model.

Source: Authors’ elaboration.

Figure 3.4: Allocation of output across alternative destinations



Note: CET refers to constant elasticity of transformation function; the supply structure in the figure applies to each of the commodities singled out in the SAM and model.

Source: Authors’ elaboration.

For non-labor factors, markets reach balance between demands and supplies via rent adjustments. Across all factors, the demand curves are downward-sloping, reflecting the responses of production activities to changes in wages. In labor markets, unemployment may be endogenous. If so, the model includes a wage curve that establishes a negative relation between the real wage and the unemployment rate or, alternatively, a positive relation between the real wage and the employment rate (see Figure 3.5). For non-labor factors, full employment is assumed.

Figure 3.5: Labor market specification



Source: Authors’ elaboration.

The above discussion refers to the functioning of the model economy in a single year. In our CGE, growth over time is endogenous. The economy grows due to accumulation of capital (determined by investment and depreciation), exogenous growth in the stocks of labor and other non-capital factors (for example, agricultural land), and growth in total factor productivity (TFP). Apart from an exogenous component, the TFP of any production activity potentially depends on the levels of capital stocks (typically government infrastructure stocks).

## Data

### Social Accounting Matrix

The basic accounting structure and much of the underlying data required to implement our CGE model is be derived from a Social Accounting Matrix (SAM). (Technically, the SAM is used to calibrate the CGE model. In other words, the SAM is used to compute benchmark (or initial) values for all behavioral parameters and exogenous variables in the CGE model.) A SAM is a comprehensive, economy-wide statistical representation of the modeled economy at a specific point in time. It is a square matrix with identical row and column accounts where each cell in the matrix shows a payment from its column account to its row account. It can be used for descriptive purposes and is the key data input for a CGE. Major accounts in a standard SAM are: (a) activities that carry out production; (b) commodities (goods and services) which are produced and/or imported and sold domestically and/or exported; (c) factors used in production which include labor, capital, land and other natural resources; and (d) institutions such as households, government, tourists, and the rest of the country and world. Generally speaking, most features the SAM required by our CGE model are familiar from social accounting matrices used in other models.[[3]](#footnote-3) However, the SAM our CGE model has non-conventional features related to the explicit treatment of foreign tourism-related spending together with the corresponding inflow of foreign exchange.

In most cases, a SAM is built using supply and use tables (SUTs) as the starting point.

### Non-SAM Data

In addition to the SAM, our tourism-extended dynamic CGE model requires a set of elasticities (for production, consumption and trade; econometrically estimated and/or obtained from the literature); and base-year estimates for sectoral employment levels and unemployment. Furthermore, given that this is a dynamic model, we need to project the modeled economy under the assumption of a “business as usual” (BaU) scenario. Then, the BaU scenario serves as a reference for comparing the non-base simulation scenarios; i.e., scenarios in which one or more shocks are introduced are compared to the said baseline or reference scenario. For the BaU, we require base-year capital stocks, a baseline projection for population and labor force growth, and a baseline projection for GDP growth.

In a typical application to a developing country, the chosen values for elasticities are as follows: (a) the elasticities of substitution among factors (i.e., labor, capital, and natural resources) are in the 0.2-0.9 range, lower for natural resource activities such as agriculture (0.25) and mining (0.2) (Narayanan et al., 2012); (b) the wage curve unemployment elasticity is -0.5 (Blanchflower and Oswald, 2005); and (c) on the basis of Sadoulet and de Janvry (1995) and Annabi et al. (2006), trade-related elasticities are in the 0.8-2 range for the substitution between imports and domestic purchases and transformation between exports and domestic sales. In addition, and given the uncertainty with respect to our elasticity values, we normally conduct a systematic sensitivity analysis of our simulation results with respect to their values to assess the robustness of our results.

# Mathematical Statement

To simplify model presentation, this mathematical statement assumes the following: all tax rates are exogenous, no consumption subsidies, no regulated industries, and transfers that follow rules (e.g., are an exogenous share of GDP) are considered as exogenous variables. Of course, these elements are available in the model code, which is written in GAMS (General Algebraic Modeling System) and solved as a system of non-linear equations. In addition, the model presentation assumes the following macroeconomic closure rule is in place: endogenous direct tax rates clear the government budget, non-government investment is endogenous and clears the savings-investment balance (i.e., investment is savings-driven), and movements in the real exchange clear the current account of the balance of payments.

## A.1. Notation

The mathematical presentation of the CGE uses the notational conventions shown in Table A.1. Tables A.2-A.5 define model sets, variables, and parameters.

Table A.1: Notational principles

|  |  |
| --- | --- |
| **Items** | **Notation** |
| Sets | Lower-case Latin letters as subscripts to variables and parameters |
| Endogenous variables | Upper-case Latin letters (without a bar)\* |
| Exogenous variables\*\* | Upper-case Latin letters with a bar\* |
| Parameters\*\* | Lower-case Latin letters\* or lower-case Greek letters (with or without superscripts) |

\* The names of Latin letter variables and parameters that refer to prices, quantities, and factor wages (rents) start with *P*, *Q*, and *WF*, respectively.

\*\* The distinction between exogenous variables and parameters is that the latter always have exogenous values whereas the former under alternative assumptions may be endogenous.

Table A.2: Sets

|  |  |
| --- | --- |
| **Name** | **Description** |
|  | time periods (simulation years) |
|  | activities (or industries) |
|  | commodities (i.e., goods and services) |
|  | transactions commodities (services paid under distribution margins) |
|  | institutions (i.e., households, enterprises, government, rest of the country, and rest of the world) |
|  | domestic non-government institutions |
|  | Households |
|  | Investment |
|  | non-government investment |
|  | government investment |
|  | government |
|  | rest of the world |

Table A.3: Variables

|  |  |
| --- | --- |
| **Name** | **Description** |
|  | household consumption expenditure |
|  | consumer price index |
|  | index for domestic producer prices (PDS-based) |
|  | government expenditure |
|  | exchange rate (dom. currency per unit of for. currency) |
|  | government demand scaling factor |
|  | government capital stocks |
|  | marginal propensity to save for dom non-government inst insdng |
|  | savings rate scaling factor |
|  | government net domestic financing |
|  | government net foreign financing |
|  | net foreign financing domestic non-government institution i (FCU) |
|  | output price of activity a |
|  | demand price for commodity c produced and sold domestically |
|  | supply price for comm c produced and sold domestically |
|  | export price for c (domestic currency) |
|  | price of intermediate aggregate |
|  | replacement cost of capital |
|  | import price for c (domestic currency) |
|  | composite commodity price for c |
|  | value-added price for activity a |
|  | producer price for commodity c |
|  | level of activity a |
|  | quantity sold domestically of domestic output c |
|  | quantity of exports for commodity c |
|  | quantity demanded of factor f from activity a |
|  | supply of factor f |
|  | quantity of government demand for commodity c |
|  | quantity consumed of commodity c by household h |
|  | quantity of commodity c as intermediate input to activity a |
|  | quantity of aggregate intermediate input |
|  | quantity of investment demand for commodity c |
|  | volume of gross fixed capital formation by destination |
|  | volume of non-government fixed investment by activity |
|  | quantity of imports of commodity c |
|  | quantity of goods supplied domestically (composite supply) |
|  | RoW tourism demand quantity of comm c |
|  | quantity of trade and transport demand for commodity c |
|  | quantity of aggregate value added |
|  | quantity of domestic output of commodity c |
|  | real government net domestic financing |
|  | government savings |
|  | savings domestic non-government institution i |
|  | foreign savings (foreign currency) |
|  | share for institution *i* in the income of factor *f* |
|  | total factor productivity index |
|  | transfers from dom inst insdng to inst ins |
|  | rate of income tax for household h |
|  | scaling factor for income tax rate |
|  | unemployment rate for factor f |
|  | average price of factor f |
|  | average remuneration of factor f |
|  | wage distortion factor for factor f in activity a |
|  | factor income |
|  | government revenue |
|  | income of (domestic non-government) institution insdng |
|  | income of institution i from factor f |

Table A.4: Latin letter parameters

|  |  |
| --- | --- |
| **Name** | **Description** |
|  | subsistence cons of com *c* for household *h* |
|  | marginal propensity to save for domestic non-government institution *i* |
|  | quantity of government demand for commodity *c* |
|  | volume of gross fixed capital formation by destination |
|  | rate of tax on producer gross output value |
|  | rate of sales tax |
|  | rate of direct tax on factor income |
|  | rate of factor use tax |
|  | export tax rate for commodity c |
|  | import tariff rate for commodity c |
|  | transfers from insp to ins or factor |
|  | share of institution *i* in post-tax post-savings income of institution *i'* |
|  | export price for *c* (foreign currency) |
|  | import price for *c* (foreign currency) |
|  | changes in inventories |
|  | trade and transport input of c per unit of commodity c’ produced and sold domestically |
|  | trade and transport input of c per unit of commodity c’ exported |
|  | trade and transport input of c per unit of commodity c’ imported |
|  | RoW tourism demand quantity of commodity c per tourist |
|  | RoW number of tourists |
|  | RoW tourism demand quantity of commodity c |
|  | exogenous component of sectoral TFP |
|  | intermediate input c per unit of aggregate intermediate |
|  | aggregate value added coefficient for act a |
|  | aggregate intermediate input coefficient for act a |
|  | consumer price index weights |
|  | domestic sales price weights |
|  | quantity of commodity c per unit of investment inv |
|  | depreciation rate for non-government capital |
|  | depreciation rate for government capital |
|  | base-year net foreign financing domestic non-government institution i (FCU) |

Table A.5: Greek letter parameters

|  |  |
| --- | --- |
| **Name** | **Description** |
|  | share parameter for CES activity production fn |
|  | efficiency parameter in the value added production fn for a |
|  | elasticity of substitution between factors |
|  | exponent in the value added production fn for a |
|  | yield of output c per unit of activity a |
|  | marg shr of hhd cons on commodity c |
|  | Armington function shift parameter for commodity c |
|  | elasticity of substitution between dom goods and imports for c |
|  | Armington function exponent for commodity c |
|  | Armington function share parameter for imports commodity c |
|  | Armington function share parameter for domestic commodity c |
|  | CET function shift parameter for commodity c |
|  | elasticity of transformation between dom sales and exports for c |
|  | CET function exponent for commodity c |
|  | CET function share parameter for exports commodity c |
|  | CET function share parameter for domestic commodity c |
|  | constant price elasticity of RoW tourism demand (< 0) |
|  | elasticity of wage with respect to unemployment rate |
|  | sensitivity of the allocation of new capital for f (in FCAPNG) across activities (in A) to current deviations of activity capital rents from the economy-wide average |

## A.2. Equations

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

### Production Function

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

Equations PF3-PF5 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 , where is a “distortion” factor that allows modeling cases in which the factor remuneration differs across activities.[[4]](#footnote-4) 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.[[5]](#footnote-5)

Equation PF6 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 elasticity parameter. In equation PF6, variable refers to the public capital stock in sector *inv* in the base year. In other words, our model assumes that, based on available empirical evidence, that public infrastructure has positive externalities on sectoral TFP. For model calibration, the initial public capital stock can be estimated through alternative methods; for example, based on recent data for public investments.

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).[[6]](#footnote-6)

Equation PF7 computes the production of each product on the basis of the 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.

Equation PF8 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 () is a weighted average of the prices of each of the commodities that is demanded as an intermediate input (equation PF9), with as weights. As we have seen, is the quantity of commodity *c* used as an intermediate input in activity *a* per unit of . The price of each activity is a weighted average of the prices of the commodities it produces (equation PF10).

*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.

Table A.6: Equations for production function

|  |  |  |
| --- | --- | --- |
| PF1 |  |  |
| PF2 |  |  |
| PF3 |  |  |
| PF4 |  |  |
| PF5 |  |  |
| PF6 |  |  |
| PF7 |  |  |
| PF8 |  |  |
| PF9 |  |  |
| PF10 |  |  |
| PF11 |  |  |

### Foreign and Domestic Trade

Equations TW1 and TW2 define domestic prices of exports () and imports (), respectively. It is assumed that the modeled economy is small; thus, world prices for exports and imports are given ( and ; also, see below). The government can collect tariffs on imports and taxes on exports, at rates and , respectively. Besides, the model also considers trade and transport margins applied to exports and imports; i.e., and represent the quantity of trade/transport commodity *ct* per unit of exports and imports of commodity *c*, respectively. Equation TW3 computes the demand price of the domestic product, by adding to its supply price the corresponding trade and transport margin. Thus, parameter 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.

On the consumption side, and following the Armington (1969) assumption, we assume that products are also differentiated based on their country of origin (e.g., Jamaican rum is different from Guatemalan rum). Consequently, it is possible to consider two-way trade (i.e., the same product is exported and imported simultaneously). To model the imperfect substitution between domestic and imported products, we use a CES function (equation TW4).[[7]](#footnote-7) Equation TW5 is the tangency condition that determines the domestic/imported mix of total supply/demand for each product. Equation TW6 computes the supply price of the composite product as a weighted average of the domestic and imported varieties of commodity *c*.

On the production side, production can be sold in the domestic market and/or exported to the rest of the world. In terms of modeling, we use a CET (Constant Elasticity of Transformation) function (equation TW7).[[8]](#footnote-8) Equation TW8 corresponds to the first order conditions of the profit maximization problem solved by the producer. Equation (TW9) is the zero profit condition for the production of commodity *c*, from where price is obtained.

Finally, equation TW10 in this bloc 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.

Table A.7: Equations for trade with rest of the world

|  |  |  |
| --- | --- | --- |
| TW1 |  |  |
| TW2 |  |  |
| TW3 |  |  |
| TW4 |  |  |
| TW5 |  |  |
| TW6 |  |  |
| TW7 |  |  |
| TW8 |  |  |
| TW9 |  |  |
| TW10 |  |  |

### Factor Incomes and Endowments

Equation F1 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 (second term) and the rest of the country (third term). Thus, the model allows capturing the income of household members that commute between the local economy and the rest of the country. Similarly, households in the local economy can receive capital income from investments in the rest of the country. Equation F2 computes the institutional shares in factor incomes as function of the institutional endowments of factors. In turn, equation F3 computes the income received by each institution for being the owner of factor *f*, net of the applicable local and central (direct) taxes on factor income. Equation F4 computes factor supplies by adding the factors endowments of institutions.

Table A.8: Equations for factor incomes and endowments

|  |  |  |
| --- | --- | --- |
| F1 |  |  |
| F2 |  |  |
| F3 |  |  |
| F4 |  |  |

### Institutions

#### Domestic Non-Government Institutions

Equation I1 computes the income of the domestic non-government institution i(insdng) (i.e., households and enterprises) as the sum of two elements: (1) factor income, and (2) transfers from other institutions. Equation I2 defines the marginal propensity to save for the domestic non-government institutions. Initially, variable is equal to one.[[9]](#footnote-9) Equation I3 computes the value of savings for each domestic non-government institution in the model, as a linear function of disposable income. In equation I4, transfers from a domestic non-government institution *i* (e.g., households, enterprises, others) to institution *i*' are modeled as an exogenous share of the income of institution *i* net of savings and direct taxes. Equation I5 computes the consumption spending by households as their income net of transfers to other institutions, savings, and direct taxes. Household consumption expenditure is distributed across commodities according to a Stone-Geary utility function, from which a linear expenditure system is derived (equation I6).

Table A.9: Equations for domestic non-government institutions

|  |  |  |
| --- | --- | --- |
| I1 |  |  |
| I2 |  |  |
| I3 |  |  |
| I4 |  |  |
| I5 |  |  |
| I6 |  |  |

#### Government

Equation G1 computes the income tax rate, as the product of an exogenous component () and a scaling factor (). Equation G2 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 domestic currency. Equation G3 computes the government consumption of commodity *c*. It is assumed that the commodity composition of government consumption is fixed at its initial values. Initially, variable is equal to one. The government uses its income to provide goods and services and make transfers to other institutions (equation G4). Equation G5 computes government surplus as the difference between current income () and total spending, which in turn results from the addition of recurrent () and capital spending . Equation G6 defines government deficit as the negative of government surplus. Equation G7 is the government capital account, which shows how the government finances its deficit. Finally, equation G8 defines real net domestic financing.

Table A.10: Equations for government

|  |  |  |
| --- | --- | --- |
| G1 |  |  |
| G2 |  |  |
| G3 |  |  |
| G4 |  |  |
| G5 |  |  |
| G6 |  |  |
| G7 |  |  |
| G8 |  |  |

#### Tourists

Equations T2 and T2 show alternative demand functions used to model tourism export demand from the rest of the world. In T1, tourism demand is modeled as an exogenous volume. In T2, tourism demand is modeled through a constant elasticity of demand function. In the latter case, the modeled economy 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. In equation T2, foreign tourists’ demand is a function of domestic (tourism-related) prices relative to the exchange rate .

Table A.11: Equations for tourism demand

|  |  |  |
| --- | --- | --- |
| T1 |  |  |
| T2 |  |  |

### Equilibrium Conditions

Equation E1 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 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, both developed and developing. 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. Equation E2 is the equilibrium condition in the market for factor *f*.

Equation E3 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, changes in inventories, and consumption by domestic and foreign tourists.

Equation E4 is the savings-investment balance; four 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 rest of the world is represented through the current account of the balance of payments, expressed in foreign currency (equation E5). 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 E7 computes the investment demand of commodity *c*. It is assumed that the commodity composition of investment is exogenous – see parameter . Thus, if there is an increase in investment, investment demand for all goods and services will increase in the same proportion.[[10]](#footnote-10)

Equation E8 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).

Table A.12: Equilibrium conditions

|  |  |  |
| --- | --- | --- |
| E1 |  |  |
| E2 |  |  |
| E3 |  |  |
| E4 |  |  |
|  |  |  |
|  |  |  |
| E5 |  |  |
|  |  |  |
|  |  |  |
| E8 |  |  |

### 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 private investment in the accommodation industry. Naturally, investment in each period increases the capital stock available in the next period. Next, 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 D1 computes the price of one unit of capital, both private and public; the new capital is assembled using fixed coefficient production function. Equation D2 computes the average capital rate of return, as the ratio between total capital income and total capital stock. Equation D3 computes the share of each activity in the new capital stock, following the explanation on the previous paragraph. The parameter, which varies between zero and one, measures the degree of capital mobility among productive sectors. When is zero, investment is distributed among sectors only based on the initial share of each sector in the total capital stock. When is positive, investment is distributed among sectors also based on the relative capital returns. Equations D4 and D5 show how sectoral private and public capital stocks are updated, respectively. Finally, equation D6 compute the nominal government investment.

*Table A.13: Dynamics; investment by destination*

|  |  |  |
| --- | --- | --- |
| D1 |  |  |
| D2 |  |  |
| D3 |  |  |
| D4 |  |  |
| D5 |  |  |
| D6 |  |  |

1. The government primary deficit is defined as spending on consumption, investment, and domestic transfers minus taxes and transfers from abroad. This deficit is covered by domestic and foreign net financing. [↑](#footnote-ref-1)
2. In addition, note that the model allows for the identification of one or more tourism demand modalities. [↑](#footnote-ref-2)
3. See Pyatt and Round (1985) or King (1981) for a more detailed introduction to SAM construction and interpretation. [↑](#footnote-ref-3)
4. 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. [↑](#footnote-ref-4)
5. Besides, for the factors considered as specific, equation (PF4) is interpreted as an equilibrium condition between factor supply and demand. [↑](#footnote-ref-5)
6. Note that, unlike the $ica\_{c,a}$ parameters, the Leontief technical coefficients are expressed as share of output. [↑](#footnote-ref-6)
7. The elasticity of substitution between domestic purchases and imports is $σ\_{c}^{q}={1}/{\left(1+ρ\_{c}^{q}\right)}$. [↑](#footnote-ref-7)
8. The elasticity of transformation between domestic sales and exports is $σ\_{c}^{x}={1}/{\left(ρ\_{c}^{x}-1\right)}$. [↑](#footnote-ref-8)
9. Besides, in this presentation it is assumed that $MPSADJ\_{t}$ is an exogenous variable. [↑](#footnote-ref-9)
10. This presentation assumes that investment is considered as an endogenous variable; see below the discussion of macroeconomic closure rule. [↑](#footnote-ref-10)