Analysing the Impacts of Closure of a Military Base Using a Dynamic CGE Model

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RESUMO/ABSTRACT

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Military bases are commonplace in many countries and may have a significant impact in the communities where they are integrated. Impacts of military bases have been analysed through different perspectives. Our aim is to analyse their economic impact. The importance of military bases has become a topic of discussion particularly when base closures or base activity reductions are under consideration. In a previous paper the authors looked at the issue using a static CGE model applied to the analysis of the economic impact of a US base located in the island of Terceira in the Azores. In the current paper a dynamic model is used to study the same issue, using more recent data and disaggregating the impact among different household categories.

A base closure scenario is created and the impacts traced through various economic indicators. It is concluded that GDP falls, relative to the base scenario for a number of years recovering after some time, assuming that worsened trade balances are compensated by other transfers. This fall is prompted by a fall in employment, personal income and consumption. The model also predicts that the impact hurts different household income groups with diverse intensity. Lower income households are hurt more in relative terms but generate a smaller absolute impact. With time, the negative impact tapers off for most income groups except for the lowest which keeps on loosing more until the end of the simulation period.

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1. Introduction

Military bases are commonplace in many countries and may have a significant impact in the communities where they are integrated. Impacts of military bases have been analysed through different perspectives. Our aim is to analyse their economic impact. The importance of military bases has become a topic of discussion particularly when base closures or base activity reductions are under consideration. In a previous , Bayar, et al (2007) looked at the issue using a static CGE model applied to the analysis of the economic impact of a US base located in the island of Terceira in the Azores.

The model used was a standard static CGE model calibrated using a SAM constructed with 1998 data, with sixteen sectors. Based on that data it was found that closure of the base would represent a fall of 0,89% of GDP, a fall in equivalent variation of 27,9 million euros and a fall in employment of about 1,2% of an active population of around 100 thousand.

In the current paper a dynamic model is used to study the same issue, using more recent data (2001) and disaggregating the impact among different household categories, different government levels and different trade blocks.

Discussions over the importance and the impact of the base for the local economy are recurrent in an attempt, on the part of the participants, to advance arguments in favour or against its presence. The current paper tries to contribute with a quantification of the economic impact of the base using a dynamic CGE model of the Azorean economy.

A closure scenario is created and the impacts traced through various economic indicators including some household detail.

Hoffmann, et al (1996) analyze the impact of defense cuts on the economy in California using a computable general equilibrium (CGE) model. Their focus is on the migration of factors from California to other states and the impact of this migration on the economy. CGE models are better suited to analyze the economy wide impact of these defense cuts and their study shows that the impacts are highly sensitive to the assumption of inter-state mobility.

Other studies have taken a less elaborate approach looking mostly at lost direct expenditures and jobs on an accounting approach and looking other social and environmental impacts.
In what follows section 2 presents the main variables that characterize the impact of the base on the local economy. Section 3 reviews the main characteristics of a dynamic CGE model of the Azores. Section 4 reviews the results of calibration of the model and the results of the closure scenario developed. Section 5 presents some of the main conclusions that can be drawn from application of the model.

2. The Military Base in Terceira/Azores

The base in Terceira/Azores houses both US and Portuguese military activities. It comprises an airport adequate for landing any known type of aircraft, fuel storage tanks and port facilities. This base has been extensively used in various international conflicts, namely those that have occurred in the last half century and in the Middle East during recent times.

The impact of the American component of the base can be simulated by the model using data on the main variables. In the simulation undertaken here the relevant data collected characterizes expenditures on construction works and repair, employment and private consumption by the US military, servicemen and civilians.

Access of locals to purchases in the base’s stores can also be taken into consideration. It is common for some locals to make their purchases in the base stores at prices that are lower than those practiced in the local stores, for a wider variety of products. There are no good estimates for the total value of the purchases made in these stores, which is equivalent to purchasing the goods abroad. Given that there are no good estimates of the values involved, two scenarios will be created to test the impact of these “imports”: one where the import effect is zero, the reference scenario and one in which 50% of the income is spent on these “foreign” stores.

The main elements of the data on the activity of the US military are summarized in tables 1 and 2. Table 1 provides an estimate of the value (in US Dollars) of the construction works and repair commissioned by the Lajes Field Base for 2004 and for 2005.
Table 1 Construction works and repair commissioned by the Lajes Field base

<table>
<thead>
<tr>
<th>Projects</th>
<th>US$</th>
<th>US$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2004</td>
<td>2005</td>
</tr>
<tr>
<td>Repair breakwater</td>
<td>14.400.000</td>
<td>7.000.000</td>
</tr>
<tr>
<td>Construct housing, phase 3</td>
<td>13.392.000</td>
<td>0</td>
</tr>
<tr>
<td>Add/renovate fitness center</td>
<td>4.086.000</td>
<td>5.689.000</td>
</tr>
<tr>
<td>Community Improvements</td>
<td>3.865.644</td>
<td>7.644.000</td>
</tr>
<tr>
<td>Airfield improvements</td>
<td>407.592</td>
<td>150.000</td>
</tr>
<tr>
<td>Housing improvements</td>
<td>833.241</td>
<td>663.550</td>
</tr>
<tr>
<td>Fuel System improvements</td>
<td>556.046</td>
<td>4.010.000</td>
</tr>
<tr>
<td>DoDDS improvements</td>
<td>568.117</td>
<td>615.000</td>
</tr>
<tr>
<td></td>
<td>38.110.644</td>
<td>25.771.550</td>
</tr>
</tbody>
</table>

Source: U.S. Air force

An evaluation of the local consumption expenditure by the US base staff in the Azores is given in Table 2.

To estimate the local impact of the Lajes Field Base it is assumed that 30 per cent of the payroll of active duty personnel living on base is spent outside the base. For the active duty personnel living off base this figure is estimated at 50 per cent, and for US civilians living outside the base it is assumed at 55%. For the Portuguese civilians working on base, it is assumed that 100 per cent of their income is spent off base. This means that the total money impact amounts to about USD35 million.

Table 2 Annual payroll and estimates regarding the loss in terms of private consumption

<table>
<thead>
<tr>
<th></th>
<th>Annual Payroll</th>
<th>Impact Factor</th>
<th>Local Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2004</td>
<td>2005</td>
<td>2004</td>
</tr>
<tr>
<td>Reference Scenario</td>
<td>57,509,059</td>
<td>61,247,015</td>
<td>34,710,940</td>
</tr>
<tr>
<td>Active duty on base</td>
<td>19,814,147</td>
<td>19,287,261</td>
<td>0.30</td>
</tr>
<tr>
<td>Active duty off base</td>
<td>13,209,431</td>
<td>12,858,174</td>
<td>0.50</td>
</tr>
<tr>
<td>US civilians</td>
<td>5,163,335</td>
<td>8,900,109</td>
<td>0.55</td>
</tr>
<tr>
<td>Portuguese civilians</td>
<td>19,322,146</td>
<td>20,201,471</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Source: U.S. Air force

The closure of the US component of the Lajes Field base would have direct and indirect impacts on the economy of the Azores through the following channels:

- The reduction in the demand for construction works and repair;
- The employment loss of the Portuguese civilians working on the base, which leads to a loss in the labour income and consumption demand both domestic and foreign, namely the demand of goods from the base’s stores;
- The loss in the consumption demand from the US active duty personnel living on base and off base;
- The loss of the rents of local lodging contracted quarters.

The original impact comes through a reduction in the purchases of goods and services in the local market, equivalent to a reduction of exports to the US.
3. The Model

The current version of the modelling platform of the Azores economy was first presented in Bayar, et. al (2007b). For this reason, only the main characteristics of the model will be presented here. All derived equations of the model are presented in the annex to the current paper as are lists of relevant variables and parameters.

It is a dynamic multi-sectoral computable general equilibrium model (CGE), which incorporates the economic behaviour of six economic agents: firms, households, regional government, Mainland government, European Commission and the external sector.

The goods-producing sectors, consisting of both public and private enterprises, are disaggregated into 45 branches of activity. Households are divided into six income groups, to analyze the distributional effects of various policy measures. Special attention is paid to the economic links between the regional government, the Mainland government and the European Commission. With regard to the rest of the world the economy is treated as a small open economy with no influence on (given) world market prices. Trade relations are differentiated according to four main trade partners: Mainland, EU, US and the rest of the world. The behaviour of each agent in the model is described in detail below.

The model has been solved by using the general algebraic modelling system GAMS (Rosenthal, 2006).

3. Firms

Producers are assumed to operate in 45 perfectly competitive markets, corresponding to an equal number of branches as listed in Table 1, and maximize profits (or minimize costs for each level of output) to determine the optimal levels of inputs and output. Furthermore, production prices equal average and marginal costs, a condition implied by profit maximization for constant returns to scale technology.

The level of production for each branch of activity is determined from a nested production structure (see Figure 1). In the first stage, producers are assumed to choose between intermediate inputs and value-added according to a Leontief production
function. In the second stage, the optimal mix between capital and labour is given by another optimization process, where substitution possibilities between capital and labour are represented by a constant elasticity of substitution (CES) function. Firms’ costs related to corporate income tax and social security contributions are also taken into account in the optimization process.

Value-added is related to domestic production by branch through a Leontief production function, which assumes an optimal allocation of inputs.

Similarly, total intermediate inputs used by industry depend on domestic demand according to fixed coefficients.

Thus, domestic production are valued at basic prices net of taxes but including direct subsidies on production from the regional government and direct subsidies on production from the European Agricultural Guidance and Guarantee Fund (EAGGF), from the Financial Instrument for Fisheries Guidance (FIFG), from the European Regional Development Fund (ERDF), from the European Social Fund (ESF) and from US, is given by the sum of value-added for each branch valued at basic prices and intermediate commodities used by each sector valued at the price of the commodities, less subsidies on intermediate consumption but including the trade and transport margins and value-added taxes on intermediate consumption.

Value-added is a CES aggregation of capital and labour.
Table 1: Activity and commodity desegregation in AzorMod
| 1 | Agriculture, hunting and forestry, logging |
| 2 | Fishing |
| 3 | Mining and quarrying |
| 4 | Production of meat and meat products |
| 5 | Processing of fish and fish products |
| 6 | Manufacture of dairy products |
| 7 | Prepared animal feeds |
| 8 | Beverages & tobacco products |
| 9 | Fruits, vegetables, animal oils, grain mill, starches |
| 10 | Textiles and leather |
| 11 | Wood and products of wood and cork |
| 12 | Pulp, paper products; publishing and printing |
| 13 | Coke, refined petroleum products and nuclear fuel |
| 14 | Chemicals and chemical products |
| 15 | Rubber and plastic products |
| 16 | Other non-metallic mineral products |
| 17 | Basic metals and fabricated metal products |
| 18 | Machinery and equipment n.e.c. |
| 19 | Electrical and optical equipment |
| 20 | Transport equipment |
| 21 | Manufacturing n.e.c. |
| 22 | Electricity, gas, steam and hot water supply |
| 23 | Collection, purification and distribution of water |
| 24 | Construction |
| 25 | Sale, maintenance, repair of motor vehicles and motorcycles |
| 26 | Wholesale trade and commission trade, except of motor vehicles and motorcycles |
| 27 | Retail trade, except of motor vehicles and motorcycles |
| 28 | Hotels and restaurants |
| 29 | Land transport; transport via pipelines |
| 30 | Water transport |
| 31 | Air transport |
| 32 | Supporting transport activities; activities of travel agencies |
| 33 | Post and telecommunications |
| 34 | Financial intermediation, excluding insurance and pension funding |
| 35 | Insurance and pension funding, except compulsory social security |
| 36 | Activities auxiliary to financial intermediation |
| 37 | Real estate activities |
| 38 | Renting of machinery and equipment without operator |
| 39 | Computer and related activities; research and development |
| 40 | Other business activities |
| 41 | Public administration and defence; compulsory social security |
| 42 | Education |
| 43 | Health and social work |
| 44 | Other community, social and personal service activities |
| 45 | Activities of households as employers of domestic staff |
Capital is industry specific, introducing rigidities in the capital market. The inter-sectoral wage differential is a parameter derived as the ratio between the wage by branch and the national average wage (Dervis, De Melo and Robinson, 1982). Holding the inter-sectoral wage differentials constant in counterfactual policy simulations introduces rigidities in the labour market.

Each branch of activity in AzorMod produces several types of goods and services. The optimal allocation of domestic production between the different types of commodities is given by a Leontief function.

4. Households

Households are split into six income groups, the first group being the poorest one. The representative household in each income group receives a part of the capital income (net operating surplus), a part of the labour income, unemployment benefits from the Mainland government and other net transfers from the regional and Mainland governments. The representative household in each income group pays income taxes and saves a share of the net income.

Household propensity to save reacts to changes in the after-tax average return to capital.

The disposable budget for consumption is allocated between different goods and services according to a Stone-Geary utility function.

In the allocation process, the consumer first decides on the minimum (subsistence) level of consumption of commodity. Then, the marginal income is allocated between different types of commodities according to the marginal budget shares. A schematic representation of households’ decisions, by income group, is given in Figure 2.

Household welfare gains/losses are valued using the equivalent variation in income, which is based on the concept of a money metric indirect utility function (Varian, 1992).

Equivalent variation measures the income needed to make the household as well off as she is in the new counter-factual equilibrium (policy scenario) evaluated at benchmark prices. Thus, the equivalent variation is positive for welfare gains from the policy scenario and negative for losses.
5. Regional government

Regional government collects all the taxes, such as: taxes on income and wealth and taxes on products and on production and receives transfers from the Mainland government, EU funds and transfers from the external sector (see Figure 3):

In the derivation of each category of tax revenue the tax rate is applied to the corresponding tax base.
Taxes on products are differentiated in the model according to the category of consumption on which they apply: intermediate consumption, private consumption, and gross capital formation.

The total transfers received by the regional government are given by transfers from the Mainland government, transfers from EU as direct subsidies on production and other transfers from EU, transfers from US and transfers from the rest of the world.

Regional government expenditures comprise the public current consumption, total transfers by the government and subsidies on products and on production.

The optimal allocation of the public current consumption between different types of goods and services is given by the maximization of a Cobb-Douglas function, subject to the budget constraint.

The maximization of the utility function yields the demand equations for public current consumption by type of commodity.

Total transfers by the regional government include transfers to the households.

The difference between the regional government revenues and the government expenditures yields the government savings, which are set to zero in all cases to reflect the fact that the regional government is not allowed to incur new debt.

6. Mainland government

Mainland government collects all the social security contributions, provides unemployment benefits and makes transfers to the households and to the regional government.

Social security contributions are derived by applying the social contributions rate to gross wages. Unemployment benefits received by each household income group are determined by the combination of the replacement rate, the national average wage, the total number of unemployed, and the share of unemployed subject to unemployment benefits in each household income group.

7. European Commission

European Commission provides EU funds as direct subsidies to the production sectors and other EU funds to the regional government.
8. Foreign trade

The specification of the foreign trade is based on the small-country assumption, which means that the country is a price taker in both its import and its export markets. Four different trade partners are distinguished in the model: Mainland, EU, US and the rest of the world.

On the import side, imperfect substitution is assumed between domestically produced and imported goods, according to the Armington function (see Figure 4). Thus, domestic consumers use composite goods of imported and domestically produced goods, according to a CES function.

Balance of payments, expressed in foreign currency, takes into account all the trade and capital flows and is differentiated according to each trade partner.

Figure 4. Foreign trade specification
9. Investment demand

Total savings, used to buy investment goods, are given by the sum of savings from the different agents and the trade partners.

Total investments in real terms are given by the difference between savings and inventories.

The optimal allocation of total investments between different types of investment commodities is given by the Leontief function.

The composite price (unit cost) of investments is defined as the weighted average of the price of investment goods.

10. Price equations

A common assumption for CGE models, which has also been adopted here, is that the economy is initially in equilibrium with the quantities normalized in such a way that prices of commodities equal unity. Due to the homogeneity of degree zero in prices, the model only determines the relative prices. Therefore, a particular price is selected to provide the numeraire against which all relative prices in the model will be measured. We choose the GDP deflator as the numeraire.

Different prices are defined for all the branches, exports and imports. As already explained, trade and transport margins are paid on all categories of demand in AzorMod except the government consumption (on intermediate consumption, on private consumption and on investment goods).

The domestic price of imports from Mainland is determined by the price of imports from Mainland expressed in foreign currency and the exchange rate.

Similarly, the domestic price of imports from EU is given by the price of imports from EU expressed in foreign currency and the corresponding exchange rate.

The domestic price of imports from US and from ROW, further include the tariff rate on each commodity for imports from US and the tariff rate on imports from ROW.
The consumer price index \((PCINDEX)\) used in the model is defined as:

\[
PCINDEX = \sum_{c,qu} \sum_{ctm,c,qu} \left\{ \frac{P + \sum_{ctm,c,qu} tchtm \cdot P_{ctm} \cdot (1 + texc \cdot (1 + tc + vatc) \cdot CZ)}{\sum_{c,qu} \sum_{ctm,c,qu} \left[ P_{ctm} + \sum_{ctm,c,qu} tchtmz \cdot P_{ctm} \cdot (1 + texcz \cdot (1 + tcz + vatcz) \cdot CZ) \right]} \right\}
\]

where \(P_c\) is the price index of commodity \(c\) net of taxes and \(P_{Z_c}\) gives its benchmark level, \(tchtm\) represents the trade and transport margin rate on private consumption and \(tchtmz\) is its benchmark level, \(texc\) gives the excise duties rate and \(texcz\) its benchmark level, \(vatc\) provides the value-added tax rate and \(vatcz\) its benchmark level and \(tc\) gives the tax rate corresponding to other taxes on private consumption, while \(tcz\) is its benchmark level. Finally, \(CZ\) accounts for the benchmark level of private consumption of commodity \(c\) by income group \(qu\).

Consumer prices \((PCT_{c,qu})\) are further defined as:

\[
PCT_{c,qu} = \left( P + \sum_{ctm,c,qu} tchtm \cdot P_{ctm} \cdot (1 + texc \cdot (1 + tc + vatc) \cdot CZ) \right)
\]

11. Labour market

The following identity defines the relation between the labour supply, the labour demand, and unemployment:

\[
\sum_{s} LSK_s = LSR - UNEMP
\]

where \(LSK_s\) stands for the number of employees in industry \(s\), \(UNEMP\) represents the number of unemployed and \(LSR\) reflects the active population.

The responsiveness of real wage to the labour market conditions is surprised by a wage curve (Sanz-de-Galdeano & Turunen, 2006):

\[
\log(PL/PCINDEX) = elasU \cdot \log(UNRATE) + err
\]

where \(PL\) is the nominal average wage corresponding to national employment (net of social security contributions), \(PCINDEX\) is the consumer price index, \(UNRATE\) provides the unemployment rate, \(err\) is the error term and \(elasU\) is the unemployment elasticity.

The labour supply is provided by the following equation:

\[
LSR = LSRI \cdot \{ [PL \cdot (1 - tyavr) \cdot PCINDEXZ] / [PLZ \cdot (1 - tyavrz) \cdot PCINDEX] \}^{elasL}
\]
where \( LSRI \) is the benchmark level corresponding to the active population, \( tyavr \) is the average personal income tax rate and \( tyavr_z \) its benchmark level, and \( PLZ \) and \( PCINDEXZ \) are the benchmark levels corresponding to the nominal national wage and CPI, respectively. \( elasLS \) further provides the elasticity of labour supply.

The average personal income tax rate is determined as:

\[
tyavr = \frac{\sum_{qu} (ty_{avr, qu} \cdot YH_{qu})}{\sum_{qu} YH_{qu}}
\]

where \( ty_{avr, qu} \) stands for the personal income tax rate levied on the household income group \( qu \) and \( YH_{qu} \) gives the total income of the household income group \( qu \).

The national employment \((EMPN)\) is defined as:

\[EMPN = LSRI - UNEMP\]

The national average wage including social security contributions \((PLAVRT)\) is determined as:

\[PLAVRT \cdot (LSR - UNEMP) = \sum_s \{ PL \cdot (1 + tl_s / (1 - tl_s)) \cdot (1 + prem_{LSK_s}) \cdot LSK_s \}
\]

where \( PL \) is the national average wage, \( prem_{LSK_s} \) gives the wage premium is sector \( s \) and \( tl_s \) provides the social contributions rate in sector \( s \).

12. Market clearing equations

The equilibrium in the product, capital and labour markets requires that demand equals supply at prevailing prices (taking into account unemployment for the labour market). Labour market clearing equation has already been presented above. Capital stock is sector specific, such that the equality between capital demand and supply determines the return to capital by branch of activity.

Separate market clearing equations are distinguished in the model for each commodity. For the trade and transport services, the sum of demand for intermediate consumption of each commodity, the private demand for each commodity, the public demand for each commodity the demand for investment goods, the demand for inventories and the demand for trade and transport services which are invoiced separately (trade and transport margins)
should be equal with the total supply of each commodity from imports and domestic production:

The demand for trade and transport services, invoiced separately (Löfgren, Harris and Robinson, 2002), is further derived as the sum of demand for trade and transport services on private consumption, of demand for trade and transport services on investment goods and of demand for trade and transport services on intermediate consumption.

The demand for inventories for each commodity is defined as a fixed share of domestic sales.

13. Incorporation of dynamics

AzorMod has a recursive dynamic structure composed of a sequence of several temporary equilibria. The first equilibrium in the sequence is given by the benchmark year. In each time period, the model is solved for an equilibrium given the exogenous conditions assumed for that particular period. The equilibria are connected to each other through capital accumulation. Thus, the endogenous determination of investment behaviour is essential for the dynamic part of the model. Investment and capital accumulation in year \( t \) depend on expected rates of return for year \( t+1 \), which are determined by actual returns on capital in year \( t \).

The normal rate of return to capital in each branch is specified as an inverse logistic function (see Figure 5) of the proportionate growth in sector’s \( s \) capital stock (Dixon and Rimmer, 2002).

The minimum possible growth rate is set at the negative of the rate of depreciation in each branch. This condition implies that investments in each branch of activity have positive values, such that once installed, capital cannot be shifted from one sector to another except for the gradual process of depreciation. The maximum possible growth rate of capital stock in industry is constrained in order to avoid unrealistically large simulated growth rates (Dixon and Rimmer, 2002). In the current version the limit is taken equal to 6 per cent for all the branches. For example, if the historically normal growth rate in an industry is 4 per cent, the upper limit in any year \( t \) would not exceed 10 per cent.
The model is solved dynamically with annual steps. The simulation horizon of the model has been set at 13 years.

14. Closure rules

The closure rules refer to the manner in which demand and supply of commodities, the macroeconomic identities and the factor markets are equilibrated ex-post. Due to the complexity of the model, a combination of closure rules is needed. The particular set of closure rules should also be consistent, to the largest extent possible, with the institutional structure of the economy and with the purpose of the model.

In mathematical terms, the model should consist of an equal number of independent equations and endogenous variables. The closure rules reflect the choice of the model.
builder of which variables are exogenous and which variables are endogenous, so as to achieve ex-post equality.

Three macro balances are usually identified in CGE models that can be a potential source of ex-ante disequilibria and must be reconciled ex-post (Adelman and Robinson, 1989):

- The savings-investment balance;
- The government balance;
- The external balance.

The most widely used macro closure rule for CGE models is based on the investment and savings balance. In the model, the investment is assumed to adjust to the available domestic and foreign savings. This reflects an economy in which savings form a binding constraint.

Additional assumptions are needed with regard to regional government behaviour in AzorMod. First, regional government savings are fixed in real terms while regional government total current consumption adjusts to achieve the target set with respect to the government savings. The allocation between the consumption of different goods and services is provided by a Cobb-Douglas function. Secondly, the transfers received by the regional government from the Mainland government, from the EU, from the US and from the ROW are fixed in real terms. On the expenditure side, the regional government transfers to the households are also fixed in real terms.

For the external balance, the exchange rates are kept unchanged in the simulations, while the balances of the current accounts adjust. An alternative closure is also possible where the balances of the current accounts corresponding to US and ROW are set while the real exchange rates adjust.

The setup of the closure rules is important in determining the mechanisms governing the model. Therefore, the closure rules should be established also taking into account the policy scenario in question.

According to Walras’ law if \((n-1)\) markets are cleared the \(n\)th one is cleared as well. Therefore, in order to avoid over-determination of the model, the current account balance with respect to ROW is dropped. However, the system of equations guarantees, through Walras’ law, that the total imports from ROW less the total exports to ROW and the transfers from ROW equals the current account balance.
4. Calibration of the Model and Simulation of Tax Changes

The model was calibrated using a SAM matrix constructed for the year 2001 for the Azorean economy.

The scenario created, seeks to analyse the impact of the US base in the Azores in the economic activity of this region. This is achieved by assuming that the American component of the base activity is reduced to zero. This implies a direct decline of expenditures in the local economy, a direct loss of about 900 jobs and the absence of about 3,000 foreigners that are associated to the base.

The scenario can be set up in different ways. We consider here a decrease in current account balance in trade with the US. Basically we assume that reduction of activity in the base leads to less sales of Azorean products and services.

As expected, this has a negative impact on most indicators including GDP, private consumption and private GDP. Table 1 shows some of the results.

Table 1: Aggregate Impacts of a Decrease in the US Base Activity

<table>
<thead>
<tr>
<th>Macroeconomic effects in real terms (% change to the BAU)</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>-0.44</td>
<td>-0.39</td>
<td>-0.33</td>
<td>-0.28</td>
<td>-0.22</td>
<td>-0.17</td>
<td>-0.12</td>
<td>-0.06</td>
<td>-0.01</td>
<td>0.05</td>
<td>0.10</td>
<td>0.16</td>
</tr>
<tr>
<td>Private consumption</td>
<td>-1.79</td>
<td>-1.72</td>
<td>-1.66</td>
<td>-1.59</td>
<td>-1.53</td>
<td>-1.46</td>
<td>-1.40</td>
<td>-1.33</td>
<td>-1.27</td>
<td>-1.20</td>
<td>-1.14</td>
<td>-1.07</td>
</tr>
<tr>
<td>Government consumption</td>
<td>-0.32</td>
<td>-0.33</td>
<td>-0.34</td>
<td>-0.35</td>
<td>-0.36</td>
<td>-0.36</td>
<td>-0.37</td>
<td>-0.38</td>
<td>-0.39</td>
<td>-0.40</td>
<td>-0.41</td>
<td>-0.42</td>
</tr>
<tr>
<td>Gross fixed investment</td>
<td>3.09</td>
<td>3.20</td>
<td>3.32</td>
<td>3.44</td>
<td>3.56</td>
<td>3.68</td>
<td>3.81</td>
<td>3.94</td>
<td>4.08</td>
<td>4.21</td>
<td>4.35</td>
<td>4.48</td>
</tr>
<tr>
<td>Foreign balance</td>
<td>0.54</td>
<td>0.61</td>
<td>0.69</td>
<td>0.77</td>
<td>0.85</td>
<td>0.93</td>
<td>1.02</td>
<td>1.10</td>
<td>1.19</td>
<td>1.28</td>
<td>1.37</td>
<td>1.46</td>
</tr>
<tr>
<td>Exports</td>
<td>-1.49</td>
<td>-1.48</td>
<td>-1.46</td>
<td>-1.44</td>
<td>-1.42</td>
<td>-1.40</td>
<td>-1.37</td>
<td>-1.35</td>
<td>-1.32</td>
<td>-1.29</td>
<td>-1.25</td>
<td>-1.22</td>
</tr>
<tr>
<td>Imports</td>
<td>-0.23</td>
<td>-0.18</td>
<td>-0.13</td>
<td>-0.07</td>
<td>-0.01</td>
<td>0.05</td>
<td>0.11</td>
<td>0.18</td>
<td>0.24</td>
<td>0.31</td>
<td>0.38</td>
<td>0.45</td>
</tr>
<tr>
<td>Private GDP</td>
<td>-0.50</td>
<td>-0.42</td>
<td>-0.33</td>
<td>-0.24</td>
<td>-0.15</td>
<td>-0.07</td>
<td>0.02</td>
<td>0.11</td>
<td>0.20</td>
<td>0.29</td>
<td>0.38</td>
<td>0.47</td>
</tr>
</tbody>
</table>

The impact on the labour market is also consistent with the previous results. Employment falls, unemployment rises and the active population falls. These negative impacts taper off over time as the excess labour is gradually reintegrated in the market.

Table 2: Labour Market Impacts of a Decrease in the US Base Activity

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>National employment</td>
<td>-0.10</td>
<td>-0.08</td>
<td>-0.05</td>
<td>-0.03</td>
<td>0.00</td>
<td>0.02</td>
<td>0.05</td>
<td>0.07</td>
<td>0.10</td>
<td>0.12</td>
<td>0.15</td>
<td>0.17</td>
</tr>
<tr>
<td>Number of unemployed</td>
<td>2.33</td>
<td>1.74</td>
<td>1.18</td>
<td>0.61</td>
<td>0.05</td>
<td>-0.51</td>
<td>-1.07</td>
<td>-1.63</td>
<td>-2.20</td>
<td>-2.77</td>
<td>-3.34</td>
<td>-3.92</td>
</tr>
<tr>
<td>Active population</td>
<td>-0.05</td>
<td>-0.04</td>
<td>-0.02</td>
<td>-0.01</td>
<td>0.00</td>
<td>0.01</td>
<td>0.02</td>
<td>0.03</td>
<td>0.05</td>
<td>0.06</td>
<td>0.07</td>
<td>0.08</td>
</tr>
<tr>
<td>Unemployment rate (%)</td>
<td>2.27</td>
<td>2.25</td>
<td>2.24</td>
<td>2.23</td>
<td>2.21</td>
<td>2.20</td>
<td>2.19</td>
<td>2.18</td>
<td>2.16</td>
<td>2.15</td>
<td>2.14</td>
<td>2.12</td>
</tr>
<tr>
<td>Unemployment rate (% points difference with BAU)</td>
<td>0.05</td>
<td>0.04</td>
<td>0.03</td>
<td>0.01</td>
<td>0.00</td>
<td>-0.01</td>
<td>-0.02</td>
<td>-0.04</td>
<td>-0.05</td>
<td>-0.06</td>
<td>-0.08</td>
<td>-0.09</td>
</tr>
</tbody>
</table>
To assess the redistributive impact of the policy we can look at what it implied for the different household categories considered. Overall, real income, real consumption and equivalent variation decreased due to a decrease in employment and expenditure. The negative impacts taper on these indicators but remain negative for the full period. Tables 3, 4 and 5 show the results.

### Table 3: Household Income Impacts of Decrease in the US Base Activity

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HH1</td>
<td>-5.03</td>
<td>-4.90</td>
<td>-4.77</td>
<td>-4.65</td>
<td>-4.53</td>
<td>-4.41</td>
<td>-4.29</td>
<td>-4.17</td>
<td>-4.06</td>
<td>-3.95</td>
<td>-3.84</td>
<td>-3.74</td>
</tr>
<tr>
<td>HH2</td>
<td>-3.50</td>
<td>-3.40</td>
<td>-3.30</td>
<td>-3.21</td>
<td>-3.11</td>
<td>-3.02</td>
<td>-2.93</td>
<td>-2.84</td>
<td>-2.75</td>
<td>-2.66</td>
<td>-2.57</td>
<td>-2.49</td>
</tr>
<tr>
<td>HH3</td>
<td>-2.47</td>
<td>-2.40</td>
<td>-2.33</td>
<td>-2.27</td>
<td>-2.20</td>
<td>-2.13</td>
<td>-2.07</td>
<td>-2.00</td>
<td>-1.94</td>
<td>-1.87</td>
<td>-1.81</td>
<td>-1.74</td>
</tr>
<tr>
<td>HH4</td>
<td>-1.94</td>
<td>-1.88</td>
<td>-1.82</td>
<td>-1.76</td>
<td>-1.71</td>
<td>-1.65</td>
<td>-1.59</td>
<td>-1.53</td>
<td>-1.47</td>
<td>-1.41</td>
<td>-1.35</td>
<td>-1.29</td>
</tr>
<tr>
<td>HH5</td>
<td>-1.67</td>
<td>-1.63</td>
<td>-1.58</td>
<td>-1.53</td>
<td>-1.48</td>
<td>-1.43</td>
<td>-1.39</td>
<td>-1.34</td>
<td>-1.29</td>
<td>-1.24</td>
<td>-1.19</td>
<td>-1.14</td>
</tr>
<tr>
<td>HH6</td>
<td>-1.43</td>
<td>-1.39</td>
<td>-1.36</td>
<td>-1.32</td>
<td>-1.29</td>
<td>-1.25</td>
<td>-1.21</td>
<td>-1.18</td>
<td>-1.14</td>
<td>-1.10</td>
<td>-1.07</td>
<td>-1.03</td>
</tr>
</tbody>
</table>

In relative terms, lower income groups tend to bear a greater burden of the reduction in economic activity. This can be assessed through the relative fall on income and on consumption.

In absolute terms, the effect on equivalent variation provides a greater negative impact for higher income groups. It is also interesting to note that the lowest income group becomes worse off with time while the negative impact on the other groups tends to decline.
These numbers can be compared with those obtained from a static model run by Bayar, et al. (2007a), reproduced in table 6. The numbers seem to be consistent with those obtained from the dynamic model run with more recent data.

<table>
<thead>
<tr>
<th>Macroeconomic variables</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP (% change)</td>
<td>-0.89</td>
</tr>
<tr>
<td>Unemployment rate (%)</td>
<td>4.09</td>
</tr>
<tr>
<td>Change in unemployment rate (% points)</td>
<td>1.16</td>
</tr>
<tr>
<td>Welfare gains/losses (thousands EURO)</td>
<td>-27,919</td>
</tr>
<tr>
<td>Welfare gains/losses (% of households income)</td>
<td>-2.13</td>
</tr>
</tbody>
</table>

Table 6: Impacts of a Decrease in the US Base Activity – Static Model 1998

5. Conclusions

The current paper set out to measure the impact of a US military facility in the Azores, using a multi sector, multi household, dynamic CGE model, calibrated using a SAM matrix constructed with 2001 data.

The main concern was to analyse the impact of the measure on a few major economic indicators, particularly GDP, as well as on the labour market and on private wellbeing.

As expected, the reduction in the facility’s activity led to a reduction in GDP in the short run, a result that is, however, inverted in the longer run.

The impact on private consumption and wellbeing is negative for the full period. Lower income households tend to bear a relatively greater burden of the fall.

The results are partly driven by the model closure methodology that was used, namely the compensation of deteriorated trade balances by increased savings from outside sources. This in turn causes investment to increase, driving up GDP. As such, the negative impacts that were estimated should be considered an underestimate of the real effects.

Future versions of the model will consider different closure rules to avoid the mentioned effects.
References


ANNEXES

15. Model equations

15.1.1. Firms

\[ SF = shYKF \cdot \sum_i PK_i \cdot KSK_i \]  \hspace{1cm} (A.1)

\[ KL_s = aKL_s \cdot XD_s \]  \hspace{1cm} (A.2)

\[ KSK_s = KL_s \cdot \{ PKL_s \cdot \left( (1+tk_s) + d_s \cdot PI \right) \}^{\sigma_F} \cdot \gamma FK_s^{\sigma_F} \cdot aF_s^{(\sigma_F - 1)} \]  \hspace{1cm} (A.3)

\[ LSK_s = KL_s \cdot \{ PKL_s \cdot \left( (1+premLSK_s) \cdot \left( 1+tl_s \cdot \left( (1-tl_s) \right) \right) \}^{\sigma_F} \cdot \gamma FL_s^{\sigma_F} \cdot aF_s^{(\sigma_F - 1)} \]  \hspace{1cm} (A.4)

\[ PKL_s \cdot KL_s = PK_s \cdot \left( (1+tk_s) \cdot KSK_s \right) + PL \cdot \left( 1+premLSK_s \right) \cdot \left( 1+tl_s \cdot (1-tl_s) \right) \cdot LSK_s + DEM, \cdot PI \]  \hspace{1cm} (A.5)

\[ PD_s = (1-tp_s+tsp_s+tspeua_s \cdot MUtspeu+tspeufi_s \cdot MUTspeu+tspeuer_s \cdot MUTspeu+tspeua_s) \cdot XD_s = PKL_s \cdot KL_s + \sum_i \{ io_{cs} \cdot XD_s \cdot \left[ (1-\text{tsic}_{cs}) \cdot P_e + \sum_{cs} tictm_{cs,cs} \cdot P_{e,cs} \right] \cdot (1+vatic_{cs}) \} \]  \hspace{1cm} (A.6)

15.1.2. Households

\[ \{ P_e + \sum_{cs} tictm_{cs,cs,qu} \cdot P_{e,qu} \} \cdot (1+\text{exc}_{qu}) \cdot (1+\text{tc}_{qu} + \text{vat}_{qu}) \cdot C_{qu} = \{ P_e + \sum_{cs} tictm_{cs,qu,qu} \cdot P_{e,qu} \} \cdot \left[ (1+\text{exc}_{qu}) \cdot (1+\text{tc}_{qu} + \text{vat}_{qu}) \cdot \mu H_{qu} + \alpha H_{qu} \cdot \left\{ CBUD_{qu} - \sum_{cc} \{ P_{c,qu} + \sum_{cs} tictm_{cs,qu,qu,qu} \cdot P_{c,qu} \} \right\} \cdot \left( 1+\text{vatic}_{qu} \right) \} \]  \hspace{1cm} (A.7)

\[ YH_{qu} = shYKH_{qu} \cdot \sum_s PK_s \cdot KSK_s + shYLH_{qu} \cdot \sum_s PL \cdot (1+premLSK_s) \cdot LSK_s + TRHML_{qu} \cdot ERML + shUNEMPB_{qu} \cdot trep \cdot PL \cdot \text{UNEMP} + TRHG_{qu} \cdot \text{PCINDEX} \]  \hspace{1cm} (A.8)

\[ CBUD_{qu} = (1-ty_{qu}) \cdot YH_{qu} - SH_{qu} \]  \hspace{1cm} (A.9)

\[ SH_{qu} = MPS_{qu} \cdot (1-ty_{qu}) \cdot YH_{qu} \]  \hspace{1cm} (A.10)

\[ MPS_{qu} = MPSZ_{qu} \cdot \left\{ [(1-ty_{qu}) \cdot PKavr]/[(1-ty_{qu}) \cdot PKavrZ] \right\}^{\text{tms}_{qu}} \]  \hspace{1cm} (A.11)

15.1.3. Regional government

\[ GREV = TRPROP + TRPROD + TRANSR \]  \hspace{1cm} (A.12)

\[ TRPROP = \sum_{ps} tps_{ps} \cdot YH_{ps} + \sum_s tk_s \cdot KSK_s \cdot PK_s \]  \hspace{1cm} (A.13)

\[ TRPROD = \sum_{ps} tps_{ps} \cdot XD_s \cdot PD_s + \sum_s \{ \{ P_e + \sum_{cs} tictm_{cs,qu,qu} \cdot P_{e,qu} \} \cdot \left[ \text{tec}_{qu} + (1+\text{exc}_{qu}) \cdot (\text{tc}_{qu} + \text{vat}_{qu}) \cdot C_{qu} \} + \sum_{cc} \{ P_e + \sum_{cs} tictm_{cs,qu,qu} \cdot P_{e,qu} \} \cdot \text{vat}_{c} \right] \cdot \left[ I_c + \sum_{cs} \{ (1-\text{tsic}_{cs}) \cdot P_e + \sum_{cs} tictm_{cs,cs,cs} \cdot P_{e,cs} \} \cdot \text{vatic}_{cs} \cdot io_{cs} + \sum_{cs} (\text{mus}_{cs} \cdot PWMUS_s \cdot MUS_s \cdot ERUS) + \sum_{cs} (\text{mrw}_{cs} \cdot PWMROW_c \cdot MROW_c \cdot \text{EROW}) \right] \]  \hspace{1cm} (A.14)
TRANSR = TRGML ∙ ERML + TRGEU ∙ EREU + TRGEC ∙ EREU + TRGUS ∙ ERUS + TRGW ∙ ERROW

GEXP = CGBUD + TRANS + SUBSID

\( P_c \cdot CG_e = \alpha CG_e \cdot CGBUD \)  

TRANS = \( \sum_{\text{qq}} TRHG_{\text{qq}} \cdot PCINDEX \)

SUBSID = \( \sum_{\text{c,s}} tsic_{\text{c,s}} \cdot P_c \cdot io_{\text{c,s}} \cdot XD_s + \sum_s [(tsp_s + tspeuea_s \cdot MUtspeu + tspeufi_s \cdot MUtspeu + tspeuer_s \cdot MUtspeu + tspeues_s \cdot MUtspeu + tspusa_s) \cdot XD_s \cdot PD_s ] \)

TRGEC ∙ EREU = MUtspeu ∙ \( \sum_s [(tspeuea_s + tspeufi_s + tspeuer_s + tspeues_s) \cdot XD_s \cdot PD_s ] \)

\( \text{SG} \cdot \text{GDPDEF} = \text{GREV} - \text{GEXP} \)

\( r\text{TRPROPGDP} = \text{TRPROP} / \text{GDPC} \cdot 100 \)

\( r\text{TRPRODGDP} = \text{TRPROD} / \text{GDPC} \cdot 100 \)

\( r\text{TRANSGDP} = \text{TRANS} / \text{GDPC} \cdot 100 \)

\( r\text{CGBUDGDP} = \text{CGBUD} / \text{GDPC} \cdot 100 \)

\( r\text{TRANSGDP} = \text{TRANS} / \text{GDPC} \cdot 100 \)

\( r\text{SUBSIDGDP} = \text{SUBSID} / \text{GDPC} \cdot 100 \)

\( r\text{SGGDP} = \text{SG} \cdot \text{GDPDEF} / \text{GDPC} \cdot 100 \)

15.1.4. Mainland government

\( \text{SGML} = \sum_s \{tl_s / (1 - tl_s) \cdot LSK_s \cdot PL_s \cdot (1 + \text{ premLSK}_s) / \text{ERML} \} - \sum_{\text{qq}} \text{TRHML}_{\text{qq}} - \sum_{\text{qq}} (\text{shUNEMPB}_{\text{qq}} \cdot \text{trep} \cdot \text{PL} \cdot \text{UNEMP} / \text{ERML}) - \text{TRGML} \)

15.1.5. European Commission

\( \text{SGEC} = - \text{TRGEC} - \text{TRGEU} \)

15.1.6. Domestic supply to domestic and foreign markets

\( XDDE_s = \sum_c ioC_{c,e} \cdot XD_s \)

\( PD_s = \sum_c ioC_{c,e} \cdot PDDE_c \)

15.1.7. Foreign sector

\( \text{EML}_c = XDDE_c \cdot (PDDE_c / \text{PEML}_c) \cdot T_c^\gamma \cdot T_c^\alpha \cdot T_c^{(\alpha T_c - 1)} \)

\( \text{EEU}_c = XDDE_c \cdot (PDDE_c / \text{PEEU}_c) \cdot T_c^\gamma \cdot T_c^\alpha \cdot T_c^{(\alpha T_c - 1)} \)

\( \text{EUS}_c = XDDE_c \cdot (PDDE_c / \text{PEUS}_c) \cdot T_c^\gamma \cdot T_c^\alpha \cdot T_c^{(\alpha T_c - 1)} \)
\[ E_{\infty} = (P_{EML_{\infty}} \cdot EML_{\infty} + P_{EEU_{\infty}} \cdot EEU_{\infty} + P_{EUS_{\infty}} \cdot EUS_{\infty} + P_{PEROW_{\infty}} \cdot EROW_{\infty}) / INDEXE_{\infty} \]  

(A.39)

\[ EDML_{\infty} = EDIML_{\infty} \cdot (P_{WEML_{\infty}} \cdot EML_{\infty} / P_{EML_{\infty}}) \cdot \alpha \]  

(A.40)

\[ EDEU_{\infty} = EDIEU_{\infty} \cdot (P_{WEEU_{\infty}} \cdot EEU_{\infty} / P_{EEU_{\infty}}) \cdot \alpha \]  

(A.41)

\[ EDUS_{\infty} = EDIUS_{\infty} \cdot (P_{WEUS_{\infty}} \cdot EUS_{\infty} / P_{EUS_{\infty}}) \cdot \alpha \]  

(A.42)

\[ EDROW_{\infty} = EDIROW_{\infty} \cdot (P_{WEROW_{\infty}} \cdot EROW_{\infty} / P_{PEROW_{\infty}}) \cdot \alpha \]  

(A.43)

\[ MML_{\infty} = X_{\infty} \cdot (P_{/PMML_{\infty}}) \cdot \gamma A1_{\infty} \cdot \alpha A^{(\alpha-1)} \]  

(A.44)

\[ MEOU_{\infty} = X_{\infty} \cdot (P_{/PMEU_{\infty}}) \gamma A2_{\infty} \cdot \alpha A^{(\alpha-1)} \]  

(A.45)

\[ MUS_{\infty} = X_{\infty} \cdot (P_{/PMUS_{\infty}}) \gamma A3_{\infty} \cdot \alpha A^{(\alpha-1)} \]  

(A.46)

\[ MROW_{\infty} = X_{\infty} \cdot (P_{/PMROW_{\infty}}) \gamma A4_{\infty} \cdot \alpha A^{(\alpha-1)} \]  

(A.47)

\[ XDD_{\infty} = X_{\infty} \cdot (P_{/PDD_{\infty}}) \gamma A5_{\infty} \cdot \alpha A^{(\alpha-1)} \]  

(A.48)

\[ P_{\infty} \cdot X_{\infty} \cdot PMML_{\infty} \cdot MML_{\infty} + P_{\infty} \cdot PMEU_{\infty} \cdot MEU_{\infty} + P_{\infty} \cdot PMUS_{\infty} \cdot MUS_{\infty} + P_{\infty} \cdot PMROW_{\infty} \cdot MROW_{\infty} + P_{\infty} \cdot PDD_{\infty} \cdot XDD_{\infty} \]  

(A.49)

\[ M_{\infty} = (PWMML_{\infty} \cdot EML_{\infty} + PWMEU_{\infty} \cdot EEU_{\infty} + PWMUS_{\infty} \cdot EUS_{\infty} + PWMROW_{\infty} \cdot EROW_{\infty}) / INDEXM_{\infty} \]  

(A.50)

\[ SML = \sum_{\infty} (MML_{\infty} \cdot PWMMML_{\infty} - EML_{\infty} \cdot PEML_{\infty} / ERML) + SGML \]  

(A.51)

\[ SEU = \sum_{\infty} (MEU_{\infty} \cdot PWMEU_{\infty} - EEU_{\infty} \cdot PEEU_{\infty} / EREU) + SGEC \]  

(A.52)

\[ SUS = \sum_{\infty} (MUS_{\infty} \cdot PWUS_{\infty} - EUS_{\infty} \cdot PEUS_{\infty} / ERUS) - TRGUS \]  

(A.53)

\[ SROW = \sum_{\infty} (PMROW_{\infty} \cdot PWMROW_{\infty} - EROW_{\infty} \cdot PEROW_{\infty} / EROW) - TRGW \]  

(A.54)

### 15.1.8. Investment

\[ S = \sum_{m} SH_{m} + SF + SG \cdot GDPDEF \cdot SML \cdot EML + SEU \cdot EEU + SUS \cdot EUS + SROW \cdot EROW + \sum_{\infty} DEP \cdot PI \]  

(A.55)

\[ I_{\infty} = ioI_{\infty} \cdot ITT \]  

(A.56)

\[ PI = \sum_{\infty} [(1 + vati) \cdot \{ P_{\infty} + \sum_{c} \{ icitm_{c \infty} \cdot P_{c} \} \cdot ioI_{\infty} \}] \]  

(A.57)
\[ PL \cdot ITT = S - \sum_c SV_c \cdot P_c \]  
(A.58)

\[ SV_c = svr \cdot X_c \]  
(A.59)

\[ DEP_s = d_s \cdot KSK_s \]  
(A.60)

15.1.9. Labor market

\[ \log(PL/PCINDEX) = \text{elasU} \cdot \log(UNRATE) + \text{err} \]  
(A.61)

\[ LSR = LSRI \cdot \{(PL \cdot (1 - \text{tyavr}) \cdot PCINDEXZ) / [PLZ \cdot (1 - \text{tyavrz}) \cdot PCINDEX]) \}^{\text{elasS}} \]  
(A.62)

\[ \text{tyavr} = \sum_{q^r} (ty_{q^r} \cdot YH_{q^r}) / \sum_{q^r} YH_{q^r} \]  
(A.63)

\[ EMPN = LSR - \text{UNEMP} \]  
(A.64)

\[ \text{UNRATE} = \text{UNEMP}/LSR \]  
(A.65)

15.1.10. Trade and transport margins

\[ \text{MARGTM}_{cim} = \sum_{c} \text{tchtm}_{cim,c,qu} \cdot C_{c,qu} + \sum_{c} \text{tcitm}_{cim,c} \cdot I_{c} + \sum_{c} \text{tcictm}_{cim,c, qu} \cdot io_{c,s} \cdot XD_s \]  
(A.66)

15.1.11. Market clearing

\[ \sum_x \text{LSK}_x = LSR - \text{UNEMP} \]  
(A.67)

\[ \sum_x \text{io}_{cim,x} \cdot XD_s + \sum_x C_{cimc,qu} + CG_{cim} + I_{cim} + SV_{cim} + \text{MARGTM}_{cim} = X_{cim} \]  
(A.68)

\[ \sum_x \text{io}_{ncim,x} \cdot XD_s + \sum_x C_{ncimc,qu} + CG_{ncim} + I_{ncim} + SV_{ncim} = X_{ncim} \]  
(A.69)

\[ \text{EML}_c = EDML_c \]  
(A.70)

\[ \text{EEU}_c = EDEU_c \]  
(A.71)

\[ \text{EUS}_c = EDUS_c \]  
(A.72)

\[ \text{EROW}_c = EDROW_c \]  
(A.73)

15.1.12. Price definitions

\[ \text{PCINDEX} = \left[ \left\{ P + \sum_{c} \text{tchtm}_{cimc,qu} \cdot P_{c,qu} \right\} \cdot \left( 1 + texc_{c,qu} \right) \cdot \left( 1 + tcv_{c,qu} + vatc_{c,qu} \right) \cdot CZ_{c,qu} \right] \]  
(A.74)

\[ \sum_{c,qu} \left[ \left\{ PZ + \sum_{c} \text{tchmz}_{cimc,qu} \cdot PZ_{c,qu} \right\} \cdot \left( 1 + texcz_{c,qu} \right) \cdot \left( 1 + tcz_{c,qu} + vatcz_{c,qu} \right) \cdot CZ_{c,qu} \right] \]  
(A.75)

\[ \text{INDEXE}_c = (\text{PEM}_c + \text{EMLZ} + \text{PEEU} + \text{EEUZ} + \text{PEUS} + \text{EUSZ} + \text{PEROW} + \text{EROWZ}_c) / (\text{PEMLZ}_c + \text{EMLZ} + \text{PEEU} + \text{EEUZ} + \text{PEUS} + \text{EUSZ} + \text{PEROW} + \text{EROWZ}_c) \]  
(A.76)

\[ \text{INDEXM}_c = (\text{PWMML}_c + \text{ERML} + \text{MMLZ} + \text{PWMEO}_c + \text{EREO} + \text{MEUZ} + \text{PWMUS} + \text{ERUS} + \text{MUSZ} + \text{PWMROW} + \text{EROW} + \text{MROWZ}_c) / (\text{PWMMLZ}_c + \text{ERMLZ} + \text{MMLZ} + \text{PWMEO}_c + \text{EREO} + \text{MEUZ} + \text{PWMUS} + \text{ERUS} + \text{MUSZ} + \text{PWMROW} + \text{EROW} + \text{MROWZ}_c) \]  
(A.76)
\[ PMML_c = PWMML_c \cdot ERML \]  \hspace{1cm} (A.77)

\[ PMEU_c = PWMEU_c \cdot EREU \]  \hspace{1cm} (A.78)

\[ PMUS_c = PWMUS_c \cdot ERUS \cdot (1+tmus_c) \]  \hspace{1cm} (A.79)

\[ PMROW_c = PWMROW_c \cdot ERROW \cdot (1+ttnrew_c) \]  \hspace{1cm} (A.80)

\[ RINT = \sum \{ (PK_c/PD_c) \cdot KSK_c \} / \sum KSK_c \]  \hspace{1cm} (A.81)

\[ PKavr = \sum \{ (PK_c/PCINDEX_c) \cdot KSK_c \} / \sum KSK_c \]  \hspace{1cm} (A.82)

\[ PCT_c = \sum \{ P_c + \sum \frac{tchtm_{c,m,c,p}}{c_m} \cdot P_{c,m} \cdot (1+tcexc_c) \cdot (1+tc_c+vateq_{c,p}) \} + \sum CG_c \cdot P_c + \sum \{ I_c \cdot (1+vati_c) \cdot [P_c + \sum \frac{tcitm_{c,m,c,p}}{c_m} \cdot P_{c,m}] \} + \sum SV_c \cdot P_c + \sum EML_c \cdot PEML_c \]
\[ + \sum EEU_c \cdot PEUZ_c + \sum EUS_c \cdot PEUS_c + \sum EROW_c \cdot PEROW_c - \sum MML_c \cdot PWMLL_c \cdot ERLM_c - \sum MEU_c \cdot PWMEU_c \cdot EREU_c - \sum MUS_c \cdot PWMSU_c \cdot ERUS_c - \sum MKROW_c \cdot PWMRW_c \cdot ERROW_c \]  \hspace{1cm} (A.85)

\[ GDP = \sum \{ C_{c,p} \cdot [ PZ_c + \sum \frac{tchtm_{c,m,c,p}}{c_m} \cdot PZ_{c,m} ] \cdot (1+tecz_c) \cdot (1+tc_{c,p}+vateq_{c,p}) \} + \sum CG_c \cdot PZ_c + \sum \{ I_c \cdot (1+vati_c) \cdot [PZ_c + \sum \frac{tcitm_{c,m,c,p}}{c_m} \cdot PZ_{c,m}] \} + \sum SV_c \cdot PZ_c + \sum EML_c \cdot PEMLZ_c + \sum EEU_c \cdot PEUZ_c + \sum EUS_c \cdot PEUSZ_c + \sum EROW_c \cdot PEROWZ_c - \sum MML_c \cdot PWMLLZ_c \cdot ERLMZ_c - \sum MEU_c \cdot PWMEUZ_c \cdot EREUZ_c - \sum MUS_c \cdot PWMSUZ_c \cdot ERUSZ_c - \sum MKROWZ_c \cdot PWMRWZ_c \cdot ERROWZ_c \]  \hspace{1cm} (A.86)

\[ GDPP = \sum \{ C_{c,p} \cdot [ PZ_c + \sum \frac{tchtm_{c,m,c,p}}{c_m} \cdot PZ_{c,m} ] \cdot (1+tecz_c) \cdot (1+tc_{c,p}+vateq_{c,p}) \} + \sum \{ I_c \cdot (1+vati_c) \cdot [PZ_c + \sum \frac{tcitm_{c,m,c,p}}{c_m} \cdot PZ_{c,m}] \} + \sum SV_c \cdot PZ_c + \sum EML_c \cdot PEMLZ_c + \sum EEU_c \cdot PEUZ_c + \sum EUS_c \cdot PEUSZ_c + \sum EROW_c \cdot PEROWZ_c - \sum MML_c \cdot PWMLLZ_c \cdot ERLMZ_c - \sum MEU_c \cdot PWMEUZ_c \cdot EREUZ_c - \sum MUS_c \cdot PWMSUZ_c \cdot ERUSZ_c - \sum MKROWZ_c \cdot PWMRWZ_c \cdot ERROWZ_c \]  \hspace{1cm} (A.87)

**15.1.13. Gross Domestic Product at Current and Constant Market Prices**

\[ GDP = \{ C \cdot [ P + \sum \frac{tchtm_{c,m,c,p}}{c_m} \cdot P_{c,m} ] \cdot (1+tecx_c) \cdot (1+tc_c+vateq_{c,p}) \} + \sum CG \cdot P + \sum \{ I \cdot (1+vati) \cdot [P + \sum \frac{tcitm_{c,m,c,p}}{c_m} \cdot P_{c,m}] \} + \sum SV \cdot P + \sum EML \cdot PEML + \sum EEU \cdot PEUZ + \sum EUS \cdot PEUSZ + \sum EROW \cdot PEROW - \sum MML \cdot PWMLL \cdot ERLM - \sum MEU \cdot PWMEU \cdot EREU - \sum MUS \cdot PWMSU \cdot ERUS - \sum MKROW \cdot PWMRW \cdot ERROW \]  \hspace{1cm} (A.88)

\[ GDPP = \{ C \cdot [ PZ + \sum \frac{tchtm_{c,m,c,p}}{c_m} \cdot PZ_{c,m} ] \cdot (1+tecz) \cdot (1+tc_{c,p}+vateq_{c,p}) \} + \sum \{ I \cdot (1+vati) \cdot [PZ + \sum \frac{tcitm_{c,m,c,p}}{c_m} \cdot PZ_{c,m}] \} + \sum SV \cdot PZ + \sum EML \cdot PEMLZ + \sum EEU \cdot PEUZ + \sum EUS \cdot PEUSZ + \sum EROW \cdot PEROW - \sum MML \cdot PWMLLZ \cdot ERLMZ - \sum MEU \cdot PWMEUZ \cdot EREUZ - \sum MUS \cdot PWMSUZ \cdot ERUSZ - \sum MKROWZ \cdot PWMRWZ \cdot ERROWZ \]  \hspace{1cm} (A.89)

\[ GDPDEF = GDP/GDP \]  \hspace{1cm} (A.90)
15.1.14. Components of GDP at constant prices

\[
CT = \sum_c \{ PZ_c + \sum_{c,m} tchtmz_{c,m,c,p} \cdot PZ_{c,m} \cdot (1+tecxz_{c,p}) \cdot (1+tcz_{c,p} + vatc_{c,p}) \}
\]

(A.88)

\[
CGT = \sum_c CG_{c} \cdot PZ_c
\]

(A.89)

\[
IT = \sum_c \{ I_c \cdot (1+vatiz_c) \cdot (PZ_c + \sum_{c,m} tchtmz_{c,m,c,p} \cdot PZ_{c,m}) \} + \sum c SV_c \cdot PZ_c
\]

(A.90)

\[
ET = \sum_c \{ (EML_c \cdot PMLZ_c + EEU_c \cdot PEUZ_c + EUS_c \cdot PEUSZ_c + EROW_c \cdot PEROWZ_c) \}
\]

(A.91)

\[
MT = \sum_c \{ (MML_c \cdot PWMMLZ_c + EMLZ_c \cdot MEU_c \cdot PWMEUZ_c + EREUZ_c \cdot MUS_c \cdot PWMUSZ_c + EROW_c \cdot PWROWZ_c + ERROWZ_c) \}
\]

(A.92)

15.1.15. Equivalent variation in income

\[
VU_{qp} = \{ CBUD_{qp} - \sum_c \{ P_e + \sum_{c,m} tchtmz_{c,m,c,p} \cdot P_{c,m} \} \cdot (1+tecxz_{c,p}) \cdot (1+tcz_{c,p} + vatc_{c,p}) \}
\]

\[
\mu H_{c,p} \cdot \prod_c \{ \alpha H_{c,p} \} / \{ \alpha H_{c,p} \} \}
\]

(A.93)

\[
VUL_{qp} = \{ CBUDZ_{qp} - \sum_c \{ PZ_e + \sum_{c,m} tchtmz_{c,m,c,p} \cdot PZ_{c,m} \} \cdot (1+tecxz_{c,p}) \cdot (1+tcz_{c,p} + vatc_{c,p}) \}
\]

\[
\mu H_{c,p} \cdot \prod_c \{ \alpha H_{c,p} \} / \{ \alpha H_{c,p} \} \}
\]

(A.94)

\[
EV_{qp} = \sum_c \{\{PZ_e + \sum_{c,m} tchtmz_{c,m,c,p} \cdot PZ_{c,m} \} \cdot (1+tecxz_{c,p}) \cdot (1+tcz_{c,p} + vatc_{c,p}) \} / \alpha H_{c,p} \}
\]

(A.95)

15.1.16. Capital accumulation

\[
ROR_{st} = -1 + (PK_{st}/PI_{st}) \}
\]

(A.96)

\[
\alpha ROR_{st} = e^{\{ \alpha ROR_{st} \cdot (KSkmax - KSkmin) \}
\]

(A.97)

\[
INVS_{st} = KSK_{st} \cdot \{ \alpha ROR_{st} \cdot KSkmax \cdot (KSkkrend - KSkkmin) + KSkkmin \}
\]

(A.98)

\[
INV_{st} = INVS_{st} / \sum s AlvINV_{st} \cdot (S_t - \sum c SV_{c,t} \cdot P_{c,t}) / PI_t
\]

(A.99)

\[
KSK_{s+1,t} = (1-d_s) \cdot KSK_{st} + INV_{st}
\]

(A.100)
19. List of Endogenous variables

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBUD\textsubscript{qu}</td>
<td>households budget disposable for consumption by income group</td>
</tr>
<tr>
<td>C\textsubscript{c,qu}</td>
<td>consumer demand for commodity ( c ) by income group ( qu )</td>
</tr>
<tr>
<td>CGBUD</td>
<td>regional government current expenditures</td>
</tr>
<tr>
<td>CG\textsubscript{c}</td>
<td>public current consumption of commodity ( c ) by the regional government</td>
</tr>
<tr>
<td>CGT</td>
<td>total public consumption by the regional government at constant prices</td>
</tr>
<tr>
<td>CT</td>
<td>total private consumption at constant prices</td>
</tr>
<tr>
<td>DEP\textsubscript{i}</td>
<td>depreciation related to public and private capital stock</td>
</tr>
<tr>
<td>EDEU\textsubscript{c}</td>
<td>export demand of commodity ( c ) from EU</td>
</tr>
<tr>
<td>EDML\textsubscript{c}</td>
<td>export demand of commodity ( c ) from Mainland</td>
</tr>
<tr>
<td>EDROW\textsubscript{c}</td>
<td>export demand of commodity ( c ) from the rest of the world</td>
</tr>
<tr>
<td>EDUS\textsubscript{c}</td>
<td>export demand of commodity ( c ) from US</td>
</tr>
<tr>
<td>EEU\textsubscript{c}</td>
<td>export supply of commodity ( c ) by the domestic producers to EU</td>
</tr>
<tr>
<td>EML\textsubscript{c}</td>
<td>export supply of commodity ( c ) by the domestic producers to Mainland</td>
</tr>
<tr>
<td>EMPN</td>
<td>national employment</td>
</tr>
<tr>
<td>EROW\textsubscript{c}</td>
<td>export supply of commodity ( c ) by the domestic producers to the rest of the world</td>
</tr>
<tr>
<td>ET</td>
<td>total exports at constant prices</td>
</tr>
<tr>
<td>EUS\textsubscript{c}</td>
<td>export supply of commodity ( c ) by the domestic producers to US</td>
</tr>
<tr>
<td>EV\textsubscript{qu}</td>
<td>equivalent variation in income, by household income group</td>
</tr>
<tr>
<td>GDP</td>
<td>gross domestic product at constant prices</td>
</tr>
<tr>
<td>GDPC</td>
<td>gross domestic product at current market prices</td>
</tr>
<tr>
<td>GDPP</td>
<td>private gross domestic product at constant prices</td>
</tr>
<tr>
<td>GEXP</td>
<td>total regional government expenditures</td>
</tr>
<tr>
<td>GREV</td>
<td>total regional government revenues</td>
</tr>
<tr>
<td>I\textsubscript{c}</td>
<td>demand for investment good ( c )</td>
</tr>
<tr>
<td>INDEXE\textsubscript{c}</td>
<td>price index corresponding to exports by type of commodity ( c )</td>
</tr>
<tr>
<td>INDEXM\textsubscript{c}</td>
<td>price index corresponding to imports by type of commodity ( c )</td>
</tr>
<tr>
<td>INV\textsubscript{s}</td>
<td>investments carried out in branch ( s ) (actual level)</td>
</tr>
<tr>
<td>INV\textsubscript{S}</td>
<td>investments carried out in branch ( s ) (first estimate)</td>
</tr>
<tr>
<td>IT</td>
<td>total gross capital formation at constant prices (including inventories)</td>
</tr>
<tr>
<td>ITT</td>
<td>total investments in real terms</td>
</tr>
<tr>
<td>KL\textsubscript{s}</td>
<td>value-added by branch</td>
</tr>
<tr>
<td>LSK\textsubscript{s}</td>
<td>number of employees in branch ( s )</td>
</tr>
<tr>
<td>LSR</td>
<td>active population</td>
</tr>
<tr>
<td>MARGTM\textsubscript{clm}</td>
<td>trade and transport margins</td>
</tr>
</tbody>
</table>
MEU<sub>c</sub> imports of commodity <i>c</i> from EU
MML<sub>c</sub> imports of commodity <i>c</i> from Mainland
MPS<sub>qu</sub> households propensity to save, by income group
MROW<sub>c</sub> imports of commodity <i>c</i> from the rest of the world
MT total imports at constant prices
MUS<sub>c</sub> imports of commodity <i>c</i> from US
<sub>P</sub><sub>c</sub> price level of domestic sales (composite commodities coming from imports and domestic production)
PCINDEX consumer price index
PCT<sub>c,qu</sub> consumer prices (including taxes)
PDD<sub>c</sub> price index of domestic production delivered to home market by type of good <i>c</i>
PDDE<sub>c</sub> price index of domestic production delivered to home and foreign markets by type of good <i>c</i>
PD<sub>s</sub> price index of domestic production by branch of activity
PEEU<sub>c</sub> domestic price of exports to EU received by the domestic producers
PEML<sub>c</sub> domestic price of exports to Mainland received by the domestic producers
PEROW<sub>c</sub> domestic price of exports to the rest of the world received by the domestic producers
PEUS<sub>c</sub> domestic price of exports to US received by the domestic producers
PI price index corresponding to composite investment good
PKav<sub>r</sub> real average return to capital received by the household
PKL<sub>s</sub> price index corresponding to value-added by branch of activity
PK<sub>s</sub> return to capital by branch of activity
PL national average wage (excluding social security contributions)
PLAVRT national average wage (including social security contributions)
PMEU<sub>c</sub> domestic price of imports from EU
PMML<sub>c</sub> domestic price of imports from Mainland
PMROW<sub>c</sub> domestic price of imports from the rest of the world (including tariffs)
PMUS<sub>c</sub> domestic price of imports from US (including tariffs)
RINT average return to capital corresponding to firms
ROR<sub>c,t</sub> normal rate of return to capital
rSGGDP regional government savings to the GDP ratio
rSUBSIDGDP total subsidies by the regional government to the GDP ratio
rTRANSRGDP total transfers received by the regional government to the GDP ratio
rTRPRODGDP regional government revenues from taxes on products and on production to the GDP ratio
rTRPROPGDP regional government revenues from taxes on income and wealth to the GDP ratio
S total savings
SEU balance of the current account with respect to EU
SF firms savings
SGEC net transfers by the European Commission to Azores
SGML net transfers by the Mainland government to Azores
SH_{qu} \quad \text{households savings by income group}
SML \quad \text{balance of the current account with respect to Mainland}
SROW \quad \text{balance of the current account with respect to ROW}
SUBSID \quad \text{total subsidies by the regional government}
SUS \quad \text{balance of the current account with respect to US}
SV_{c} \quad \text{inventories}
TRANS \quad \text{total transfers by the regional government}
TRANSR \quad \text{total transfers received by the regional government}
TRPROD \quad \text{regional government revenues from taxes on products and on production}
TRPROP \quad \text{regional government revenues from taxes on income and wealth}
tyav{\text{r}} \quad \text{average personal income tax rate}
UNEMP \quad \text{number of unemployed}
UNRATE \quad \text{unemployment rate}
VU_{qu} \quad \text{level of indirect utility corresponding to the households, by income group}
X_{c} \quad \text{domestic sales of composite commodities coming from imports and domestic production}
XDD_{c} \quad \text{domestic production delivered to home market}
XDDE_{c} \quad \text{domestic production delivered to home and foreign markets (by type of commodity)}
XD_{s} \quad \text{domestic production by branch of activity}
YH_{qu} \quad \text{households income, by income group}
aROR_{s,t} \quad \text{parameter in the supply of capital function}
### 20. List of Exogenous variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$CZ_{c,qu}$</td>
<td>consumer demand for commodity $c$ (benchmark value)</td>
</tr>
<tr>
<td>$EDIEU_{c}$</td>
<td>export demand of commodity $c$ from EU (benchmark value)</td>
</tr>
<tr>
<td>$EDIML_{c}$</td>
<td>export demand of commodity $c$ from the Mainland (benchmark value)</td>
</tr>
<tr>
<td>$EDIROW_{c}$</td>
<td>export demand of commodity $c$ from the rest of the world (benchmark value)</td>
</tr>
<tr>
<td>$EDIUS_{c}$</td>
<td>export demand of commodity $c$ from US (benchmark value)</td>
</tr>
<tr>
<td>$EREU$</td>
<td>exchange rate with respect to EU</td>
</tr>
<tr>
<td>$EREUZ$</td>
<td>exchange rate with respect to EU (benchmark value)</td>
</tr>
<tr>
<td>$ERML$</td>
<td>exchange rate with respect to Mainland</td>
</tr>
<tr>
<td>$ERMLZ$</td>
<td>exchange rate with respect to Mainland (benchmark value)</td>
</tr>
<tr>
<td>$ERROW$</td>
<td>exchange rate with respect to the rest of the world</td>
</tr>
<tr>
<td>$ERROWZ$</td>
<td>exchange rate with respect to the rest of the world (benchmark value)</td>
</tr>
<tr>
<td>$ERUS$</td>
<td>exchange rate with respect to US</td>
</tr>
<tr>
<td>$ERUSZ$</td>
<td>exchange rate with respect to US (benchmark value)</td>
</tr>
<tr>
<td>$GDPDEF$</td>
<td>GDP deflator</td>
</tr>
<tr>
<td>$KSK_{s}$</td>
<td>capital demand by branch (capital stock)</td>
</tr>
<tr>
<td>$LSRI$</td>
<td>active population (benchmark value)</td>
</tr>
<tr>
<td>$MPSZ_{qu}$</td>
<td>households propensity to save, by income group (benchmark value)</td>
</tr>
<tr>
<td>$PCINDEXZ$</td>
<td>consumer price index (benchmark value)</td>
</tr>
<tr>
<td>$PEEUZ_{c}$</td>
<td>domestic price of exports to EU received by the domestic producers (benchmark value)</td>
</tr>
<tr>
<td>$PEMLZ_{c}$</td>
<td>domestic price of exports to Mainland received by the domestic producers (benchmark value)</td>
</tr>
<tr>
<td>$PEROWZ_{c}$</td>
<td>domestic price of exports to the rest of the world received by the domestic producers (benchmark value)</td>
</tr>
<tr>
<td>$PEUSZ_{c}$</td>
<td>domestic price of exports to US received by the domestic producers (benchmark value)</td>
</tr>
<tr>
<td>$PKavrz$</td>
<td>real average return to capital received by the household (benchmark value)</td>
</tr>
<tr>
<td>$PLZ$</td>
<td>national average wage (excluding social security contributions) – benchmark value</td>
</tr>
<tr>
<td>$PWEEU_{c}$</td>
<td>price of exports to EU in foreign currency</td>
</tr>
<tr>
<td>$PWEML_{c}$</td>
<td>price of exports to Mainland in foreign currency</td>
</tr>
<tr>
<td>$PWEROW_{c}$</td>
<td>price of exports to ROW in foreign currency</td>
</tr>
<tr>
<td>$PWEUS_{c}$</td>
<td>price of exports to US in foreign currency</td>
</tr>
<tr>
<td>$PWMEU_{c}$</td>
<td>price of imports from EU in foreign currency</td>
</tr>
<tr>
<td>$PWMEUZ_{c}$</td>
<td>price of imports from EU in foreign currency (benchmark value)</td>
</tr>
<tr>
<td>$PWMML_{c}$</td>
<td>price of imports from Mainland in foreign currency</td>
</tr>
<tr>
<td>$PWMMLZ_{c}$</td>
<td>price of imports from Mainland in foreign currency (benchmark value)</td>
</tr>
<tr>
<td>$PWMROW_{c}$</td>
<td>price of imports from ROW in foreign currency</td>
</tr>
</tbody>
</table>
PWMROWZ_c: price of imports from ROW in foreign currency (benchmark value)
PWMUS_c: price of imports from US in foreign currency
PWMUSZ_c: price of imports from US in foreign currency (benchmark value)
PZe: price level of domestic sales (composite commodities coming from imports and domestic production) – benchmark value
RORH_h: historically normal rate of return to capital
SG: regional government savings
TRGEC: transfers received by the regional government from EU as direct subsidies on production
TRGEU: other transfers received by the regional government from EU
TRGML: transfers received by the regional government from the Mainland government
TRGUS: transfers received by the regional government from US
TRGW: transfers received by the regional government from the rest of the world
TRHG_{qu}: transfers received by the households from the regional government, by income group
TRHML_{qu}: transfers received by the households from the Mainland government, by income group
VUI_{qu}: level of indirect utility corresponding to the household, by income group (benchmark level)
21. List of Parameters

- **aA_c**: efficiency parameter in the Armington function for imports
- **aF_s**: efficiency parameter in the CES production function of the firm
- **aKL_s**: Leontief parameter - share of value added in domestic production
- **aT_c**: efficiency parameter in the CET function for exports
- **d_s**: depreciation rate by branch of activity
- **elasE_c**: price elasticity of export demand
- **elasLS**: elasticity of labour supply
- **elasS_qu**: elasticity of private savings with respect to after-tax rate of return, by income group
- **elasU**: unemployment elasticity
- **err**: error term in the wage curve equation
- **io_c,s**: technical coefficients corresponding to intermediate consumption
- **ioC_s,c**: shares of domestic production delivered to home and foreign markets by branch of activity and commodity
- **iol_c**: Leontief parameter for the investment demand by type of investment good
- **KSKgmax_s**: maximum possible growth rate of capital stock in branch s
- **KSKgmin_s**: minimum possible growth rate of capital stock in branch s (equal to the negative of the rate of depreciation in branch s)
- **KSKtrend_s**: industry’s historically normal growth rate
- **premLSK_s**: wage premium over the average wage in domestic employment by branch
- **shUNEMPB_qu**: share of unemployment benefits received by the households, by income group
- **shYKF**: share of the net operating surplus retained by the firms
- **shYKH_qu**: share of the net operating surplus received by the households, by income group
- **shYLH_qu**: share of labour income received by the households, by income group
- **svrc**: share of inventories in domestic sales
- **tc_c,qu**: tax rate corresponding to other taxes on private consumption of commodity c
- **tchtm_ctm,c,qu**: quantity of commodity ctm as trade and transport services per unit of private consumption
- **tchtmz_ctm,c,qu**: quantity of commodity ctm as trade and transport services per unit of private consumption (benchmark value)
- **tcictm_ctm,c,s**: quantity of commodity ctm as trade and transport services per unit of intermediate consumption
- **tcitm_ctm,c**: quantity of commodity ctm as trade and transport services per unit of investment goods
- **tcitmz_ctm,c**: quantity of commodity ctm as trade and transport services per unit of investment goods (benchmark value)
- **tcz_c,qu**: tax rate corresponding to other taxes on private consumption of commodity c (benchmark value)
- **texc_c,qu**: excise duties rate on private consumption of commodity c
excise duties rate on private consumption of commodity $c$ (benchmark value)
corporate tax rate in branch $s$
social security contributions rate in branch $s$
tariff rate applied on imports of commodity $c$ from ROW
tariff rate applied on imports of commodity $c$ from US
tax rate on production in branch $s$
replacement rate out of national average wage (net of social security contributions)
subsidy rate on intermediate consumption
subsidy rate on production from the European Agricultural Guidance and Guarantee Fund (EAGGF)
subsidy rate on production from the European Regional Development Fund (ERDF)
subsidy rate on production from the European Social Fund (ESF)
subsidy rate on production from the Financial Instrument for Fisheries Guidance (FIFG)
subsidy rate on production in branch $s$
subsidy rate on production from US
average personal income tax rate (benchmark level)
personal income tax rate by income group
personal income tax rate by income group (benchmark level)
value-added tax rate on private consumption of commodity $c$
value-added tax rate on private consumption of commodity $c$ (benchmark value)
value-added tax rate on investment good $c$
value-added tax rate on intermediate consumption of commodity $c$
value-added tax rate on investment goods (benchmark level)
Cobb-Douglas preference parameter in the regional government utility function
marginal budget shares in the Stone-Geary utility function
CES distribution parameter for imports from Mainland in the Armington function
CES distribution parameter for imports from EU in the Armington function
CES distribution parameter for imports from US in the Armington function
CES distribution parameter for imports from ROW in the Armington function
CES distribution parameter for the domestic demand from the domestic producers in the Armington function
CES distribution parameter for capital in the production function of the firm
CES distribution parameter for labour in the production function of the firm
CET distribution parameter for exports to Mainland
CET distribution parameter for exports to EU
CET distribution parameter for exports to US
CET distribution parameter for exports to ROW
\( \gamma T_{5c} \) CET distribution parameter for domestic production delivered to home markets

\( \mu H_{c,qu} \) subsistence level out of consumer demand for commodities

\( \sigma A_c \) substitution elasticities for the Armington function

\( \sigma F_s \) CES capital-labour substitution elasticities by branch

\( \sigma T_c \) elasticities of transformation in the CET function
22. List of indices used in the model

- **c**: a subscript for one of the commodities (45 types of commodities)
- **cc**: the same as *c* (used for exposition purposes)
- **ctm**: a subscript for trade and transport services (7 types of trade and transport services)
- **nctm**: a subscript for all the other commodities except trade and transport services (38 types of commodities)
- **qu**: a subscript for one of the households income groups (6 households income groups)
- **s**: a subscript for one of the production activities (45 branches of activity)
- **ss**: the same as *s* (used for exposition purposes)
- **t**: a subscript for year *t*