A MULTISECTORAL MODEL FOR PORTUGAL WITH A MULTIREGIONAL EXTENSION

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Abstract

This paper presents an input-output based model for Portugal (MODEM 6A), designed for policy and demand shocks evaluation. The model considers 59 industries and it is calibrated for each year on the basis of existing systems of input-output tables and other data from National Accounts or of projected scenarios for Portugal. The model allows the simulation of the impact of demand and income shocks on global and sectoral output, imports, and employment as well as on fiscal variables, disposable income and private consumption. The model has a multiregional extension allowing the breakdown of national impacts by seven Portuguese regions. A fiscal policy rule may be included in the model simulations, allowing the evaluation of public expenditure programs with no deterioration of public deficit.

Keywords: Multisectoral Model; Multiregional Model; Input-Output; Policy Evaluation

1. INTRODUCTION

MODEM is a multisectoral, input-output based model for Portugal which was developed in the Department of Foresight and Planning (DPP), with the purpose of evaluating the macroeconomic impact of public policies and of other exogenous demand and income shocks at the national, sectoral and (since 2000), also regional levels.

The first version of the model was concluded in 1992 and, since then, new versions have been developed with improvements in model specification and coefficients' updates.

The purpose of this paper is to present the latest version of this model (MODEM 6A), implemented in 2008/09. Compared to version 5 (described in Dias and Lopes, 2005a) the main changes are:

- Change in the National Accounts basis, from base 1995 to base 2000, which implied, among other things, an autonomous consideration of transport margins;

- Revision of technical coefficients on the basis of a system of symmetric input-output tables built for Portugal for year 2005;

- Change of the model's price basis to current prices only;

- Endogenisation of the Balance of factor income.

The definition of model variables at current prices only had the purpose of simplifying model specification and coefficient estimation, having in consideration that, in the current version, the model is almost static[1] and prices are all exogenous, so that a conversion to constant prices will only be necessary for inter-temporal comparisons, which can easily be done in a spreadsheet, with exogenously defined price indexes, after running the appropriate model simulations.

Section 2 presents a description of the core model (the national block) while section 3 explains the regional block. Section 4 presents the method of estimation of the model

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[1] The only dynamic element in the model's current version is the equation for public debt (equation 60, Appendix 3).

coefficients and section 5 describes model applications in policy evaluation. Finally, section 6 presents some concluding remarks.

Appendix 1 presents a simplified diagram showing the main interactions in the model. Appendix 2 presents multiplier effects on GDP of some public policies, calculated through model simulations. Appendixes 3 and 4 present the list of model equations for the national and regional blocks, respectively, while appendix 5 lists the model variables and coefficients. Finally, appendix 6 shows the products/branches considered in the model and presents an example of values attributed to the tradability coefficients used in the regional block.

2. THE NATIONAL BLOCK

The national block of MODEM 6A is a static multisectoral model with 59 homogeneous branches (using ESA95[2] product nomenclature, P60), listed in Appendix 6.

This block allows the evaluation, at the national level, of the effect of exogenous demand and income shocks on domestic output, value added, employment and imports, by branches/products, as well as on disposable income, private consumption, GDP and fiscal variables.

The logic of the model is that supply is determined by demand and all components of final demand are exogenous except private consumption.

For each sector (except for sectors 1,2 and 5: Agriculture, Forestry and Fishing), **Output** and **Imports** are determined by final demand using matrices of technical coefficients decomposed into Domestic Production coefficients and Import coefficients (equations 1 and 11 in Appendix 3). Domestic output for Agriculture, Forestry and Fishing is exogenously determined and the adjustment between demand and supply in these sectors is made through imports (equations10).

Gross value added (GVA) at basic prices in each branch is obtained by multiplying the corresponding domestic output by a product transformation coefficient (equations 19).

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[2] *vide:* European Commission (1996).

Employment in each branch is obtained through the division of the respective GVA by the labour productivity estimated for that branch (equations 20).

Total output, imports, GVA and employment are obtained through the summation of the respective values across all sectors (equations 30 to 33).

Residents' **private consumption,** (C, equation 42), is determined by private (Households+Non-Profit Institutions Serving Households – NPISH) disposable income. Households' Consumption on the Territory is obtained from *C* through the addition of Tourism Balance and the subtraction NPISH's consumption (equations 43 to 45).

Households+NPISH's **disposable income** (YD, equation 51) is determined from national disposable income (equal to the sum of GDP with the balances of factor income, RF and of current transfers, TRE and OTRU, with the RoW), to which we subtract Government+Companies' disposable income.

Balances of current transfers with the Rest of the World (RoW) are exogenous while a part of the balance of factor income is an exogenously defined fraction of interest on public debt.

It is assumed that companies' disposable income represents an exogenously defined share of GDP while Governments' disposable income is obtained from the difference between Government's total revenue and total expenditure except public consumption.

Each component of **final demand** is **decomposed** into 59 products (corresponding to the branches considered in the model) and, for each product and demand component, three parts are identified: the part satisfied by domestically produced goods at basic prices, the part corresponding to imported goods CIF and the part corresponding to taxes less subsidies on products.

This decomposition is normally made using coefficients estimated on the basis of systems of input-output matrices for the Portuguese economy. However, alternative coefficients may be used in the simulation of demand shocks, allowing for a different breakdown by products of demand and/or a different import or tax content of the demand for each product, compared to the reference scenario.

The form of disaggregation of the various final demand components into products and parts is showed in equations 2 to 8 (domestic part), 12 to 18 (imported part) and 23 to 28 (taxes less subsidies).

Equations signaled with an apostrophe (2' to 28') correspond to the alternative of supplying to the model the values of final exogenous demand already decomposed by products. Note that, in this case, there is a need for special calculations concerning trade and transport products (50 to 52; 60, 61) through the application of specific trade and transport margins to the final demand of each of the remaining products.

GDP at market prices (Y) is obtained from the sum of final demand components and deduction of total imports (equation 50). Alternatively, GDP may also be calculated through the sum of total GVA at basic prices with total taxes (net of subsidies) on products (equation 50a). Although model specification and the method of calculation of model coefficients theoretically ensure that the results of both methods of GDP calculation are equal, this equation is normally included in the model simulation (assigning a different name to the dependent variable) with the purpose of detecting any possible errors in model programming or in coefficient estimation.

Government Total Balance (SGG) is obtained through the difference between total revenue and total expenditure (equation 61).

Public expenditure components are all exogenous with the exception of interest on public debt (JURG, equation 60), which depends on the level of public debt and on an implicit interest rate, defined exogenously.

Government capital transfers (TRKG) and **current transfers with the RoW**, TREG are only considered in balance (revenue less expenditure) and are both exogenous.

The other components of public revenue (taxes, social contributions and property income) are all endogenous. Taxes and contributions are functions of the corresponding tax basis (or a proxy of it) multiplied by exogenous tax rates. Taxes are decomposed into five categories: direct taxes on Households+NPISH (TD), company direct taxes (TDSC), capital taxes (TK), taxes (net of subsidies) on products (TIS) and other taxes on production (TP).

Direct taxes on Households+NPISH (TD, equation 53) are a function of private disposable income, while both **company** (TDSC, equation54) and **capital taxes** (TK, equation 57), as well as **Government Property Income+Gross Operating Surplus** (REPG, equation 59) are determined by GDP.

Taxes (net of subsidies) on products (TIS) are determined for each product from tax coefficients applied to the various intermediate and final demand flows (equations 22 to 29) and then aggregated across all products (equation 41).

Other taxes on production (TP) are calculated for each branch applying a tax coefficient to the respective output (equations 21) and aggregating across all branches (equation 40).

Social contributions received by the Government (CSOCG, equation 58) are a function of total compensation of employees.

The change in **public debt** (DIV, equation 60) depends on government total balance.

The above description corresponds to the standard version of the model, used in reference simulations. For variant simulations (used to evaluate the impact of policies and other exogenous shocks), a **fiscal policy rule** is often included in order to equate the public deficit (as percentage of GDP) to the reference scenario. This rule is particularly important in the evaluation of policies involving additional public expenditure because it ensures their financing.

In the **fiscal policy rule version** (equations 53', 62' and 63) , public deficit as a percentage of GDP is an exogenous variable (equal to the value simulated in the reference scenario) and the adjustment is made through the direct tax rate on Households+NPISH (rtdyd, equation 63).

3. THE REGIONAL BLOCK

MODEM's regional block was developed in order to allow the breakdown of national impacts of public policies or of other demand or income shocks (simulated in the national block) by the various Portuguese regions. In the current model version these regions are currently the seven NUTS II regions (according to the 1989 regions

nomenclature): North, Center, Lisbon and Tagus Valey, Alentejo, Algarve, Azores and Madeira.

The first version of MODEM's regional block was developed in 2000 to meet a request for an *ex-ante* evaluation of the regional impact of Regional Operational Programs financed by European Union structural funds (CSF III).[3]

This block can only be used when we have the regional breakdown of exogenous final demand components, except for Exports, as, for this variable, regionalization is endogenously determined by the model, for each exported product.

The national and regional blocks are connected in a top-down approach as the values simulated in the national block are used as inputs for simulating the regional block but with no feedback from the regional to the national block.

The methodology adopted for building the regional block was inspired in some of the suggestions expressed in Martins (2000) although it represents an evolution from them.

Given the unavailability of consistent systems of regional input-output matrices for all Portuguese regions[4] it was not possible to implement a methodology at the regional level similar to the one used at the national level and so the method implemented was based on a number of simplifying assumptions concerning regions.

The first assumption was that, for each branch, technical coefficients and their breakdown into national and import coefficients (an_{ij} and am_{ij}) were the same for all regions (equal to the ones estimated for Portugal).

A coefficient of tradability with the remaining Portuguese regions was defined for each region and branch (δ_{ir}), situated between zero and one (**zero** meaning perfect tradability and **one** meaning absolute non-tradability). These coefficients should reflect, not only the physical possibility of inter-regional trade but also the degree of preference for the region's own goods for reasons such as a lower price (associated to lower transport costs) and/or greater freshness (eg: bread, etc).

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[3] This first version is described in Dias (2000) and its application to the ex-ante evaluation of ROPs is shown in Dias and Lopes (2001).

[4] A project for developing consistent systems of I-O tables for all NUTS II Portuguese regions is currently (in 2009) being initiated in DPP.

For perfectly tradable goods ($\delta_{ir} = 0$) it was assumed that demand for domestic good i would be satisfied by the various Portuguese regions proportionately to the respective geographic distribution of GVA, as shown by the Regional Accounts, while for non-tradable goods and services ($\delta_{ir} = 1$) demand would be satisfied by the region where demand was generated.

The regional block has 791 simultaneously determined equations: 392 equations for regional output by branches (56 endogenous output branches $\times$ 7 regions), the same amount of equations for demand generated in each region for each product and seven equations (one for each region) calculating the share of each region in the induced national disposable income.

Simultaneous determination of regional supply (output) and demand is justified by the interdependency of these two sets of variables: output is determined by demand but the productive process generates itself more demand (for intermediate goods and for consumption goods as production generates more disposable income).

In equations for **regional output** (Appendix 4, eq. 64) the output of branch i in region r is determined by the demand addressed to it, which is composed of total demand for non-tradable goods of branch i generated in the own region ($\delta_{ir} \times DN_{ir}$) plus a fraction ($\gamma^*_{ir}$) of total demand for domestic tradable goods of branch i (generated in all Portuguese regions, $\sum_s (1 - \delta_{is}) \times DN_{is}$ and abroad, EXN_i).

γ^*_{ir} (equations 65) is the fraction of total demand for domestic tradable goods of branch i that is satisfied by output of region r. In these equations we use Boole Algebra, including propositions (*e.g.*: $\delta_{ir} = 1$) that assume the value $= 1$ if they are true and zero if they are false. When $\delta_{ir} \neq 1$ and $\delta_{is} \neq 1$ for all regions s (*i.e.*, when the goods produced in branch i are, at least partially tradable among all portuguese regions), γ^*_{ir} is equal to the share of region r in National Gross Value Added of branch i (γ_{ir}, calculated for each year from the respective Regional Accounts). When $\delta_{ir} = 1$ (*i.e.* when goods of branch i are totally non-tradable between region r and the remaining regions) then $\gamma^*_{ir} = 0$ because we assume that, in this case, region r cannot satisfy any demand generated outside the region. Finaly, when $\delta_{ir} \neq 1$ but there is some $\delta_{is} = 1$, then $\gamma^*_{ir} = \gamma_{ir} / (\Sigma_s$

$\gamma_{is} \times (\delta_{is} \neq 1))$ which means that γ^*_{ir} is the share of region r in national GVA of branch i, recalculated after excluding the regions where i is non-tradable.

Specification of equations 64 and 65, associated to the fact that $\Sigma_r \gamma_{ir} = 1$ and the imposition, for all branches with positive exports, of $\delta_{ir} < 1$ for at least one region, ensure that, for each branch, the sum of regional output across all regions is equal to total demand of Portuguese goods from that branch (domestic demand $= \Sigma_r DN_{ir}$ +foreign demand $= EXN_i$):

$$\sum_r X_{ir} = \sum_r DN_{ir} + EXN_i$$

Demand for domestic good i **generated in region** r (DN_{ir}, equations 66) is composed of intermediate demand, associated to the own region's production ($\Sigma_j an_{ij} \times X_{jr}$) and final demand, decomposed into (almost) exogenous final demand (DDN_{ir}) e induced final demand ($DIZN_{ir}$).

DDN_{ir} (equations 67) is equal to the sum of exogenous final demand for domestic good i, generated in region r (Public Consumption, NPISH's Consumption, GFCF, Net Acquisition of Valuables, Change in Inventories) with a fraction of Households' consumption of domestic good i (equal to the share of exogenous (after tax) income received by region r on total private disposable income simulated by the model in the national block). Exogenous income includes subsidies, Government current transfers and current transfers/incomes received from the RoW.

Final induced demand of domestic good i generated in region r ($DIZN_{ir}$, equations 73) is assumed to be a proportion of total Households' consumption of that domestic good which is not associated to the exogenous income. This proportion (α_r, equations 74) is equal to the share of region in total national GVA (simulated by the model).

Regional Gross Value Added in each branch (equations 76) is obtained in a similar way to the national GVA determination, i.e. through the multiplication of the corresponding regional output by the national product transformation coefficient (in line with the assumption of equal technical coefficients for all regions).

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Regional employment in each branch (equations 77) is obtained through the division of the respective GVA by the regional labour productivity estimated for that branch (calculated from Regional Accounts).

The form of specification of the regional block ensures that the sum of regional outputs (GVA) for each branch equals total output (GVA) simulated for Portugal for that branch in the national block. However, for Employment, the identity between the sum of regional employment in each branch across all regions, simulated in the regional block and the corresponding total employment simulated in the national block may not necessarily hold because different labour productivities are considered for the different regions and for Portugal as a whole. Therefore, whenever the regional block is used, equations 20 and 32 (determining employment in the national block) are disabled and sectoral and total employment at the national level are obtained through the sum of regional employment simulated in the regional block (equations 79 and 80).

4. MODEL CALIBRATION

Model coefficients are normally estimated for each of the years for which model simulations are necessary, on the basis of available statistical information from National and Regional Accounts (for past and present years) and considering scenarios for the Portuguese economy (for future years).

After estimating all the model coefficients for the national block, for a specific year, a model reference simulation is performed for that year using the national block in order to check the correctness of model specification and coefficients estimation, through the comparison of simulated and actual (or projected) values for each variable. Model calibration for each year is only accepted when all values match.

At the moment of writing this paper, MODEM 6A has been calibrated only for 2005 on the basis of final National and Regional Accounts for that year, which include a system of symmetric input-output tables (product by product)[5] considering the same products/homogeneous branches as existing in the model (listed in Appendix 6).

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[5] Presented in Dias (2008).

Inter-regional tradability coefficients (δ_{ir}) are defined taking into account the following aspects:

- The nature of goods and services produced in each branch, analyzing each branch's composition at a more detailed level;

- The share of national (regional) output in the satisfaction of internal national (regional) demand for each branch, calculated from national and regional existing input-output tables.

Anyway, there is a certain degree of subjectivity in the definition of values for these tradability coefficients and so sensitivity analysis has been performed using different assumptions for the values of δ_{ir}, as it was the case in Dias and Lopes (2005b), where the impact of Regional Operational Programs was evaluated (*ex-post*, for 2000-2003) using MODEM 5. As an example, Appendix 6 presents the central assumption for those coefficients used in that study.

It should be noted that the degree of inter-regional tradability tends to increase along time as a result of new technologies facilitating trade and mobility, in particular for services (with the generalization of internet use) and so these coefficients should be revised along time.

For the national block, **technical coefficients** for 2005 were calculated from the following set of eleven input-output tables (Dias, 2008):

- FT : Total Flows at purchasers' prices;

- PN: Domestic Output at basic prices;

- M : Imports CIF;

- TIS: Taxes, net of subsidies, on products;

- MCk: Trade Margins of type k, for k=50 (trade of motor vehicles and fuel), 51(other wholesale trade), 52(other retail trade) (three I-O tables);

- MTNk: Transport Margins of type k, satisfied by domestic output, for k=60 (land transport), 61 (water transport) (two I-O tables);

- MTMk: Transport Margins of type k, satisfied by imports, for k=60 (land transport), 61 (water transport) (two I-O tables).

Let MAT_{ij} or MAT_{iF} represent the elements of order (i,j) or (i,F) of the corresponding input-output table for MAT= the abovementioned I-O tables, X_j = domestic output of product j at basic prices, F = C (Households' consumption), CS15 (NPISH's final consumption), G (Government final consumption), I (GFCF), VE (Change in inventories), V (Net acquisition of valuables), EX (Exports) and Ftot= total value (at purchasers' prices) of final demand of type F.

Technical coefficients were calculated using the following formulas:

$a_{ij}=FT_{ij}/X_j$ Total technical coefficient of order (i, j), representing the quantity of product *i* (at purchasers' prices) necessary to produce one unit of product *j* (at basic prices);

$a_{iF}=FT_{iF}/Ftot$ Share of product *i* (at purchasers' prices) in total final demand of type F (at purchasers' prices);

$an_{ij}=PN_{ij}/X_j$ Quantity of domestically produced good *i* (at basic prices) used to produce one unit of product *j* (at basic prices);

$an_{iF}=PN_{iF}/Ftot$ Share of domestically produced good *i* (at basic prices) in total final demand of type F (at purchasers' prices);

$am_{ij}=M_{ij}/X_j$ Quantity of imported product *i* (CIF) used to produce one unit of product *j* (at basic prices);

$am_{iF}=M_{iF}/Ftot$ Share of imported product good *i* (CIF) in total final demand of type F (at purchasers' prices);

a^{*}_{ij} – quantity of product *i* (at basic prices) necessary to produce one unit of product *j* (at basic prices) ($a^{*}_{ij} = an_{ij} + am_{ij}$);

a^*_{iF} – Share of product i (at basic prices) in total final demand of type F (at purchasers' prices) ($a^*_{iF} = an_{iF} + am_{iF}$);

$ats_{ij} = TIS_{ij}/X_j$ Taxes on products (net of subsidies) included in the input of product i necessary to produce one unit of product j;

$ats_{iF} = TIS_{iF}/Ftot$ Share of taxes on products (net of subsidies) paid for product i in total final demand of type F (at purchasers' prices);

$av_i = VAB_i/X_i$ Product transformation coefficient for product i (share of GVA in the value of domestic output of product i, at basic prices);

$al_i = REM_i/X_i$ Share of compensations of employees in the value of domestic output of product i, at basic prices;

$otp_i = TP_i/X_i$ Share of Other Taxes on Production in the value of domestic output of product i, at basic prices;

$amtm_{kF} = (-\sum_{i \neq k} MTMk_{iF})/Ftot$ (-)Share of transport margins satisfied by imports in total final demand of type F (at purchasers' prices).

$amtn_{kF} = (-\sum_{i \neq k} MTNk_{iF})/Ftot$ (-)Share of transport margins satisfied by domestic output in total final demand of type F (at purchasers' prices)

It was also necessary to calculate trade and transport margins' rates for each product and component of final demand. These rates are used for the simulation of the output of branches supplying trade services (50 to 52) and of output and imports[6] of land (60) and water (61) transport services whenever the structure of some final demand components is different from the reference structure (based on I-O tables). This need derives from the fact that margin rates have a wide variation across the 59 product considered in the model (for example, they are null for Construction and Services).

Trade margin rate of type k on final demand of type F for product i was calculated by the following formula:

$tmcF_i^k = MCk_{iF} / FT_{iF}$ for   F=C, G, I, V, EX;   k = 50, 51, 52; $i \neq k$

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[6] It should be noted that, while trade margins are entirely satisfied by domestic output, this may not be the case for transport margins, which can be partially satisfied by imports.

Transport margin rates of type k on final demand of type F for product i, satisfied, respectively by domestic output and by imports wer calculated by the following formulas:

$$tmtnF_i^k = MTNk_{iF} / FT_{iF} \quad \text{(satisfied by domestic output)}$$

$$tmtmF_i^k = MTMk_{iF} / FT_{iF} \quad \text{(satisfied by imports)}$$

for $F = C, I$; $\quad k = 60, 61$; $\quad i \neq k$

5. MODEL APPLICATIONS - POLICY EVALUATION

The various versions of MODEM have been used in the evaluation of the impact on the Portuguese economy of large projects and events, such as public investment programs, including those co-financed by the European Union.

Examples of such studies are, at the national level, the evaluation of the impact of EXPO'98, which took place in Lisbon (DPP, 1996; Proença *et al*., 1998) and of the Government Investment and Development Programs, PIDDAC (Dias and Lopes, 2004), and, at the national and regional levels, the evaluations of Regional Operational Programs (Dias and Lopes, 2001 and 2005b).

Appendix 1 presents a simplified model diagram showing the main channels of influence of exogenous demand and income shocks on macroeconomic variables.

Impact evaluation at the national level is made through the comparison of the results of two model simulations for each of the years to which the impacts refer to:

- a **reference simulation**, reproducing the observed or projected performance for the Portuguese economy;

- a **simulation** corresponding to **what would happen to the economy in the absence (presence) of the exogenous shock** subject to evaluation (depending whether the shock is already included or not in the reference simulation). This simulation is performed after revising the values of the exogenous variables in order to exclude (include) the direct effect of the shock on them.

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The macroeconomic impact of the shock is measured through the percent deviation between the two simulations for each model variable, such as GDP and Employment.

When we wish to estimate the breakdown of national impacts by regions, using the regional block, the second simulation is done **considering only the effects of the shock** by attributing to the exogenous variables only the values directly attributable to it. Given that the model is linear, the results of this simulation are identical to the difference between the simulations "with" and "without" the shock.

Concerning MODEM 6A, some model simulations were performed at the national level to estimate the multiplier effect of various types of public policies on GDP. A summary of the results of those simulations is presented in Appendix 2, comparing the effects of the following types of public expenditure: Public Investment in Infrastructures, in Equipment and in Computer Services; Public Consumption (Education Services; Public Administration) and Current Transfers to Households.

The size of the multiplier effect on GDP is strongly related to the import content (direct+indirect) of each type of expenditure, as well as to the assumed level of marginal propensity to consume (MPC). Appendix 2 presents, for each type of expenditure, the respective direct and indirect import contents and the multiplier effects on GDP for two different levels of MPC (0.7 and 0.9).

Among the selected types of public expenditure, the highest multiplier effect on GDP was observed for **Education** (1.3 to 1.5), due to its low import content (3%), while the lowest impact respects to **Investment in Equipment** (0.4 to 0.5), which has the highest import content (68%). By descending order of the estimated multiplier effects on GDP we have (after Education expenditure and before Investment in Equipment) **Public Administration Services** (1.3 to 1.4), **Investment in Computer Services** (1.1 to 1.2), **Investment in Infrastructures** (1.1 to 1.2) and **Current Transfers to Households** (0.6 to 0.9).

The impact of current (monetary) transfers to households, measured by the model, is only indirect, through the additional consumption expenditure generated by the additional disposable income, but because normally not all this income is spent

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(MPC<1), the impact of this transfers is generally lower than the impact of social transfers in kind (consumer goods and services), which have a direct impact on the economy.

The impact of private consumption on GDP is also, on average, lower than the impact of public consumption given the higher importer content of the first (25% on average), compared to the second (9% on average).

6. CONCLUDING REMARKS

This paper presented MODEM 6A, a multisectoral (input-ouput based) model for Portugal with a multiregional extension, allowing the evaluation of the impact of public policies and of other exogenous demand and income shocks on macroeconomic variables, at the national, sectoral (59 sectors) and regional (7 regions) levels.

The model is currently calibrated for 2005 on the basis of a complete system of symmetric (product by product) input-output tables for Portugal.

The link between the national and the regional blocks in the model is of a top-down nature: firstly, national impacts are simulated in the national block and secondly, a breakdown of national impacts by seven Portuguese regions is performed in the regional block through a system of 791 simultaneous equations ensuring the balance between regional demand and supply for each product in an interactive way.

Some results of model simulations at the national level were presented in section 5 and Appendix 2, showing the estimated multiplier effects of various types of public expenditure on GDP, including various types of public investment (infrastructures; equipment; computer services), public consumption (education services; public administration) and current transfers to households. From the selected types of public expenditure, the highest multiplier effect refers to **Education** (1.3 to 1.5), followed by **Public Adminstration** (1.3 to 1.4), **Investment in Computer Services**(1.1 to 1.2), **Investment in Infrastructures** (1.1 to 1.2), **Current Transfers to Households** (0.6 to 0.9), with the lowest impact coming from **Investment in Equipment** (0.4 to 0.5). These results are strongly related to the import content (direct and indirect) of each type of

expenditure (for public consumption and investment), a higher import content implying a lower impact on GDP. For current transfers on households, their impact on GDP depend on marginal propensity to consume associated to those transfers and on the import content of private consumption.

Although the model, in its current formulation, simulates only demand-side effects of public policies, it is interesting to verify that the highest simulated impact goes to Education expenditure, which is also the type of public expenditure (investment in human capital) with the highest multiplier effect on GDP using a different type of model for the Portuguese economy, HERPOR, a macroeconometric dynamic model considering both demand and supply-side effects of public policies (Dias, 2006, section 4.2).

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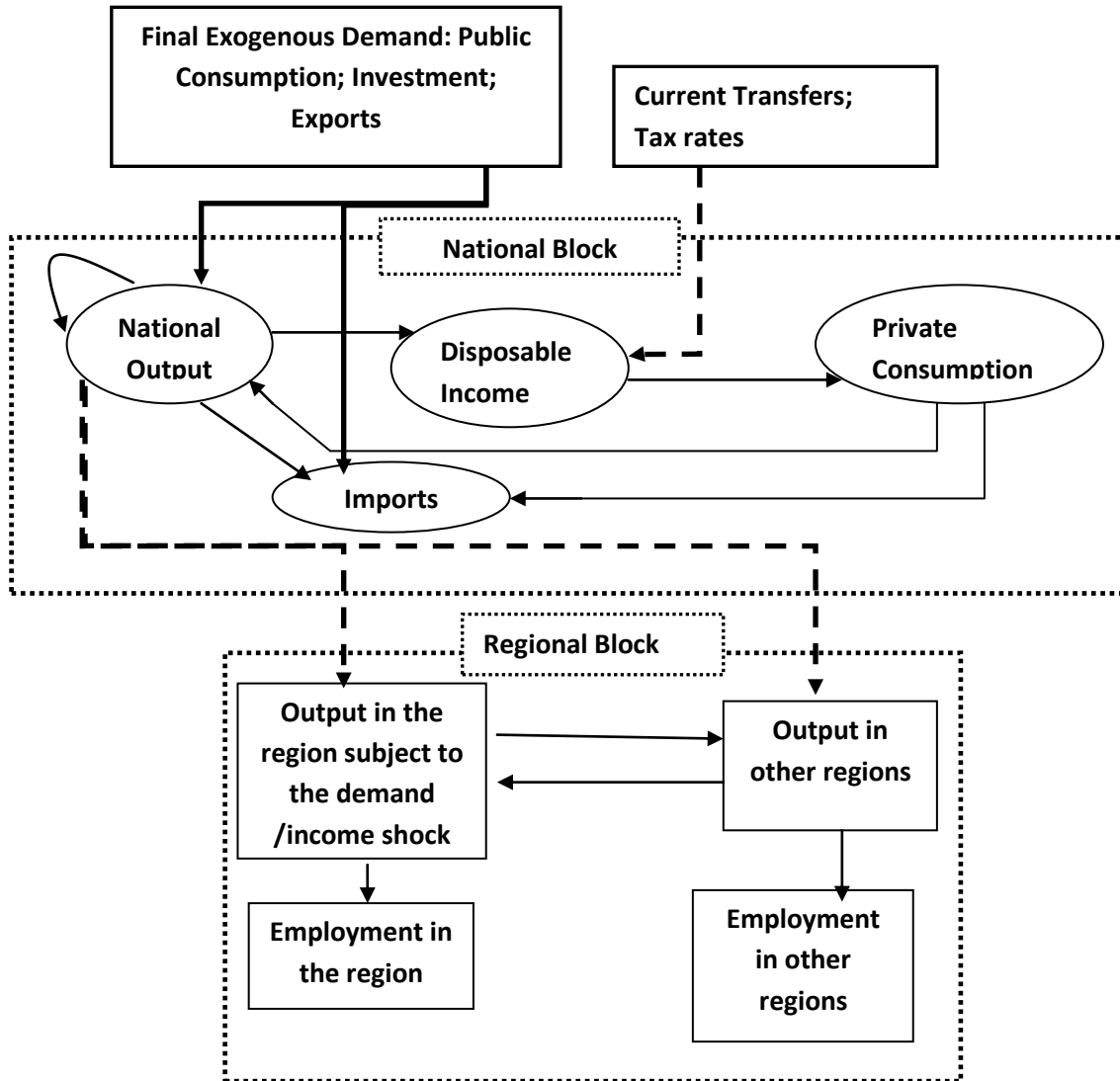
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MODEM 6 AND THE EVALUATION OF THE IMPACT OF EXOGENOUS DEMAND AND INCOME SHOCKS - A SIMPLIFIED DIAGRAM

```
┌─────────────────────────────┐
│ Final Exogenous Demand: Public │      ┌──────────────────┐
│ Consumption; Investment;     │      │ Current Transfers; │
│        Exports               │      │    Tax rates       │
└─────────────────────────────┘      └──────────────────┘

            National Block

    ╭──────────╮      ╭──────────╮        ╭──────────╮
    │ National │ ───> │ Disposable│ <──── │  Private  │
    │  Output  │      │  Income   │ ────> │Consumption│
    ╰──────────╯      ╰──────────╯        ╰──────────╯
                  ╭──────────╮
                  │  Imports  │
                  ╰──────────╯

            Regional Block

┌─────────────────┐        ┌──────────────┐
│  Output in the  │ ─────> │  Output in    │
│ region subject to│ <──── │ other regions │
│   the demand     │        └──────────────┘
│  /income shock   │               │
└─────────────────┘               ▼
        │                  ┌──────────────┐
        ▼                  │  Employment  │
┌─────────────────┐        │  in other    │
│  Employment in  │        │   regions    │
│   the region    │        └──────────────┘
└─────────────────┘
```

APPENDIX 2

MULTIPLIER EFFECT OF PUBLIC POLICIES ON GDP

Evaluation with MODEM 6A, with no fiscal policy rule and using coefficients estimated for Portugal, 2005; rf1=0.85

Type of public expenditure (product codes in brackets)	Import content			Multiplier effect on GDP	
	Direct	Indirect	Dir+Indir	MPC =0.7	MPC=0.9
Investment in Infrastructures (a) (45)	0	0.20	0.20	1.07	1.19
Investment in Equipment (b)(28 to 36)	0.55	0.13	0.68	0.43	0.47
Investment in Computer and related Serv. (72)	0.09	0.08	0.17	1.11	1.22
Public Consumption - Education Services (80)	0	0.03	0.03	1.33	1.48
Public Consumption – Administration(75)	0	0.06	0.06	1.29	1.44
Current Transfers to Households				0.61	0.86

Households' Consumption (total)	0.13	0.12	0.25
Public Consumption (total)	0.02	0.08	0.09

MPC: marginal propensity to consume.

(a) Assuming that it is 100% Gross Fixed Capital Formation (GFCF) in Construction.

(b) GFCF in the products 28 to 36 (using the structure for those products observed for Portuguese total GFCF in 2005).

See Appendix 6 for product identification.

APPENDIX 3

EQUATIONS OF MODEM 6A – NATIONAL BLOCK

Note: Unless otherwise specified, indexes *i* and *j* (identifying products/branches) assume the values 1,2, 5, 10 to 37, 40 to 41, 45, 50 to 52, 55, 60 to 67, 70 to 75, 80, 85, 90 to 93 and 95 (from ESA 95 Product Nomenclature P60). Summations are across all index values, unless otherwise specified. **Exogenous** variables are presented in **bold** characters. All coefficients and rates are also exogenous with the exception of the private income tax rate (rtdyd) which is endogenous in the fiscal policy rule model version.

1. SECTORAL EQUATIONS

1.1. Output, Expenditure and Employment

Domestic Output (except for Agriculture, Forestry and Fishing):

(1) $X_i = \sum_j an_{ij} \times X_j + CTN_i + GN_i + CS15N_i + IN_i + VEN_i + ACOVN_i + EXN_i$ (i = 10,...,95)

Private Consumption (households) of domestic goods and services:

(2) $CTN_i = an_{iC} \times CT$ (i = 10,...,95)

or

(2') $CTN_i = an_{iC} \times CTS + qn_{iC} \times \mathbf{CEP_i}$ for $i \neq 1, 2, 5, 50, 51, 52, 60, 61$ and

$CTN_k = \sum_{i \neq k} tmcc_i^k \times (a_{iC} \times CTS + \mathbf{CEP_i}) + (a_{kc} - ats_{kc} - am_{kc}) \times CTS$

$+ [(a_{kc} - ats_{kc} - am_{kc})/(a_{Kc})] \times \mathbf{CEP_k}$ for   k = 50, 51, 52   and

$CTN_k = \sum_{i \neq k} tmtnc_i^k \times (a_{iC} \times CTS + \mathbf{CEP_i}) + (a_{kc} - ats_{kc} - am_{kc} - amtm_{kc}) \times CTS$

$+ [(a_{kc} - ats_{kc} - am_{kc} - amtm_{kc})/(a_{kc})] \times \mathbf{CEP_k}$ for   k = 60, 61

Consumption of domestic goods and services by Non-Profit Institutions Serving Households (NPISH):

(3) $CS15N_i = an_{ics15} \times \mathbf{CS15}$ (i = 10,...,95)

Public Consumption of domestic goods and services :

(4) $GN_i = an_{iG} \times \mathbf{G}$ (i = 1,...,95)
 or
(4') $GN_i = qn_{iG} \times \mathbf{G_i}$ for $i \neq 50, 51, 52$ and

$GN_k = \sum_{i \neq k} tmcg_i^k \times \mathbf{G_i} + [(a_{kG} - ats_{kG} - am_{KG})/(a_{KG})] \times \mathbf{G_k}$ for k = 50, 51, 52

Gross Fixed Capital Formation (GFCF) of domestic goods and services:

(5) $IN_i = an_{iI} \times \mathbf{IT}$ $\qquad$ (i = 1,...,95)

or

(5') $IN_i = qn_{iI} \times \mathbf{I_i}$ $\qquad$ for all $\qquad$ i ≠ 50, 51, 52, 60, 61 $\qquad$ and

$\quad IN_k = \sum\limits_{i \neq k} tmci_i^k \times \mathbf{I_i} + [(a_{kI} - ats_{kI} - am_{kI})/(a_{KI})] \times \mathbf{I_K}$ $\quad$ for k = 50, 51, 52

$\quad IN_k = \sum\limits_{i \neq k} tmtni_i^k \times \mathbf{I_i} + [(a_{kI} - ats_{kI} - am_{kI} - amtm_{kI})/(a_{kI})] \times \mathbf{I_k}$ $\quad$ for k = 60, 61

Change in Inventories of domestic goods:

(6) $VEN_i = an_{iVE} \times \mathbf{VE}$ $\qquad$ (i = 1,...,95)

Net Acquisition of Valuables of domestic goods:

(7) $ACOVN_i = an_{iv} \times \mathbf{ACOV}$ $\qquad$ (i = 1,...,95)

or

(7') $ACOVN_i = qn_{iV} \times \mathbf{ACOV_i}$ $\qquad$ for all i ≠ 50, 51, 52 $\qquad$ and

$\quad ACOVN_k = \sum\limits_{i} tmcv_i^k \times \mathbf{ACOV_i} + [(a_{kV} - ats_{kV} - am_{kV})/(a_{kV})] \times \mathbf{ACOV_k}$ $\quad$ for k=50,51,52

Exports of domestic goods and services at basic prices:

(8) $EXN_i = an_{iEX} \times (\mathbf{EXTS} + qacif \times MT)$ $\qquad$ (i = 1,...,95)
or

(8') $EXN_i = qn_{iEX} \times EX_i$ $\qquad$ for all i ≠ 50, 51, 52 $\qquad$ and

$\quad EXN_k = \sum\limits_{i \neq k} tmcx_i^k \times EX_i + [(a_{kEX} - ats_{kEX} - am_{kEX})/(a_{kEX})] \times EX_k$ $\quad$ for k = 50, 51, 52

Exports at purchasers' prices:

(9) $EX_i = \mathbf{EXS_i} + w_i \times qacif \times MT$ $\qquad$ (i = 1,...,95)

Imports of products of Agriculture, Forestry and Fishing:

(10) $M_i = \sum\limits_{j} a_{ij}^* X_j + a_{iC}^* \times CTS + (a_{iC}^*/a_{iC}) \times \mathbf{CEP_i} + (a_{iI}^*/a_{iI}) \times \mathbf{I_i} + a_{iCS15}^* \times \mathbf{CS15} + GM_i + GN_i +$

$+ VEN_i + VEM_i + ACOVN_i + ACOVM_i + EXN_i + EXM_i - \mathbf{X_i}$ $\qquad$ (i = 1,2,5)

Imports of other goods and services:

(11) $M_i = \sum\limits_{j} am_{ij} X_j + CTM_i + CS15M_i + GM_i + IM_i + VEM_i + ACOVM_i + EXM_i$ $\quad$ (i = 10,...,95)

22

Private Consumption (households) of imported goods and services:

(12) $CTM_i = am_{iC} \times CT$ $\qquad$ (i = 10,...,95)

or

(12') $CTM_i = am_{iC} \times CTS + qm_{iC} \times \mathbf{CEP_i}$ $\qquad$ for i = 10,..., 55, 62,...,95 $\qquad$ and

$\qquad CTM_k = \sum_{i \neq k} tmtmc_i^k \times (a_{iC} \times CTS + \mathbf{CEP_i}) + (a_{kc} - ats_{kc} - an_{kc} - amtn_{kc}) \times CTS$

$\qquad\qquad + [(a_{kc} - ats_{kc} - an_{kc} - amtn_{kc})/(a_{kc})] \times \mathbf{CEP_k}$ $\qquad$ for $\quad$ k = 60, 61

Consumption of imported goods and services by NPISH:

(13) $CS15M_i = am_{ics15} \times \mathbf{CS15}$ $\qquad$ (i = 10,...,95)

Public Consumption of imported goods and services:

(14) $GM_i = am_{iG} \times \mathbf{G}$ $\qquad$ or $\quad$ (14') $GM_i = qm_{iG} \times \mathbf{G_i}$ $\qquad$ (i = 1,...,95)

GFCF of imported goods and services:

(15) $IM_i = am_{iI} \times \mathbf{IT}$ $\qquad$ (i = 1,...,95)

or

(15') $IM_i = qm_{iI} \times \mathbf{I_i}$ $\qquad$ for i ≠ 60, 61 $\qquad$ and

$\qquad IM_k = \sum_{i \neq k} tmtmi_i^k \times \mathbf{I_i} + [(a_{kI} - ats_{kI} - an_{kI} - amtn_{kI})/(a_{kI})] \times \mathbf{I_k}$ $\quad$ for $\:$ k = 60, 61

Change in Inventories of imported goods:

(16) $VEM_i = am_{iVE} \times \mathbf{VE}$ $\qquad\qquad\qquad$ (i = 1,...,95)

Net Acqusition of Valuables of imported goods:

(17) $ACOVM_i = am_{iv} \times \mathbf{ACOV}$ $\quad$ ou $\quad$ (17') $ACOVM_i = qm_{iv} \times \mathbf{ACOV_i}$ $\qquad$ (i = 1,...,95)

Exports of imported goods:

(18) $EXM_i = am_{iEX} \times (\mathbf{EXTS} + qacif \times MT)$ $\quad$ (i = 1,...,95)
or

(18') $EXM_i = qm_{iEX} \times EX_i$ $\qquad$ (i = 1,...,95)

Gross Value Added at basic prices (GVA):

(19) $VAB_i = av_i \times X_i$ $\qquad\qquad\qquad$ (i = 1,...,95)

Employment:

(20) $N_i = VAB_i / \mathbf{PROT_i}$ ⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀ (i = 1,...,95)

1.2. Indirect taxes and subsidies

Other Taxes on Production:

(21) $TP_i = otp_i \times X_i$ ⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀ (i = 1,...,95)

Taxes less subsidies on products:

(22) $TIS_i = \sum_j ats_{ij} \times X_j + CTIS_i + CS15IS_i + GIS_i + IIS_i + VEIS_i + ACOVIS_i + EXIS_i$ ⠀⠀ (i = 1,...,95)

Taxes less subsidies on products for Households' Private Consumption:

(23) $CTIS_i = ats_{iC} \times CT$ ⠀⠀ or ⠀⠀ (23') $CTIS_i = ats_{iC} \times CTS99 + qis_{iC} \times \mathbf{CEP_i}$ ⠀⠀ (i = 1,...,95)

Taxes less subsidies on products for NPISH's Consumption:

(24) $CS15IS_i = ats_{iCs15} \times CS15$ ⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀ (i = 1,...,95)

Taxes less subsidies on products for Public Consumption :

(25) $GIS_i = ats_{iG} \times \mathbf{G}$ ⠀⠀⠀⠀⠀⠀⠀ or ⠀⠀⠀⠀ (25') $GIS_i = qis_{iG} \times \mathbf{G_i}$ ⠀⠀⠀⠀ (i = 1,...,95)

Taxes less subsidies on products for GFCF:

(26) $IIS_i = ats_{iI} \times \mathbf{IT}$ ⠀⠀⠀⠀⠀⠀⠀⠀ or ⠀⠀ (26') $IIS_i = qis_{iI} \times \mathbf{I_i}$ ⠀⠀⠀⠀⠀⠀ (i = 1,...,95)

Taxes less subsidies on products for Change in Inventories:

(27) $VEIS_i = ats_{iVE} \times \mathbf{VE}$ ⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀ (i = 1,...,95)

Taxes less subsidies on products for Net Acqusition of Valuables:

(28) $ACOVIS_i = ats_{iV} \times \mathbf{ACOV}$ ⠀⠀ or ⠀⠀ (28') $ACOVIS_i = qis_{iV} \times \mathbf{ACOV_i}$ ⠀⠀ (i = 1,...,95)

Taxes less subsidies on products for Exports:

(29) $EXIS_i = (ats_{iEX}/a_{iEX}) \times EX_i$ ⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀ (i = 1,...,95)

2. TOTALIZING EQUATIONS

(30) $X = \Sigma X_i$ ⠀⠀⠀⠀⠀⠀⠀⠀⠀⠀ **Total domestic output at basic prices**

(31) $VAB = \Sigma\ VAB_i$ **Total Gross Value Added at basic prices (GVA)**

(32) $N = \Sigma\ N_i$ **Total Employment**

(33) $MT = \Sigma\ M_i$ **Total Imports CIF (excluding Tourism)**

(34) $IT = \Sigma\ \mathbf{I_i}$ **Total GFCF**

(35) $G = \Sigma\ \mathbf{G_i}$ **Public Consumption**

(36) $ACOV = \Sigma\ \mathbf{ACOV_i}$ **Net Acquisition of Valuables**

(37) $EXT = \Sigma\ EX_i$ **Exports (excluding Tourism)**

(38) $CEP = \Sigma\ \mathbf{CEP_i}$ **Tourism Exports**

(39) $REM = \Sigma\ al_i X_i$ **Compensation of Employees**

(40) $TP = \Sigma\ TP_i$ **Other Taxes on Production**

(41) $TIS = \Sigma\ TIS_i$ **Taxes less subsidies on products**

3. MACROECONOMIC EQUATIONS

3.1. GDP, income and expenditure:

(42) $C = \beta_0 + \beta_1 \times YD$ **Residents' Private Consumption (Households+NPISH)**

(43) $CTS = C - CPE - \mathbf{CS15}$ **Resident Households' Consumption on Territory**

(44) $CPE = \alpha \times C$ **Tourism Imports**

(45) $CT = CTS + CEP$ **Households' Consumption on Territory**

(46) $EX = EXTS + CEP$ **Exports FOB (including Tourism)**

(47) $EXTS = EXT - qacif \times MT$ **Exports (excluding tourism) after deducting CIF/FOB adjustment**

(48) $M = MTS + CPE$ **Imports FOB (including Tourism)**

(49) $MTS = MT \times (1 - qacif)$ **Imports FOB (excludingTourism)**

(50) $Y = C + G + IT + \mathbf{VE} + \mathbf{ACOV} + EX - M$ **GDP obtained from Expenditure**

(50a) $Y = VAB + TIS$ **GDP obtained from GVA**

Private Disposable Income (Households+NPISH):

(51) YD = Y×(1 - psy) +RF+**TRE**+**OTRU** –TD–**TD2S** – TDSC – CSOCG – TISUB – REPG + **TRIG** + JURG

(52) RF = **RF0** - rf1*JURG   **Balance of Factor income with the RoW**

3.3. Publice Finance

(53) TD = rtdyd × YD   **Direct Taxes on Households+NPISH**

(53') TD = SGG – TDSC – CSOCG – TISUBG – REPG + **GCORR** + **TRIG** – **TRE**+JURG – TK – **TRKG** + **IG**   (fiscal policy rule version)

(54) TDSC = rtdsy × Y   **Direct Taxes on Corporations**

(55) TISUB=TIS+TP– **OZG** – **OZC**   **Total Indirect Taxes less Subsidies**

(56) TISUBG=(TIS+TP)×tigts– **OZG**   **Indirect taxes less Subsidies (received-payed by the Government)**

(57) TK = tky × Y   **Capital taxes**

(58) CSOCG = tcsocg × REM   **Social Contributions received by the Government**

(59) REPG=repgy×Y   **Government Gross Operating Surplus+Property Income**

(60) DIV = DIV(-1) – SGG + **DAT**   **Public Debt**

(61) JURG = **RG** × DIV   **Interest on Public Debt**

Government Total Balance:

(62) SGG = TD + TDSC + **TD2S** + CSOCG + TISUBG + REPG – **GCORR** – **TRIG** + **TREG** – JURG + TK + **TRKG** - **IG**

(62') SGG = **sggy** × Y   (fiscal policy rule version)

Direct Tax Rate on Households+NPISH   (for fiscal policy rule version only):

(63) rtdyd = TD / YD

APPENDIX 4

EQUATIONS OF MODEM 6A – REGIONAL BLOCK

Note: Index j assumes the values 1, 2, 5, 10 to 37, 40 to 41, 45, 50 to 52, 55, 60 to 67, 70 to 75, 80, 85, 90 to 93 and 95 (from ESA95 Product nomenclature P60), index i assumes the same values except 1, 2 e 5 (the branches with exogenous output) and indexes r and s refer to the seven NUTS II Portuguese regions (North, Center, Lisbon and Tagus Valey, Alentejo, Algarve, Azores and Madeira). Summations are across all index values, unless otherwise specified. **Exogenous** variables are presented in **bold** characters. All coefficients and rates are also exogenous with the exception of the private income tax rate (rtdyd) which is endogenous in the fiscal policy rule model version.

1. REGIONAL OUTPUT

Output of branch i in region r:

(64) $X_{ir} = \delta_{ir} \times DN_{ir} + \gamma^*_{ir} \times [\sum_s (1 - \delta_{is}) \times DN_{is} + EXN_i]$

Proportion of total demand for domestically produced tradable goods of branch i that is satisfied by region r:

(65) $\gamma^*_{ir} = [\gamma_{ir} \times (\delta_{ir} \neq 1)] / [\sum_s \gamma_{is} \times (\delta_{is} \neq 1) + (\delta_{ir} = 1)]$

2.. REGIONAL DEMAND

Total demand for domestic good i, generated in region r:

(66) $DN_{ir} = \sum_j an_{ij} \times X_{jr} + DDN_{ir} + DIZN_{ir}$

(Almost) Exogenous Final Demand for domestic good i, generated in region r:

(67) $DDN_{ir} = [(\textbf{YEXOG}_r)/(1 + rtdyd)/YD] \times CTN_i + CS15N_{ir} + GN_{ir} + IN_{ir} + VEN_{ir} + ACOVN_{ir}$

Consumption of domestic good i by NPISH, in region r:

(68) $CS15N_{ir} = an_{ics15} \times \textbf{CS15}_r$

Public Consumption of domestic good i, in region r:

(69) $GN_{ir} = an_{iG} \times \textbf{G}_r$

or

(69') $GN_{ir} = qn_{iG} \times \textbf{G}_{ir}$ for $i \neq 50, 51, 52$ and

      $GN_{kr} = \sum_{i \neq k} tmcg^k_i \times \textbf{G}_{ir} + [(a_{kG} - ats_{kG} - am_{KG})/(a_{KG})] \times \textbf{G}_{kr}$ for $k = 50, 51, 52$

GFCF in region _r_ , using domestic good _i_:

(70) $IN_{ir} = an_{iI} \times \mathbf{IT_r}$

or

(70') $IN_{ir} = qn_{iI} \times \mathbf{I_{ir}}$ para $i \neq 50, 51, 52, 60, 61$ and

$$IN_{kr} = \sum_{i \neq k} tmci_i^k \times \mathbf{I_{ir}} + [(a_{kI} - ats_{kI} - am_{kI})/(a_{KI})] \times \mathbf{I_{kr}} \quad \text{for } k = 50, 51, 52$$

$$IN_{kr} = \sum_{i \neq k} tmtni_i^k \times \mathbf{I_{ir}} + [(a_{kI} - ats_{kI} - am_{kI} - amtm_{kI})/(a_{kI})] \times \mathbf{I_{kr}} \quad \text{for } k = 60, 61$$

Change in Inventories of domestic good _i_ in region _r_:

(71) $VEN_{ir} = an_{iVE} \times \mathbf{VE_r}$

Net Acquisition of Valuables of domestic good _i_ in region _r_:

(72) $ACOVN_{ir} = an_{iv} \times \mathbf{ACOV_r}$

or

(72') $ACOVN_{ir} = qn_{iV} \times \mathbf{ACOV_{ir}}$ for $i \neq 50, 51, 52$ and

$$ACOVN_{kr} = \sum_{i \neq k} tmcv_i^k \times \mathbf{ACOV_{ir}} + [(a_{kV} - ats_{kV} - am_{kV})/(a_{KV})] \times \mathbf{ACOV_{kr}} \quad \text{for } k = 50, 51, 52$$

Induced Final Demand for domestic good _i_, generated in region _r_:

(73) $DIZN_{ir} = \alpha_r \times [1 - (\sum_s (YEXOG_s))/(1 + rtdyd)/YD] \times CTN_i$

3. REGIONAL GROSS VALUE ADDED AND EMPLOYMENT

(74) $\alpha_r = VAB_r / VAB$ **Share of region _r_ in induced disposable income**

(75) $VAB_r = \sum_i VAB_{ir}$ **Total GVA of region _r_**

(76) $VAB_{ir} = av_i \times X_{ir}$ **GVA of branch _i_ in region _r_**

(77) $N_{ir} = VAB_{ir} / \mathbf{PROT_{ir}}$ **Employment in branch _i_, region _r_**

(78) $N_r = \sum_i N_{ir}$ **Total Employment in region _r_**

(79) $N_i = \sum_r N_{ir}$ **Total Employment in branch i**

(80) $N = \sum_r N_r$ **Total Employment at national level**

APPENDIX 5

LIST OF MODEL VARIABLES AND COEFFICIENTS

Notes: The variables that are not identified as exogenous (in brackets) are endogenous. For simplification indexes (referring to products/branches - i,j,k and regions – r,s) have been omitted in most cases.

For coefficients, see also section 4, which explains the method of calculation of technical coefficients and of trade and transport margin rates. Coefficients defined in section 4 are not included in this appendix.

1. VARIABLES:

α_r – Share of GVA generated in region r in total GVA generated at the national level (simulated by the model).

ACOV – Net Acquisition of valuables **(exogenous)**

ACOVIS – Taxes less subsidies on Net Acquisition of Valuables

ACOVN – Net Acquisition of Valuables of domestic goods at basic prices.

ACOVM – Net Acquisition of Valuables of imported goods (CIF)

C – Residents' Private Consumption (Households + NPISH)

CEP – Exports of Tourism **(exogenous** by products)

CPE – Imports of Tourism

CS15 – Consumption of Non-Profit Institutions Serving Households (NPISH) **(exogenous)**

CS15IS – Taxes less subsidies on Consumption by NPISH

CS15M – Consumption of imported goods by NPISH (CIF).

CS15N – Consumption of domestically produced goods by NPISH, at basic prices

CSOCG – Social Contributions received by the Government

CT – Households' Private Consumption on the Territory at purchasers' prices

CTIS – Taxes less subsidies on Households' Private Consumption on the Territory

CTM – Households' Private Consumption of imported goods (CIF), on the Territory

CTN – Households' Private Consumption of domestically produced goods, on the Territory, at basic prices

CTS – Resident Households' Private Consumption on the Territory at purchasers' prices.

DAT – Change in public debt not associated to public deficit **(exogenous)**

DDN$_{ir}$ – Almost Exogenous Final Demand for domestic good i, generated in region r

DIV – Public debt

DIZN$_{ir}$ – Induced Final Demand for domestic good i, generated in region r

DN$_{ir}$ – Total demand for domestic good i, generated in region r

EX$_i$ – Exports (FOB) of product i

EX – Total Exports FOB, including Tourism

EXM$_i$ – Exports of imported goods CIF (product i)

EXN$_i$ – Exports of domestically produced goods at basic prices (product i)

EXS$_i$ – Exports of product i after deducting CIF/FOB adjustment **(exogenous)**

EXIS$_i$ – Taxes less subsidies on Exports of product i

EXT – Total exports (excluding Tourism)

EXTS – Total exports (excluding Tourism) after deducting CIF/FOB adjustment

G – Public Consumption **(exogenous** by products**)**

GIS – Taxes less subsidies on Public Consumption

GM – Public Consumption of imported goods, CIF

GN – Public Consumption of domestically produced goods at basic prices

I – GFCF at purchasers'prices **(exogenous** by products and regions**)**

IIS – Taxes less subsidies on products for GFCF

IG – Public investment (GFCF) **(exogenous)**

IM – GFCF in imported goods, CIF

IN – GFCF in domestically produced goods, at basic prices

IT – Total GFCF at purchasers'prices

JURG – Interest on public debt

M$_i$ – Imports CIF of product i

M – Total Imports FOB, including Tourism

MT – Total Imports CIF, excluding Tourism

MTS – Total Imports FOB, excluding Tourism

N – Employment (Full-time equivalents)

OTRU – Balance of Other current transfers with the Rest of the World (RoW), including TD2S **(exogenous)**

OZC – Other subsidies on production (excluding subsidies on products) payed by EU **(exogenous)**

OZG – Other subsidies on production (excluding subsidies on products) payed by the Government **(exogenous)**

PROT – Labour productivity **(exogenous)**

REM – Compensation of employees

REPG – Government Gross Operating Surplus+Property Income

RF – Balance of factor income with the RoW

RF0 - Exogenous component of RF

RG – Interest rate on public debt **(exogenous)**

SGG – Government Total Balance

TD – Direct Taxes on Households+NPISH

TDSC – Direct taxes on corporations

TD2S – Balance of direct taxes with the RoW (received by the Government and payed by Households) **(exogenous)**

TIS – Taxes less subsidies on products

TISUB – Total indirect taxes less subsidies

TISUBG – Government total indirect taxes less subsidies

TK – Capital taxes

TP – Other taxes on production (excluding taxes on products)

TRE – Balance of private current transfers with the RoW **(exogenous)**

TREG – Balance of current transfers between the Government and the RoW (received less payde by the Govermnment) **(exogenous)**

TRIG – Balance of current transfers between the Government and internal agents (payed less received by the Government) **(exogenous)**

TRKG – Balance of Government Capital transfers (received less payed) **(exogenous)**

VAB – Gross Value Added at Basic prices

VE – Change in Inventories at purchasers' prices **(exogenous)**

VEIS – Taxes less subsidies on Change in Inventories

VEM – Change in Inventories of imported goods CIF

VEN – Change in Inventories of domestically produced goods at Basic prices

X – Domestic Output at Basic prices

Y – GDP at market prices

YD – Private Disposable Income (Households + NPISH)

YEXOG$_r$ – Exogenous income allowed to region r (eg: subsidies, Government and ROW current transfers – model variables at national level: OZG, OZC, TRIG, TRE and RF).

2. COEFFICIENTS (see also section 4):

psy – share of companies' disposable income in GDP.

qacif – CIF/FOB adjustment coefficient

qis$_{iF}$ – Share of Taxes less Subsidies in the value (at purchasers' prices) of final demand of type F for product i

qm$_{iF}$ – Share of Imports CIF in the value (at purchasers' prices) of final demand of type F for product i

qn$_{iF}$ – Share of domestic output (at basic prices) in the value (at purchasers' prices) of final demand of type F for product i

repgy – Share of REPG in GDP.

rf1 - Share of interest on public debt that is paid to the RoW.

rtdsy – Share of TDSC in GDP.

rtdyd – Share of taxes(TD) in Households+NPISH' disposable income (YD).

sggy – Government total balance (SGG) in % of GDP.

tcsocg – Share of Social Contributions payed to the Government(CSOCG) in total Compensation of Employees (REM).

tigts – Share of Government in total indirect taxes (received) less subsidies on products (paid).

tky – Capital Taxes as a % of GDP.

w_i – Share of product i in total CIF/FOB adjustment.

α – Share of Tourism Imports in Private Consumption (C)

β_0 – Autonomous Private Consumption (independent of Disposable Income)

β_1 – Marginal Propensity to consume

γ_{ir} – share of region r in branch i' Portuguese Gross Value Added (calculated for each year from Portuguese Regional Accounts).

γ^*_{ir} – Proportion of total demand for domestic tradable goods of branch i that is satisfied by region r' output.

δ_{ir} – Tradability coefficient of goods of branch i between region r and the remaining Portuguese regions (share of non-tradable goods on total) ($0 \le \delta_{ir} \le 1$)

APPENDIX 6

	Products/branches considered in MODEM 5 and 6 (P60)	Coefficients δ_{ir} used in Dias and Lopes (2005)		
Code	**Description**	**Continental Regions**	**Azores**	**Madeira**
01	Products of agriculture, hunting and related services	0	0.95	0.7
02	Products of forestry. logging and related services	0	0.15	0.2
05	Fish and other fishing products; services incidental of fishing	0	0.95	0.95
10	Coal and lignite; peat	0	0	0
11	Crude petr.&nat.gas; serv.to oil&gas extract. exclud. Surveying	0	0	0
12	Uranium and thorium ores	0	0	0
13	Metal ores	0	0	0
14	Other mining and quarrying products	0	0.95	0.6
15	Food products and beverages	0.1	0.3	0.2
16	Tobacco products	0	0.8	0.8
17	Textiles	0	0	0
18	Wearing apparel; furs	0	0	0
19	Leather and leather products	0	0	0
20	Wood& wood prod. and cork (except furnit.); articles Straw& plaiting mat.	0	0.3	0.2
21	Pulp. paper and paper products	0	0	0
22	Printed matter and recorded media	0	0.1	0.1
23	Coke. refined petroleum products and nuclear fuels	0	0	0
24	Chemicals. chemical products and man-made fibres	0	0	0
25	Rubber and plastic products	0	0	0
26	Other non-metallic mineral products	0	0.6	0.4
27	Basic metals	0	0	0
28	Fabricated metal products except machinery and equipment	0	0.2	0.2
29	Machinery and equipment n.e.c.	0	0	0
30	Office machinery and computers	0	0.3	0
31	Electrical machinery and apparatus n.e.c.	0	0	0
32	Radio. television and communication equipment and apparatus	0	0	0
33	Medical. precision and optical instruments. watches and clocks	0	0	0
34	Motor vehicles. trailers and semi-trailers	0	0	0
35	Other transport equipment	0	0	0
36	Furniture; other manufactured goods n.e.c.	0	0	0
37	Secondary raw materials	0	0	0
40	Electrical energy. gas. steam and hot water	0	1	1
41	Collected and purified water. distribution services of water	1	1	1
45	Construction work	1	1	1
50	Trade, maint., repair of motor vehic. and motorcyc.; retail sale of auto. fuel	1	1	1
51	Wholesale trade and trade services. except of motor vehicles and motorcycles	0.95	0.96	0.96
52	Retail trade except motor vehic.&motorcyc.; repair.Pers.&household goods	1	1	1
55	Hotel and restaurant services	0.75	0.9	0.9
60	Land transport; transport via pipeline services	0.2	1	1
61	Water transport services	0.05	0.9	0.9
62	Air transport services	0	0	0
63	Supporting and auxiliary transport services; travel agency services	0.4	0.9	0.9
64	Post and telecommunication services	0.15	0.6	0.6
65	Financial interm.. except insurance and pension funding services	0.7	0.7	0.7
66	Insurance & pension funding. except compulsory social .sec.	0.7	0.8	0.7
67	Services auxiliary to financial intermediation	0.2	0.2	0.2
70	Real estate services	1	1	1
71	Renting machin.&equip. without operator and of personal and househ. goods	0.5	0.5	0.5
72	Computer and related services	0.1	0.1	0.1
73	Research and development services	0.5	0.8	0.8
74	Other business services	0.5	0.5	0.5
75	Public administration and defence services; compulsory social security serv.	1	1	1
80	Education services	1	1	1
85	Health and social work services	1	1	1
90	Sewage and refuse disposal services. sanitation and similar services	1	1	1
91	Membership organisation services n.e.c.	0.8	1	1
92	Recreational. cultural and sporting services	0.7	0.9	0.9
93	Other services	0.99	1	1
95	Private households with employed persons	1	1	1