Sectoral Leadership in International Competitiveness*

Elsa Cristina Neves Januário Vaz†

(EcoMod 2008 - Conference on Policy Modeling)

1 May 2008

Abstract

The purpose of this paper is to identify the type of labour and the sectors where labour productivity should be improved to raise the international competitiveness of Portugal. A static multi-sectoral general equilibrium model, with multi-national and single-country versions is used. The model allows the identification of the sectors that are leaders in competitiveness improvement. It is expectable that for some countries this role should be played by the traditional exporting-sectors, while for other countries the effort should be concentrated on the suppliers of intermediate goods. The results show that the choice of sector, and type of labour, are crucial for the improvement of the international competitiveness of the Portuguese economy. In addition, the criterion used to measure competitiveness also has an important role. While the multifactor productivity is especially increased when the promotion of labour competencies occurs in exporting-sectors and importing-sectors, the population welfare have a greater impact with the generalised improvement of unskilled labour competencies.

KEYWORDS: General equilibrium models, competitiveness, productivity.

Contents

*I am grateful for the financial support given for my research by CEFAGE. I thank the helpful comments of Renato Flôres, Thomas Rutherford, Sherman Robinson, Ali Bayar, Renger van Nieuwkoop, Olga Ivanova, Scott Macdonld and specially Cristina Mohora.

†University of Évora, Economics Department (elsavaz@uevora.pt) and ISEG.

1 Introduction

The last two enlargements of the European Union created new problems to the Portuguese economy, challenging its performance and future development. Many politicians, as well as academics, defend that Portuguese firms must be more competitive in international markets, especially now when new member-states have the same accessibility to the European market as Portugal and some advantages on the attraction of new investments. It is also admitted that the improvement of the Portuguese competitiveness is only possible if labour becomes more productive. Moreover, the concept of "competitiveness of an economy" used by European institutions, and by other international institutions, implies a "significant and sustainable growth of productivity". Thus, the improvement of productivity in Portugal is a key issue to the success of its economy.

In this study we test two alternatives which may lead to the increase of labour productivity: the improvement of labour qualifications and labour competencies. When workers invest in their qualifications, they are transferred to the qualified set of labour. In this case we have to test the effects of a decrease of unskilled labour with an increase of skilled labour. The increase of labour competencies is possible when any type of labour starts to produce more maintaining their qualifications. So, we may test an increase of competencies of skilled labour, unskilled labour, or both. As a result, we will identify the sectors and the

type of labour whose productivity should be improved in order to promote the Portuguese international competitiveness.

2 Testing International Competitiveness

As previously stated, a change of labour productivity may result both from an improvement of the qualifications or of competencies.

To test the impact of the qualifications' promotion it is necessary to decrease the share of unskilled labour (for example, 10% of workers get higher qualifications) and to increase that of skilled labour.

The promotion of competencies, maintaining the qualifications, may lead to an increase of production with the same number of workers (or even less). This means that the promotion of labour's efficiency has a similar result as an increase in the number of workers. Technically, it accounts to stating that the more efficient labour ($\widetilde{LQ}_{reg,\text{sec}}$ for skilled labour and $\widetilde{LU}_{reg,\text{sec}}$ for unskilled labour) is a proportion of initial labour,

$$\widetilde{K}_{reg,\text{sec}} = K_{reg,\text{sec}} \tag{1}$$

$$\widetilde{LQ}_{reg,\text{sec}} = \frac{1}{AQ_{reg,\text{sec}}} * LQ_{reg,\text{sec}} \tag{2}$$

$$\widetilde{LU}_{reg,\text{sec}} = \frac{1}{AU_{reg,\text{sec}}} * LU_{reg,\text{sec}} \tag{3}$$

where are $AQ_{reg,\text{sec}}$ and $AU_{reg,\text{sec}}$ the parameters of competencies. These parameters are initially equal to 1 and $(1 + x)$ after the promotion of labour's efficiency.

3 A Static General Equilibrium Model for Portugal

The aim of this framework is to model the Portuguese economy and that of its most relevant partners. To this end, we consider five agents and two markets. Foreign currencies are not considered because data are expressed in the same monetary unit.

Table 1: Agents and markets

Agents	Markets
Families	Goods
Firms	Factors
Banks (Investment)	
Government	
Rest of the World	

The adopted aggregation used for the 57 sectors of the data base is that used in Brücker (1998), in his classification of competitiveness factors, often used on European Institutions studies.[1]

Table 2: Sectors of activity

Sectors
Resource intensive ("res")
Labour intensive ("lab")
Specialised suppliers ("spe")
Scale and Capital intensive ("sca")
R&D intensive ("rd")
Non industrial and non classified ("non")

In geographical terms, two approaches considered to aggregate the 87 regions of the data base. The first comprises four regions: Portugal and three regions with which it has commercial relationships - EU 14 (older member countries, excluding Portugal)[2], EU12 (the 12 newly acceded member countries)[3] and ROW (the Rest of the World). In the second, the Portuguese partners are aggregated in one region (called ROW) and the small country conditions are applied to Portugal.

For reasons of technical simplification, it is considered that Portugal, EU14, EU12 and ROW, have the same behaviour structure, therefore presenting identical functions for all agents and markets. However, since the initial statistical data are obviously distinct, both the calibrated parameters and the effects from a similar economic policy in Portugal will differ across region.

Given the current scenario of increasing globalisation of economic activities, and knowing that a significant part of production and trade within the EU is controlled by multinational corporations, it is acceptable that this simplification, though a source of bias in the results, is not excessively limiting. It is also evident the increased similarity of consumption patterns in the different EU countries. Therefore, considering the differences in production patterns among regions as more related to production specialisation and economic rationalisation, rather than to different behaviour patterns, will not, by itself, diminish the interest of the results obtained with the model.

3.1 Firm Behaviour and Foreign Trade

The productive sector in this model of the Portuguese economy is characterised by the existence of 6 profit maximiser sectors that produce 6 goods and supply in accordance to a nested production function with capital (a composite factor that aggregates capital, natural resources and land), labour (Skilled and Unskilled), and intermediate goods (also a composite good). At the first level, a Leontief

[1] A matrix of equivalence was created to apply this aggregation to the GTAP Data Base.

[2] Germany, Austria, Belgium, Denmark, Spain, Finland, France, Greece, Netherlands, Italy, Ireland, Luxembourg, United Kingdom, Sweden.

[3] Cyprus, Slovenia, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Czech Republic, Slovakia, Romania and Bulgaria.

technology is used with the added value and intermediate goods as factors of production. At the second level we have, on the one hand, the added value as a CES (Constant Elasticity of Substitution) function with constant returns to scale, with capital and labour as factors of production, and, on the other hand, the intermediate goods as a Leontief technology function.

The elasticity of substitution between capital and labour, between domestic production for domestic market and exports, and between domestic production for domestic market and imports are exogenous.

Returns on capital and wages are equal across sectors what can be considered a critical assumption, especially with the sectoral aggregation used. However, it is also assumed that the promotion of the efficiency of one type of labour in a specific sector will result in a rise of the wages for that type of labour in that sector, i.e. a productivity premium. Therefore, the choice made allows the identification of the adjustments of labour productivity in real terms.

Firms pay taxes for the use of resources (capital and labour) as well as for the use of intermediate goods.

The behaviour of each firm may be generalised in two groups of decisions on *how* and *how much* to produce. In the first group the producer should choose the optimal combination of primary and intermediate resources that are needed to produce, i.e. the best way of obtaining goods or services. At the second group the agent's decisions determine how much will be distributed in the domestic market along with imported goods, and how much will go to the foreign market, i.e. the optimum level of production.

3.1.1 How to Produce?

Firstly, the firm chooses the basket of intermediate goods and the basket of primary factors by means of a Leontief production function. This type of function assumes that the production of each sector is done with minimum fixed amounts from the baskets of intermediate goods and factors of production, i.e. fixed coefficients. This mean that it is not possible the substitution between them, i.e. is not possible to produce only with intermediate goods or only with primary factors, since they are perfect complements in this function.[4]

The demand functions for $K_{reg,\text{sec}}$, $LQ_{reg,\text{sec}}$ and $LU_{reg,\text{sec}}$ in each sector, are obtained by minimizing the cost function,[5]

$$\begin{aligned} Cost_{reg,\text{sec}}\left(K_{reg,\text{sec}}, LQ_{reg,\text{sec}}, LU_{reg,\text{sec}}\right) = [(1+tk_{reg,\text{sec}}) * pk_{reg} + \\ + PI_{reg} * d_{reg,\text{sec}}] * K_{reg,\text{sec}} + \\ + (1+tlq_{reg,\text{sec}}) * plq_{reg} * (AQ_{reg.\,\text{sec}} * LQ_{reg,\text{sec}}) + \\ + (1+tlu_{reg,\text{sec}}) * plu_{reg} * (AU_{reg,\text{sec}} * LU_{reg,\text{sec}}) \end{aligned} \tag{4}$$

[4] See Silberberg and Suen (2001) for specific issues about Leontief and CES functions .

[5] The subscript "reg" and "sec" means that the variable is disaggregated by regions and sectors.

subject to the restriction $XD_{reg,\text{sec}}$,[6]

$$XD_{reg,\text{sec}} = aF_{reg,\text{sec}} * [\gamma Fk_{reg,\text{sec}} * K_{reg,\text{sec}}^{-\frac{1-\sigma F_{reg,\text{sec}}}{\sigma F_{\text{sec}}}} + \\ + \gamma Fq_{reg,\text{sec}} * (Aq_{reg.\,\text{sec}} * LQ_{reg,\text{sec}})^{-\frac{1-\sigma F_{reg,\text{sec}}}{\sigma F_{\text{sec}}}} + \\ + \gamma Fu_{reg,\text{sec}} * (Au_{reg,\text{sec}} * LU_{reg,\text{sec}})^{-\frac{1-\sigma F_{reg,\text{sec}}}{\sigma F_{\text{sec}}}}]^{-\frac{\sigma F_{reg,\text{sec}}}{1-\sigma F_{reg,\text{sec}}}} \quad (5)$$

3.1.2 How much to Produce?

This second group of decisions is divided in two parts. On the one hand, the producer determines the share of its production that will be distributed in the domestic market and in foreign markets. On the other hand, the agent quantifies the composite good $X_{reg,\text{sec}}$, using the amount offered in the domestic market and the imported amount, which will be subject to the intermediate and final demand of the market.

The first type of decisions entails the maximisation of revenues as a function of the demand location,[7]

$$REV_{reg,\text{sec}}(XDD_{reg,\text{sec}}, E_{reg,regg,\text{sec}}) = pdd_{reg,\text{sec}} * XDD_{reg,\text{sec}} + \\ + \sum_{regg} pe_{reg,regg,\text{sec}} * E_{reg,regg,\text{sec}} \quad (6)$$

subject to a transformation function with constant elasticity (CET function), which reveals a limited substitution between the domestic distribution and exports, by sector,

$$XD_{reg,\text{sec}} = aT_{reg,\text{sec}} * [\sum_{regg} \gamma T_{reg,regg,\text{sec}} * E_{reg,regg,\text{sec}}^{-\rho T_{reg,\text{sec}}} + \\ + \left(1 - \sum_{regg} \gamma T_{reg,regg,\text{sec}}\right) * XDD_{reg,\text{sec}}^{-\rho T_{reg,\text{sec}}}]^{-\frac{1}{\rho T_{reg,\text{sec}}}} \quad (7)$$

where $aT_{reg,\text{sec}}$ is the efficiency coefficient and $\gamma T_{reg,regg,\text{sec}}$ assumes the values of the parameters of export distribution in the different locations. $\sigma T_{reg,\text{sec}}$ is the domestic production's elasticity of substitution between exports for the different regions and domestic distribution, and may be calculated by $\frac{1}{1+\rho T_{reg,\text{sec}}}$. $XDD_{reg,\text{sec}}$ represents the domestic production offered in each domestic market,

[6] $\sigma F_{reg,\text{sec}}$ represents Allen's partial elasticity of substitution (from now on referred to as elasticity of substitution) between factors and is determined by $\sigma F_{reg,\text{sec}} = \frac{1}{1+\rho F_{reg,\text{sec}}}$. In Cobb-Douglas functions $\sigma F_{\text{sec}} = 1$ and in Leontief functions $\sigma F_{\text{sec}} = 0$. However, CES function allows the use of other values for this elasticity. This means that the former two functions are special cases of this last function.

[7] The subscript *reg* and *regg* have the same meaning - regions, which allows the differentiation between the region of origin and the region of destiny of the flow.

$E_{reg,regg,\text{sec}}$ are exports of domestically produced goods to the regions considered ($EU14$, $EU12$ and ROW), $pdd_{reg,\text{sec}}$ represent prices of domestic goods in the domestic market, $pe_{reg,regg,\text{sec}}$ are domestic prices of exports for the different destinations (market prices of exports).

The used database (GTAP, version 6) considers customs taxes but also a set of selected non-tariff barriers, besides anti-dumping rights (used in Canada, USA and the EU). On the one hand, non-tariff barriers that increase the prices of foreign goods in domestic markets are aggregated as customs taxes. On the other hand, those non-tariff barriers that change the domestic prices of domestically produced goods are added to production taxes. Finally, those non-tariff barriers that change the domestic prices of exports are added to export taxes. One disadvantage of this distribution is that all these taxes are accounted for as a government revenue or expenditure, even though some trade barriers are gains for importers only.[8]

At the second part of this structure of production "distribution" the producer supplies the market with a composite good ($X_{reg,\text{sec}}$) consisting of domestic and foreign goods, which he produces and imports. This is expressed by an Armington function, which is a linearly homogeneous CES production function, revealing the existence of limited or imperfect substitution between national and foreign goods.[9]

$$X_{reg,\text{sec}} = aA_{reg,\text{sec}} * [\sum_{regg} \left(\gamma A_{reg,regg,\text{sec}} * M_{reg,regg,\text{sec}}^{-\rho A_{reg,\text{sec}}}\right) + \\ + \left(1 - \sum_{regg} \gamma A_{reg,regg,\text{sec}}\right) * XDD_{reg,\text{sec}}^{-\rho A_{reg,\text{sec}}}]^{-\frac{1}{\rho A_{reg,\text{sec}}}} \quad (8)$$

In order to maximise profits, each firm has to minimise the cost of this composite good, subject to equation (8),

$$Cost_{reg,\text{sec}}(M_{reg,regg,\text{sec}}, XDD_{reg,\text{sec}}) = \sum_{regg} (pm_{reg,regg,\text{sec}} * M_{reg,regg,\text{sec}}) + \\ + pdd_{reg,\text{sec}} * XDD_{reg,\text{sec}} \quad (9)$$

$aA_{reg,\text{sec}}$ is the efficiency parameter, $\gamma A_{reg,regg,\text{sec}}$ assumes the values of the distribution parameters, and $\sigma A_{reg,\text{sec}} = \frac{1}{1+\rho A_{reg,\text{sec}}}$ is the elasticity of substitution between the domestic good and goods imported from the distinct regions. $M_{reg,regg,\text{sec}}$ is the imported amount from each region (regg). The prices, in domestic currency, of such imported goods are represented by $pm_{reg,regg,\text{sec}}$.

3.1.3 International trade as a connection between economies

In this general equilibrium model, international trade is the link between different regions. The introduction of linkages between countries must be done with

[8] The same is considered in both models analysed in Whalley (1985).

[9] See Armington (1969).

caution since normally trade flows are valued in different ways. In fact, the exports of each country are normally valued at fob (Free On Board) prices and their imports are usually valued at cif (Cost, Insurance and Freight) prices, over which are applied the tariffs. In the GTAP-6 data base, the difference between cif prices and fob prices are the "transport margins on imports". This means that we have also the imports valued at fob prices ($M_{reg,regg}$), and the correspondence between quantities imported from the partners and the quantities exported by that partners is direct.

$$M_{reg,regg,\text{sec}} = E_{regg,reg,\text{sec}} \tag{10}$$

In the used data base exist both "transport margins on imports" and "transport margins on exports". Both of them represent expenses with the transport of imported and exported goods paid by national agents, which increase domestic imports' and exports' prices. However, the former is disaggregated on import country level and the last is aggregated for each exporter country. This means that we know, for each country, the transport margins on imports from each partner and, only the total transport margin on export.

If we consider that $pwe_{reg,regg,\text{sec}}$ is the fob price of exports, it may be verified that the difference between this prices and their market prices, in domestic currency, depends on the weight of taxes on exports ($te_{reg,regg,\text{sec}}$)[10] and the weight of "transport margins on exports" valued at market prices. $P_{reg,"non"}$ is used to value this margins because it is in this specific sector that we have this services.

$$pe_{reg,regg,\text{sec}} = pwe_{reg,regg,\text{sec}} * (1 - te_{reg,regg,\text{sec}}) + P_{reg,"non"} * emg_{reg,\text{sec}} \tag{11}$$

where $emg_{reg,\text{sec}}$ represents the weight of "transport margins on exports" on total exports. This means that these services have the same impact on all sectors and all partners, for each unit exported.

On the other hand, if the weight of custom taxes, discriminated by region, is $tm_{reg,regg,\text{sec}}$ and the fob price of imports is $pwm_{reg,regg,\text{sec}}$, which is equal to $pwe_{regg,reg,\text{sec}}$, the difference between this price and the market price of imports will depend on taxes applied by the region to imported goods, according to their origin and "transport margins on imports", also valued at market prices,

$$pm_{reg,regg,\text{sec}} = (1 + tm_{reg,regg,\text{sec}}) * pwe_{regg,reg,\text{sec}} + P_{reg,"non"} * mg_{reg,regg,\text{sec}} \tag{12}$$

where $mg_{reg,regg,\text{sec}}$ represents the weight of "transport margins on imports" on imports, from each partner.

In the context of this model, the Balance of Payments is divided in two parts, one for Goods and Services Balance ($SF_{reg,regg}$) and other for transport

[10] Or subsidies if their values are negative.

margins related to international trade ($MARGB_{reg}$).[11]

$$SF_{reg,regg} = \sum_{\text{sec}} (pwe_{regg,reg,\text{sec}} * M_{reg,regg,\text{sec}}) - \sum_{\text{sec}} (pwe_{reg,regg,\text{sec}} * E_{reg,regg,\text{sec}}) \tag{13}$$

being $SF_{reg,regg}$ the foreign savings, i.e. the surplus of the Portuguese economy if negative, or deficit if positive.

$$MARGB_{reg} = \sum_{regg} \sum_{\text{sec}} (mg_{reg,regg,\text{sec}} * M_{reg,regg,\text{sec}} - emg_{reg,\text{sec}} * E_{reg,regg,\text{sec}}) \tag{14}$$

3.2 The Behaviour of the Representative Family

In this study a representative family is used as a proxy for all consumers. It is an assumption that erases social diversity, a characteristic of all economies, but is justified by the fact that the objective of the model is the measurement of the effects of economic policies in countries' external competitiveness and not at the level of income distribution among consumers.

It is considered that the representative family is the owner of all production factors and that the capital and labour endowments are exogenous, i.e. it is assumed that there is an external immobility of such factors. Unemployment is allowed in the model, and depends on changes of wages' rates.

The representative family maximises a non-homogeneous Stone-Gary utility function, which produces a linear system of expenses (known as LES function), subject to a budget constraint.

Family income is obtained with the selling of productive resources to firms (capital, skilled and unskilled labour), with the payment of unemployment subsidies and of other government transfers,

$$\begin{aligned} YH_{reg} = {} & pk_{reg} * KS_{reg} + plq_{reg} * (LQS_{reg} - UNEMPQ_{reg}) + \\ & + \sum_{\text{sec}} [plq_{reg} * (Aq_{reg,\text{sec}} - 1) * LQ_{reg,\text{sec}}] + \\ & + plu_{reg} * (LUS_{reg} - UNEMPU_{reg}) + \\ & + \sum_{\text{sec}} [plu_{reg} * (Au_{reg,\text{sec}} - 1) * LU_{reg,\text{sec}}] + TRF_{reg} \end{aligned} \tag{15}$$

YH_{reg} represents the family total income, KS_{reg}, LUS_{reg} and LQS_{reg} are capital and labour endowments, $UNEMPQ_{reg}$ and $UNEMPU_{reg}$ are the unemployment of skilled and unskilled labour, TRF_{reg} is the total amount of family's government transfers.

[11] Capital flows are not included in the equation because it is assumed that all factors are immobile between countries. Structural funds and other European Union funds are also not considered. These issues are left for future developments of the model

Families' expenses are allocated to income taxes (ty_{reg}), savings (SH_{reg}) and to the consumption of goods and services ($C_{reg,\text{sec}}$).

Savings are a fixed share of income, which means that the marginal propensity to save (mps_{reg}) is constant, after deducting taxes paid to the government,

$$SH_{reg} = mps_{reg} * [YH_{reg} - ty_{reg} * (YH_{reg} - TRF_{reg})] \tag{16}$$

and allow the calculation of the income available to consumption ($CBUD_{reg}$),

$$CBUD_{reg} = YH_{reg} - ty_{reg} * (YH_{reg} - TRF_{reg}) - SH_{reg} \tag{17}$$

The consumer optimum choice is determined through the maximisation of the LES utility function ($UH_{reg}(C_{reg,\text{sec}})$), subject to the budgetary constraint that relates the income available to consumption with the value of expenses,

$$UH_{reg}(C_{reg,\text{sec}}) = \prod_{\text{sec}} (C_{reg,\text{sec}} - \mu H_{reg,\text{sec}})^{\alpha H_{reg,\text{sec}}} \tag{18}$$

$$\text{where} \quad \sum_{\text{sec}} \alpha H_{reg,\text{sec}} = 1 \quad \text{and} \quad C_{reg,\text{sec}} > \mu H_{reg,\text{sec}} \geq 0$$

$$\text{s.t.} \quad CBUD_{reg} = \sum_{\text{sec}} [(1 + tc_{reg,\text{sec}}) * p_{reg,\text{sec}} * C_{reg,\text{sec}}] \tag{19}$$

where $\mu H_{reg,\text{sec}}$ represents the minimum amount of family consumption for each good, and $p_{reg,\text{sec}}$ is the price of the goods sold in the domestic market (domestic and imported goods).[12]

The unemployment is endongenized using a Wage Curve type of relationship between the rate of change in real gross wage rate and the rate of change in the unemployment rate. Since there are two types of labour, two Wage Curves are used.

3.3 Government Behaviour

In what concerns the behaviour of the economic agent 'government', it is considered that it is responsible for tax collection and transfers' payments to families, namely unemployment subsidies and other transfers (such as pensions or health related transfers). The considered taxes are those on consumption ($tc_{reg,\text{sec}}$, $tcg_{reg,\text{sec}}$, $tci_{reg,\text{sec}}$, $tcf_{reg,\text{sec}}$), on the use of capital ($tk_{reg,\text{sec}}$) and labour ($tlq_{reg,\text{sec}}$ and $tlu_{reg,\text{sec}}$), on income (ty_{reg}), on imports ($tm_{reg,regg,\text{sec}}$) and exports ($te_{reg,regg,\text{sec}}$), and on production ($txd_{reg,\text{sec}}$). All these taxes are proportional to the taxable basis.

[12] When $\mu H_{reg,\text{sec}} = 0$, $\forall$ (reg, sec), the LES function is transformed into a Cobb-Douglas function, which is homogenous of degree 1 (linear homogenous) if $\sum_{\text{sec}} \alpha H_{\text{sec}} = 1$. Therefore, LES functions are a generalization of Cobb-Douglas functions, and allows the use of an elasticity of substitution not equal to 1. So, the option done in this paper may be more reasonable and less limited to study consumer behaviour.

It is assumed that the government demand for goods and services ($\overline{CG}_{reg,\text{sec}}$) is constant, and their savings only change with prices and taxes.

Total government revenues consist of total tax revenues ($TAXR_{reg}$) since the productive activities of the government are included in the activity of firms.

$$\begin{aligned} TAXR_{reg} = {} & ty_{reg} * (YH_{reg} - TRF_{reg}) + \sum_{\text{sec}} [p_{reg,\text{sec}} * (tc_{reg,\text{sec}} * C_{reg,\text{sec}} + \\ & + tcg_{reg,\text{sec}} * \overline{CG}_{reg,\text{sec}} + tci_{reg,\text{sec}} * I_{reg\,\text{sec}}) + \sum_{\text{secc}} (tcf_{reg,\text{secc,sec}} * \\ & * io_{reg,\text{secc,sec}} * p_{reg,\text{secc}} * XD_{reg,\text{sec}}) + tk_{reg,\text{sec}} * pk_{reg} * K_{reg,\text{sec}} + \\ & + tlq_{reg,\text{sec}} * plq_{reg} * Aq_{reg,\text{sec}} * LQ_{reg,\text{sec}} + \\ & + tlu_{reg,\text{sec}} * plu_{reg} * Au_{reg,\text{sec}} * LU_{reg,\text{sec}} + \\ & + \sum_{regg} (tm_{reg,regg,\text{sec}} * pwe_{regg,reg,\text{sec}} * M_{reg,regg,\text{sec}} + te_{reg,regg,\text{sec}} * \\ & * pwe_{reg,regg,\text{sec}} * E_{reg,regg,\text{sec}}) + txd_{reg,\text{sec}} * pd_{reg,\text{sec}} * XD_{reg,\text{sec}}] \end{aligned} \tag{20}$$

Government pays unemployment subsidies at a rate $trep_{reg}$, as a share of average wages, and other transfers, such as pensions and health subsidies, that are constant in real terms and transformed into nominal variables using a Laspeyres price index ($pcindex_{reg}$),

$$pcindex_{reg} = \sum_{\text{sec}} \left(\frac{(1 + tc^{t}_{reg,\text{sec}}) * p^{t}_{reg,\text{sec}} * C^{0}_{reg,\text{sec}}}{(1 + tc^{0}_{reg,\text{sec}}) * p^{0}_{reg,\text{sec}} * C^{0}_{reg,\text{sec}}} \right) \tag{21}$$

where the superscript is the moment in time ("0" for benchmark values and "t" for values after the scenario simulation), as in Wage Curves.

Total transfers (TRF_{reg}) are expressed by the equation,

$$\begin{aligned} TRF_{reg} = {} & trep_{reg} * (plq_{reg} * UNEMPQ_{reg} + plu_{reg} * UNEMPU_{reg}) + \\ & + TRO_{reg} * pcindex_{reg} \end{aligned} \tag{22}$$

3.4 Investment Demand

The demand for investment will be included in the model in a very simple way, considering investment as investment goods, i.e. goods and services identical to those demanded by firms and consumers, valued at market prices (including taxes). It is considered that there is an entity that allocates savings across investment goods, in all sectors, in accordance to a Cobb-Douglas utility function ($UI_{reg}(I_{reg,\text{sec}})$), where $I_{reg,\text{sec}}$ is the amount of investment goods and $\alpha I_{reg,\text{sec}}$ is the income elasticity of the investment good demand.

$$UI_{reg}(I_{reg,\text{sec}}) = \prod_{\text{sec}} I^{\alpha I_{reg,\text{sec}}}_{reg,\text{sec}} \qquad \text{where} \qquad \sum_{\text{sec}=1} \alpha I_{reg,\text{sec}} = 1 \tag{23}$$

The demand is determined by the maximisation of this utility function, subject to the constraint of total savings (S_{reg}) where $tci_{reg,\text{sec}}$ is the weight of taxes on the consumption of the goods used as investment goods,

$$S_{reg} = \sum_{\text{sec}} I_{reg,\text{sec}} * p_{reg,\text{sec}} * (1 + tci_{reg,\text{sec}}) \tag{24}$$

total savings being equal to the following identity,

$$S_{reg} = SH_{reg} + GDPDEF_{reg} * SG_{reg} + \sum_{regg} SF_{reg,regg} + \\ + \sum_{\text{sec}} d_{reg,\text{sec}} * pi_{reg} * K_{reg,\text{sec}} + MARGB_{reg} * p_{reg,"non"} \tag{25}$$

where pi_{reg} is the Unit Cost Expenditure.

3.5 General Equilibrium

Every macro identities are satisfied and the closure equations used follows Lofgren, Harris, and Robinson (2002) alternatives. For government balance their first alternative (GOV-1) is used, where public expenses are constant and revenues result from different fixed tax rates. So, government savings depend on the prices, the production and the other agents' consumption. For the external balance we assume, in the multiregional version of the model, that the real exchange rate is fixed and the foreign savings are flexible (second alternative, ROW-2). In the second version of the model the small country condition is applied to Portugal, the foreign savings are fixed and adjustments in the real exchange rate are allowed (ROW-1). Finally, for saving-investment balance we assume flexible capital formation, since all savings are variable in national currency, and the investment correspond to the sectoral allocation of savings using fixed proportions (SI-3).

3.6 Data Base

In this version of the model the benchmark equilibrium data for the year 2001 are generated from Global Trade Analysis Project (GTAP) version 6 Data Base for major variables,[13] except for unemployment rates ($tunempq_{reg}$ and $tunempu_{reg}$), rates of unemployment subsidy ($trep_{reg}$), other government transfers for the households (TRO_{reg}), all transformation and substitution elasticities ($\sigma F_{reg,\text{sec}}$, $\sigma T_{reg,\text{sec}}$, $\sigma A_{reg,\text{sec}}$), unemployment elasticity ($elasU_{reg}$) and the minimum amount of families' consumption for each good ($\mu H_{reg,\text{sec}}$). The great advantage of this data base is the possibility of direct comparison of different input-output matrixes, and its easy accessibility. In what concerns the parameters that do not exist in the data base, the statistical sources are distinct.

[13] See Hertel (1998) for details.

For the unemployment rates the rates of National Statistic Institute (INE), for Portuguese values and the rates of EUROSTAT for remaining regions, are used.[14]

The parameter $trep_{reg}$ is calculated with EUROSTAT data, as the weight of unemployment subsidy *per* unemployed person, in each region, relatively to the nominal compensation *per* employee.[15]

The sources of data on other government transfers for the households (TRO_{reg}) are National Accounts of INE, and EUROSTAT.[16] To avoid any incompatibility between these statistics sources and GTAP data base, this parameter is introduced as a percentage of household's consumption at current prices.

The unknown parameter of the household utility function ($\mu H_{reg,\text{sec}}$) is subjective because it depends mainly on household preferences. Since we have only one representative household in each region, it is almost a random choice. Our choice are the consumption levels of the families with the lower income, by sectors, from the Inquiry to Families' Budget applied by INE.

With respect to substitution and transformation elasticity and the unemployment elasticity, the sources are different. For elasticity of substitution between production factors ($\sigma F_{reg,\text{sec}}$), the values generated by the general equilibrium program "RunGTAP - Version 5" of GTAP data base, considering the same sectorial and regional aggregation as in this model are used. For elasticity of substitution between domestic and imported goods ($\sigma A_{reg,\text{sec}}$), the values considered by OECD in a tariff trade simulator (the most used in international literature) are used.[17] The discrimination between regions is made using the respective weights of each product in each sector.

For transformation elasticity ($\sigma T_{reg,\text{sec}}$), an approximation is calculated, using aggregate flows, in Portugal. For the other regions, the values used in DART model are applied.[18]

Finally, for unemployment elasticity ($elasU_{reg}$), different values, considering different features used in several important empirical studies, are tested. First, the values calculated for OECD countries, presented initially by Blanchflower and Oswald (1994) ($-0,1$), and referred by several authors, are used.[19] Second, the hypothesis studied by Brücker (2002), stating that economies with lower income would present lower wage elasticity than economies with higher income are considered. In this case, the value $-0,1$ for the regions UE14 and ROW, the value $-0,08$ for Portugal and the value $-0,05$ for UE12 are used. Third, the existence of hysteresis in the Portuguese labour market, found by Montuenga, García, and Fernández (2003), using a wage elasticity of $0,1$ for Portugal, and keeping the second hypothesis for the remain regions is tested. The three cases

[14] See Instituto Nacional de Estatística (2001) and http://epp.eurostat.ec.europa.eu/.

[15] See "Out-of-work income maintenance and support" and "Nominal compensation per employee" in http://epp.eurostat.ec.europa.eu/.

[16] See "Quadro de Contas Económicas Integradas", Instituto Nacional de Estatística (2004) and http://epp.eurostat.ec.europa.eu/.

[17] See OCDE (2003).

[18] See Klepper, Peterson, and Springer (2003).

[19] See Blanchflower (2001) and Jansen (2004).

permit to test how the effects of our simulations differ, when the Portuguese labour market is more or less flexible.

For other parameters values, the calibration procedures often applied in general equilibrium models are used.[20] Given benchmark data base, calibration imposes the equilibrium as a restriction on model specification and generates the parameters values. After this procedure the model is computed using the General Algebraic Modeling System (GAMS) software due to Brooke, Kendrick, Meeraus, and Raman (1998) and McCarl (2006).

4 Alternative Scenarios and Results

It is important to stress that the significant difference of regions' sizes and sectors' sizes implies a careful analysis. In the aggregation used we have one region that corresponds to just one small country (Portugal) and three other regions corresponding to three groups of countries also differing in size. EU14 and EU12, although with similar number of countries (14 and 12) represent two different markets, since their countries have different levels of development. The forth region is the greatest - "rest of the world" - and represents the aggregation of key players in international trade such as USA, China, India and the 57 remain countries of the data base.

This aggregation may be critical, but is used since we need to remove from benchmark data base the trade barrier that was still considered between Portugal and EU12, EU14 and EU12, and between countries of EU12.[21] After this liberalization of international trade flows we test different simulations using all partners separately and ensemble with the application of the small country condition to Portugal. In future developments of the model individual countries of the regions EU14 and EU12 will be considered and, from region "row", significant economies such as USA, China, India or some countries from South America will be selected.

From the benchmark data base we can see that, in both exports (Table 1a, in appendix) and in imports (Table 2a, in appendix), the main trade partners of Portugal and EU12 are the fourteen EU Member-States included in the region UE14. This situation suggest the existence of some conflict of interests if any similarity of exports (in quantities or quality of products) of both Portugal and EU12 exists. However, it is important to stress that the issues concerning the quality of products will not be studied since sector disaggregation is not fine enough. To this kind of analysis we need an aggregation of six or eight digit of combined nomenclature.

We can also notice that the total value of both exports and imports of Portugal and EU12 to EU14 are different, but the weight of each sector in these trade flows shows a significant similarity. This means that each sector has the same importance in both economies.

[20] See Shoven and Whalley (1998).

[21] The reason for this consideration is the year of the benchmark data base - 2001.

Additionally, it is evident that the factor intensity in each sector of the EU14 market is similar to the factor intensity of each sector in the EU12 market than to the Portuguese market (Table 3a, in appendix). This may explain some effects of the liberalization between UE14, EU12 and Portugal. In fact, this similarity may be a good reason for the improvement of foreign investment (especially Foreign Direct Investment - FDI) in the EU12 countries by firms from the EU14. The new member states are much more attractive since the beginning of accession process. However, this difference between factor intensity of EU12 sectors and that of Portuguese sectors may indicate that the production structure is distinct enough to guarantee a level of product differentiation that might improve intra-industrial trade between these three regions.

4.1 Competencies or qualifications: a choice to be made

The structural assumptions of the model do not allow the development of tests on the rise of qualifications by sectors, even though it is possible to see the results on the competitiveness' indexes by sectors. Therefore, we must compare the promotion of qualifications and competencies with the same level of aggregation, distinguishing skilled labour from unskilled labour only. Thus, tests of qualification of the less qualified labour, that represent the transfer of 10% of the unskilled labour to the set of skilled labour are performed, and the results are compared with the effects of an increase of total labour's competencies.

The analysis of different competitiveness indexes[22] shows that, globally, the promotion of competencies has better immediate effects on international competitiveness of the Portuguese economy than the promotion of labour qualification. However, the results should be interpreted with care.

The calibrated parameters represent the initial possible technology for the initial endowments. On the one hand, when labour qualifications are improved it is possible to use new, more efficient and innovative techniques. These changes can only be reflected with the modification of theses parameters, which depends on different factors, such as the availability of new technologies, the willing to invest, the adjustment ability of firms or the existence of innovation programs. On the other hand, it is acceptable that the adjustment process of the economy become faster when the competencies of labour are improved, and thus simplifying and decreasing the cost of promoting international competitiveness. So, the promotion of competencies may be considered as the more efficient way to improve the international competitiveness of Portugal.

4.2 The sectoral leadership

After testing the improvement of competencies of each type a labour in each sector, using the multinational general equilibrium model with and without the small country condition, some consistent results reflecting the importance of the type of labour and the sector chosen are identified.

[22] The Productivity of different type of labour, Multi-factor productivity and Unit labour cost.

First, the promotion of unskilled labour competencies has a greater impact on Portuguese international competitiveness in major sectors.

Second, changes in labour efficiency in non industrial sectors ("*non*") will have positive effects on all other sectors, wile the opposite is never true.

Third, wages (including the premium of productivity) follow the evolution of labour productivity, with the improvement of the population well-being. However, in spite of rising wages, the improvement of the unskilled labour efficiency will decrease its unit labour cost. This means that the increase of production and the decrease of demand for this type of labour compensate the rise of the workers' income.

The next step is to apply the same methodology to different combinations of sectors and types of labour, that could represent a possible strategy for the policy makers. So, the following scenarios will be tested:

Table 3: Scenarios (increases of 10%)

S1 - E	increase of Aq and Au in "lab", "spe" and "non"
S2 - M	increase of Aq and Au in "spe", "sca" and "non"
S3 - C	increase of Aq and Au in "res" and "non"
S4 - IO	increase of Aq and Au in "res", "sca" and "non"
S5 - Comp.	increase of Aq in "non" and Au in "res", "lab", "sca" and "non"

The first scenario (S1 - E) represents the promotion of labour efficiency in traditional exporting-sectors. The second (S2 - M) corresponds to the improvement of labour competencies in sectors of imports substitution. The next two scenarios (S3 - C and S4 - IO) are related with the sectors of final consumption and intermediate products. Finally, the promotion of competencies in the type of labour and in the sectors that had better results in the previous analysis (S5 - Comp) are considered.

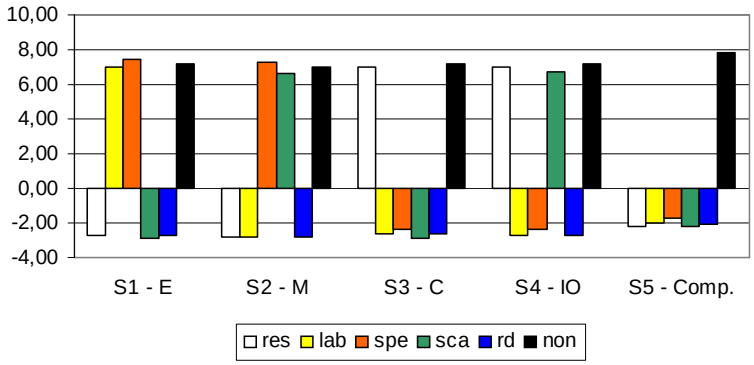
The effects can be seen in terms of relative changes in all variables. However, in this paper, only the results related to the indexes of multi-factor productivity, average single-factor productivity, unit labour cost and the agent's well-being are presented.

4.2.1 Effects on productivity (multi-factor and single-factor)

The results for single-factor productivity indexes reveal greater effects on unskilled labour productivity (Figure 1 to 3), although very similar to skilled labour productivity, and smaller ones on capital productivity.

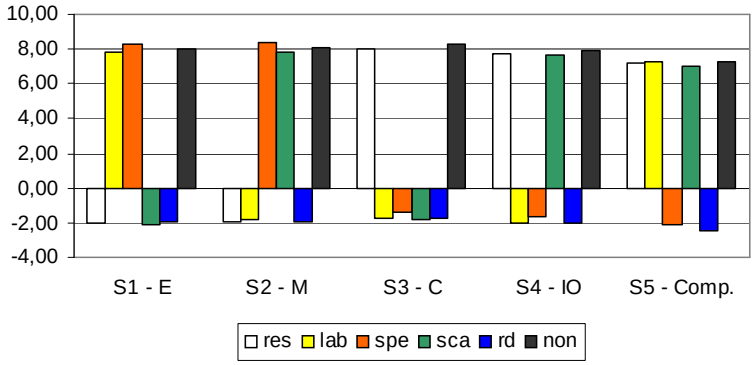
Capital productivity increase occur in all scenarios and in all sectors. However, for labour (skilled and unskilled) the positive effects only emerge in sectors where labour competencies are improved. Additionally, the domestic production increase in all sectors, in all scenarios (see table 6a, in appendix).

Figure 1: Changes of skilled labour productivity in Portugal (%)



Only in the last scenario are an asymmetric variation of competencies of skilled and unskilled labour tested. In all other scenarios tests of similar changes in the two types of labour are developed. Notwithstanding, the effects on the factors' demand are not always identical (see table 4a, in appendix).

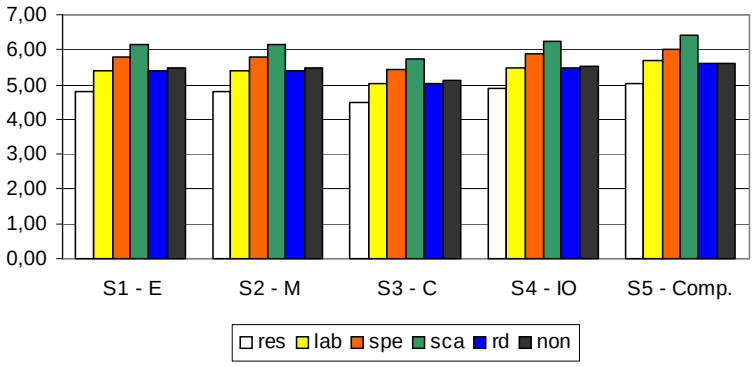
Figure 2: Changes of unskilled labour productivity in Portugal (%)



While the unskilled labour demand normally decrease with the improvement of this factor's competencies, the demand for skilled labour decreases only in non industrial sectors (in all scenarios) and in sectors intensive in resources (only for the third and fourth scenarios: S3 - C and S4 - IO). This means that

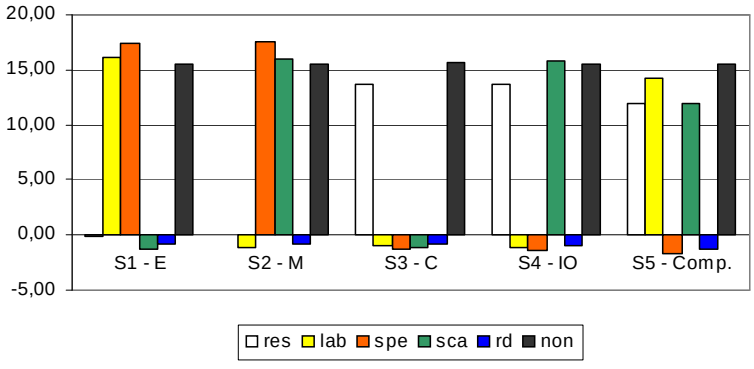
the rise of domestic production is large enough to improve this type of labour productivity.

Figure 3: Changes of capital productivity in Portugal (%)



It is also important to take into account that all scenarios have higher impacts on unskilled labour productivity than in any other factor's productivity. This result is important to this analysis, since the Portuguese economy is more abundant in this type of labour.

Figure 4: Changes of Multi–factor Productivity in Portugal (%)

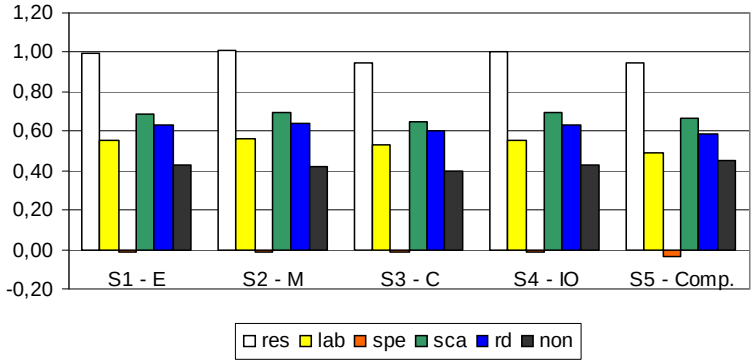


The multi-factor productivity index (Figure 4) represents the aggregated change on factor productivities. Its results allow us to identify the former two scenarios (S1 - X and S2 - M) as the most beneficial strategies, not only because the increases are higher and the decreases are lower, but also because it represents an improvement of the net export position of the Portuguese economy.

4.2.2 Effects on unit labour costs

Using the Unit Labour Cost index (Figure 5), is evident that all scenarios have very similar impacts on the cost of production. However, the most interesting results, i.e., smaller increases, happens when the economic efforts are oriented towards the last scenario.

Figure 5: Changes of unit labour cost (%)

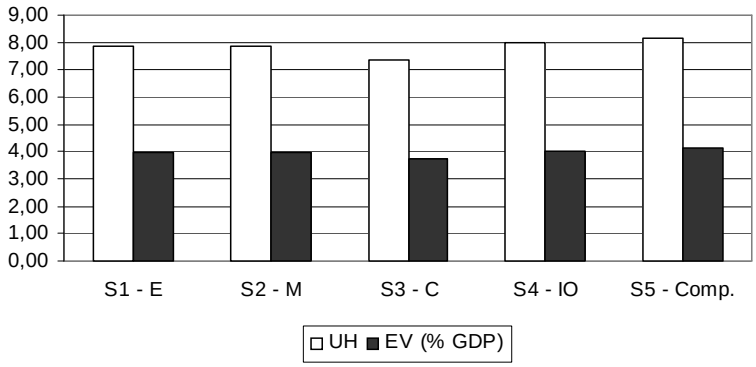


4.2.3 Effects on the population well-being

Finally, in what concerns the population well-being index, the results are again very similar for all scenarios. Notwithstanding, we can say that the last scenario has a very slight preference.

Concluding, the traditional exporting-sectors and the sectors of import's substitution play a more important role if the aim is the competitiveness of the economy. However, if the purpose is to improve the population well-being, the choice must be the efficiency of labour in those sectors considered in the last scenario.

Figure 6: Changes of the population well-being (%)



4.3 Sensitivity of model results

The elasticity's parameters are the key behavioural parameters in the model. They are important, as they determine the strengths of simulations effects over the terms of trade and, consequently, over the competitiveness of the economy. Sensitivity tests are needed and imply the replication of all simulations with elasticity's levels increased and reduced by 20%. Similar procedures are used in Flôres, Jr (1997) and Ghosh (2002).

With the sensitivity analysis of the model, we try to assess if the competitiveness of Portuguese products is more or less dependent on the substitutability of factors, the ability to transform domestic production into exports, and the level of substitution of domestic production by imports.

The results of the application to multi-factor index (Table 7a, in appendix) reveal that this index, in particular (and the model, in general) is not very sensitive in relation to all the behavioural parameters tested, since the results are similar to the initials. Thus, we may consider that these results reveal a degree of robustness and that the model is suitable to test the effects on the Portuguese competitiveness.

5 Concluding remarks

As Portugal is one of the less rich countries in the European Union, the identification of the sectors, as well as the type of labour, in which efforts must be made in order to improve the Portuguese competitiveness is very important. The model used in this paper, as well as the five strategies tested, suggests that the choices are sensitive to the concept of international competitiveness adopted.

Since a more qualitative concept of international competitiveness is used, such as that used by European Commission, attention should be focused on the different indexes of labour productivity and on the index of well-being. Consequently, to efficiently improve the competitiveness of Portuguese products in international markets, different choices are available, depending on the preferred sector. For example, a good choice is a more efficient labour in the traditional exporting-sectors and in the sectors of import's substitution. Finally, if the emphasis is on the improvement of the population well-being, the promotion of skilled labour's competencies must occur in non industrial sectors only and the improvement of unskilled labour must be generalized (except for the small sectors of R&D and Specialised suppliers).

References

Armington, P. S. (1969): "A Theory of Demand for Products Distinguished by Place of Production," *International Monetary Fund Staff Papers*, 16(1), 159–176.

Blanchflower, D. G. (2001): "Unemployment, Well-Being, and Wage Curves in Eastern and Central Europe," *Journal of the Japonese and International Economies*, 15, 364–402.

Blanchflower, D. G., and A. J. Oswald (1994): *The Wage Curve*. MIT Press, Cambrige.

Brooke, A., D. Kendrick, A. Meeraus, and R. Raman (1998): *GAMS: A User Guide*. GAMS Development Corporation.

Brücker, H. (1998): "The Removal of Barriers to Trade and Emerging Patterns of Specialisation," *Interim 1: The impact of Trade*, Berlin, September.

——— (2002): "Can International Migration Solve the Problems of European Labour Markets?," *UNECE, Economic Survey of Europe*, 2, 109–142.

Flôres, Jr, R. G. (1997): "The Gains from MERCOSUL: A General Equilibrium, Imperfect Competition Evaluation," *Journal of Policy Modeling*, 19(1), 1–18.

Ghosh, M. (2002): "The Revival of Regional Trade Arrangements: A GE Evaluation of the Impact on Small Countries," *Journal of Policy Modeling*, 24, 83–101.

Hertel, T. W. (ed.) (1998): *Global Trade Analysis: Modeling and Applications*. Cambridge University Press.

Instituto Nacional de Estatística (2001): *Estatísticas do Emprego - 4l Trimestre de 2001*. Instituto Nacional de Estatística.

——— (2004): *Contas Nacionais Anuais (Base 2000) 1995-2003*. Instituto Nacional de Estatística.

Jansen, E. S. (2004): "Modelling Inflation in the Euro Area," *European Central Bank Working Paper Series*, 322.

Klepper, G., S. Peterson, and K. Springer (2003): "DART97: A Description of the Multi-Regional, Multi-Sectoral Trade Model for the Analysis of Climate Policies," *KIEL Working Paper*, 1149.

Lofgren, H., R. L. Harris, and S. Robinson (2002): *A Standard Computable General Equilibrium (CGE) Model in GAMS*. Microcomputer in Policy Research, International Food Policy Research.

McCarl, B. A. (2006): *McCarl GAMS User Guide Version 22.0*. Available on-line with GAMS' software.

Montuenga, V. M., I. García, and M. Fernández (2003): "Regional Wage Flexibility: The Wage Curve in Five EU Countries," *Regions, Europe and Labour Market Recent Problems and Development*.

OCDE (2003): "Tariffs and Trade: OECD Query and Simulation Package," *(CD-ROM)*.

Shoven, J., and J. Whalley (1998): *Applying General Equilibrium*, Surveys of Economic Literature. Cambridge University Press.

Silberberg, E., and W. C. Suen (2001): *The Structure of Economics: A Mathematical Analysis*. McGraw-Hill Publishing Company.

Whalley, J. (1985): *Trade Liberalization Among Major World Trading Areas*. The MIT Press, Cambridge, Massachusetts.

A Other results

Table 1a: Initial weight of exports (%)

	res	lab	spe	sca	rd	non	Total (10^9 \$)	% of total
prt - ue14	13,81	26,21	18,22	25,10	0,80	15,87	21,885	69,21
prt - ue12	7,34	17,17	32,87	18,50	0,96	23,16	0,598	1,89
prt - row	14,17	15,16	13,35	10,95	2,35	44,02	9,138	28,90
ue14 - prt	16,37	13,66	25,96	31,66	1,18	11,16	31,093	1,25
ue14 - ue14	13,59	8,53	22,93	33,09	2,73	19,12	1322,273	53,34
ue14 - ue12	10,01	14,35	32,37	31,34	0,94	10,98	119,794	4,83
ue14 - row	8,96	8,82	25,18	23,25	4,06	29,74	1005,817	40,57
ue12 - prt	8,52	5,94	15,16	49,92	0,21	20,25	0,798	0,43
ue12 - ue14	15,13	18,63	24,57	24,39	2,00	15,29	111,943	60,59
ue12 - ue12	23,59	10,49	15,49	36,98	2,12	11,34	21,034	11,38
ue12 - row	13,55	7,68	18,24	19,86	2,34	38,32	50,981	27,59
row - prt	14,15	7,94	15,51	11,86	3,59	46,95	11,714	0,28
row - ue14	9,01	11,84	21,79	12,56	3,35	41,46	1003,991	23,82
row - ue12	8,39	8,83	19,31	12,86	4,45	46,16	62,832	1,49
row - row	12,02	12,11	30,52	19,74	2,77	22,83	3136,337	74,41

Source: Author's calculus based on GTAP-6 data base.

Table 2a: Initial weight of imports (%)

	res	lab	spe	sca	rd	non	Total (10^9 \$)	% of total
prt - ue14	16,37	13,66	25,96	31,66	1,18	11,16	31,093	71,31
prt - ue12	8,52	5,94	15,16	49,92	0,21	20,25	0,798	1,83
prt - row	14,15	7,94	15,51	11,86	3,59	46,95	11,714	26,86
ue14 - prt	13,81	26,21	18,22	25,10	0,80	15,87	21,885	0,89
ue14 - ue14	13,59	8,53	22,93	33,09	2,73	19,12	1322,273	53,75
ue14 - ue12	15,13	18,63	24,57	24,39	2,00	15,29	111,943	4,55
ue14 - row	9,01	11,84	21,79	12,56	3,35	41,46	1003,991	40,81
ue12 - prt	7,34	17,17	32,87	18,50	0,96	23,16	0,598	0,29
ue12 - ue14	10,01	14,35	32,37	31,34	0,94	10,98	119,794	58,65
ue12 - ue12	23,59	10,49	15,49	36,98	2,12	11,34	21,034	10,30
ue12 - row	8,39	8,83	19,31	12,86	4,45	46,16	62,832	30,76
row - prt	14,17	15,16	13,35	10,95	2,35	44,02	9,138	0,22
row - ue14	8,96	8,82	25,18	23,25	4,06	29,74	1005,817	23,94
row - ue12	13,55	7,68	18,24	19,86	2,34	38,32	50,981	1,21
row - row	12,02	12,11	30,52	19,74	2,77	22,83	3136,337	74,63

Source: Author's calculus based on GTAP-6 data base.

Table 3a: Factor intensity of Portuguese production

		res	lab	spe	sca	rd	non
prt	LQ/K	0,54	0,76	2,19	1,20	0,93	1,75
	LU/K	1,70	2,75	3,58	2,56	2,36	1,82
ue14	LQ/K	0,28	0,49	1,33	0,68	0,80	0,51
	LU/K	0,85	1,64	2,16	1,43	2,03	0,65
ue12	LQ/K	0,14	0,22	0,31	0,19	0,44	0,35
	LU/K	0,87	1,41	1,11	0,86	2,02	0,66
row	LQ/K	0,27	0,42	0,73	0,52	1,09	0,68
	LU/K	0,93	1,53	1,12	1,06	2,10	1,08

Source: Author's calculus based on GTAP-6 data base.

Table 4a: Changes of factors demand in Portugal, (%)

Skilled labour						
	res	lab	spe	sca	rd	non
S1 - E	8,91	0,20	1,51	10,30	35,24	-2,04
S2 - M	9,04	10,33	1,63	0,40	35,37	-1,93
S3 - C	-1,39	9,67	11,04	9,78	32,85	-2,38
S4 - IO	-0,93	10,30	11,76	0,34	35,66	-1,99
S5 - Comp.	8,33	9,82	11,14	9,66	35,59	-2,49
Unskilled labour						
	res	lab	spe	sca	rd	non
S1 - E	8,11	-0,59	0,71	9,33	34,17	-2,82
S2 - M	8,05	9,25	0,64	-0,69	34,05	-2,90
S3 - C	-2,26	8,64	10,00	8,63	31,60	-3,31
S4 - IO	-1,61	9,49	10,93	-0,49	34,66	-2,72
S5 - Comp.	-1,10	0,29	11,64	0,20	36,21	-2,05
Capital						
	res	lab	spe	sca	rd	non
S1 - E	1,04	1,74	3,07	0,84	24,83	-0,46
S2 - M	1,06	1,73	3,08	0,85	24,82	-0,47
S3 - C	1,00	1,62	2,89	0,80	23,10	-0,44
S4 - IO	1,05	1,76	3,10	0,84	25,14	-0,47
S5 - Comp.	0,94	1,84	3,06	0,78	25,74	-0,46

Source: Author's calculus.

Table 5a: Changes of factors prices in Portugal, (%)

Skilled labour						
	res	lab	spe	sca	rd	non
S1 - E	-2,07	7,73	7,73	-2,07	-2,07	7,73
S2 - M	-2,15	-2,15	7,63	7,63	-2,15	7,63
S3 - C	7,77	-2,03	-2,03	-2,03	-2,03	7,77
S4 - IO	7,73	-2,06	-2,06	7,73	-2,06	7,73
S5 - Comp.	-1,58	-1,58	-1,58	-1,58	-1,58	8,26
Unskilled labour						
	res	lab	spe	sca	rd	non
S1 - E	-1,45	8,40	8,40	-1,45	-1,45	8,40
S2 - M	-1,39	-1,39	8,47	8,47	-1,39	8,47
S3 - C	8,58	-1,29	-1,29	-1,29	-1,29	8,58
S4 - IO	8,36	-1,49	-1,49	8,36	-1,49	8,36
S5 - Comp.	7,88	7,88	-1,93	7,88	-1,93	7,88
Capital						
S1 - E			7,80			
S2 - M			7,80			
S3 - C			7,30			
S4 - IO			7,89			
S5 - Comp.			8,05			

Source: Author's calculus.

Table 6a: Changes of total domestic production in Portugal, (%)

	res	lab	spe	sca	rd	non
S1 - E	5,32	7,14	9,40	7,05	31,36	5,02
S2 - M	5,31	7,10	9,41	7,05	31,33	5,02
S3 - C	4,97	6,64	8,80	6,59	29,10	4,70
S4 - IO	5,38	7,23	9,51	7,14	31,78	5,08
S5 - Comp.	5,49	7,63	9,66	7,32	32,71	5,15

Source: Author's calculus.

Table 7a: Sensitivity analysis

σF												
	+20%						-20%					
	res	lab	spe	sca	rd	non	res	lab	spe	sca	rd	non
S1 - E	-0,22	15,95	17,40	-1,43	-1,05	15,47	0,19	16,32	17,60	-1,10	-0,68	15,71
S2 - M	-0,18	-1,21	17,44	15,82	-1,00	15,47	0,23	-0,84	17,63	16,11	-0,64	15,71
S3 - C	13,53	-1,13	-1,37	-1,29	-0,93	15,54	13,85	-0,78	-1,19	-0,99	-0,59	15,76
S4 - IO	13,47	-1,30	-1,53	15,73	-1,08	15,46	13,83	-0,91	-1,32	16,04	-0,70	15,70
S5 - Comp.	11,80	14,11	-1,75	11,86	-1,40	15,45	12,20	14,56	-1,49	12,24	-0,96	15,70
σA												
	+20%						-20%					
	res	lab	spe	sca	rd	non	res	lab	spe	sca	rd	non
S1 - E	-0,05	16,10	17,49	-1,30	-0,90	15,57	-0,06	16,10	17,48	-1,30	-0,90	15,57
S2 - M	-0,01	-1,06	17,52	15,94	-0,85	15,57	-0,02	-1,06	17,51	15,94	-0,86	15,57
S3 - C	13,66	-0,99	-1,30	-1,16	-0,79	15,63	13,66	-0,99	-1,30	-1,17	-0,79	15,62
S4 - IO	13,62	-1,14	-1,44	15,86	-0,92	15,56	13,62	-1,14	-1,44	15,85	-0,93	15,56
S5 - Comp.	11,96	14,30	-1,64	12,02	-1,22	15,55	11,96	14,29	-1,65	12,01	-1,22	15,55
σT												
	+20%						-20%					
	res	lab	spe	sca	rd	non	res	lab	spe	sca	rd	non
S1 - E	-0,05	16,10	17,49	-1,29	-0,90	15,57	-0,06	16,10	17,48	-1,30	-0,90	15,57
S2 - M	-0,01	-1,06	17,52	15,94	-0,85	15,57	-0,02	-1,06	17,51	15,93	-0,86	15,56
S3 - C	13,66	-0,99	-1,29	-1,16	-0,79	15,63	13,65	-0,99	-1,30	-1,17	-0,80	15,62
S4 - IO	13,62	-1,14	-1,44	15,86	-0,92	15,56	13,62	-1,14	-1,45	15,85	-0,93	15,56
S5 - Comp.	11,97	14,30	-1,64	12,02	-1,22	15,56	11,96	14,29	-1,65	12,01	-1,23	15,55
elasU												
	-0,8						+0,1					
	res	lab	spe	sca	rd	non	res	lab	spe	sca	rd	non
S1 - E	-0,06	16,11	17,51	-1,27	-0,89	15,59	0,07	16,06	17,25	-1,44	-0,95	15,34
S2 - M	-0,02	-1,05	17,54	15,95	-0,84	15,59	0,15	-1,08	17,31	15,89	-0,86	15,33
S3 - C	13,64	-0,97	-1,27	-1,15	-0,78	15,65	13,91	-1,00	-1,48	-1,24	-0,79	15,41
S4 - IO	13,61	-1,12	-1,41	15,88	-0,91	15,58	13,82	-1,23	-1,67	15,74	-0,99	15,33
S5 - Comp.	11,97	14,33	-1,60	12,05	-1,19	15,58	11,89	13,88	-2,06	11,58	-1,58	15,33

Source: Author's calculus.