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SIMULATING THE EFFECTS OF THE EUROPEAN SINGLE MARKET: A CGE ANALYSIS FOR SPAIN*

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Abstract

In this paper we provide an empirical assessment of two of the measures proposed in the context of the European Single Market, namely, easing the provision of domestic and foreign services, and modifying the rules of public procurement, for the case of Spain. We build and simulate a computable general equilibrium (CGE) model, which incorporates three particular features: (i) increasing returns to scale and a non-competitive price rule; (ii) sectoral export demand functions; and (iii) equilibrium unemployment according to a matching function approach.

Key words: Computable general equilibrium, European Single Market, Spanish economy

JEL classification: D58, F15, F17

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1. Introduction

In the mid-1980s the European Communities (now European Union, EU) launched the so called Single Market Programme (SMP henceforth), with the aim of eliminating any existing barriers to the mobility of goods, services, labour, and capital (Commission of the European Communities, 1985). The Programme, to be completed by January 1st, 1993, envisaged the elimination of those trade barriers still remaining despite the completion of the customs union: i.e., fiscal barriers, quantitative barriers, market access restrictions directed at firms from other member countries (and, in particular, public procurement), customs formalities, technical regulations, etc. The SMP also contemplated some measures aimed to promote an increased competition. An overview of the SMP can be seen in Flam (1992).

Despite the important progress attained, after ten years there still remain several restrictions, which put a limit to the full operation of a common market for goods and factors within the EU. In general, the areas where the SMP rules have not been entirely fulfilled are those related to technical barriers to the exchange of goods, restrictions in public procurement, and obstacles to the free movement of services (European Commission, 2003). Hence, since barriers to a full common market in the EU still remain, some new directives aimed to implement the principles of the SMP are currently being developed. Accordingly, the need for further assessments of the SMP is still in order, which would be particularly relevant in some areas such as the single market for services, or the regulation of public procurement. In addition, there are no many assessments available of these issues in the context of the SMP; we just can quote Copenhagen Economics (2005) and Kox *et al.* (2004) on trade services liberalization, and COWI (2003) on public procurement.

On the other hand, the Spanish economy can represent an interesting case of study for the effects of the SMP, due to several reasons. First, Spain can be considered a medium-size economy, given the size of her main macroeconomic variables, which has experienced a process of rapid growth in the last forty years, starting from a relatively weak position as compared to the rest of Western European countries. This has been particularly true after her accession to the EU in 1986, allowing her an even deeper integration with other more advanced economies, so Spain has been able to join the Economic and Monetary Union from its start. Further on, a new assessment of the SMP effects would have an additional interest in the Spanish case, since Spain would be one of the four more restrictive EU members regarding international trade in services (Kox *et al*., 2004). In sum, the Spanish experience could be of interest for other medium-size economies expected to follow a process of integration with other relatively more advanced countries.

In this paper we provide an empirical assessment of two of the measures proposed in the context of the SMP, namely, easing the provision of domestic and foreign services, and modifying the rules of public procurement, for the case of Spain. As mentioned above, these are probably the areas where further advancements in the implementation of the SMP are still needed (European Commission, 2002, 2004). We do this by means of a computable general equilibrium (CGE) model simulated for the Spanish economy, which provides a more complete analysis, as compared to partial equilibrium models; see Shoven and Whalley (1992) for a survey of this kind of models. This methodology, on the other hand, has not been applied before to assess the effects of the SMP on the Spanish economy, with the only exception of Gómez-Plana (1998)

and Bajo-Rubio and Gómez-Plana (2000), who focus instead on the measures implemented in the first stage of the SMP (i.e., removal of trade barriers, decrease in transport costs, and harmonization of technical barriers).

We will build a CGE model, which is an extension of Gómez-Plana (1998) and Bajo-Rubio and Gómez-Plana (2000, 2004), and incorporates three particular features: (i) increasing returns to scale and a non-competitive price rule; (ii) sectoral export demand functions; and (iii) equilibrium unemployment according to a matching function approach. Notice that these assumptions would be justified from recent empirical work on the Spanish economy. So, for instance, Siotis (2003) estimates sectoral markups for a large firm-level data set encompassing all sectors of economic activity apart from financial institutions, and finds significant values in most cases. On the other hand, Moreno (1997) estimates export demand functions for a set of Spanish manufacturing sectors, obtaining evidence against the small country assumption for four of them: Energy, Chemicals and non-metallic mineral products, Metal products (including machinery and equipment), and Other manufactures. Finally, assuming full employment would be quite unrealistic for the Spanish economy, and the matching function approach seems to work reasonably well in the simulations of Bajo-Rubio and Gómez-Plana (2004).

The rest of the paper is organized as follows. The setup of the model is presented in section 2, the empirical analysis and results are discussed in section 3, and section 4 concludes.

2. The model

The model of this paper is static, and describes a single open economy, disaggregated in thirteen production sectors, with fourteen consumption goods, a single representative consumer, a public sector, and a rest of the world. The equilibrium of the economy involves three conditions simultaneously: zero-profit in all activities; market-clearing in goods and capital markets; and some constraints related to the macroeconomic closure, disposable income, and unemployment. In this section we present a brief description of the model; the full set of equations can be seen in the Appendix.

2. 1. Production

Production is based on a nested technology of intermediate inputs, capital, and labour. The firm's problem consists of maximizing profits (or, alternatively, minimizing costs, in the dual approach) subject to the technology constraint. The unit cost functions are obtained from this firm's problem, and are then used in the zero-profit conditions. In turn, the demands for factors and intermediate inputs come from the application of Shepard's lemma on cost functions, and are later used in the goods' and factors' market-clearing equations.

There are many well-known approaches to modelling competition among firms in CGE models, in addition to the more common assumption of perfect competition; see, e.g., Francois and Roland-Holst (1997), Hoffmann (2002) or Willenbockel (2004). However, a trade-off between theoretical complexity and empirical data availability is always present, since the lack of data usually prevents implementing many imperfect competition specifications, or forces oneself to using inadequate data (such as aggregated figures, old data, or from other countries), which has been a common

critique to deterministic CGE models. For these reasons, we have opted for representing competition among firms in the following way.

The model incorporates increasing returns to scale and a non-competitive pricing rule, due to the existence of some fixed costs on both labour and capital. The presence of fixed costs means that average costs are higher than marginal costs, so that firms set prices by charging a markup on marginal costs. This pricing rule is based on the assumption that firms face demand functions with negative slopes, and compete à la Cournot. There is free entry and exit of firms in each sector, so that in equilibrium firms just break even.

The non-competitive pricing rule is obtained from the first-order condition of the firm's problem described above, leading to a markup described by the Lerner index. The calibrated markup for sector *i* is:

$$MARKUP_i = \frac{\Omega_i}{N_i ELAS_i}$$

where the price-cost margin $MARKUP_i$ depends on: (i) the conjectural variations parameter, Ω_i; (ii) the share of a typical firm in sector *i*'s output, equal to the inverse of the number of firms in each sector, N_i; and (iii) the perceived elasticity of demand faced by sector *i*, $ELAS_i$. In the empirical application, $\Omega_i = 1$, since firms compete *à la* Cournot; N_i is proxied by the Herfindahl index on concentration, under the assumption of symmetrical firms (see section 3.1); and $ELAS_i$ is proxied by $\sigma_i^A + (1-\sigma_i^A)\theta_i$, where σ_i^A is the Armington elasticity, and θ_i is the output share of sector *i* on total output (Willenbockel, 2004).

2. 2. Consumption

There is a representative household behaving as a rational consumer. The level of consumer's wealth is determined by the endowments of capital and labour, jointly with exogenous net transfers paid by the public sector. The fixed endowment of labour should be interpreted as a maximum supply of labour since leisure and unemployment are assumed to be endogenous. Hence, labour supply would be elastic up to the endowment constraint.

The household's decision problem consists of choosing her optimal consumption bundle, by maximizing a nested utility function subject to a budget constraint. Preferences are represented by a nested utility function on savings, leisure, and (consumption of) goods. Notice that, given our static approach, we consider a unit elasticity of substitution between (consumption of) goods and savings (Howe, 1975), so that savings can be interpreted as the purchase of bonds for future consumption. The budget constraint includes total factor rents jointly with exogenous net transfers paid by the public sector, less exogenous income taxes. Demand functions for savings, leisure, and goods, are derived from the first-order conditions, and are included in the goods and labour market-clearing conditions, as well as in the macroeconomic closure for savings.

2. 3. Public sector

The role of the public sector in the model is twofold, i.e., owner of resources (e.g. from capital endowment and tax revenue), and purchaser of certain goods; in addition, it also determines the policy rules. As a resources owner, its wealth includes income from capital rents, net transfers paid to the representative household and received from the

rest of the world, and tax revenues. Taxes consist of social contributions paid by employers and employees, value added taxes, other net indirect taxes, and income taxes. All taxes are modelled as effective *ad valorem* rates calibrated from benchmark data, except for income taxes that are taken as an exogenous fixed amount. In order to isolate any bias from the public sector on results, *ad valorem* tax rates are allowed to change endogenously under the equal yield assumption.

The public sector also enters the model as a purchaser. The public sector expenditure includes both market (i.e., output that is disposed of in the market at economically significant prices) and non-market goods (i.e., output that is provided at prices that are not economically significant).

2. 4. Foreign sector

The model incorporates the large open economy assumption for the exports of the manufacturing sectors, and the small open economy assumption for the exports of the remaining sectors, as well as for imports. On the one hand, some market power would appear for certain manufacturing goods sold to the rest of the world, for which the country would behave as a price-setter, and this has been implemented by including export demand functions. On the other hand, the economy would face a perfectly elastic export supply function (i.e., exogenous world prices) for the rest of sectors, where a constant elasticity of transformation function between domestic and foreign sales is used. Regarding imports, we assume that goods are differentiated according to their origin (i.e., domestic or foreign), following Armington's assumption (Armington, 1969), which allows for the possibility of intra-industry trade despite the assumption of exogenous world prices.

The foreign sector is closed by assuming that the difference between receipts and payments from the rest of the world is exogenous. This restriction would avoid, e.g., a permanent increase in exports with no change in imports, an unlikely scenario since it would involve an unlimited capital inflow to the country.

2. 5. Factor markets

Two factors enter into the model: capital and labour. With respect to capital, both the representative household and the public sector own fixed endowments. The capital rents adjust to clear the domestic capital market, under the assumptions of capital international immobility and perfect mobility across domestic sectors. The only owner of labour is the representative household. As explained in section 2.2, the demand for leisure is derived from the household's problem. Hence, labour supply (i.e., the labour endowment less the demand for leisure) would be elastic up to the fixed amount of labour. In the same way as capital, labour is assumed to be international immobile, but mobile within the country.

We assume the presence of equilibrium unemployment along with a matching function approach, following Pissarides (2000) and Balistreri (2002). A matching rule gives the number of jobs as a function of the number of workers looking for a job (i.e., the unemployed), and the number of firms looking for workers (i.e., the vacancies). Firms and workers are assumed to spend some resources before job creation and production take place. Therefore, real wages net of taxes (W) include a premium ($1/H$) on reservation wages (W_0) that represents search costs:

$$W = W_0 \frac{1}{H}$$

In turn, the *H*-functions (i.e., the inverse of the premium) have properties similar to those of the matching functions:

$$H = \left(1 - \overline{U}\right)\left(\frac{LD}{\overline{LD}}\right)^{\eta_0}\left(\frac{U}{\overline{U}}\right)^{\eta_1}$$

where a bar denotes the benchmark value for the referred variable, *U* is the unemployment rate, *LD* is the aggregate demand for labour, η_0 is the elasticity with respect to labour demand (measuring the positive externality from firms to workers), and η_1 is the elasticity with respect to unemployment (measuring the positive externality from workers to firms). Labour demand is used as a proxy for vacancies, as in Balistreri (2002).

2. 6. Macroeconomic closure for investment and savings

Following Dervis *et al.* (1981), total investment is split into sectoral gross capital formation using a fixed-coefficients Leontief structure. Notice that, in our static framework, investment shows its influence on the economy as a component of final demand. The model embodies a macroeconomic closure equation stating that investment and (private, public, and foreign) savings are equal.

2. 7. Equilibrium conditions

The equilibrium of the economy is a set of prices and an allocation of goods and factors that solves simultaneously three sets of equations:

- Zero-profit conditions for all sectors.
- Market-clearing in goods and factor markets.
- Constraints on disposable income (that must equal expenditures for all agents), equilibrium unemployment, and macroeconomic closure of the model.

Finally, the model is solved using Rutherford's (1999) method, based on Mathiesen (1985), which treats general equilibrium models as mixed complementarity problems, and is implemented in the empirical application using GAMS/MPSGE. A description of the calibration procedure can be found in Dawkins *et al.* (2001).

3. Empirical analysis and results

3. 1. Calibration and data

The model presented in the previous section has been calibrated using Spanish data. The main data set is the Spanish Social Accounting Matrix (SAM), elaborated by Uriel *et al.* (2005) from the Spanish National Accounts and Household Budget Survey, and reshaped to fit our model following the methodology explained in Gómez-Plana (2001). Elasticities are taken from econometric evidence: elasticities of substitution between labour and capital, and Armington elasticities come from GTAP (Hertel, 1997); elasticities of transformation come from de Melo and Tarr (1992); and the elasticity of substitution between leisure and consumption has been obtained using the procedure of Ballard *et al.* (1985), from the uncompensated elasticity of labour supply estimated by García and Molina (1998). Finally, the elasticities of the matching function are taken from Burda and Wyplosz (1994), the elasticities of the export demand function from Moreno (1997), and the Herfindahl indices on concentration from Bajo-Rubio and Salas (1998). We use the Consumer Price Index (CPI) as numeraire.

3. 2. Scenarios and simulations

As mentioned in the Introduction, we will simulate in our CGE model the effects of two of the measures proposed in the context of the SMP, namely, easing the provision of domestic and foreign services, and modifying the rules of public procurement. Recall that these are probably the areas where further advancements in the implementation of the SMP are still needed. It is important to notice that we are not trying to quantify exactly the effects of the particular policy measures considered, on the performance of the Spanish economy. More precisely, our objective will be trying to identify the main trends followed by some relevant variables after the policy shock, together with the major mechanisms influencing them.

Concerning the removal of barriers on services, the European Commission has proposed in 2004 a Directive to ease the freedom of establishment for service providers and the free movement of services within the EU. According to Copenhagen Economics (2005), this Directive would reduce the existing barriers to the provision of services by more than 50%. Three sectors (Business services, Communication services, and Wholesale and retail trade; SMP sectors henceforth) would be explicitly under the rules of the Directive. In Copenhagen Economics (2005), tariff equivalents (i.e., the percentage impacts on prices) are estimated for these three sectors, for two types of barriers: rent-creating barriers, which reduce competition on raising prices above marginal costs, and so generating rents to the incumbent firms; and cost-creating barriers, which increase the use of real resources. These tariff equivalents, both at its benchmark level and a post-Directive simulation, are shown in Table 1.

In the empirical application below, barriers on services have been modelled as *ad valorem* tariff equivalents (see Table 1). Then, the removal of these barriers has been simulated in the following way: through an exogenous fall in the markup over costs, i.e., the wedge between producer prices and producer costs, in the case of rent-creating barriers; and through an exogenous increase in productivity, in the sense that a greater amount of output can be produced using the same amount of inputs, in the case of cost-creating barriers.

On the other hand, according to European Commission (2004), public procurement prices paid by public authorities would be lower when the EU directives were applied. In particular, the simulations performed in COWI (2003) show that the price of those purchases where directives on public procurement were not applied, would have been around 40% higher than otherwise. We have simulated a quantitative equivalent expenditure cut in public procurement, when purchasing the same physical amount of goods and services, using as benchmark the figures on public expenditure shown in the Spanish SAM of Uriel *et al.* (2005).

Summarizing, our simulation of the above SMP policies will be presented in three scenarios:

- Scenario RCB: Change in rent-creating barriers in SMP sectors (from benchmark to post-Directive tariff equivalents, according to Table 1).
- Scenario CCB: Change in cost-creating barriers in SMP sectors (from benchmark to post-Directive tariff equivalents, according to Table 1).

- Scenario PPR: Savings in public procurement, with an exogenous decrease in the prices paid, when purchasing the same physical amount of goods and services.

3. 3. Simulation results

The results from the above simulations on the main macroeconomic variables appear in Table 2. As can be seen, all the three simulated policies lead to significant increases in both Gross Domestic Product (GDP) and welfare (measured as Hicksian equivalent variations)[1]. Since prices would fall, both the real wage and real capital rental rates would increase, lowering employment and raising leisure, which would slightly increase the rate of unemployment. Finally, both exports and imports would increase in the RCB and PPR scenarios, and decrease in the CCB scenario. Overall, the trade balance would improve in the three scenarios.

Next, we present in tables 3 through 6 the results across sectors for some relevant variables. Regarding prices (Table 3), they would strongly decrease for the SMP sectors (especially Business services) in the RCB scenario, with small changes in the rest of sectors; similar but weaker effects would appear in the CCB scenario. In turn, the PPR scenario would show small decreases in prices for most sectors, higher in general for the SMP sectors.

The effects on sectoral output are shown in Table 4. In the RCB scenario, there would appear a fall in output for the SMP sectors (mostly occurring in Business services and, to a lower extent, in Wholesale and retail trade), coupled with a raise in output in the rest of sectors. On the contrary, the other two scenarios would register a generalized increase in output for all sectors, with the only exception of Agriculture and, especially, Other services, in the CCB and PPR scenarios, respectively.

Table 5 shows the changes in relative factor intensity, as measured by the capital/labour ratio. In the RCB scenario, all sectors would experience an increase in their relative capital intensity (with the only exceptions of Metal and machinery, and Energy and water), an effect that would be stronger in general for the SMP sectors. Conversely, in the CCB scenario the capital/labour ratio would fall in all sectors, except for the large increase in Business services and, much more slightly, in Wholesale and retail trade (i.e., two of the SMP sectors). In turn, in the PPR scenario the capital/labour ratio would experience a generalized fall in all sectors.

Finally, according to the results in Table 6, final consumption would raise in nearly all sectors, in the RCB and CCB scenarios. However, the situation would be very different in the PPR scenario, with final consumption experiencing significant decreases in some sectors, in particular Health, Education, Social work, and Community services.

In the rest of this section we will sketch the main mechanisms driving the above results.

Beginning with the RCB scenario, the decrease in rent-creating barriers would mean initially an exogenous relative decrease in the prices of the goods from SMP

[1] Notice that the welfare result for the PPR scenario should be interpreted with caution, given that the size of the public sector has changed.

sectors, so that, *ceteris paribus*, the real rents of the productive factors would also fall. Accordingly, the SMP sectors would reduce their demand for both labour and capital. Since these sectors would be relatively capital-intensive (see the first column in Table 5), and capital is fully employed, the rest of sectors would absorb the surplus of the primary factors, which would involve an increase in the relative price of labour (i.e., a Stolper-Samuelson effect). So, capital would be relatively cheaper, and most of the sectors would become more capital-intensive, which, *ceteris paribus*, would increase the output of non-SMP sectors and reduce that of SMP sectors.

In turn, in the CCB scenario the decrease in the cost-creating barriers for the SMP sectors is modelled as an increase in labour productivity for these sectors. This greater labour productivity in the SMP sectors (in fact, only remarkable in Business services and, to a lower extent, in Wholesale and retail trade) represents a labour-saving technical change, which would increase their capital/labour ratio. This effect would lower the relative price of labour, so the capital/labour ratio of the non-SMP sectors would fall. On the other hand, the increase in labour productivity in any particular sector would lead, *ceteris paribus*, to a rise in total labour productivity that would translate into a biased expansion of the frontier of possibilities of production towards labour-intensive goods. If the goods' relative prices would remain unchanged, the output of labour-intensive goods would increase, due the Rybczynski effect. However, as capital becomes relatively more expensive than labour, capital-intensive goods would become also relatively more expensive, so the rise in output would be less biased to labour-intensive goods (i.e., those from the non-SMP sectors).

Lastly, in the PPR scenario public expenditure would be reduced. Final consumption would fall for some goods closely related to public sector activities (such as Community, Education, Health, and Social work services), which would be reflected in the performance of the related production sectors. This is the case of Other Services, a sector strongly linked with the goods purchased by the public sector, which would experience a significant fall in output.

3. 4. Sensitivity analysis

To conclude, we present a sensitivity analysis of the above results. Accordingly, we focus on the three main assumptions of the model: the matching unemployment rule, the large open economy assumption, and increasing returns to scale with a non-competitive price rule. In particular, we have tested a perfectly competitive labour market, the small open economy framework has been assumed for all sectors, and the productive sector has been modelled as perfectly competitive with a production technology of constant returns to scale. The effects on macroeconomic variables from changes in these three assumptions are shown in Table 7, as scenarios LAB, SOE and CRTS, respectively[2]. Though most of the results would be unchanged, in the LAB scenario there would be no unemployment, which gives a higher rise in welfare. In turn, in the SOE scenario both exports and imports would show higher increases in the RCB and PPR scenarios; whereas in the case of the CCB scenario exports would increase instead of decreasing, and the decrease in imports would be higher. Finally, the results from the CRTS scenario do not prove to be too different from those in Table 2, except for imports in the CCB scenario, which would be roughly unchanged instead of decreasing. Therefore, when analyzing the effects on particular variables from policies such as those included

[2] The results in terms of sectoral variables are available from the authors upon request.

into the SMP, researchers and policymakers should be aware of the relevance of some other assumptions, in addition to those directly related to the foreign sector, such as the modelling of the labour market; the assumption of imperfect competition, however, does not seem to be so relevant for the final results.

4. Conclusions

The SMP was launched in the mid-1980s in order to eliminate any barriers still remaining within the EU, to the mobility of goods, services, labour, and capital. However, ten years after its envisaged completion, several restrictions still remain, in particular regarding trade services liberalization and the regulation of public procurement.

In this paper we have provided an empirical assessment of two of the measures proposed in the areas where further advancements in the implementation of the SMP are still needed, namely, easing the provision of domestic and foreign services, and modifying the rules of public procurement, for the case of Spain. More specifically, three alternative policies have been simulated: in the case of services, an exogenous fall in the markup over costs (removal of rent-creating barriers), and an exogenous increase in productivity (removal of cost-creating barriers), for three particular sectors (which we termed SMP sectors); and, in the case of public procurement, an exogenous cut in public expenditure. To this end, we have built and simulated a CGE model, which incorporates three particular features: (i) increasing returns to scale and a non-competitive price rule; (ii) sectoral export demand functions; and (iii) equilibrium unemployment according to a matching function approach. In any case, our objective was not trying to quantify exactly the effects of these particular policy measures on the performance of the Spanish economy, but rather trying to identify the main trends followed by some relevant variables and the major mechanisms influencing them.

In general, the three policy shocks simulated in the model represented an improvement in resource allocation, leading to significant increases in GDP and aggregate welfare, with a positive effect on the trade balance. Prices would fall in most sectors, especially in the SMP sectors, so that both the real wage and real capital rental rates would increase. However, even though output would rise in most sectors, some of the sectors concerned (such as Business services or Other services) would experience a fall in output in some of the simulations. In addition, aggregate employment would fall, and leisure would rise, so slightly increasing the rate of unemployment.

To conclude, notice that, despite the favourable outcomes of the policy measures analyzed in this paper, in terms of lower prices, and higher GDP and welfare, some negative effects could appear in those sectors more particularly concerned, even leading to harmful consequences in terms of unemployment. Therefore, some accompanying policies addressed to support those sectors and groups losing from these policies, would be in order.

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Table 1. Tariff equivalents for rent- and cost-creating barriers: Spain and EU-25

	Rent-creating barriers				Cost-creating barriers	
	Domestic firms		Foreign firms		Domestic firms	
	Benchmark	Post-Directive	Benchmark	Post-Directive	Benchmark	Post-Directive
Business services	7.11 (5.5)	0.2 (0.2)	11.14 (11.0)	0.9 (0.7)	14.48 (9.3)	2.4 (3.0)
Communication services	0.21 (0.2)	0.0 (0.0)	0.73 (0.9)	0.1 (0.1)	1.79 (1.3)	1.7 (1.2)
Wholesale and retail trade	2.2 (2.4)	0.6 (0.5)	2.0 (3.1)	0.3 (0.3)	1.1 (0.9)	0.4 (0.3)

Source: Copenhagen Economics (2005).
Note: The values for EU-25 are given in parentheses.

Table 2. Simulation results: Effects on macroeconomic variables
(% change from benchmark)

	Scenarios		
	RCB	CCB	PPR
GDP	1.11	0.41	0.63
Welfare	5.30	4.59	4.90
Real wage rate	1.37	0.23	0.98
Real capital rental rate	1.05	0.70	0.43
Employment	-0.20	-0.14	-0.13
Unemployment rate	0.07	0.05	0.04
Exports	0.57	-0.12	0.22
Imports	0.35	-0.20	0.13

Table 3. Simulation results: Effects on prices
(% change from benchmark)

	Scenarios		
	RCB	CCB	PPR
Agriculture	0.59	0.33	0.39
Energy and water	0.19	0.07	0.08
Nonenergy minerals, chemicals	-0.28	-0.19	-0.08
Metal and machinery	-0.19	-0.21	-0.05
Other manufacturing	0.08	-0.01	0.18
Construction	-0.10	-0.15	-0.05
Wholesale and retail trade	-1.35	-0.11	0.02
Hotel and restaurant services	0.46	0.23	0.13
Communication services	0.07	0.04	-0.12
Financial intermediation services	0.11	-0.06	-0.24
Renting	0.61	0.37	-0.01
Business services	-7.19	-3.78	-0.10
Other services	0.43	-0.05	-0.14
SMP sectors	-3.24	-1.36	-0.17
Non-SMP sectors	-0.00	0.14	-0.08

Table 4. Simulation results: Effects on output
(% change from benchmark)

	Scenarios		
	RCB	CCB	PPR
Agriculture	-0.06	-0.46	0.02
Energy and water	0.22	-0.07	0.40
Nonenergy minerals, chemicals	1.34	0.38	0.51
Metal and machinery	1.85	0.57	1.01
Other manufacturing	0.65	0.10	0.37
Construction	1.55	0.70	0.66
Wholesale and retail trade	-0.81	0.44	0.67
Hotel and restaurant services	0.43	0.13	0.55
Communication services	0.16	0.36	0.59
Financial intermediation services	0.00	0.45	0.26
Renting	0.40	0.26	0.61
Business services	-7.13	2.22	0.37
Other services	0.05	0.08	-2.36
SMP sectors	-2.15	0.87	0.56
Non-SMP sectors	0.73	0.25	0.01

Table 5. Simulation results: Effects on the ratio capital/labour
(Benchmark level and % change from benchmark)

	Benchmark level	Scenarios		
		RCB	CCB	PPR
Agriculture	5.97	0.10	-0.29	-0.06
Energy and water	3.55	-0.02	-0.68	-0.99
Nonenergy minerals, chemicals	1.07	0.00	-0.69	-0.81
Metal and machinery	0.51	-0.04	-0.69	-0.74
Other manufacturing	0.78	0.08	-0.69	-0.67
Construction	0.69	0.11	-0.77	-0.67
Wholesale and retail trade	1.79	0.11	0.01	-0.63
Hotel and restaurant services	2.89	0.14	-0.69	-0.47
Communication services	1.42	0.04	-0.71	-0.86
Financial intermediation services	1.01	0.02	-0.70	-0.88
Renting	25.90	0.08	-0.71	-0.75
Business services	0.60	0.10	11.65	-0.78
Other services	0.24	0.10	-0.70	-0.63

Table 6. Simulation results: Effects on final consumption
(% change from benchmark)

	Scenarios		
	RCB	CCB	PPR
Food and non-alcoholic beverages	0.93	0.32	0.65
Tobacco and alcoholic beverages	1.34	0.49	2.58
Clothing and footwear	1.00	0.35	1.00
Housing	0.94	0.33	0.72
Home appliances	0.98	0.35	0.91
Health services	0.19	-0.04	-2.69
Transport services	1.09	0.39	1.39
Communication services	1.04	0.37	1.16
Recreational, cultural services	0.97	0.34	0.92
Education services	0.29	-0.06	-3.16
Hotel and restaurant services	0.95	0.33	0.75
Other consumption	0.98	0.34	0.87
Social work services	0.42	0.02	-2.36
Community services	0.12	-0.16	-4.14

Table 7. Sensitivity analysis: Effects on macroeconomic variables
(% change from benchmark)

	Scenarios								
	RCB			CCB			PPR		
	LAB	SOE	CRTS	LAB	SOE	CRTS	LAB	SOE	CRTS
GDP	1.10	1.16	1.08	0.41	0.42	0.40	0.63	0.65	0.62
Welfare	11.19	5.34	5.27	10.49	4.59	4.58	10.79	4.92	4.89
Real wage rate	1.37	1.44	1.33	0.24	0.24	0.22	0.98	1.01	0.97
Real capital rental rate	1.04	1.07	1.04	0.69	0.70	0.67	0.43	0.44	0.41
Employment	-0.21	-0.20	-0.20	-0.15	-0.14	-0.13	-0.13	-0.12	-0.12
Unemployment rate	-	0.07	0.07	-	0.05	0.04	-	0.04	0.04
Exports	0.57	1.33	0.57	-0.12	0.13	-0.11	0.22	0.60	0.22
Imports	0.35	0.94	0.36	-0.20	-0.41	0.00	0.13	0.43	0.13

Appendix. The model

As a general rule, the notation in the model is as follows: endogenous variables are denoted by capital letters, exogenous variables by capital letters with a bar, and parameters by small Latin and Greek letters. There are 13 (i, j = 1,…, 13) production sectors, where sectors 2 to 5 are exporters under the large open economy assumption; and there are 14 (k = 1,…, 14) consumption goods. All endogenous variables, and the exogenous variables and parameters, are listed in tables A1 and A2, respectively. The model's equations are as follows.

A. 1. Production

The base model presents increasing returns to scale due to some fixed costs, and a non-competitive pricing rule. Given that the upper nest is a Leontief function, the zero-profit condition for sector i is:

$$PROFIT_i^X = PX_i\left(1-oit_i\right)-\frac{\left(R\overline{KF_i}+W\overline{LF_i}\right)N_i}{X_i}-c_{0i}PVA_i-\sum_{j=1}^{13}c_{ji}PO_j=0 \quad (i = 1,\ldots, 13) \tag{A1}$$

where, according to the nested structure, the unit cost of the value added composite for sector i is a CES function:

$$PVA_i=\frac{1}{\alpha_i}\left(a_i^{\sigma_i^{LK}}\left(1+socce_i+soccw_i\right)^{1-\sigma_i^{LK}}W^{1-\sigma_i^{LK}}+(1-a_i)^{\sigma_i^{LK}}R^{1-\sigma_i^{LK}}\right)^{\frac{1}{1-\sigma_i^{LK}}} \quad (i = 1,\ldots, 13) \tag{A2}$$

We assume that the domestic producers maximize profits, and choose the optimal mix of domestic production and imports, and that of domestic sales and exports. This leads to the two zero-profit conditions:

$$PROFIT_i^A = PA_i-\left(e_i^{\sigma_i^A}PX_i^{1-\sigma_i^A}+(1-e_i)^{\sigma_i^A}\left(\overline{PFX}FC\right)^{1-\sigma_i^A}\right)^{\frac{1}{1-\sigma_i^A}}=0 \ (i = 1,\ldots, 13) \tag{A3}$$

$$PROFIT_i^{CET} = PA_i-\frac{1}{\zeta_i}\left(d_i^{-\varepsilon_i}PO_i^{\varepsilon_i+1}+(1-d_i)^{-\varepsilon_i}\left(\overline{PFX}FC\right)^{\varepsilon_i+1}\right)^{\frac{1}{\varepsilon_i+1}}=0 \ (i = 1, 6 \text{ to } 13) \tag{A4}$$

$$PROFIT_i^{CET} = PA_i-\frac{1}{\zeta_i}\left(d_i^{-\varepsilon_i}PO_i^{\varepsilon_i+1}+(1-d_i)^{-\varepsilon_i}PEXP_i^{\varepsilon_i+1}\right)^{\frac{1}{\varepsilon_i+1}}=0 \quad (i = 2 \text{ to } 5) \tag{A4'}$$

These zero-profit conditions are used to get derived demand functions, by applying the Shepard's Lemma on cost functions.

Next, we introduce the corresponding market clearing equations, with demands and supplies showing in the left-hand and the right-hand side, respectively:

$$X_i\left(-\frac{\partial PROFIT_i^X}{\partial PO_j}\right)=II_{ji} \qquad (i, j = 1,\ldots, 13) \tag{A5}$$

$$\sum_{i=1}^{13}N_i\overline{KF_i}+\sum_{i=1}^{13}X_i\left(-\frac{\partial PROFIT_i^X}{\partial R}\right)=\overline{K_{RC}}+\overline{K_G} \tag{A6}$$

$$\sum_{i=1}^{13}N_i\overline{LF_i}+\sum_{i=1}^{13}X_i\left(-\frac{\partial PROFIT_i^X}{\partial W}\right)=\left(\overline{L}-Q_l\right)(1-U) \tag{A7}$$

$$A_i\left(-\frac{\partial PROFIT_i^A}{\partial PX_i}\right) = X_i \qquad (i = 1,\ldots, 13) \qquad \textbf{(A8)}$$

$$A_i\left(-\frac{\partial PROFIT_i^A}{\partial FC_i}\right) = IMP_i \qquad (i = 1,\ldots, 13) \qquad \textbf{(A9)}$$

$$A_i\left(-\frac{\partial PROFIT_i^{CET}}{\partial PO_i}\right) = O_i \qquad (i = 1,\ldots, 13) \qquad \textbf{(A10)}$$

$$A_i\left(-\frac{\partial PROFIT_i^{CET}}{\partial FC_i}\right) = EXP_i \qquad (i = 1, 6 \text{ to } 13) \qquad \textbf{(A11)}$$

$$A_i\left(-\frac{\partial PROFIT_i^{CET}}{\partial PEXP_i}\right) = EXP_i \qquad (i = 2 \text{ to } 5) \qquad \textbf{(A11')}$$

$$X_i + IMP_i = O_i + EXP_i \qquad (i = 1,\ldots, 13) \qquad \textbf{(A12)}$$

$$I_i + \sum_{j=1}^{13} II_{ij} + CF_i = O_i \qquad (i = 1,\ldots, 13) \qquad \textbf{(A13)}$$

Finally, the markup function is:

$$MARKUP_i = \frac{PX_i\left(1+oit_i\right) - c_{0i}PVA_i - \sum_{j=1}^{13} c_{ji}PO_j}{PX_i\left(1+oit_i\right)} \qquad (i = 1,\ldots, 13) \qquad \textbf{(A14)}$$

that corresponds to the Lerner index:

$$MARKUP_i = \frac{\Omega_i}{N_i ELAS_i} \qquad (i = 1,\ldots, 13) \qquad \textbf{(A15)}$$

with:

$$ELAS_i = \sigma_i^A - \left(\sigma_i^A - 1\right)\frac{PX_i X_i}{\sum_{i=1}^{13} PX_i X_i} \qquad (i = 1,\ldots, 13) \qquad \textbf{(A16)}$$

A. 2. Consumption

The final demand functions are derived from the maximization of the representative consumer's nested welfare function:

$$WF = \left(Q_c\right)^{1-\tau_{sav}}\left(Q_{sav}\right)^{\tau_{sav}} \qquad \textbf{(A17)}$$

subject to the budget constraints:

$$Y_{RC} = W\left(\overline{L} - Q_l\right)\left(1-U\right) + R\overline{K_{RC}} + \overline{NTPS} \qquad \textbf{(A18)}$$

$$Y_{RC} = P_{sav}Q_{sav} + \sum_{k=1}^{14} PB_k\left(1+vat_k\right)CFB_k^{RC} \qquad \textbf{(A19)}$$

where the nests in the welfare function are defined by:

$$Q_c = \left(b^{\sigma^{CL}} Q_{cg}^{1-\sigma^{CL}} + (1-b)^{\sigma^{CL}} Q_l^{1-\sigma^{CL}}\right)^{\frac{1}{-\sigma^{CL}}} \qquad \textbf{(A20)}$$

$$Q_{cg} = \prod_{k=1}^{14}\left(CFB_k^{RC}\right)^{\tau_k} \qquad \textbf{(A21)}$$

The transformation from production goods into consumption goods follows a fixed coefficient structure:

$$CFB_k = \left(\frac{CF_1}{f_{1k}}, ..., \frac{CF_{13}}{f_{13k}} \right) \qquad (k = 1,\ldots, 14) \qquad \textbf{(A22)}$$

and consumption goods are purchased by the representative consumer and the public sector:

$$CFB_k = CFB_k^{RC} + CFB_k^G \qquad (k = 1,\ldots, 14) \qquad \textbf{(A23)}$$

The solution to the maximization problem yields the demand functions for savings, leisure, and final demand.

Finally, the demand for exports in the large open economy sectors is modelled through a constant-elasticity demand function such as:

$$EXP_i = \left(PEXP_i\right)^{-\mu_i} \qquad (i = 2 \text{ to } 5) \qquad \textbf{(A24)}$$

A. 3. Public sector

The income of the public sector is given by:

$$\overline{Y_G} = R\overline{K_G} + \sum_{i=1}^{13}\left(SOCCE_i + SOCCW_i + OIT_i\right) + \sum_{k=1}^{14} VAT_k - \overline{NTPS} \qquad \textbf{(A25)}$$

where revenues come from several taxes:

$$SOCCE_i = Wsocce_i X_i \left(-\frac{\partial PROFIT_i^X}{\partial W} \right) \qquad (i = 1,\ldots, 13) \qquad \textbf{(A26)}$$

$$SOCCW_i = Wsoccw_i X_i \left(-\frac{\partial PROFIT_i^X}{\partial W} \right) \qquad (i = 1,\ldots, 13) \qquad \textbf{(A27)}$$

$$OIT_i = PX_i\, oit_i X_i \left(-\frac{\partial PROFIT_i^X}{\partial PX_i} \right) \qquad (i = 1,\ldots, 13) \qquad \textbf{(A28)}$$

$$VAT_k = PB_k vat_k CFB_k \qquad (k = 1,\ldots, 14) \qquad \textbf{(A29)}$$

Due to the assumption of neutrality in the behaviour of the public sector, the macro closure rules are:

$$\overline{BALPUB} = \overline{SAVPUB} - \overline{INVPUB} \qquad \textbf{(A30)}$$

$$\sum_{k=1}^{14} CFB_k^G = \overline{Y_G} - \overline{SAVPUB} \qquad \textbf{(A31)}$$

A. 4. Investment, savings, and foreign sector

The macro closure of the model involve some other constraints related to investment and savings in the open economy:

$$\sum_{i=1}^{13} PO_i I_i = PINV\, \overline{INVTOTAL} \qquad \textbf{(A32)}$$

$$\overline{PFX}\, EXP_1 + \sum_{i=2}^{5} PEXP_i EXP_i / FC + \sum_{i=6}^{13} \overline{PFX}\, EXP_i - \sum_{i=1}^{13} \overline{PFX}\, IMP_i = \overline{D} \qquad \textbf{(A33)}$$

$$P_{sav} Q_{sav} + \overline{SAVPUB} - PINV\ \ \overline{INVTOTAL} = \overline{D}\ \ FC \qquad \textbf{(A34)}$$

A. 5. Factor markets

To conclude, the equilibrium in the capital market is given in **(A6)**, and the equilibrium in the labour market in **(A7)**, with some restrictions related to the matching unemployment assumptions:

$$W = W_0 \frac{1}{H} \qquad \textbf{(A35)}$$

$$H = \left(1 - \overline{U}\right) \left(\frac{\sum_{i=1}^{13} X_i \left(-\frac{\partial PROFIT_i^X}{\partial W} \right)}{\sum_{i=1}^{13} \overline{X_i} \left(-\frac{\partial PROFIT_i^X}{\partial W} \right)} \right)^{\eta_0} \left(\frac{U}{\overline{U}} \right)^{\eta_1} \qquad \textbf{(A36)}$$

Table A1. Endogenous variables

Symbol	Definition
A_i	Armington aggregate (total amount of goods supplied) of sector i
CF_i	Final domestic consumption of goods produced by sector *i*
CFB_k	Final domestic consumption of good *k*
CFB_k^G	Final public domestic consumption of good *k*
CFB_k^{RC}	Final private domestic consumption of good *k*
$ELAS_i$	Perceived elasticity of demand in sector *i*
EXP_i	Exports of sector *i*
FC	Factor of conversion of foreign currency into domestic currency
H	Inverse of the premium on the reservation wage rate
I_i	Investment (gross capital formation) in goods produced by sector *i*
II_{ij}	Intermediate inputs from sector *j* used by sector *i*
IMP_i	Imports from sector *i*
IT_i	Revenue from tariffs on imports from sector *i*
$MARKUP_i$	Price-cost margin in sector *i*
N_i	Number of firms in sector *i*
O_i	Production of sector *i* sold in the domestic market
OIT_i	Revenue from other indirect taxes in sector *i*
P_{sav}	Shadow price of savings
PA_i	Unit cost of the Armington aggregate of sector *i*
PB_k	Price of good *k*
$PEXP_i$	Unit cost of exports of sector *i*
$PINV$	Unit cost of aggregate investment
PO_i	Unit cost of the production of sector *i* sold in the domestic market
$PROFIT_i^A$	Unit profits for A_i (according to origin)
$PROFIT_i^{CET}$	Unit profits for A_i (according to destination)
$PROFIT_i^X$	Unit profits for X_i
PVA_i	Unit cost of the primary factors used in sector *i*
PX_i	Price of the goods produced by sector *i*
Q_c	Demand for aggregate consumption
Q_{cg}	Demand for aggregate consumption of goods
Q_l	Demand for leisure
Q_{sav}	Demand for savings
R	Capital rental rate
$SOCCE_i$	Revenue from social contributions paid by employers of sector *i*
$SOCCW_i$	Revenue from social contributions paid by employees of sector *i*
U	Unemployment rate
VAT_k	Revenue from the value added tax on good *k*
W	Wage rate
W_0	Reservation wage rate
WF	Welfare
X_i	Production of sector *i*
Y_{RC}	Disposable income of the representative consumer

Table A2. Exogenous variables and parameters

Symbol	Definition
$\overline{BALPUB}$	Balance of the public sector
$\overline{D}$	Trade balance surplus
$\overline{INVPUB}$	Investment of the public sector
$\overline{INVTOTAL}$	Total investment of the economy
$\overline{K_{RC}}$	Capital endowment of the representative consumer
$\overline{K_G}$	Capital endowment of the public sector
$\overline{KF_i}$	Fixed requirements of capital in sector *i*
$\overline{L}$	Labour endowment
$\overline{LF_i}$	Fixed requirements of labour in sector *i*
$\overline{NTPS}$	Net transfers from the public sector to the representative consumer
$\overline{PFX}$	World prices
$\overline{SAVPUB}$	Savings of the public sector
$\overline{U}$	Unemployment rate in the base year
$\overline{X_i}$	Effective production of sector *i* in the base year
$\overline{Y_G}$	Income of the public sector
a_i, b_i, c_{0i}, c_{ji}, d_i, e_i, f_{ik}	Share parameters
oit_i	Other indirect taxes rates, *ad valorem*, in sector *i*
$socce_i$	Social contributions rates, *ad valorem*, paid by employers in sector *i*
$soccw_i$	Social contributions rates, *ad valorem*, paid by employees in sector *i*
vat_k	Value added tax rates, *ad valorem*, on good *k*
Ω_i	Conjectural variations parameter in sector *i*
α_i, ζ_i	Scale parameters
ε_i	Elasticity of transformation in sector *i*
η_0, η_1	Externalities in the matching unemployment rule, from labour demand and unemployment
μ_i	Elasticity of the demand for exports in sector *i*
σ_i^k	Armington elasticity of substitution in sector *i*
σ^{CL}	Elasticity of substitution between consumption and leisure
σ_i^{LK}	Elasticity of substitution between labour and capital in sector *i*
τ_k, τ_{sav}	Share parameters