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The impact of foreign multinationals in ICT sectors: A CGE evaluation

(Preliminary version)

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Abstract

Foreign multinational enterprises (MNEs) play an important role in Information and Communication Technologies (ICT) sectors of the Spanish economy. However, our CGE simulations do not support the view that more foreign MNEs operating in those sectors imply a threat for employment. The important amount of net FDI inflows that Telecommunications has received in recent years would have helped to fight unemployment in Spain, while the decreases in FDI in Computer services would have contributed to the increase of the unemployment rate. In addition, our analysis of different levels of wage rigidity points out that with more rigid wages the effect of any shock in the economy is amplified. This latter outcomes holds both at the macro and microeconomic level.

Keywords: Computable general equilibrium, Foreign direct investment, Information and Communications Technologies.

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1. Introduction

The emergence of Information and Communication Technologies (ICT) involves one of the most important breakthroughs that humanity has experienced. It affects a wide variety of spheres ranging from public sector and firms' operations, as well as individuals' ways of life. According to the World Bank, there are an estimated 6.8 billion mobile-cellular subscriptions globally, out of the 7.1 billion of people on earth, by the end of 2013 (World Bank, 2014). This implies that the vast majority of people are part of the new "knowledge society".

Research has shown that the spread of ICT is associated with such economic benefits as higher productivity and lower costs (*Czernich et al., 2011;* Katz et al., 2013*)*. There exists evidence linking the larger productivity of the US versus that of Europe with Information Technologies (IT). In particular, van Ark et al. (2008) have found that European economies experienced a similar productivity increase as the United States in IT-producing sectors (such as semiconductors and computers) but failed to achieve the spectacular levels of productivity growth in the sectors that used IT intensively—predominantly market service sectors, including wholesale, retail, and financial services). More recently, these findings have been put in relationship with better management techniques in US firms compared to their European counterparts (Bloom et al., 2012). Other empirical studies find that IT is important to increase trade (e.g., through e-commerce) and to offer new economic opportunities, job creation and innovation, (World Bank, 2014).

In this paper we try to grasp the impact of foreign multinationals enterprises (MNEs) operating in IT sectors in a "middle case" economy, such as the one of Spain. This country does not stand out in the world economy panorama due to its ICT intensity, however, it does not exhibit a lagged position either. A holistic measure of "digitalization", which combines data on infrastructure, capacity, skill, quality and usage point supports this middle case assumption (Katz et al., 2013). The positive side of the "middle case position" is that there is scope for large gains from investing in ICT policies. In particular, the situation in Spain is characterized by a rather extended use of ICT among the population contrasting with a lagged position of firms' position in digitalization (e.g., less usage of company's web facilities and great scope for the expansion of e-commerce) (OECD, 2012). Therefore, our modeling of ICT will focus more on the enterprises' side of the economy.

The presence of MNEs in ICT sectors of the Spanish economy (and generally across countries) is quite remarkable. On the one hand, in Telecommunications one of the incumbent firms is the Spanish–owned Telefónica, which has been among the Wolds's top 100 non-financial enterprises ranked by foreign assets for years, according to the World Investment Report, (UNCTAD, several Years). But the presence of Vodafone and Orange is also remarkable. Furthermore, the latter foreign MNE has shown recent appetite for Jazztel, another incumbent foreign IT firm. The proposed acquisition is now been investigated by the anti-trust authorities European Commission (European Commission, 2014a). ONO (a Spanish IT producing firm) has also been acquired in 2014 by Vodafone (European Commission, 2014b). On the other hand, by contrast, foreign multinationals in Computer and related activities seem to have lost

interest in the Spanish economy in the last years. There is evidence of sizeable decreases in the FDI position before and during the crisis. We thus will use a CGE model which considers the presence of multinationals and pay special attention to the impact of foreign direct investment (FDI) flows linked with ITC sectors.

A point of concern of the growing importance of ICTs is its impact on employment. Higher productivity could arguably reduce jobs. The same can be said about the presence of the more capital intensive foreign MNEs (compared to their domestic counterparts). Their capital intensive technologies could also reduce labor demand. We pay particular attention to these issues using a CGE model that incorporates unemployment. To the best of our knowledge it is the first to consider both the presence of MNEs and unemployment. We run our simulations using several assumptions about wage rigidity (with unemployment), as well as a full labor employment scenario in order to offer a rich assessment of possible labor market effecs. We aim at offering evidence on this underesearched area of CGE evaluations of the impact of ICTs. Our results confirm that FDI inflows going to ICT sectors result in employment increases and unemployment rate decreases, while the reduction in the net FDI position produces the reverse. Therefore, we do not find any support for threats of harmful labor effects stemming from a higher involvement of foreign MNEs in ICT sectors.

The rest of the paper is organized as follows. The next section offers an overview of the role of MNEs in the Spanish economy and the recent evolution of FDI inflows, paying special attention to ICT sectors. In section 3 we explain the model, while section 4 explains the calibration and data sources. The macro and microeconomic results are discussed in the next section. The main conclusions close the paper. There are also two Appendixes. The first one fully describes the equations, variables and parameters of the model. Sectoral definitions and correspondences across the difference classifications used are available in the second one.

2. Foreign MNEs and FDI in ICT sectors of the Spanish economy.

Following OCDE (2011) guidelines ICT sectors[1] are composed of the following three sectors: Electronics, Telecommunications and Computer and related activities. The presence of foreign MNEs in these sectors in Spain is quite remarkable, according to their shares in production and factors' (labor and capital) remunerations. The latter are available in Table 1. Particularly, in Computer and related activities more than one third of factors' remunerations correspond to foreign MNEs and they even reach a 44% weight in production in that sector. In Electronics

[1] See Appendix 7.A1 (pp. 149-165) of OECD (2011). Complete sector definitions and mappings across classifications are available in Appendix 2 of this paper. To be more precise "Telecommunications" comprises 60 Programming and broadcasting activities and 61 Telecommunications; "Computer and related services" include the following subsectors: 58 Publishing activities, 59 Motion picture, video and television programme production, sound recording and music publishing activities, 62 Computer programming, consultancy and related activities, 63 Information service activities and 95 Repair of computers and personal and household goods, while "Electronics" coincides with 26 Manufacture of computer, electronic and optical products (following NACE Rev 2).

MNEs account for around one fourth of factors' remunerations and 38% of total production[2]. In the case of Telecommunications, the shares are smaller but well beyond 10% in the three variables considered. This points to an important role of foreign MNEs in the three sectors we are analysing. Certainly, there are other sectors in which their weight is still higher, such as Motor vehicles, Chemical products or Renting and Machinery. However, in the rest of sectors the presence of MNEs is smaller than in the ICTs.

[Table 1 here]

Table 2 offers a complementary view of the importance of foreign MNEs in Spain. According to column 3, their FDI position is remarkable in Chemical products, Wholesale and retail, Telecommunications, Financial intermediation and Other industries. As reflected in column 5, during the period 2006-2013 one third of the inward FDI flows have accrued to the energy sector (33%), 16% have gone to Wholesale and retail, while Telecommunications itself has also been another attractive sector (with 8.6% of the total amount of inflows), followed by Financial intermediation (8.3%), Real state activities (6.3%) and construction (6.0%).

[Table 2 here]

Taking into account the important weight of MNEs in the ICT sectors, the FDI flows going to them increase the capital available for production in a big share of the ICT sectors. In other words, the FDI inflows displayed in Table 2, have a larger potential effect the bigger the weight of MNEs (Table 1) in the particular sector are. Another important source influencing the impact of FDI is how big it is also in terms of the previous FDI position in the sector. As shown in column 6 of Table 2, this is particularly important in the case of Electronics (39.8%) and Telecommunications (45.5%). By contrast, Computer and related activities is precisely one of the few sectors that have experienced negative FDI inflows (i.e., gross FDI inflows have been smaller than the amount of divestments undertaken by foreign MNEs) in the period 2006-2013. Among the rest of sectors only Beverages and Tobacco and Chemical products have experienced reductions in the net FDI position, as Computer and related activities has. This will offer us the opportunity to analyse the impact of reductions in FDI in ICT sectors and contrast them to the more common case in which it has gone up.

3. The model

The models in this paper follows earlier contributions on this methodology (Gómez-Plana and Latorre, 2014, Bajo-Rubio and Gómez-Plana, 2015), and represent static CGE models describing an open economy, disaggregated in 25 productive sectors, one representative consumer, the public sector and a foreign sector representing the rest of the world. The main extensions with respect to standard CGE models (see, e.g., Shoven and Whalley, 1992, or Burfisher, 2011) refer to: (i) the modelling of capital as a factor of production, and the specificity assumption; (ii) the modelling of the multinational corporations, whose use of primary factors and intermediate

[2] Data are for the year 2005. This is the latest year available for the symmetric input-output table of Spain, with which our Social Accounting Matrix (SAM) has been constructed. See below.

inputs differ from domestic corporations; and (iii) unlike the common assumption of full employment in the labour market (used in one version of the model), another model includes unemployment in a way derived from trade unions models, due to the high unemployment rate registered in the Spanish economy. In addition, the choice of the productive sectors represented in the model has been the result of a careful selection; see below.

In the rest of this section we provide a short description of the model. The full set of equations, together with the complete list of the endogenous and exogenous variables and parameters of the model, are shown in the Appendix 1.

Equilibrium conditions

The equilibrium of the model is a set of prices and an allocation of goods and factors. It involves the simultaneous solution of three sets of equations:

- Zero-profit conditions.
- Market clearing in goods and factor markets. One version of the model includes unemployment and another version assumes full labour employment.
- Constraints on disposable income (total revenue must equal total expenditure), labour market (in the model that includes unemployment), public sector constraints, and macroeconomic closure of the model.

Firms and production

Production is based on a technology characterized by a nested structure of intermediate inputs, capital and labour. The firms' decision problem is to maximise profits subject to the technology constraints, obtaining the unit cost functions, which are further used in the zero-profit conditions. In turn, the demands for factors and intermediate inputs are obtained from Shephard's lemma on cost functions, and then used in the market-clearing equations.

Firms show constant returns to scale in their technologies and fix a competitive pricing rule, with free entry and exit of firms. Figure 1 shows the nested structure of firms' technology in sector *i*. This is a two-level technology. The first nest is a Leontief function over intermediate inputs and a composite of labour and capital, where indirect taxes (oit_i^{II}) can be levied on intermediate inputs. The second nest is a CES function over labour and capital, where social contributions (soc_i) are levied on labour.

[Figure 1 here]

However, note that within each sector there are two different varieties of the same good: a national variety produced by national firms and a foreign one produced by MNEs. The price of these two varieties can differ because their costs of production vary between national firms and MNEs of the same sector. Thus, we abandon the assumption of equal costs of production for national firms and MNEs across sectors, which is present in most of the CGEs including MNEs (see Gómez-Plana and Latorre, 2014). This equal costs assumption arises because only the percentage of capital owned by MNEs is used to split the sectors into a national firms' part and another MNEs' part. Thus, the input mix is the same between both types of firm within the same sector. By contrast, in our model, we split sectors into two parts, using Eurostat's

information on the shares of production, labour and capital that MNEs and national firms own[3]. As a result, the cost structure differs between national firms and MNEs in each sector.

Representative household and consumption

There is a representative consumer household that behaves as a rational consumer. The level of consumer's welfare 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 in one model) is assumed to be endogenous. Hence, labour supply would be elastic up to the endowment constraint. The fixed endowment of capital is supplied to all sectors except to sector 25.Public services (see Table 2 below), which only utilizes public capital.

The household's decision problem consists of choosing an optimal consumption bundle, by maximizing a nested utility function subject to the budget constraint. As shown in Figure 2, preferences are represented by a nested utility function on (consumption of) goods, leisure and savings. Notice that, given our static approach, we consider a unit elasticity of substitution between savings and (consumption of) goods (Howe, 1975), so that savings can be interpreted as the purchase of bonds for future consumption. The representative consumer buys all the final consumption goods, but the good from sector 1. Goods can be subject to indirect taxes (oit_i^{CF}).

[Figure 2 here]

The budget constraint includes total factor rents jointly with exogenous net transfers paid by the public sector. Demand functions for goods, leisure and savings are derived from the first-order conditions, and are included in the goods and factor markets equations, as well as in the macroeconomic closure for savings.

Public sector

The role of the public sector in the model is twofold, i.e., it is an owner of resources (e.g., from its capital endowment and tax revenues), and a purchaser of certain goods. We deal with these two functions in turn.

As an owner of resources, public sector's wealth includes income from capital rents, tax revenues, and net transfers from the representative household. Capital rents of the public sector include, by definition (see Eurostat, 1996), the fixed capital consumption because the net operating surplus is zero for the public sector. The fixed capital consumption has been assigned to sectors "24.Other services" and "25.Public services". All capital in sector 25 is owned by the public sector, whereas in sector 24 some capital is publicly owned and the rest is private, according to empirical data (see below). Taxes consist of social contributions paid by both employers and employees and net indirect taxes. All of them have been modelled using

[3] These are the shares available in Table 1.

actual *ad valorem* rates calibrated from benchmark data, with an endogenous revenue level. The rest of taxes have been modelled as exogenous.

The public sector also enters the model as a purchaser of goods. 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).

Foreign sector

The model incorporates the small open economy assumption, meaning that the country faces a perfectly elastic export supply function. There is also a constant elasticity of transformation function between domestic and foreign sales. 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 constraint 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. However, this requires a matching movement in trade flows.

Factor markets

Two factors enter into the model: capital and labour. Regarding capital, both the private and the public sector own fixed endowments. Capital rents adjust to clear the domestic capital market, under the assumptions of capital international immobility, and no mobility across domestic sectors. Capital is specific in two levels, i.e., each sector employs only specific capital, and capital is differentiated according to ownership (i.e., public, private national and foreign). Hence the capital is specific at two levels: (1) each sector employs only specific capital; (2) sectoral capital is differentiated according to owners.

The only owner of labour is the representative household. The demand for leisure is derived from the household's optimization problem. Hence, labour supply (i.e., the labour endowment less the demand for leisure) would be elastic up to the fixed amount of labour. Labour is assumed to be internationally immobile, but mobile across domestic sectors.

There are two models with respect to labour. The first one is the standard perfect competition market. In addition, we assume a second model where labour owners (i.e., workers) have some market power so that their bargained real wage is related to the unemployment rate (Kehoe *et al.*, 1995). Accordingly, the model includes the following constraint:

$$w = \left(\frac{1-u}{1-\overline{u0}}\right)^{\frac{1}{\beta}}$$

where *w* denotes the real wage, *u* is the unemployment rate, $\overline{u0}$ is the unemployment rate in the benchmark, and β is a nonnegative parameter that measures the sensitivity of real wages

to the rate of unemployment. Thus, as β approaches infinity, the real wage approaches its benchmark value (which is 1 according to the calibration process explained below): this is the case of rigid real wages when wages do not change when unemployment does. At the other extreme, as β approaches zero, the unemployment rate approaches its benchmark value, with real wages being flexible. Other intermediate values for β would mean different flexibility levels of real wages to the unemployment rate.

Macroeconomic closure

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

Finally, the model is solved as explained in Rutherford (1999), with the general equilibrium model defined as a mixed complementarity problem (see Mathiesen, 1985). The software used in the empirical application is GAMS/MPSGE.

4. Calibration and data

The model has been calibrated using Spanish data. The calibration method is based on a benchmark equilibrium corresponding to the National Accounts and a set of exogenous parameters. A detailed explanation of the calibration method can be found in Mansur and Whalley (1984) and Dawkins *et al.* (2001).

To build the Social Accounting Matrix (SAM), we depart from the last Input-Output symmetric table available for the Spanish economy, for the year 2005[4]. In order to do so we further use the institutional sectors accounts from the Spanish National Statistics Institute (Instituto Nacional de Estadística, 2012). Public revenue data have been disaggregated into net indirect taxes and Social security contributions while the rest of taxes are exogenous. The 25-sector disaggregation in the SAM, from the 72 sectors of the Input-Output table, are the ones that have already been presented in Tables 1 and 2.

On the other hand, the choice of elasticities plays a key role in the model. The benchmark values for those elasticities are:

- Elasticities of substitution in the welfare function:
  - between consumption and savings: 1.
  - between final consumption and leisure: 1.
  - across final consumption goods: 1.
- Elasticities related to production:
  - between intermediate inputs and value added composite: 0.
  - between labour and capital: values fluctuate between 1.26 and 1.68.

[4] This is the latest year for which the symmetric IO table of the Spanish economy is available.

- between domestic and foreign goods (Armington elasticities): values fluctuate between 0.70 and 2.90.
- between goods sold in the domestic market and abroad (elasticities of transformation): values fluctuate between 1.90 and 4.30.

The literature sources for the elasticities are Narayanan and Walmsley (2008) for the elasticity of substitution between labour and capital and Armington elasticities; de Melo and Tarr (1992) for the elasticities of transformation; and the elasticity of substitution between consumption and leisure is consistent with the survey by Ballard and Kang (2003). The rest of values are common in the literature.

5. Empirical results

To put in perspective the results obtained after the entry of FDI in ICT sectors we also simulate the impact of all the FDI inflows received across all the sectors that constitute the Spanish economy, i.e., apart from shocks in ICT sectors, we also simulate the increases in the FDI position across all of the 25 sectors, as reflected in column 6 of Table 2. A key point in the paper is their role in employment in an economy with high unemployment rates. To this aim, the role of wage flexibility when the investment enters the country is checked. Note that results try to show in isolation the real effects.

Definition of scenarios

Simulations have been performed under six labour market scenarios, where the first five involve a labour market with unemployment, and the last one displays a perfect competition labour market. Specifically, these scenarios are:

(i) A very rigid real wage with respect to unemployment rate ($\beta = 20$).
(ii) A rigid real wage with respect to unemployment rate ($\beta = 3$).
(iii) A reference scenario with a plausible sensibility of real wage with respect to unemployment rate ($\beta = 1.5$).
(iv) A flexible real wage with respect to unemployment rate ($\beta = 0.1$).
(v) A very flexible real wage with respect to unemployment rate ($\beta = 0.001$).
(vi) No unemployment.

Simulation results

Macroeconomics results:

The results from the above simulations on the main macroeconomic variables appear in Table 3 as percentage changes from benchmark, except for the unemployment rate, in which case changes are expressed as percentage points.

[Table 3 here]

- The more rigid the wages, the higher the effects on the following macroeconomic variables: welfare, GDP and employment. The results of the full employment scenario are very close to the very high flexibility of real wages to the unemployment rate.

- As capital is fully employed, the change in GDP depends on the factor rents and the employment levels. The employment change is the more influential factor on GDP changes.
- Communications and Computer services play a relevant quantitative role on macroeconomic variables changes. Communications in a positive way, while the divestment in Computer services generates a negative effect. The role of Electronics is tiny.
- The results of the full employment scenario are very close to the very high flexibility of real wages to the unemployment rate.

Microeconomic results:

Next, we present the results across sectors for the two most relevant variables, namely, output (in physical units)and employment. In order to interpret these sectoral results one should take into account the constraints that the model imposes on productive factors, i.e., labour is modelled under an unemployment rule in five scenarios and leisure can take place in all scenarios, but capital is assumed fully employed and specific at the sectoral level. Notice also that in a general equilibrium framework the results can be driven by several forces which, in some cases, move in opposite directions.

We first provide an overview of the evolution of both production and employment across sectors, with what we call the "Reference scenario", which is a central value of the elasticity of wage adjustment (beta = 1.5). This will allow us to concentrate on the comparison of the impact of FDI accruing to the different ICT sectors and also display the overall effects of FDI accruing to all of the sectors of the economy simultaneously. The results appear in Table 4. In columns 1 and 5, we see that the entry of FDI in Telecommunications brings about an overall expansion in production and labor demand across the board. The same applies to the arrival of FDI flows to all sectors simultaneously (columns 4 and 8), with the exception of the sectors that experience reductions in the FDI position, namely, Beverages and Tobacco, Chemical productos and Computer services.

The reduction in the FDI positions experienced in Computer services (columns 2 and 6 of Table 4) induces a contraction across most sectors of the economy. After the small amount of FDI inflows that go to Electronics this sector experiences a considerable increase in its own production, while the rest remain nearly unchanged. Although the tendency of employment runs parallel to that of employment in the majority of cases, the adjustments in the former are more intense than in the latter.

We turn now to the analysis of the impact of different wage rigidity assumptions on labor demand after the arrival of new FDI inflows. We concentrate on labor demand because we find that Physical output at sectoral level is not very sensible to the labour market asumptions. The maximum and minimum changes are very close independently of the scenario simulated. The sectoral variance remains also very close across scenarios. Tables 5, 6, 7 and 8, present the

simulations results for labor demand of FDI going to Telecommunications, Computer services, Electronics, as well as FDI going to each of the 25 sectors respectibvely.

[Tables 5, 6, 7 and 8 here]

We find in Tables 5, 7 and 8 that as happened at the macroeconomic level, the more rigid the wages are, the highest the increases (or the smallest the reductions) in labor demand across sectors. Interestingly, for the simulation of the arrival of FDI to the different sectors of the economy, we even see that the few sectors that experience reductions in labor demand may turn out to undergo increases in that variable if the wage becomes more rigid. By contrast, the reduction in FDI in Computer services (Table 6) has worse effects in the presence of rigid wages. Contractions across sectors are more intense than in the case of flexible wages. Facing adverse shocks, a more flexible wage dampens the bad outcomes across the different sectors, as happened with the macroeconomic variables. The results of the full employment scenario are very close to the very high flexibility of real wages to the unemployment rate.

6. Conclusions

We simulate the impact of the operations of MNEs in the ICT sectors of the Spanish economy in the period 2005-2013. Our results do not support the view that more foreign MNEs operating in ICT sectors imply a threat for employment. On the contrary, net increases in FDI in those sectors, irrespectively of the wage flexibility assumed, will increase the employment rate and reduce the unemployment rate. By contrast, decreases in the FDI position will destroy employment and increase unemployment.

In addition, our analysis of different levels of wage rigidity points out that the more rigid the wages are, the largest the increases in employment and reductions in unemployment are in case of FDI increases, such as the one that has taken place in Telecommunications. However, in the same line, the more rigid the wages are, the largest the decreases in employment and increases in unemployment following reductions in the FDI position, as has happened in Computer services. In other words, with more rigid wages the effect of any shock in the economy is amplified.

This would be consistent with the idea that more rigid wages imply that there is a high number of unemployed so that it is relatively easy for firms to hire more workers without having to increase wages in order to attract them following FDI increases. Because there is an important amount of the labor force that can be easily and “cheaply” hired, GDP increases are also higher the more rigid the wages are. Wages, by contrast, still vary although less the more rigid they are, of course. With rigid wages, however, there is little possible adjustment for firms to lower wages if they are reducing production following decreases in the FDI position. Therefore, adjustments take place through contractions in the number of workers, thus, magnifying reductions in employment and GDP, as well as increases in unemployment.

At the sectoral level we also find parallel outcomes. The more rigid the wages are the largest the adjustments in labor demand across sectors in the economy and vice versa.

All in all, the important amount of net FDI inflows that Telecommunications has received would have helped to fight unemployment in Spain, while the decreases in FDI in Computer services would have contributed to the increase of the unemployment rate. Finally, we have also analyzed the evolution of Electronics. It has also received some sizeable increases in FDI according to its initial FDI position. But since it is rather small sector accounting for only 0.4% of the total FDI position, its positive evolution has only contributed to a tiny increase in employment and decrease in unemployment.

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Table 1. Foreign MNEs' shares in production, remuneration of employees and rental rate of capital in Spain (2005)

	Production	Remuneration of employees	Rental rate of capital
1.Primary goods	4.00	2.00	4.00
2.Energy	18.00	12.00	13.00
3.Food products	14.00	15.00	18.00
4.Beverages & Tobacco	13.00	14.00	15.00
5.Textiles products	3.85	4.00	3.00
6.Chemical products	38.00	40.00	43.00
7.Basic metals	4.00	4.00	5.00
8.Manufacture of metal products	7.00	6.00	7.00
9.Electronics	**38.00**	**27.00**	**26.00**
10.Motor vehicles, trailers & semi-trailers	75.83	66.68	63.27
11.Other industries	**16.00**	**15.00**	**14.00**
12.Contruction	1.00	2.00	1.00
13.Sale & repair of motor vehicles	21.64	9.66	35.97
14.Wholesale and retail trade	16.00	14.00	14.00
15.Air and water transport	11.00	10.00	9.00
16.Other transport	4.00	4.00	2.00
17.Telecommunications	16.64	9.99	13.41
18.Financial intermediation	10.00	8.00	4.00
19.Activities auxiliary to financial intermediation	10.00	8.00	4.00
20.Real estate activities	2.82	3.07	2.98
21.Renting of machinery & equipment	27.56	16.96	34.22
22.Other business activities	9.73	13.20	4.74
23.Computer and related activities	**44.00**	**36.00**	**32.00**
24.Other services	**3.00**	**3.00**	**2.00**
25.Public services	0.00	0.00	0.00

Sources: INE (2013), Eurostat (2012) and OECD (2013)

Table 2. FDI position and Net FDI inflows across sectors in Spain

	FDI position (2005)		Net FDI inflows (2006-2013)		
	In million €	% of the Total	In million € since 2005	% of the Total	% over FDI position
1.Primary goods	408.6	0.3	230.6	0.3	56.4
2.Energy	4902.6	3.4	30196.5	33.0	615.9
3.Food products	833.5	0.6	1609.8	1.8	45.5
4.Beverages & Tobacco	5015.5	3.5	-2277.2	-2.5	-45.4
5.Textiles products	3536.3	2.5	79.6	0.1	9.6
6.Chemical products	14343.1	10.0	-1739.2	-1.9	-12.1
7.Basic metals	7063.2	4.9	3068.9	3.4	43.4
8.Manufacture of metal products	1587.8	1.1	205.0	0.2	12.9
9.Electronics	598.7	0.4	238.5	0.3	39.8
10.Motor vehicles, trailers & semi-trailers	9346.7	6.5	870.8	1.0	9.3
11.Other industries	19346.6	13.5	3680.2	4.0	19.0
12.Contruction	2846.7	2.0	5527.8	6.0	194.2
13.Sale & repair of motor vehicles	1805.2	1.3	262.9	0.3	14.6
14.Wholesale and retail trade	19004.2	13.3	14682.5	16.0	77.3
15.Air and water transport	587.5	0.4	3944.9	4.3	671.4
16.Other transport	1069.8	0.7	3432.6	3.8	320.9
17.Telecommunications	17277.5	12.1	7862.0	8.6	45.5
18.Financial intermediation	13740.6	9.6	7617.5	8.3	55.4
19.Activities auxiliary to financial intermediation	1352.2	0.9	695.8	0.8	51.5
20.Real estate activities	3987.5	2.8	5789.9	6.3	145.2
21.Renting of machinery & equipment	1279.4	0.9	747.2	0.8	58.4
22.Computer and related activities	2630.9	1.8	-1299.3	-1.4	-49.4
23.Other business activities	6869.2	4.8	3045.4	3.3	44.3
24.Other services	3862.9	2.7	2999.2	3.3	77.6
25.Public services	0.0	0.0	3.1	0.0	0.0
TOTAL	143296.2	100.0	91486.9	100.0	63.8

Source: The Spanish Registry of FDI (Ministry of Economics and Competitiveness, 2013).

Table 3. Simulation results: Employment and output after FDI accruing to ICT sectors and to all sectors of the economy (in percentage, several wage scenarios)

	GDP	Real wages	Employment	Unemployment rate		Welfare
				(%)	(p.p.)	
	Very rigid wages (Beta = 20)					
17.Telecommunications	0.478	0.027	0.650	-5.356	-0.491	0.532
22.Computer and related activities	-0.191	-0.028	-0.414	2.555	0.234	-0.465
9.Electronics	0.031	0.007	0.060	-0.413	-0.038	0.041
All sectors	5.143	-0.255	7.173	-60.357	-5.529	5.820
	Rigid wages (Beta = 3)					
17.Telecommunications	0.389	0.123	0.480	-3.633	-0.333	0.390
22.Computer and related activities	-0.149	-0.074	-0.333	1.729	0.158	-0.397
9.Electronics	0.024	0.015	0.047	-0.279	-0.026	0.030
All sectors	4.230	0.850	5.373	-41.611	-3.812	4.292
	Reference scenario (Beta = 1.5)					
17.Telecommunications	0.338	0.179	0.382	-2.635	-0.241	0.307
22.Computer and related activities	-0.124	-0.100	-0.286	1.253	0.115	-0.358
9.Electronics	0.020	0.019	0.039	-0.202	-0.019	0.024
All sectors	3.681	1.522	4.303	-30.465	-2.791	3.377
	Flexible wages (Beta = 0.1)					
17.Telecommunications	0.218	0.310	0.152	-0.303	-0.028	0.115
22.Computer and related activities	-0.067	-0.161	-0.177	0.144	0.013	-0.266
9.Electronics	0.011	0.029	0.021	-0.023	-0.002	0.009
All sectors	2.338	3.190	1.721	-3.580	-0.328	1.152
	Very flexible wages (Beta = 0.001)					
17.Telecommunications	0.202	0.327	0.122	-0.003	0.000	0.090
22.Computer and related activities	-0.059	-0.169	-0.162	0.002	0.000	-0.255
9.Electronics	0.010	0.030	0.019	0.000	0.000	0.007
All sectors	2.159	3.415	1.380	-0.038	-0.003	0.857
	Full employment					
17.Telecommunications	0.202	0.327	0.122			0.089
22.Computer and related activities	-0.059	-0.169	-0.162			-0.255
9.Electronics	0.010	0.030	0.019			0.007
All sectors	2.157	3.417	1.377			0.853

Table 4. Simulation results Employment and output effects of FDI accruing to ICT sectors and to all sectors of the economy (in percentage, central wage rigidity case)

	Employment				Output			
	17.Telecommunications	22.Computer and related activities	9.Electronics	All sectors	17.Telecommunications	22.Computer and related activities	9.Electronics	All sectors
1.Primary goods	0.05	0.07	-0.03	2.19	0.01	0.01	-0.01	2.28
2.Energy	1.66	-0.93	-0.07	10.70	0.29	-0.17	-0.01	11.56
3.Food products	0.30	-0.08	-0.04	6.57	0.19	-0.05	-0.03	5.61
4.Beverages & Tobacco	0.85	-0.88	0.01	2.23	0.53	-0.55	0.00	-2.33
5.Textiles products	0.90	-0.07	-0.15	5.57	0.69	-0.05	-0.11	4.34
6.Chemical products	0.57	0.18	-0.12	-2.28	0.35	0.11	-0.07	-3.04
7.Basic metals	0.49	-0.21	-0.05	6.00	0.30	-0.13	-0.03	4.23
8.Manufacture of metal products	0.37	-0.43	0.04	4.84	0.26	-0.31	0.03	3.73
9.Electronics	0.89	-0.64	5.66	9.46	0.65	-0.48	8.29	11.73
10.Motor vehicles, trailers & semi-trailers	0.48	-0.11	-0.22	8.33	0.33	-0.08	-0.15	8.04
11.Other industries	0.54	-0.31	0.00	7.02	0.35	-0.20	0.00	5.68
12.Contruction	0.34	-1.38	0.06	3.70	0.21	-0.85	0.04	2.19
13.Sale & repair of motor vehicles	0.45	-0.42	0.00	4.39	0.28	-0.26	0.00	4.93
14.Wholesale and retail trade	0.42	-0.17	0.07	5.43	0.22	-0.09	0.04	7.45
15.Air and water transport	0.55	-0.12	-0.08	10.53	0.35	-0.08	-0.05	7.95
16.Other transport	0.56	-0.49	0.00	8.02	0.29	-0.26	0.00	4.60
17.Telecommunications	-3.58	-1.99	0.09	3.30	4.69	-0.63	0.03	6.84
18.Financial intermediation	0.49	-0.53	0.01	5.20	0.30	-0.34	0.01	4.41
19.Activities auxiliary to financial intermediation	0.88	-0.61	-0.01	8.83	0.32	-0.22	0.00	5.68
20.Real estate activities	0.94	-0.87	0.06	7.85	0.08	-0.08	0.01	3.69
21.Renting of machinery & equipment	1.10	-1.23	0.00	-1.31	0.47	-0.53	0.00	9.64
22.Computer and related activities	1.01	10.38	0.03	16.08	0.62	-12.75	0.02	-10.68
23.Other business activities	0.94	-0.79	0.05	6.90	0.60	-0.50	0.03	4.73
24.Other services	0.44	-0.27	0.03	3.89	0.25	-0.15	0.02	2.63
25.Public services	0.01	-0.01	0.00	0.10	0.01	-0.01	0.00	0.09

Table 5. Simulation results: Employment effects of FDI accruing to Telecommunications (in percentage, several wages asumptions)

	Very rigid wages	Rigid wages	Reference scenario	Flexible wages	Very flexible wages	Full employment
1.Primary goods	0.14	0.09	0.05	-0.02	-0.030	-0.030
2.Energy	2.43	1.94	1.66	1.00	0.914	0.913
3.Food products	0.51	0.37	0.30	0.11	0.086	0.086
4.Beverages & Tobacco	1.34	1.03	0.85	0.42	0.370	0.369
5.Textiles products	1.35	1.06	0.90	0.51	0.458	0.458
6.Chemical products	0.90	0.69	0.57	0.28	0.246	0.246
7.Basic metals	0.88	0.63	0.49	0.15	0.109	0.108
8.Manufacture of metal products	0.68	0.48	0.37	0.09	0.058	0.058
9.Electronics	1.26	1.03	0.89	0.58	0.537	0.537
10.Motor vehicles, trailers & semi-trailers	0.94	0.65	0.48	0.09	0.040	0.039
11.Other industries	0.87	0.66	0.54	0.25	0.213	0.212
12.Contruction	0.61	0.44	0.34	0.11	0.084	0.084
13.Sale & repair of motor vehicles	0.79	0.57	0.45	0.15	0.113	0.113
14.Wholesale and retail trade	0.73	0.54	0.42	0.15	0.115	0.114
15.Air and water transport	0.86	0.67	0.55	0.29	0.254	0.253
16.Other transport	0.93	0.69	0.56	0.24	0.201	0.201
17.Telecommunications	-3.14	-3.42	-3.58	-3.96	-4.007	-4.008
18.Financial intermediation	0.79	0.60	0.49	0.23	0.196	0.196
19.Activities auxiliary to financial intermediation	1.32	1.04	0.88	0.50	0.454	0.453
20.Real estate activities	1.61	1.19	0.94	0.37	0.301	0.301
21.Renting of machinery & equipment	1.54	1.26	1.10	0.73	0.683	0.683
22.Computer and related activities	1.31	1.12	1.01	0.76	0.725	0.725
23.Other business activities	1.24	1.05	0.94	0.69	0.658	0.658
24.Other services	0.77	0.56	0.44	0.16	0.129	0.129
25.Public services	0.03	0.02	0.01	0.00	0.001	0.001
TOTAL	0.65	0.48	0.38	0.15	0.122	0.122
Max	2.43	1.94	1.66	1.00	0.914	0.913
Min	-3.14	-3.42	-3.58	-3.96	-4.007	-4.008
Variance	0.92	0.86	0.84	0.80	0.801	0.801
Range	5.58	5.37	5.24	4.96	4.921	4.920

Table 6. Simulation results: Employment effects of FDI accruing to Computer and related activities (in percentage, several wages asumptions)

	Very rigid wages	Rigid wages	Reference scenario	Flexible wages	Very flexible wages	Full employment
1.Primary goods	0.03	0.05	0.07	0.10	0.11	0.11
2.Energy	-1.30	-1.07	-0.93	-0.62	-0.58	-0.58
3.Food products	-0.18	-0.12	-0.08	0.01	0.02	0.02
4.Beverages & Tobacco	-1.12	-0.97	-0.88	-0.69	-0.66	-0.66
5.Textiles products	-0.29	-0.15	-0.07	0.11	0.14	0.14
6.Chemical products	0.02	0.12	0.18	0.32	0.33	0.33
7.Basic metals	-0.40	-0.28	-0.21	-0.05	-0.03	-0.03
8.Manufacture of metal products	-0.58	-0.49	-0.43	-0.30	-0.29	-0.29
9.Electronics	-0.82	-0.70	-0.64	-0.49	-0.47	-0.47
10.Motor vehicles, trailers & semi-trailers	-0.33	-0.19	-0.11	0.08	0.10	0.10
11.Other industries	-0.47	-0.37	-0.31	-0.17	-0.16	-0.16
12.Contruction	-1.50	-1.42	-1.38	-1.27	-1.26	-1.26
13.Sale & repair of motor vehicles	-0.58	-0.48	-0.42	-0.28	-0.26	-0.26
14.Wholesale and retail trade	-0.32	-0.23	-0.17	-0.04	-0.03	-0.03
15.Air and water transport	-0.27	-0.18	-0.12	0.00	0.02	0.02
16.Other transport	-0.67	-0.56	-0.49	-0.35	-0.33	-0.33
17.Telecommunications	-2.23	-2.08	-1.99	-1.79	-1.77	-1.77
18.Financial intermediation	-0.68	-0.59	-0.53	-0.41	-0.40	-0.40
19.Activities auxiliary to financial intermediation	-0.82	-0.68	-0.61	-0.43	-0.40	-0.40
20.Real estate activities	-1.18	-0.98	-0.87	-0.60	-0.57	-0.57
21.Renting of machinery & equipment	-1.43	-1.30	-1.23	-1.05	-1.03	-1.03
22.Computer and related activities	**10.21**	**10.32**	**10.38**	**10.52**	**10.54**	**10.54**
23.Other business activities	-0.93	-0.84	-0.79	-0.67	-0.65	-0.65
24.Other services	-0.42	-0.33	-0.27	-0.14	-0.12	-0.12
25.Public services	-0.02	-0.01	-0.01	0.00	0.00	0.00
TOTAL	-0.41	-0.33	-0.29	-0.18	-0.16	-0.16
Max	10.21	10.32	10.38	10.52	10.54	10.54
Min	-2.23	-2.08	-1.99	-1.79	-1.77	-1.77
Variance	5.04	5.01	5.00	4.97	4.97	4.97
Range	12.44	12.40	12.37	12.32	12.31	12.31

Table 7. Simulation results: Employment effects of FDI accruing to Electronics
(in percentage, several wages asumptions)

	Very rigid wages	Rigid wages	Reference scenario	Flexible wages	Very flexible wages	Full employment
1.Primary goods	-0.03	-0.03	-0.03	-0.04	-0.039	-0.04
2.Energy	-0.01	-0.05	-0.07	-0.12	-0.124	-0.12
3.Food products	-0.02	-0.04	-0.04	-0.06	-0.057	-0.06
4.Beverages & Tobacco	0.04	0.02	0.01	-0.03	-0.031	-0.03
5.Textiles products	-0.11	-0.14	-0.15	-0.18	-0.182	-0.18
6.Chemical products	-0.10	-0.11	-0.12	-0.14	-0.146	-0.15
7.Basic metals	-0.02	-0.04	-0.05	-0.08	-0.083	-0.08
8.Manufacture of metal products	0.06	0.05	0.04	0.02	0.014	0.01
9.Electronics	5.69	5.67	5.66	5.64	5.632	5.63
10.Motor vehicles, trailers & semi-trailers	-0.18	-0.20	-0.22	-0.25	-0.249	-0.25
11.Other industries	0.02	0.01	0.00	-0.02	-0.026	-0.03
12.Contruction	0.08	0.07	0.06	0.04	0.040	0.04
13.Sale & repair of motor vehicles	0.02	0.01	0.00	-0.02	-0.027	-0.03
14.Wholesale and retail trade	0.09	0.08	0.07	0.05	0.046	0.05
15.Air and water transport	-0.06	-0.07	-0.08	-0.10	-0.107	-0.11
16.Other transport	0.03	0.01	0.00	-0.02	-0.028	-0.03
17.Telecommunications	0.13	0.10	0.09	0.06	0.051	0.05
18.Financial intermediation	0.04	0.02	0.01	-0.01	-0.010	-0.01
19.Activities auxiliary to financial intermediation	0.03	0.00	-0.01	-0.04	-0.042	-0.04
20.Real estate activities	0.11	0.08	0.06	0.02	0.011	0.01
21.Renting of machinery & equipment	0.04	0.02	0.00	-0.03	-0.029	-0.03
22.Computer and related activities	0.06	0.04	0.03	0.01	0.012	0.01
23.Other business activities	0.08	0.06	0.05	0.04	0.033	0.03
24.Other services	0.05	0.04	0.03	0.01	0.006	0.01
25.Public services	0.00	0.00	0.00	0.00	0.000	0.00
TOTAL	0.06	0.05	0.04	0.02	0.019	0.02
Max	5.69	5.67	5.66	5.64	5.632	5.63
Min	-0.18	-0.20	-0.22	-0.25	-0.249	-0.25
Variance	1.29	1.29	1.29	1.29	1.292	1.29
Range	5.87	5.87	5.87	5.88	5.881	5.88

Table 8. Simulation results: Employment effects of FDI accruing to all sectors of the economy (in percentage, several wages asumptions)

	Very rigid wages	Rigid wages	Reference scenario	Flexible wages	Very flexible wages	Full employment
1.Primary goods	3.24	2.58	2.19	1.23	1.100	1.10
2.Energy	18.20	13.48	10.70	4.12	3.268	3.26
3.Food products	8.96	7.47	6.57	4.36	4.061	4.06
4.Beverages & Tobacco	7.41	4.14	2.23	-2.32	-2.916	-2.92
5.Textiles products	10.91	7.55	5.57	0.82	0.203	0.20
6.Chemical products	0.23	-1.35	-2.28	-4.53	-4.824	-4.83
7.Basic metals	10.30	7.60	6.00	2.17	1.668	1.66
8.Manufacture of metal products	8.30	6.13	4.84	1.73	1.319	1.31
9.Electronics	14.09	11.19	9.46	5.32	4.774	4.77
10.Motor vehicles, trailers & semi-trailers	9.55	8.78	8.33	7.23	7.089	7.09
11.Other industries	10.94	8.48	7.02	3.51	3.051	3.05
12.Contruction	6.52	4.76	3.70	1.14	0.799	0.80
13.Sale & repair of motor vehicles	7.68	5.62	4.39	1.41	1.018	1.01
14.Wholesale and retail trade	8.81	6.69	5.43	2.38	1.976	1.97
15.Air and water transport	14.57	12.04	10.53	6.89	6.414	6.41
16.Other transport	12.26	9.60	8.02	4.21	3.711	3.71
17.Telecommunications	8.45	5.21	3.30	-1.25	-1.843	-1.85
18.Financial intermediation	8.56	6.45	5.20	2.18	1.776	1.77
19.Activities auxiliary to financial intermediation	13.82	10.69	8.83	4.37	3.790	3.78
20.Real estate activities	15.10	10.53	7.85	1.50	0.676	0.67
21.Renting of machinery & equipment	2.66	0.17	-1.31	-4.83	-5.291	-5.30
22.Computer and related activities	20.20	17.61	16.08	12.39	11.902	11.90
23.Other business activities	10.15	8.11	6.90	3.96	3.576	3.57
24.Other services	7.45	5.22	3.89	0.67	0.246	0.24
25.Public services	0.23	0.15	0.10	-0.03	-0.042	-0.04
TOTAL	7.17	5.37	4.30	1.72	1.380	1.38
Max	20.20	17.61	16.08	12.39	11.902	11.90
Min	0.23	-1.35	-2.28	-4.83	-5.291	-5.30
Variance	24.27	18.44	16.05	13.42	13.382	13.38
Range	19.97	18.96	18.36	17.22	17.193	17.19

Figure 1. Production function nests

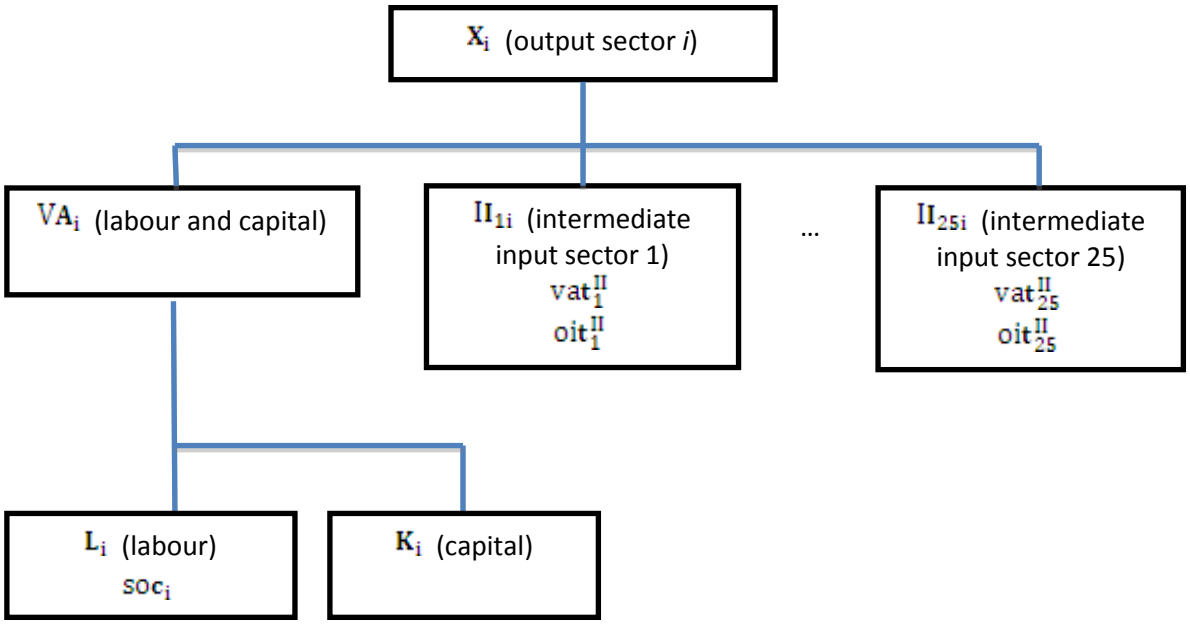
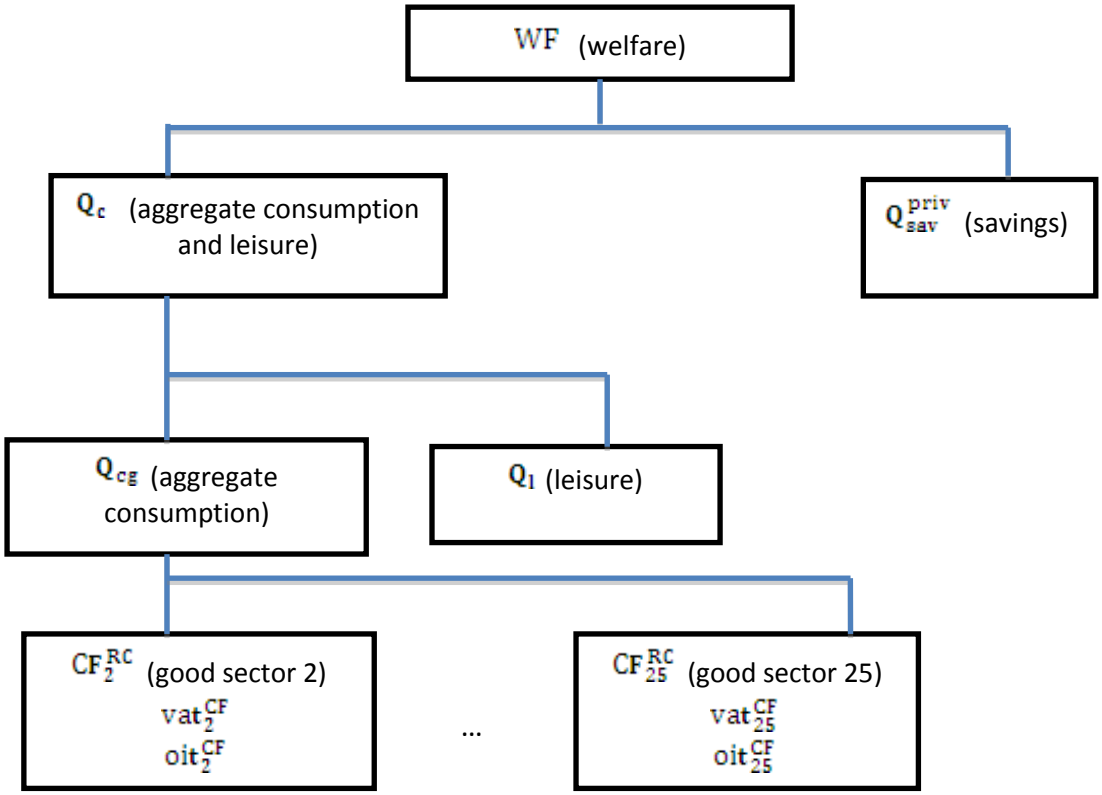


Figure 2. Welfare function nests



Appendix 1. 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 25 (*i*, *j* = 1,..., 25) production sectors and each sector produces one good. All endogenous variables, and the exogenous variables and parameters, are listed in Tables A.1 and A.2 below. The model's equations are as follows.

Production

The nested technology presents constant returns to scale and a competitive pricing rule. Given that the top nest is a Leontief function, the zero-profit condition for sector *i* is:

$$PROFIT_i^X = PX_i\left(1-oit_i^{II}-vat_i^{II}\right)-c_{0i}PVA_i-\sum_{j=1}^{18}c_{ji}PO_j=0 \qquad (i = 1,\ldots, 25) \qquad \text{(A1)}$$

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

$$PVA_i=\frac{1}{\alpha_i}\left(a_i^{\sigma_i^{LK}}\left(1+soc_i\right)^{1-\sigma_i^{LK}}W^{1-\sigma_i^{LK}}+\left(1-a_i\right)^{\sigma_i^{LK}}R_i^{1-\sigma_i^{LK}}\right) \qquad (i = 1,\ldots, 25) \qquad \text{(A2)}$$

We assume that firms maximize profits, and choose the optimal mix of national and imported goods, and that of domestic sales and exports. This leads to the following zero-profit conditions:

$$PROFIT_i^A = PA_i-\left(e_i^{\sigma_i^A}PX_i^{1-\sigma_i^A}+(1-e_i)^{\sigma_i^A}(\overline{PFX}FC)^{1-\sigma_i^A}\right)^{\frac{1}{1-\sigma_i^A}}=0 \qquad (i = 1,\ldots, 25) \qquad \text{(A3)}$$

$$PROFIT_i^{CET} = PA_i-\frac{1}{\varsigma_i}\left(d_i^{-\varepsilon_i}PO_i^{\varepsilon_i+1}+(1-d_i)^{-\varepsilon_i}(\overline{PFX}FC)^{\varepsilon_i+1}\right)^{\frac{1}{\varepsilon_i+1}}=0 \qquad (i = 1,\ldots, 25) \qquad \text{(A4)}$$

These zero-profit conditions are used to get derived demand functions, by applying the Shephard'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:

$$X_i\left(-\frac{\partial PROFIT_i^X}{\partial PO_j}\right)=II_{ji} \qquad (i, j = 1,\ldots, 25) \qquad \text{(A5)}$$

$$X_i\left(\frac{\partial PROFIT_i^X}{\partial R_i}\right)=\overline{K_i^{RC}}+\overline{K_i^{PUB}} \qquad (i = 1,\ldots, 25) \qquad \text{(A6)}$$

$$\sum_{i=1}^{18}X_i\left(\frac{\partial PROFIT_i^X}{\partial W}\right)=(\bar{L}-Q_l)(1-U) \qquad \text{(A7)}$$

$$A_i\left(-\frac{\partial PROFIT_i^A}{\partial PX_i}\right)=X_i \qquad (i = 1,\ldots, 25) \qquad \text{(A8)}$$

$$A_i\left(-\frac{\partial PROFIT_i^A}{\partial FC}\right)=IMP_i \qquad (i = 1,\ldots, 25) \qquad \text{(A9)}$$

$$A_i\left(-\frac{\partial PROFIT_i^{CET}}{\partial PO_i}\right)=O_i \qquad (i = 1,\ldots, 25) \qquad \text{(A10)}$$

$$A_i\left(-\frac{\partial PROFIT_i^{CET}}{\partial FC}\right)=EXP_i \qquad (i = 1,..., 25) \qquad \text{(A11)}$$

$$X_i+IMP_i=O_l+EXP_i \qquad (i = 1,..., 25) \qquad \text{(A12)}$$

$$I_i+\sum_{j=1}^{18}II_{ij}+CF_i=O_i \qquad (i = 1,..., 25) \qquad \text{(A13)}$$

Consumption

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

$$WF=\left(Q_c\right)^{1-\tau_{sav}}\left(Q_{sav}^{priv}\right)^{\tau_{sav}} \qquad \text{(A14)}$$

subject to the budget constraints:

$$Y_{RC}=W\left(\overline{L}-Q_l\right)(1-U)(1-it)+\sum_{i=4,...,7,9,11,...,18}R_i\overline{K_i^{RC}}(1-it)+\overline{NTPS} \qquad \text{(A15)}$$

$$Y_{RC}=P_{sav}Q_{sav}^{priv}+\sum_{i=2}^{18}PO_i\left(1+oit_i^{CF}+vat_i^{CF}\right)CF_i^{RC} \qquad \text{(A16)}$$

and the nests in the welfare function are defined by:

$$Q_c=\left(b^{\sigma^{CL}}Q_{cg}^{1-\sigma^{CL}}+(1-b)^{\sigma^{CL}}Q_l^{1-\sigma^{CL}}\right)^{\frac{1}{1-\sigma^{CL}}} \qquad \text{(A17)}$$

$$Q_{cg}=\prod_{i=2}^{18}\left(CF_i^{RC}\right)^{\tau_i} \qquad \text{(A18)}$$

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

$$CF_i=CF_i^{RC}+CF_i^{PUB} \qquad (i = 1,..., 25) \qquad \text{(A19)}$$

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

Public sector

The income of the public sector is given by:

$$Y_{PUB}=\sum_{i=1,2,3,8,10,18}R_i\overline{K_i^{PUB}}+\sum_{i=1}^{18}\left(SOC_i+OIT_i\right)+OT-\overline{NTPS} \qquad \text{(A20)}$$

where revenues come from several taxes:

$$SOC_i=Wsoc_iX_i\left(-\frac{\partial PROFIT_i^X}{\partial W}\right) \qquad (i = 1,..., 25) \qquad \text{(A21)}$$

$$OIT_i=PX_ioit_i^{II}X_i\left(-\frac{\partial PROFIT_i^X}{\partial PX_i}\right)+PO_iI_ioit_i^{GKF}+PO_iCF_i\ oit_i^{CF} \qquad (i = 1,..., 25) \qquad \text{(A22)}$$

The macro closure rule is:

$$Y_{PUB}-\sum_{i = 1,..., 10, 12, 13, 14, 16, 17}PO_i\left(1+oit_i^{CF}+vat_i^{CF}\right)CF_i^{PUB}=P_{sav}Q_{sav}^{pub} \qquad \text{(A25)}$$

Foreign sector, investment and savings

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

$$\sum_{i=1}^{18} \overline{PFXEXP_i} + \overline{FORSAV} = \sum_{i=1}^{18} \overline{PFXIMP_i} \tag{A26}$$

$$P_{sav} Q_{sav}^{priv} + P_{sav} Q_{sav}^{pub} + \overline{FORSAV} = \sum_{i=1}^{18} PO_i \left(1 + oit_i^{GKF} + vat_i^{GKF}\right) I_i \tag{A27}$$

Factor markets

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 unemployment assumptions:

$$\frac{W}{CPI} = \left(\frac{1-U}{1-\overline{U0}}\right)^{\frac{1}{\beta}} \tag{A28}$$

$$CPI = \frac{\sum_{i=1}^{18} \theta_i PO_i}{\sum_{i=1}^{18} \theta_i \overline{PO_i}} \tag{A29}$$

Table A1.1. 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*
$\mathrm{CF}_i^{\mathrm{PUB}}$	Final public consumption of goods produced by sector *i*
$\mathrm{CF}_i^{\mathrm{RC}}$	Final private consumption of goods produced by sector *i*
CPI	Consumer price index
EXP_i	Exports of sector *i*
FC	Factor of conversion of foreign currency into domestic currency
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*
O_i	Production of sector *i* sold in the domestic market
OIT_i	Other indirect taxes revenue in sector *i*
P_{sav}	Savings shadow price
PA_i	Unit cost of the Armington aggregate of sector *i*
PO_i	Unit cost of the production of sector *i* sold in the domestic market
$\mathrm{PROFIT}_i^{\mathrm{A}}$	Unit profits for A_i (according to origin)
$\mathrm{PROFIT}_i^{\mathrm{CET}}$	Unit profits for A_i (according to destination)
$\mathrm{PROFIT}_i^{\mathrm{X}}$	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
$\mathrm{Q}_{\mathrm{sav}}^{\mathrm{priv}}$, $\mathrm{Q}_{\mathrm{sav}}^{\mathrm{pub}}$	Private and public demand for savings
R_i	Capital rental rate in sector *i*
SOC_i	Revenue from social contributions paid by employers and employees of sector *i*
U	Unemployment rate
VAT_i	Value added tax revenue in sector *i*
W	Wage rate
WF	Welfare
X_i	Production of sector *i*
Y_{PUB}	Disposable income of the public sector
Y_{RC}	Disposable income of the representative consumer

Table A2. 1. Exogenous variables and parameters

Symbol	Definition
$\overline{FORSAV}$	Foreign savings
$\overline{K_i^{PUB}}$	Capital endowment of the public sector to produce good *i*
$\overline{K_i^{RC}}$	Capital endowment of the representative consumer to produce good *i*
$\overline{L}$	Labour endowment
$\overline{NTPS}$	Net transfers from the representative consumer to the public sector
$\overline{PFX}$	World prices
$\overline{U0}$	Unemployment rate in the benchmark
$a_i, b, c_{0i}, c_{ji}, d_i, e_i$	Share parameters
$oit_i^{II}, oit_i^{GKF}, oit_i^{CF}$	Other indirect taxes rates, *ad valorem*, in sector *i*, levied on intermediate inputs, investment and final consumption, respectively
soc_i	Social contributions rates, *ad valorem*, in sector *i*
α_i, ζ_i	Scale parameters
β	Flexibility of the real wage to the unemployment rate
ε_i	Elasticity of transformation in sector *i*
θ_i	Share parameter
σ_i^A	Armington elasticity of substitution in sector *i*
σ^{CL}	Elasticity of substitution between final consumption and leisure
σ_i^{LK}	Elasticity of substitution between labour and capital in sector *i*
τ_i	Elasticity of substitution across final consumption goods
τ_{sav}	Elasticity of substitution between consumption and savings

Appendix 2. Sectors in the model and their correspondences across different sectoral classifications

	Spanish Input-output Table (2005)	NACE Rev. 1	Nace Rev.2
1.Primary goods	1,2,3	01,02,05	01,02,03
2.Energy	8,9,10	23.04	19.35
3.Food products	12,13,14	15 (except 159)	10
4.Beverages & Tobacco	15.16	159.16	11.12
5.Textiles products	17,18,19	17,18,19	13,14,15
6.Chemical products	23.24	24.25	20,21,22
7.Basic metals	29.31	27.29	24.28
8.Manufacture of metal products	30	28	25
9.Electronics	32,34,35	30,32,33	26
10.Motor vehicles, trailers & semi-trailers	36	34	29,3311,3315,3316,3317
11.Other industries	4,5,6,7,11,20,21,22,25,26,27,28,33,37,38,39	10,11,12,13,14,20,21,22,25,26,31,36,37,41	05,06,07,08,09,16,17,18,23,27,30,31,36
12.Contruction	40	45	41,42,43
13.Sale & repair of motor vehicles and automotive fu	41	50	45
14.Wholesale and retail trade	42.43	51,52	46,47
15.Air and water transport	48.49	61,62	50.51
16.Other transport	46,47,50,51	60,63	49,52,79
17.Telecommunications	52	64	53,60,61
18.Financial intermediation	53,54	65,66	64,65
19.Activities auxiliary to financial intermediation	55	67	66
20.Real estate activities	56	70	68
21.Renting of machinery & equipment	57	71	77
22.Computer and related activities	58	72	58,62,63,95
23.Other business activities	60	74	69,70,71,73,74,78,80,81,82
24.Other services	44,45,59,61,62,63,64,65,66,71,72	55,56,73,80,85,90,91,92,93	37,38,39,55,56,59,72,75,85,86,87,88,90,91,92,93,94,96
25.Public services	67,68,69,70	75,80,85,90	84,97