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Supply Multipliers in Two Regional Economies*

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Abstract

This paper focuses on the analysis of the economic impact that sectorial total factor productivity – or valued added - gains have on two regional Spanish economies (Catalonia and Extremadura). In particular it is studied the quantitative effect that each sector's valued added injections has on household welfare (real disposable income), on the consumption price indices and factor relative prices, on real production (GDP) and on the government and foreign net income. To do that, we introduce the concept of **supply multiplier**. The analytical approach consists of a computable general equilibrium model, in which it is assumed perfect competition and cleared markets of goods and factors. All the parameters and exogenous variables of the model are calibrated by means of two social accounting matrices, one for each region under study. The results allow identifying those sectors with the greatest multipliers impact on consumer welfare as the key sectors in the regional economies.

Keywords: efficiency gains, supply multipliers, key sectors, computable general equilibrium

JEL Classification: C68, R13.

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1. INTRODUCTION

The purpose of this paper is to analyse the quantitative effects that increasing sectoral value added have on two regional Spanish economies: Catalonia and Extremadura. Specifically, for each sector, we compute the simulated impact on the economy that additional sectoral valued added has, in order to provide a supply side multiplier analysis. In particular we introduce and define the notion of *supply multiplier* of a certain endogenous variable as the increase that in equilibrium experiences such variable per unit of exogenous value added injected into the economy, which, in our case, is made by increasing the total factor productivity of each productive sector of the economy.

We provide a **multiplier** measure of the impact that additional sectoral value added has on some important economic variables. These variables are prices, by using an extended Consumer Price Index, CPI, and the relative prices of factors. We also look at production (GDP multipliers), and income distribution between the three agents of the economy. In particular we look at household's disposable income (Household multipliers) -a proxy for household´s welfare-, Government Disposable Income (Government Multipliers) and Foreign Disposable Income (Foreign Multipliers).

Solow (1956) and many other studies in this field have put forward the idea that efficiency or productivity gains are an important component that affects the growth of an economy, raises household purchasing power, and increases GDP per capita. Our paper focus on exogenous sectoral value added gains, coming from efficiency gains, because of the empirical evidence provided by, among others, Jorgenson et al. (2007), and Mas and Robledo (2010).[i] An important finding of these contributions is the disparity between sectoral contributions and aggregate productivity gains in an economy.[ii]

Identifying which sectors' value added gains contribute most to increasing consumer welfare (or any other relevant economic variable) is important because it helps to better understand the economic consequences of these gains and the ways that such a complex economic phenomenon can be propagated throughout the economy. Also, the present analysis may lead, for instance, to strategic R+D investment, or other sources of efficiency gains, in those sectors which may eventually give a maximum payoff to the economy. Once identified these sectors one can call them key sectors. In particular, we call key sectors to those in which the values of the household supply multipliers are above the mean sectoral values.

Previous literature in the field has very often used the multipliers techniques focused on a demand side perspective. The novelty of the approach in this paper is that the analysis is developed from a supply side perspective and consumer disposable income is used as the main indicator for classifying key sectors.

Since the pioneering contributions of Rasmussen (1956) and Chenery and Watanabe (1958), much of the related literature has focused on defining and identifying key sectors from a demand perspective. To review this literature, the interested reader can refer to, among others, Dietzenbacher (1992), García et al. (2008), and Sancho (2013). There are two fundamental criteria that have been used very often in the key sector analysis of many economies: the conventional multiplier analysis (Dietzenbacher, 2005), and the hypothetical extraction method (Strassert, 1968). The main framework which has been applied in these two criteria is the classic Input-Output model, although this analysis has also been extended to the Social Accounting Matrices (SAMs).[iii] More recently, Cardenete and Sancho (2012), have studied the extraction method within the framework of an applied general equilibrium model.

The computable general equilibrium model is an appropriate starting framework for answering those questions that are considered to be relevant to the present analysis. Following the Shoven and Walley´s model (Shoven and Whalley, 1992), it is considered, for each of the two regional economies, a multisector production side, a representative consumer (or household), a public government and a foreign sector. The traditional Walrasian equilibrium concept for the economy is used. The model is calibrated by using a SAM data set for each regional economy. Finally, the equilibrium is calculated to perform all the simulations needed to obtain the results.

The effects caused by sectoral productivity gains on an economy have been analysed in very few contributions to the literature. González-Calvet and Manresa (2007) used the Leontief price model to analyse how the productivity gains in each sector of production affected regional prices in the Catalan economy.[iv] Hanson and Rose (1997) analysed income inequality in the US by simulating productivity gains in the labour and capital of each sector with a computable general equilibrium model. More recently, Cutler and Davies (2010), studied the impact of sectoral productivity gains in Fort Collins (Colorado) on certain economic variables.[v] In a similar paper, De Miguel, Llop, and Manresa (2011) analyses the role of sectoral productivity gains on a range of variables. Nevertheless, here we use the new concept of *supply multipliers* – by using the additional value added injected in the economy- while they used the concept of **elasticity** – by using the percentage of additional efficiency gains - to identify key sectors of an economy. While in this paper, the size of a sector plays no role for being a key sector, in the elasticity approach the size plays an important part in the results. By size of a sector we mean the share of its valued added to the total value added of the economy.

The structure of the paper is as follows. The following section describes the main characteristics of the model used and the types of simulations performed. The third section describes the databases used to calibrate the two regional models. The fourth section presents the main economic features of the two economies, and the supply multipliers results of the simulations. The final section contains the paper's conclusions.

2. THE MODEL AND SIMULATIONS

2.1. The Model

Our study uses a computable general equilibrium approach which provides a complete representation of the economic agents and their behaviour. As it is well known, it also takes into account all the economic interactions represented by a complete circular flow of income. Specifically, the study is based on a static general equilibrium model that has been calibrated for the Spanish regions of Catalonia and Extremadura.

The definition of equilibrium follows Walras' tradition, which has been extended to include not only producers and consumers but also government and foreign agents. Therefore, the equilibrium is determined by a vector of prices, and a vector of activity levels, that clear all markets, and allow all agents to reach their optimizations plans. Mathematically, the model can be represented as a set of equations containing the market equilibrium conditions and all the economic agents´ optimization plans.

The main features of the computable general equilibrium model, used for the two Spanish regions, are described in what follows.[vi] The structure of production shows 15 differentiated sectors and assumes perfect competition in all markets. Each sector produces a homogeneous good by using a nested technology with constant returns-to-scale. In the first level of the production function, the total output in each sector is obtained by using a Cobb-Douglas aggregator of the domestic production and imports from abroad (i.e. Armington specification). The second level of the production function shows the domestic production as a Cobb-Douglas combination of intermediate inputs and value added. This specification is used so that it can lead to a broader interpretation of the types of simulation carried out in the following section. Finally, in the third level of the production function, the value added is obtained by combining labour and capital through a Cobb-Douglas function.

Additionally, the model has a representative household that has a Cobb-Douglas utility function which combines consumption and saving (or future consumption).[vii] The budget restriction of the household establishes that the amount of expenses in final consumption and saving cannot exceed disposable household´s income. The private income comes from selling the endowments of labour and capital, and from net transfers from government and from abroad. To obtain private disposable income the social security contributions and the direct taxes on income are subtracted from the private income of the representative household.

The government or public agent produces public services and demands public services and investment goods. The model assumes that the public agent has a Leontief utility function that combines public consumption and public investment in fixed proportions. The budget restriction of government establishes that public consumption and public investment must be equal to the total public revenues that come from taxation once net social transfers have been subtracted from government revenues. The model also includes a stock of public borrowing or government bonds that the public agent can emit in case of deficit.

Finally, the model has a generic foreign agent that includes, for each region, the rest of Spain, the European Union and the rest of the world. This agent produces a traded good through regional exports with a fixed coefficients technology. At the same time, each economy can both receive transfers from abroad and make transfers to external agents. The model allows a situation of external deficit that must be used as savings of the foreign agent. This preserves the macroeconomic equilibrium between the total saving and the total investment of the economy.

2.2. Simulations and supply multipliers

The simulation analysis is carried out individually for each production activity. We study the effects on the economy of increasing sectoral value added, which is made by increasing efficiency in each sector j ($\forall j = 1, 2, ..., 15$). We only contemplate the possibility that the efficiency gains in one sector exclusively affect that sector.

In our simulation, the equation that defines the third level of the nested production function is particularly relevant, and it can be written as:

$$VA_j = \beta_j K_j^{\alpha_j} L_j^{1-\alpha_j}, \qquad (1)$$

where $j = 1, 2, \ldots, 15$ are the production sectors, VA_j is the value added of sector j, K_j is the capital factor used in sector j and L_j is the use of labour in j. The parameter β_j in equation (1) is especially important because an increase in this parameter means that, with the same amount of capital and labour, a higher value added is obtained in each sector. This technological change, which is in fact an increase in the total factor productivity, is known in the literature as a Hicks-neutral technological change. Bearing in mind that the value added functions are Cobb-Douglas, this technological change can also be viewed as Solow neutral (where the productivity gains are attributed to capital) or Harrod neutral (where the productivity gains are attributed to labour).[viii]

The kind of simulations that we perform in these economies follow the traditional logic of the comparative statics, by comparing the initial equilibrium with the new one resulting from the simulation.

For each production sector of the economy, and to get sharper results from the simulations, we consider an *increase of 25% in the efficiency parameter* β_j of the production function that yields a *25% increase in sectoral value added*. This gain in the production efficiency implies two things. One is that with the same amount of factors, the economy produces more goods and services and, hopefully, it will increase the real GDP of the economy. Another implication particularly relevant is that we may consider the increase in efficiency production as a way of *injecting exogenous value added* into the economy; that is an exogenous injection of income into the economy. Hence, we can interpret the value of such exogenous injections as additional income. From this point of view, we may measure the impact, of such exogenous injections of income, on some endogenous relevant variables. We measure such impact by means of what we call a (sectoral) **supply multiplier. A** *supply multiplier, of a certain endogenous variable, is defined as the increase that experiences in equilibrium such variable per unit of exogenous value added injected - through a particular sector- into the economy.*

We consider as endogenous variables the real GDP of the economy, which is a measure of production, and we also analyze how the additional valued added injected impacts into the income distribution of the economy by looking at the effect on agents´ disposable income. In order to compare equilibrium values, we use the GDP deflator- for the GDP- and an extended version of the CPI, which includes consumer expenditures share and saving shares, in the computation of each agents´ disposable income. Particular attention should be paid to the *household disposable income multipliers* because it is a good proxy for the consumer´s welfare. We may call **key sectors** of the economy to those household multipliers which perform above the mean of aggregated multipliers.

3. DATABASES

The empirical calibration of the parameters of the model, rely on two social accounting matrices, one for each region (SAMCAT for Catalonia and SAMEXT for Extremadura).[ix] Given that these databases have a homogeneous structure and show the same disaggregation of accounts, the same definition of economic agents is found in both regional models.[x]

The structure of our social accounting matrices is very simple because there are information deficiencies at regional level. In the case of Catalonia, the official sources do not provide a symmetric input-output table of intermediate consumptions. To fill this statistical gap, indirect information has been used to estimate the symmetric table. In the case of Extremadura, the main limitation is that the production relations are not covered by recent statistics. For this reason, the SAMEXT is the result of an update procedure that takes the year 1990 as a reference.

Table 1. List of accounts in the SAMCAT and in the SAMEXT

Production sectors	1. Agriculture
	2. Energy
	3. Chemistry
	4. Metals and electrical equipment
	5. Automobiles
	6. Food production
	7. Textiles
	8. Paper
	9. Other industries
	10. Construction
	11. Commerce
	12. Transport and communications
	13. Finance
	14. Private services
	15. Public services
Consumption goods	16. Food
	17. Tobacco and alcohol
	18. Clothes and shoes
	19. Housing
	20. Furniture
	21. Medical assistance
	22. Transports and communications
	23. Culture and education
	24. Other consumption goods
Factors of production	25. Labour
	26. Capital
Consumers	27. Consumers
Saving-investment	28. Capital account
Public sector	29. Production taxes
	30. Product taxes
	31. Social Security taxes on employers
	32. Direct taxes on income
	33. Consumption taxes
	34. Social Security taxes on employees
	35. Government
Foreign sector	36. Foreign sector

Table 1 shows the accounts of the - 2001- SAMCAT and the -2000- SAMEXT, which coincide with those used in the regional models. The production system is divided into 15 sectors: agriculture, eight industrial activities, construction and five service sectors. Additionally, the social accounting matrices show nine consumption goods, which are different from the goods obtained in the production system. The regional SAMs reflect two factors of production, labour and capital, and a generic account containing the revenues and expenditures of the households in the economy. The capital account shows all the sources of saving and investment of all the economic agents. The government account contains the revenues and expenditures of the public administration and six accounts for the different taxes reflected in the model. The regional databases are completed with an account for the foreign agent that shows the imports, exports and net income transfers from abroad.

4. RESULTS

As it has been described above, the simulation analysis consists of separately introducing a 25% increase in the total factor productivity of each productive sector in each economy. This is equivalent to a 25% increase in the value added of each sector.

We may interpret such increase as an exogenous sectoral *valued added injection* for the economy.

During the first stage, the computation of the two regional models involves calculating the initial reference equilibriums (*benchmark situation*), in which all the prices and activity levels are unitary and the model reproduces the numerical information of the regional social accounting matrices.

After the benchmark computation, the simulation analysis consists of calculating 30 new equilibriums: one for each sector of the two regions under study. After that, a comparison of the new equilibriums with the benchmark will show, for each region, which sectors have the greatest and the least impact on some endogenous variables. This information is useful to see how the complex phenomenon of increasing sectoral value added propagates throughout the economy, and also to identify the most important activities or sectors in each region. As a result of this, local and territorial planning strategies could be defined and focused on the most influential sectors.

Before analysing the sectorial results, we offer a summary and comparison, of the two regions, based on some aggregated macroeconomic figures (Table 2 and 3) and some aggregated results (Table 4). After that, tables 5.1 and 5.2 show the effects of sectoral valued added injections on prices, quantities, and income distribution. In concrete, first, it have been analysed the changes in regional prices by an extended CPI, and the relative prices of economic factors: labour and capital. Second, it have been analysed the effect on regional production (regional real GDP multiplier). Third, a multiplier indicator has been used to calculate the impact of sectoral value added injections on the income distribution. In particular, we analyse the consumer's welfare, by using the real disposable income of households, which, in this model, is a good proxy for their equivalent variation. We also analyse the effects of increasing sectoral value added on the public and the foreign agent´s real disposable income.

Some additional aspects that should borne in mind are the following. First, given that Walras' law states that one of the equilibrium equations in the model is redundant, prices should be interpreted as relative prices, where the labour wage has been taken as *numéraire*. Consequently, the price of labour is unitary in all the simulations undertaken. In this way, the equilibrium prices are in fact relative prices with respect to the *numéraire*. Second, the same macroeconomic closure rules for the government and the foreign sector have been used in all simulations. These rules consist of making endogenous the activity level of the government and the foreign agent, and exogenously fixing the deficit for both agents.

All the simulations assume that the initial aggregate factors of the economy are fully used. It is also assumed that labour and capital flow from one sector to another to meet the equilibrium conditions.

4.1. Aggregated Indicators and Aggregated Multipliers.

In order to better understand the results of our analysis, in this section we present some aggregate basic indicators for each economy, like the GDP composition, and the sectoral value added. We also present what we call aggregate mean multipliers for each economy. Mean multipliers are defined for real GDP, for the household, government, and foreign disposable income. We also present elasticity values for each of these aggregate variables.

4.1.1. Aggregated Indicators

Table 2 shows the basic macroeconomic indicators for Extremadura -2000- and Catalonia -2001-. From this information, Extremadura has a significant smaller GDP than Catalonia (Catalonia´s GDP is 13.77 times higher than Extremadura´s), and a smaller GDP per capita (Catalonia´s GDP per capita is 2.35 higher than Extremadura´s). When we look at the GDP components there are also significant differences between these two economies. They differ mostly in the size of public and foreign sectors. In fact, the GDP share of the public sector in Extremadura (0.27) is twice of the Catalonia´s (0.13). The foreign sector in Extremadura is relatively small since the sum of imports and export shares is 0.47, with a trade deficit of 23% of its GDP. In contrast, the Catalonia foreign sector has a share of 1.35 of GDP, with a surplus of 5% of its GDP. With respect to private household consumption share, Extremadura has 12 percentage points more of its GDP than Catalonia´s.

When we look at the sectoral composition of the value added, in **table 3**, we see further differences between the two economies. These figures allow us to say that we are in front of two very different economies. It is noticeable that Extremadura has a very large agricultural sector (12.5 % in Extremadura against 2% in Catalonia), a very large Public Sector (22.4% in Extremadura against 3.2% in Catalonia), together with a small industrial sector (5.5% of Extremadura against 27.6% in Catalonia). The two economies share similar values in the construction sector, commerce, and transport and communication. Last, the finance and private services sector, for Catalonia, is 0.33 of its total value added, while is it is only 0.22 for Extremadura.

Table 2 Main Macroeconomic Indicators

	Extremadura (2000)	Catalonia(2001)
GDP (millions Eur)	9,659.0	132,971.0
GDP per Capita (Eur)	9,032.0	21,235.0
Private Consumption/GDP	0.73	0.61
Investment/GDP	0.24	0.22
Public Consumption/GDP	0.27	0.13
Exports/GDP	0.12	0.70
Imports/GDP	0.35	0.65

Table 3 Sectorial Value Added Composition

Share of Sectorial Value Added	Extremadura	Catalonia
Agriculture	0.12	0.02
Energy	0.05	0.02
Industry	0.06	0.26
Construction	0.11	0.08
Commerce	0.17	0.19
Transport and Commu.	0.05	0.07
Finance and Priv. Serv.	0.22	0.33
Public Services	0.22	0.03
Value Added (Mill Eur)	9,537	122,984

4.1.2. Aggregated (Mean) Multipliers

Table 4 presents the aggregated results by reporting the mean values and elasticities of the sectoral multipliers corresponding to the real GDP, and the income distribution among the three agents of each economy.

Columns A show the fraction of the value of each variable with respect to total value added. As we already commented in table 1, it is noticeable that the foreign agent has a different sign in each economy. For Extremadura, disposable income of the foreign agent is almost one fourth of total value added, which means that this economy heavily borrows income (savings) from abroad, since the value of its imports exceeds its exports. The Catalan economy presents a negative figure around 5% of its total value added, which means that this economy is lending income to foreign agents, since the value of its exports exceeds the value of its imports.

The different signs in the foreign sector, in these two economies, are in contrast with the greater values in disposable income of the private household and public government agent corresponding to Extremadura.

In column B we report the **Aggregate Mean Multipliers** for each variable. *Aggregated mean multipliers show the mean increase in a particular variable per unit of value added injected into the economy.* As we can see the mean values for household and government follows, roughly, the same patterns as the fraction of each variable with respect to the total value added of each economy - reported in column A-. This means that the additional income injected into the economies do not modify much the initial relative income distribution of the economy between households and the government.

With the exception of the foreign sector, the means values are greater for Extremadura than for Catalonia.

For Extremadura, it is noticeable that the mean of the GDP is greater than one, and also that the Foreign Agent has a significant negative sign. These are good news for the Extremadura economy because it means that, on average, increasing value added, from an increase in sectoral productivity, will increase GDP in a greater proportion. It also implies an increase in net exports, reducing the value of the foreign agent disposable income. For the Catalan economy, the GDP value increases at most by one in one case, while the foreign agent´s income remains almost the same.

In **column C** we report the elasticity values corresponding to the mean considered.

These variables tell us the percentage change in the mean value when value added increases by one percent. Again it is noticeable the high negative values for the foreign sector in Extremadura (-0.81), which also shows a greater than one mean elasticity (1.05) with respect to the GDP, and almost one (0.99) for the household disposable income value. For Catalonia, it is noticeable that foreign sector disposable income has a very low value.

Table 4. Aggregate Mean Multipliers and Elasticities

	(A) **Fraction of Total ValueAdded**	(A) **Fraction of Total ValueAdded**	(B) **Aggregate Mean Multipliers**	(B) **Aggregate Mean Multipliers**	(C) **Aggregate Mean Elasticity**	(C) **Aggregate Mean Elasticity**
	Extr	Cat	Extr	Cat	Extr	Cat
Household Disposable Income	0.985	0.791	0.977	0.642	0.990	0.810
Government Disposable Income	0.365	0.289	0.307	0.258	0.850	0.900
Foreign Disposable Income	0.235	-0.043	-0.188	-0.011	-0.810	-0.230
GDP	1.013	1.081	1.060	0.970	1.050	0.900
Value Added (Mill.)	9,537	122,984				

4.2. Sectoral Results

Tables 5.1 and 5.2 show, for both economies, all the sectoral results of the simulations performed. The first four columns of table 5.1show the value of an extended consumer price index, CPI, and the price of the return of capital, r , respectively. The rest of the columns show the GDP multipliers (GDP-M) for both economies. Table 5.2 show the disposable income multipliers of the Household (HDI-M), Government (GDI-M) , and the Foreign Sector(FDI-M), where we also show the CPI values to make sense of the other results.

In the last row of both tables, we show the sectoral mean for each variable. The mean is compared to the corresponding sectoral value of the variable, and we highlight values that are above such mean (below in case of the CPI and Foreign variables) with a yellow color.

4.2.1. Prices

The first two columns in Table 5.1 report the *extended consumer price index*, which includes the saving/investment price in its calculation. This index is the typical one resulting from the weighting sum of the final consumption prices, and the savings price, by using as weights the expenditure (and saving) shares, of the representative consumer. We should remember that the numeraire of the economy is the price of labour, which it is equal to one in all cases. Also, all price indexes are equal to one in the original equilibrium of the economy.

In the first two columns we color those indexes which are below the mean with the yellow one. In both economies, all price indexes are below one, and sectors like

Commerce and Private Services present an index clearly below the mean. Agriculture is also clearly below the mean in Extremadura; and Metals and Electrical Equipment is closed to the mean, but below, in Catalonia. When we look at the size of those sectors, they are large sectors in their economies. Nevertheless, some other large sectors in those economies like construction show price indexes close to one, like most of the other smaller sectors.

In the second two columns we report the *relative price of capital services*, r. Since labour and capital are given in fixed supply, we may interpret a value of r greater than one as indicative of a relative greater demand of that factor with respect to the original equilibrium, and the other way around. It also indicates that the factor distribution of income favors to the owner of capital. The results tell us that r is closed to 1 in almost all the simulations for both economies. For Extremadura, the value of r is a bit greater than one in sectors like Agriculture, Construction, and Public services, while r is a bit less than one in private services. For Catalonia the value of r is almost one in all cases.

4.2.2. GDP multipliers

We now turn our analysis to the impact of a more efficient sectoral production on the real GDP of the economy. Before that, we should say that in the GDP column we include a proxy of the size of the sector by using its value added share (in percentage value) with respect to the total value added of the economy. We put a red color to those sectors with a greater value than the mean, which is 6.666.

From the data, reported in **table 5.1**, we can see that the sectoral mean is 1.062 for Extremadura, and 0.969 for Catalonia. Now, because of the definition of this variable, a more efficient production in sectors like Construction and Public Services have a significant impact on the real GDP for both economies. In Extremadura the five most influencing sectors on the GDP supply multipliers are Chemistry (2.028), Automobiles (1.829), Textiles (1.078), Construction (1.012) and Public Services (0.954), while for Catalonia sectors like Private Services (1.060), Commerce (1.037), Public services (1.022), Finance (0.997), and Energy (0.988) show the highest values on GDP multipliers. One remark that we should make is that higher multipliers are not necessarily link to high size of the sector as can be seen in table 5.1. In fact, for Extremadura, we find the higher multipliers in three sectors whose value added amounts less than one percent of total value added. But, for Catalonia, the three largest multipliers correspond to sectors whose value added amounts to fifty percent of the economy.

4.2.3. Household Disposable Income Multipliers

Table 5.2 contains the Household Disposable Income multipliers (HDI-M). We pay particular attention to these multipliers because they are proxies for a consumer welfare indicator like equivalent variations. Following the tradition in economic analysis, but perhaps not in the input-output literature, we decide to use these multipliers to identify *key sectors* of the economy. In particular we define a *key sector* as such with a household supply multiplier above the sectoral mean of the economy.

For the Catalan economy the arithmetic mean is 0,642, while for Extremadura is higher, 0.977. For both economies two particular sectors show very low values: Construction and the Public sector, which had higher values in the GDP multipliers. The value added of both sectors for the Extremadura economy is 1/3 of the total one, while for the Catalan economy represents 10% of its total value added. The highest values, of these multipliers, in Extremadura are: Agriculture (1.45), Energy (1.00), Chemistry (2.1), Automobiles (2.00), and Food Production (1.16), which together with textiles (0.995) are what we may call the **key sectors** for this economy. In Catalonia we find many key sectors with, in general, lower values than in Extremadura: Agriculture (0.796), Energy (0.817), Automobiles (0.655), Food production (0.85), Paper (0.695), Commerce (0.934), Transportation and Communication (0.804), Finance (0.888), and Private Services (0.710). As can be seen, the size of a sector is not the cause for the multiplier values.

One way to make sense of these results can be as follows. We may think that, in these economies, an increase in the TFP of a sector, increases efficiency, reduces consumer prices and the investment price, relative to factor prices. Since the nominal factor income of the consumer is almost the same in all simulations - because factor prices are almost the same -, real disposable income increases as the CPI decreases. Hence, household consumer purchasing power increases. The actual impact of some particular sector may depend on its influence on the CPI. For instance, the efficiency of sectors like Construction and Public Sector Services has very little influence on the CPI. Increasing the efficiency of the construction sector decreases the price of the investment good (or savings), which is only a little component of our CPI, and, on the other hand this good is not used as an intermediate input in the production process by other sectors. In order to explain the low impact of more efficiently produced Public Services on real consumer income we follow a similar reasoning as the one used for the construction sector.

4.2.4. Government Disposable Income Multipliers

Table 5.2 shows the impact of each sector value added gains on the government disposable income. The arithmetic mean values are 0.307 for Extremadura and 0.258 for Catalonia. For the case of Extremadura small sectors like Automobiles (1.369), Chemistry (0.848) and Food Production (0.547) reaches the higher values; but also large sectors like Private Services (0.475), Commerce (0.468) , and Agriculture (0.408) present values above the mean. As in the case of household income multipliers, large sectors for this economy like Construction and Public Services have the lowest near to zero values. For the case of Catalonia, the four sectors with higher values are three small sectors for this economy like Agriculture (0.310), Energy (0.321), and Food Production (0.309), plus a relatively large sector like Commerce (0.326). We see the lowest values in sectors like Public Services (0.00), and Construction (0.200). The largest sector of the economy, Private Services, has almost the mean value: 0.259.

4.2.5. Foreign Disposable Income Multipliers.

In **table 5.2** we observe the impact of each sector value added gains on the Foreign Disposable Income, which is the result of all the foreign net trade that each economy caries out. A positive sign means a trade deficit, while a negative sign means a trade surplus. For the case of Extremadura, which has a large foreign deficit, most of the sectors have a negative sign, and the arithmetic mean multiplier is -0.118. The higher negative values correspond to Agriculture (-0.922), Energy (-0.468), and Food Production (-0.349). All of these sectors are net exporters already. The only two sectors with a positive sign are Construction (0.200) and Public Services (0.071). These results clearly state that sectoral efficiency gains for Extremadura will reduce its trade deficit. For the Catalan economy the mean multiplier is close to zero (0.011). In general, all sectors present values which are close to zero. This means that efficiency gains for Catalonia will leave the same net trade as in the original equilibrium, which showed a surplus.

5. CONCLUSIONS

This paper has analysed the economic impact of sectoral value added gains on the economy of two different Spanish regions: Catalonia and Extremadura. We do that by introducing the notion of the supply multiplier. In particular, it has been analysed the effects of an exogenous increase in the value added (or total factor productivity) of each production sector in these economies. The analysis focuses on the supply multipliers, that is, the quantitative increase that experiences certain endogenous variables per unit of exogenously injected sectoral value added. We consider the following variables: factor prices and an extended consumption price index (CPI), the production of the economy (real GDP), consumer's welfare (real disposable income), government income (tax revenues net of social transfers) and the foreign agent´s income. The instrument used is a standard computable general equilibrium model (following the Shoven-Whalley´s tradition) in which it is assumed perfect competition. In all the simulations performed, all the factor supplies are fixed and in equilibrium all the markets clear. The parameters of the model are obtained through calibration by using two social accounting matrices for the two Spanish regions.

The results for both regional economies are presented in the form of supply multipliers. While our analysis involves the calculation of many variables, to identify the important sectors in these economies, therefore, it is studied the impact of the productivity gains on consumers real disposable income, because it is a good proxy of consumer´s welfare.

Using traditional terminology, it may be referred to as **key sectors** those whose disposable income multipliers are above the average of all sectors. However, in contrast with the classic (demand side) multipliers, it should be pointed out that this criterion follows a novel supply side argument that has not been explored before in the literature. In Catalonia the key sectors involve both industrial sectors and service sectors as well as the agricultural one. In particular: Agriculture, Energy, Automobiles, Food Production, Paper, Commerce, Transport, Finance, Public Services. In Extremadura the key sectors are fewer than in Catalonia and are limited to industrial sectors and agriculture. In particular: Agriculture, Energy, Chemistry, Automobiles, Food Production, and Textiles. Notice that in Extremadura there is no key sectors in the services subsector of the economy.

The results should be interpreted in terms of the hypothesis used in the two regional models, which follow the standard assumptions of this literature.

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Table 5.1 Price Index and GDP Multipliers

Sectors	CPI Extr	CPI Cat	r Extr	r Cat	GDP- M-(%VA) Extr	GDP- M-(% VA) Cat
1. Agriculture	0.957	0.994	1.019	0.995	0.916 (12,53)	0.907 (2,01)
2. Energy	0.988	0.995	1.009	0.997	0.892 (4,74)	0.988 (1,77)
3. Chemistry	0.999	0.992	1.000	1.000	2.028 (0,17)	0.946 (3,75)
4. Metals and electrical equipment	0.997	0.985	1.001	1.001	0.921 (1,33)	0.950 (7,38)
5. Automobiles	0.999	0.994	0.999	1.000	1.829 (0,10)	0.941 (2,79)
6. Food production	0.993	0.992	1.000	0.999	0.887 (2,28)	0.945 (3,12)
7. Textiles	0.998	0.994	0.999	1.001	1.078 (0,55)	0.930 (2,41)
8. Paper	0.999	0.995	0.999	1.000	0.893 (0,24)	0.945 (2,31)
9. Other industries	0.999	0.992	1.001	1.000	0.893 (0,81)	0.942 (3,88)
10.Construction	0.994	0.987	1.033	1.001	1.012 (11,35)	0.944 (7,74)
11. Commerce	0.958	0.949	0.995	0.998	0.921 (16,75)	1.037 (19,43)
12. Transport and communication	0.991	0.987	1.004	0.998	0.890 (4,99)	0.976 (7,09)
13. Finance	0.991	0.987	1.005	1.000	0.894 (4,63)	0.997 (4,84)
14. Private services	0.958	0.942	0.985	0.990	0.923 (17,10)	1.060 (28,26)
15. Public services	0.988	1.000	1.021	0.999	0.954 (22,42)	1.022 (3,20)
Mean	**0.987**	**0.986**			**1.062 (6.666)**	**0.969 (6.666)**

CPI= Consumer price index, r = rental price of capital, GDP-M = Gross Domestic Product Multiplier. Equilibrium Values of GDP have been deflated by the GDP deflator. %VA= percentage of total Value Added

Table 5.2 Price Index and Income Multipliers

Sectors	CPI Extr	CPI Cat	HDI- M Extr	HDI - M Cat	GDI -M Extr	GDI -M Cat	FDI- M Extr	FDI -M Cat
1. Agriculture	0.957	0.994	1.453	0.796	0.408	0.310	-0.922	0.005
2. Energy	0.988	0.995	1.000	0.817	0.088	0.321	-0.468	0.006
3. Chemistry	0.999	0.992	2.180	0.630	0.848	0.249	-0.345	0.047
4. Metals and electrical equip	0.997	0.985	0.896	0.512	-0.009	0.242	-0.168	0.000
5. Automobiles	0.999	0.994	2.000	0.655	1.369	0.266	-0.140	0.033
6. Food production	0.993	0.992	1.160	0.815	0.547	0.309	-0.349	0.003
7. Textiles	0.998	0.994	0.995	0.579	0.027	0.279	-0.109	0.031
8. Paper	0.999	0.995	0.772	0.695	0.156	0.262	-0.073	0.034
9. Other Industries	0.999	0.992	0.869	0.597	0.004	0.255	-0.343	0.041
10.Construction	0.994	0.987	0.037	0.197	-0.034	0.200	0.202	-0.020
11. Commerce	0.958	0.949	0.947	0.934	0.468	0.326	-0.181	-0.017
12. Transport and Communication	0.991	0.987	0.725	0.804	0.166	0.293	-0.118	0.020
13. Finance	0.991	0.987	0.750	0.888	0.116	0.294	-0.126	-0.009
14. Private services	0.958	0.942	0.851	0.710	0.475	0.259	- 0.084	-0.011
15. Public services	0.988	1.000	0.021	0.0000	-0.018	0.000	0.071	0.00
Mean	**0.987**	**0.986**	**0.977**	**0.642**	**0.307**	**0.258**	-0.188	0.011

CPI= Consumer price index, HDI-M = Household Disposable Income Multiplier, GDI-M= Government Disposable Income Multiplier, FDI-M = Foreign Disposable Income multiplier. Equilibrium Values of all aggregate variables have been deflated by the CPI.

[i] The first study analyses the productivity gains of 85 sectors in the US economy during the period 1960-2005. The second quantifies the productivity gains of 27 sectors in Spain, Germany, France, Italy, the United Kingdom, the European Union and the US between 1995 and 2007.
[ii] In particular, the communications technology sector and those other sectors that have bought into this technological sector have made a large contribution to total productivity gains during the last decade.
[iii] See Pyatt and Round (1979) for the conventional multiplier analysis and Cardenete and Sancho (2006), for the extraction method. Additionally, Los (2004), used the hypothetical extraction approach in a dynamic multisectoral model to analyse the impact caused by the disappearance of a sector of the economy.
[iv] The analysis showed a sectoral ranking in terms of the impacts caused by each sector on the consumption price index of the regional economy. No other variables were considered in this study.
[v] Cutler and Davies used a multisectoral computable general equilibrium model that was adapted to the characteristics of the towns under study. For each sector of production, they simulated increases in factorial productivity, capital and labour.
[vi] A complete description of the model, with a list of the equations and the variables involved, can be found in De Miguel-Vélez et al. (2009).
[vii] The model distinguishes between production goods and consumption goods. Consumption goods are obtained through a conversion matrix of fixed coefficients that defines a direct (and linear) relationship between production prices and consumption prices.
[viii] Acemoglu (2009) contains a formal analysis of these possibilities.
[ix] Llop (2012) describes the construction and characteristics of the social accounting matrix of Catalonia. De Miguel-Vélez et al. (2009) describe the structure of the social accounting matrix of Extremadura.
[x] The SAMEXT is for 2000 and the SAMCAT is for 2001. Given that the statistical availabilities in each region concern different years it could not be used the same temporal reference. However, the results can be directly compared given that there is only one year’s difference between the two SAMs and that the patterns of revenues and expenditures have practically no variation over short periods of time.