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Fiscal Federalism using a Computable General Equilibrium Model

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ABSTRACT

The objective of this work is to develop a bi-regional computable general equilibrium model that follows the walrasian tradition, extended with the inclusion of the public sector and the foreign external, and based on the social accounting matrices of Andalusia and Spain, elaborated for 1995, to analysis the effects of changes in direct taxes and their sectorial distribution, under the perspective of the Fiscal Federalism, about level of GDP, productive sectors, prices, tax collections and social welfare in national and regional level.

Keywords: fiscal federalism, computable general equilibrium model, direct taxes, social security.

JEL classification: C68, D58, H77.

1. Introduction

The reality of the states continues to show the economic differences that exist between the different territories that constitute those states. This is why, from a Welfare State approach, when we analyze the role of the public sector, we can point out three problems that would exist if the public sector did not intervene: inefficient resources allocations would take place; the income distribution among individuals resulted from the market's action would not be socially efficient; and, finally, the market would be unable to reach the economy's equilibrium (Musgrave, 1959).

These economic problems generated by the government's non intervention could be diminished through its intervention. This requires financing and is the reason why the existence of different governmental levels and the attribution of economic competences sets out problems of resources distribution. We are talking about responsibility for the expenditure but also for the revenue of the different units that constitute the State, that is, we are talking about **Fiscal Federalism**.

In later years, fiscal co-responsibility both for the expenditure and most recently also for the revenue is having effects on the economy, at the state level as much as at the regional level (or provincial, or local). Disparities between regions and their unequal developmental processes are issues very much linked to the way fiscal responsibility for the expenditure and particularly for the revenue is defined.

The theory of imposition in federal economies, where decisions on tax imposition are autonomous, has been traditionally focused on the consequences which possible changes in those taxes would have on welfare and horizontal externalities (Wildasin, 1989). Later on, this line of research focused on the field of the so-called "fiscal architecture". Contributions like those of Boadway and Keen (1997) have examined the effects of tax variations introduced at the state level on the regional level, and viceversa – vertical externalities. More recently, applied general equilibrium models, like the one here presented, and those of Nechiva (1997), Groenewold, Hagger and

Madden (2000), expanded and improved in Groenewold, Hagger and Madden (2003), or Schwarm (2004), have analyzed, from a fiscal federalism perspective, the consequences of competition between tax variations at the regional and the national level.

Classic arguments such as that of Oates (1972), who stated that the result of tax competition will tend to reduce the degree of efficiency in public services, in an attempt to keep taxes low in order to attract business, can be analyzed through models like the one here suggested.

The methodology used in this work is that of a countable general equilibrium model that follows the Walrasian equilibrium traditional – Scarf and Shoven (1984), Shoven and Whalley (1992) – expanded through the inclusion of the public and the foreign sectors. From this initial data base, we will elaborate an applied general equilibrium model which adopts the *top-down* methodology and which will allow us to study the effects of changes implemented both in taxes and in public expenditure – and its sectorial distribution – in Andalusia –region southern Spain- and in Spain.

This paper has got a double objective: in the first place, because of the methodology used, the computable general equilibrium model allows us to do more than just a theoretical exercise, facilitating its application on the reality of a region such as Andalusia, and, therefore, allowing as well its application on any other proposed region or country. In the second place, it allows us to suggest alternatives on the elaboration of expenditure and taxing policies by analyzing the effects that different measures put forward by the regional government or by the state have on Andalusia, always considering the reciprocal effects of each measure. Among those effects we will be able to analyze macro-economic issues, like the impacts on the GDP, the productive sectors, tax revenue, relative prices and the effects on social welfare, etc.

This work is divided into four sections. In the first one, we set out the methodology and the most important characteristics of our model. In the second one, we present

the data bases used for the simulations, while in the third section we execute the different simulations and empirical applications. We finish with a summary of the main results and a description of future research lines.

2. Methodology

To have a set of tools that allow us to study and gather the degree of economic interdependence (and dependence) between two regions, or between a region and the rest of the country, is certainly useful in order to determine the defficiencies and adjustment needs when adopting specific economic policies.

Taking this into consideration, the model selected is an applied general equilibrium model that follows the *top-down* methodology. This approach allows us to obtain national-wide results regarding the output, tax revenue, final demand, etc., and extrapolate them to a regional level. The availability of social accounting matrices, both national and regional, facilitates the task. Alternative methodologies, like the *bottom-up* or hybrid ones, are not recommended because of the nature of the simulations here effected and because of the just mentioned availability of statistical information (see Ahmed and O'Donnoghue, 2006, for further details). The economy's equilibrium is a situation on which consumers maximize their utility, productive sectors maximize their net benefits and the public sector's revenue meets the payments of the different economic agents. In this equilibrium, the amounts supplied will equal the demands in all markets.

The applied general equilibrium model – previously designed to analyze direct taxes in the Andalusian economy (Cardenete and Sancho, 2003), improved and expanded to include polluting emissions and the introduction of environmental taxes (André, Cardenete and Velázquez, 2005) – will be modified in order to introduce the variations of institutional public revenue and expenditure allocations in the Spanish and the Andalusian economy.

2.1. The model

The model used considers 9 productive sectors that correspond with an aggregation of the social accounting matrices for Spain and Andalusia in 1995. The production technology corresponds with what, in terms of an applied general equilibrium model, is known as the *nested production function*. Sector *j*'s domestic production, noted as Xd_j, takes as factors the remaining sectors' production as well as the primary factors (labour, *L*, and capital, *K*) – which are combined using Cobb-Douglas technology and which provide the sector's value added, VA_j – combined through fixed coefficients or Leontief technology. Total production, Q_j, is the result of combining domestic production Xd_j with the corresponding imports $Xrow_j$ using Cobb-Douglas technology and following Armington's hypothesis (1969). It is, therefore, a static applied general equilibrium model that sets out the effect of introducing tax measures without the possibility of technological change – except for the substitution of factors in the value added function.

Continuing with the model's structure, the government taxes economic transactions, thus obtaining a tax revenue[1], *R*; it has an influence on the consumer's available income, *YDISP*, it effects transfers to the private sector, *TPS*, and it demands goods and services, GD_j. The difference between its revenue and its payments represents the balance (surplus or deficit) of the public budget, *PD*, according to the following expression[2]:

[1] See André, Cardenete and Velázquez (2005) for further details on how to calculate all direct and indirect taxes in the model.

[2] In our model, we understand Public Administration as all the existing public institutions in the Autonomous Region: Local – provincial government, municipalities and other entities – and Regional – departments of the regional government and autonomous institutions – as well as National, and also the Social Security Administration when acting upon the regional economic territory. It also includes those firms, institutes, founds, etc. that are 50% financially supported with transfers from other administrations.

$$PD = R - TPScpi - GD_j p_j \qquad (1)$$

where *cpi* is the Consumer Price Index and p_j is the production price level (before VAT) of sector *j*'s goods. The foreign sector is aggregated into three great trade areas (the rest of Spain, Europe and the rest of the world) and its deficit or surplus is determined by *ROWD:*

$$ROWD = \sum_{j=1}^{9} rowp\ IMP_j - TROW - \sum_{j=1}^{9} rowp\ EXP_j \qquad (2)$$

where IMP_j represents sector *j*'s foreign products imports, EXP_j , sector *j*'s exports, and *TROW* the incoming transfers for the consumer.

Final demand comes from various sectors. On the one hand, sectors of non-consumed demand, plus investments and exports; on the other, the families' demand of consumer goods. In our case, we will consider 9 types of goods – identified with their productive sectors – and a representative consumer who demands present consumer goods. The rest of his available income consists on his savings. The purchases of this representative consumer are financed, mainly, with the revenue derived from selling his initial factors provision. The available income of the representative consumer (*YDISP*) is determined by the addition of his labour revenue, plus the transfers he receives, minus the direct taxes he is submitted to:

$$YDISP = w L + r K + cpi\ TPS + TROW - DT\ (r K + cpi\ TPS + TROW) - DT\ (w L - WC\ w L) - WC\ w L \qquad (3)$$

where *w* and *r* are respectively the prices of labour and capital, and *L* and *K* represent the amounts of those factors sold by the consumer, *DT* the direct tax type (income tax) and *WC* labour contribution to the Social Security System by workers.

The consumer's objective is to maximize the utility reported to him by the consumer goods CD_j and the savings SD, as in a Cobb-Douglas function, subject to the budget restriction established by his available income.

$$\begin{aligned} &\text{maximize} && U\ (CD_j, SD\ ) = (\prod_{j=1}^{9} CD_j^{\alpha_j}) SD^{\beta} \\ &\text{s.t.} && p_j CD_j + invp\ SD\ = YDISP \end{aligned} \tag{4}$$

Regarding investment and savings, it is convenient to say that this is a *saving driven model*, which means a model on which the closing equation is defined so that investments are exogenous, savings are determined by the consumers' decision to maximize their utility, and deficits, both that of the public sector and that of the foreign sector, are endogenously determined according to the following accounting identity:

$$\sum_{j=1}^{9} INV_j\, p_{inv} = SDpinv + PD + ROWD \tag{5}$$

where p_{inv} is an investment goods price index.

Regarding the factor market, labour and capital demands are calculated assuming that firms minimize the cost of producing the value added. Capital supply is considered to be unelastic and labour supply is considered perfectly elastic at the real salary level, which depends on the unemployment rate, according to the specification used in Kehoe et al. (1988). In addition, the government's and the foreign sectors' activity levels are not fixed, allowing relative prices, the productive sectors' activity levels and public and foreign deficits to function as endogenous variables, as we just explained.

The economy's equilibrium is a situation on which consumers maximize their utility, productive sectors maximize their net benefits and the public sector's revenues meet the payments of the different economic agents. In this equilibrium, supplies equal demands in all markets.

Formally, the model reproduces a state of equilibrium in the Spanish and the Andalusian economy in which the supply and demand functions of all goods are obtained to solve the problems related to maximizing utility and benefits. The result is a vector of goods and factor prices, activity levels and tax revenue so that they all meet the above described conditions.

2.2 Data bases and calibration

The numeric specification of the models' parameters has been drawn from the social accounting matrix for Spain for 1995 – SAMESP95 – (Cardenete y Sancho, 2006) and from the social accounting matrix for Andalusia for 1995 – SAMAND95 – (Cardenete y Sancho, 2003), through the estimate method known as *calibration*, whose advantages and difficulties (Mansur and Whalley, 1984) we were already acquainted with. The following parameters were taken into account: technical coefficients of the productive sectors, both domestic and foreign; technical coefficients of the productive factors that produce the unit value added; tax rates of all taxes, both direct and undirect; participation coefficients of the consumers' utility functions, which have a Cobb-Douglas structure; participation coefficients and scale parameters of the value added function that applies the same Cobb-Douglas technology; technical coefficients of the value added; technical coefficients of the intermediate goods; technical coefficients of the imported goods; and technical coefficients of the domestic goods. These parameters will be specified by assigning to them the values that allow to reproduce the social accounting matrix as the economy's equilibrium. This equilibrium will be defined so that all prices and activity levels equal one. After the simulation, this will also allow to observe directly the

percentage variations on those prices, in relative terms, and the activity levels, in absolute terms.

Social accounting matrices are elaborated considering nine industrial sectors, two productive factors (labour and capital), a savings/investment account, a public administration account, direct (income tax and labour contribution to Social Security) and indirect taxes (firm contribution to Social Security, VAT, production tax and tariffs), one foreign sector and a representative consumer (see table 1 for the SAMs structure).

(INSERT TABLE 1)

3. Simulations and empirical implementation

To analyze the impact which the expansion of fiscal sovereignty would have on an autonomous region – Andalusia in our case – we have decided to set out a foreseeable and disputed starting hypothesis in the case of Spain's economy, that is, the nation-wide 17% reduction of the income tax, compensating this reduction with an increase of the same tax at the regional level. This fiscal income variation policy would be implemented together with an expenditure co-responsibility policy, which would effect a reduction on the transfers from the central administration to the autonomous region. In this model, social assitance is divided into two categories: unemployment benefits and other social benefits. We will reduce this second component, which includes, in the SAM, the state transfers to the autonomous region.

This starting scenario is complemented with the tax neutrality hypothesis, which means that both the state and the autonomous region public deficits remain unaltered. This decision follows the tradition of making fiscal federalism simulations with a constant budget balance – or imbalance – restriction. This decision is basic in the applied general equilibrium model since the so-called closing equation, the one

that determines the model's equilibrium, is precisely the tax revenue equation (see equation 1), and therefore the results will be highly sensitive to its modification.

Starting from these basic premises, we have chosen to complete the work with a sensitivity analysis. In order to do it we have decided to compare the basic scenario with another one where the increase of direct tax revenue by the autonomous government is compensated with an increase of the unemployment benefits (scenario 2), instead of with an increase of other social benefits (scenario 1).

The main results can be observed In table 2. We see how the increase of the national GDP (1,735%) produces a 0,213% increase at the regional level (we regionalize the effect by considering the weigh of the regional GDP on the national GDP). Also, the direct effect of the income tax medium rate increase – 17% in the case of Andalusia – would be a 0,165% reduction of the GDP. The net effect would be a 0,093% increase of the regional GDP. Evidently, this amount is not very significant, but it shows that the assumption of greater fiscal sovereignty would provoke on the Andalusian autonomous region an increase on the GDP, despite the direct tax increase also implemented.

Starting the analysis with some of the aggregated demand components, we observe important increases both in private consumption and in gross capital creation at the national level (almost 2%) while the two components remain practicaly the same (the reductions are minimal) in the case of the Andalusian economy.

At the same time, the national public expenditure grows about 1% while the expenditure is almost unaltered at the regional level. It is interesting to point out, at the national level, that unemployment benefits diminish – something which can be explained by an employment rate increase, derived from the positive effect of the income tax reduction on the economic activity – as the rest of the social benefits do – including the state transfers to the autonomous regions. In contrast, both types of benefits increase at the regional level.

(INSERT TABLE 2)

Regarding the specifically fiscal results, we observe, at the national level, an important decrease of the income tax revenue (over 6,5%) caused by the fall of this tax medium rate, although this rate's increase at the regional level does not reflect the opposite effect so significantly (the revenue increase does not reach 1%). At the national level, the revenue of all taxes is over 1% higher after the measure is implemented while at the regional level the revenue slightly decreases. The national tax revenue only suffers a 1% reduction while the regional tax revenue experiences a very weak increase, just 0,1%. Finally, we observe how fiscal pressure is reduced at the national level (over 2% lower) while at the regional level it is now only 0,4% higher.

(INSERT TABLE 3)

To accomplish our objective of doing a small sensitivity exercise, we reply the previous exercise increasing, at the Andalusian level, not the social benefits but the unemployment benefits, in order to compensate the tax revenue increase due to the transfer of fiscal sovereignty. This simple simulation (see table 4) shows a smaller increase in the income tax revenue as well as smaller decreases in other taxes revenues, even though the net effect is that of a smaller revenue when compared to the previous scenario, being fiscal pressure practically the same, since the revenue decrease is linked to the decrease in the economic activity measured through the GDP.

(INSERT TABLE 4)

Attending to certain macromagnitudes, we observe that the effect in macro-economic terms is somehow more positive than on scenario 1. On the one hand, the decrease of the GDP and that of the aggregated demand components are both greater. Also the benefits increase, both for unemployment and for other social needs, is greater. In net terms there is a 0,171% increase of the regional GDP, slightly higher than that of scenario 1 (see table 5).

(INSERT TABLE 5)

4. Conclusions

In this work, we have tried to analyze the regional effects of a national fiscal policy measure, like the competence of a direct tax management, linked to the reduction of transfers from the federal government to the autonomous regions. We have made the simulation starting from a fiscal autonomy hypothesis, considered both from an income and an expenditure point of view (scenario 1 confronted to scenario 2), trying so that the regional government maximizes the utility of a representative consumer, who is subject to the budget restriction circumscribed to an applied general equilibrium model at a national-regional level, following the *top-down* methodology. The regional government assumes the implemented fiscal policy as given. For the simulation we have used data bases of the Spanish and Andalusian economies in 1995.

In our simulation we have taken as a basis the hypothesis of a 17% reduction of the national government income tax medium rate in favour of the regional government, compensating the national tax revenue decrease with a decrease of the national transfers to the regional government. From the regional government's point of view, the exercise is exactly the opposite. We have done the simulation using two different scenarios at the regional level: with an increase of other social benefits or, alternatively, an increase of the unemployment benefits.

The main conclusion is that, in net terms, the Andalusian autonomous region – should this simulation be real – would benefit from a slight increase of the regional GDP, greater in the second scenario. Fiscal pressure at the regional level would remain almost unaltered, although there would be a tax revenue increase – basically derived from the income tax increase.

Even though the results are clearly positive and support a greater fiscal sovereignty transfer from the national to the regional government, we must not forget the restrictions derived from any simulation based on an static computable general equilibrium model. The results, in any case, coincide with similar exercises made on other economies, such as those of Groenewold et al. (2003) on the Australian economy. The updating of data bases, historical comparisons or an analysis from the perspective of vertical externalities would surely enrich these results.

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