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Keywords: Tax on retail sales of some fuels, computable general equilibrium models, social accounting, fiscal policy.

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ABSTRACT

This paper simulates the effects on the economy of Extremadura that are produced by a new tax on retail sales of some fuels. A computable general equilibrium model involving various labour market scenarios is employed as a modelling framework. Model parameters are obtained by calibration, using a social accounting matrix for Extremadura updated to the year 2000. Further, we also include an additional simulation in which a hypothetical regional tax rate, to finance environmental policies, is considered. This second simulation assumes constant fiscal revenues. The results of the first simulation show that the effects of this tax are modest. The simulation shows household welfare losses, decreasing activity levels and generalised price reductions, except in production sectors more directly linked to the oil products sector. In addition, we also observe that this hypothetical additional regional fuel tax rate would reinforce the effects produced by the national tax rate.

Keywords: Tax on retail sales of some fuels, computable general equilibrium models, social accounting matrices, fiscal policy

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1. - Introduction

The "Tax on Retail Sales of Some Fuels" (Impuesto sobre las Ventas Minoristas de determinados Hidrocarburos), created in 2002, is a relatively recent tax in the Spanish fiscal system. It is defined as an indirect tax on the retail sales and own consumption of automotive fuels (petrol, gas-oil, fuel oil and kerosene), liquid fuels for heating and some additives. The application of this tax is theoretically supported by its capacity to collect tax revenues and for the correction of negative externalities (LABANDEIRA AND LÓPEZ, 2002). Thus, it serves a dual purpose: controlling demand and collecting tax revenue.

In the decentralized Spanish fiscal system, revenue generated by this fuel tax in a region is transferred by the central government to its corresponding regional government. Further, regional governments are able to augment the national tax rate with an additional regional tax rate. Such regional tax revenue can only be applied to finance the regional health system. However, revenue from the regional tax rate can also be used to finance environmental policies.

The main objective of this paper is to analyse the effects that have been caused by the introduction of this tax on retail sales of some fuels in a regional economy, specifically the economy of Extremadura. ROMERO and SANZ (2003) have already studied its effects on the overall Spanish economy, by using a partial equilibrium approach. At a regional level, CANSINO *et al*. (2005) developed an input-output price model to determine its effects on the Andalusian regional economy.

Our paper is similar to the latter, because we employ a similar modelling framework and we also analyse the effects of the tax on a regional economy. However, we develop a computable general equilibrium (CGE) model for the analysis.

In general terms, these models translate the theoretical Walrasian general equilibrium system into fully operative tools, in which prices guarantee the equilibrium of the economy. That is, they represent real models of concrete economies that explicitly incorporate the full interdependences among the economic agents. This feature makes the computable general equilibrium models very useful for simulating economic policy decisions, showing the direct and indirect effects on the relevant economic variables with a high level of disaggregation.

More specifically, the paper introduces two different applications. First, we determine the effects that this fuel tax has caused in Extremadura, where its current tax rate consists of the national rate only. In addition, we carry out a second simulation, in which a hypothetical additional regional fuel tax rate is introduced in order to finance environmental policies. Further, in this second exercise we impose a reduction in income tax, to maintain constant tax revenue.

Given that the Spanish regional governments have some capacity to alter this tax, it is important to point out the relevance of this analysis to a given regional economy. Besides, the tax on retail sales of some fuels has achieved greater importance in the Spanish economy as a consequence of the discussion about the regional financing system.

The paper is structured as follows. In Section 2, we present the main features of the CGE model employed. Section 3 shows the social accounting matrix (SAM) built for the Extremadurian economy that was used to calibrate the model parameters. A detailed description of the proposed simulations is then presented in Section 4, together with the main results obtained. Finally, Section 5 presents the main conclusions that can be drawn from the analysis of simulation results.

2. - The model

We have developed a static CGE model for the Extremadurian economy. It allows us to determine the effects on resource allocation caused by the introduction of the tax on retail sales of some fuels. This model involves a set of equations that reflect equilibrium conditions and the behaviour of the different economic agents. As such, we can consider the producers, the households, the public sector and the foreign sector in general terms. In this section, we develop a detailed analysis of each sector or agent (subsections A to D below), including some observations in relation to the labour market (subsection E) and the notion of equilibrium used (subsection F).

A) Production

The model for the Extremadurian economy incorporates 16 activity sectors (see Figure 1). It is assumed that each activity sector produces a homogeneous product, according to a nested production function. At the first nesting level, the total production of each sector (Q_j) is obtained as a Cobb-Douglas aggregate of domestic output (Qd_j) and imports (Qm_j). At the second level, the domestic production for each sector is obtained with a fixed-coefficients technology between intermediate inputs (X_{ij}) and value added (VA_j). Finally, at the third nesting level, the value added of each sector is obtained by combining the primary factors of capital (K_j) and labour (L_j), according to a Cobb-Douglas technology function. The expressions used at these three levels are given in (1), (2) and (3) respectively:

$$Q_j = \beta_{Aj}\, Qd_j^{\delta dj}\, Qm_j^{1-\delta dj} \tag{1}$$

$$Qd_j = \min\left\{ X_{1j}/a_{1j}, X_{2j}/a_{2j}, \ldots, X_{16j}/a_{16j}, VA_j/v_j \right\} \tag{2}$$

$$VA_j = \beta_j K_j^{\alpha_j} L_j^{1-\alpha_j}, \quad j = 1,2,\ldots,16 \tag{3}$$

In these expressions, β_{Aj} and β_j are scale parameters; δd_j are parameters which reflect the share of domestic output of *j* in *j´s* total production; parameters a_{zj} express the minimum amount of *z* needed to obtain a unit of *j*; v_j is the technical coefficient of value added; and, finally, α_j and (1-α_j) are parameters which represent the participation of the primary factors, capital and labour, with regard to value added.

Finally, it is assumed that firms obtain their demand functions for inputs and supplies of outputs by maximising profits under these technological constraints.

B) Consumption

The model assumes only one consumer. We consider the following Cobb-Douglas utility function (*U*), defined in terms of saving and consumption:

$$U = \sum_{h=1}^{9} \gamma_h \ln C_h + \gamma_s \ln S \tag{4}$$

In (4), the parameters γ_h and γ_s reflect the share of disposable income for commodities *h* and/or for private savings. *S* represents the saving and C_h expresses the private consumption of commodity *h*.[1]

Inequality (5) shows the budget constraint for this representative household group:

$$\sum_{h=1}^{9} p_h (1 + vat_h) C_h + p_i S = \sum_{h=1}^{9} p_h^F C_h + p_i S \le YD \tag{5}$$

The sum on the left hand side is the expenditure on final consumption. The parameter vat_h is the value added tax rate for the commodity *h*, and p_h^F is its final consumption price inclusive of taxes. Private saving is also included in the expression, being valued at the saving/investment price, p_i.

The right hand side of inequality (5) shows disposable income, *YD*. This income comes from the sale of its endowments of capital (*K*) and labour (*L*), at the prices *r* and *w* respectively. In addition, households receive transfers from the public sector, (*TPS*), indexed by the consumption price index (*cpi*), and receive transfers from the foreign sector (*TFS*), although their total quantitative importance is minimal. Finally, households have to pay employees' social contributions and income tax, whose rates are *ess* and τ, respectively.

Thus, the disposable income of the only household group[2] is given by (6):

$$YD = (1-\tau)\left[rK + wL(1-u) + cpi\ TPS + TFS - ess\ wL(1-u)\right] \qquad (6)$$

The representative consumer derives the consumption demand functions by maximising the utility function subject to the budget restriction shown in (5).

C) Government

The activity of the government consists, on the one hand, of producing public services**,** by using the technology of "Non-sales oriented services" (j_{16} , see Figure 1), while, on the other, of demanding public services (public consumption, C^G_{j16}) and investment goods (C^G_i). In this sense, this agent can be considered to maximise a Leontief utility function (U^G), defined by (7):

$$U^G = \min\left\{C^G_{j16}, \gamma^G C^G_i\right\} \qquad (7),$$

where γ^G is an economic policy parameter reflecting the existence of a fixed proportion between public consumption and public investment.

The budget constraint that the government confronts can be expressed by inequality (8):

$$p_{j16}C_{j16}^{G} + p_{i}C_{i}^{G} \leq R^{G} + p_{i}w_{i}^{G} - cpi\ TPS \qquad (8)$$

The left hand side of this inequality reflects government spending on consumption and investment. On the right hand side, tax revenues are (R^G), from which transfers paid to households have to be subtracted. w_i^G represents the stock of debt that the government issues when it is in budgetary deficit. The rest of the sectors could buy this debt at the same price as saving/investment, p_i.

With respect to the total tax revenues R^G, the model includes net taxes on production, employers' social contributions, import taxes and the previously mentioned value added tax as indirect taxes. As direct taxes, employees' social contributions and income tax are considered. The tax revenue components (a) to (f) are specified in (9) to (14) respectively:

a) Taxes on production (*Rt*):

$$Rt = \sum_{j=1}^{16} t_j \left[\sum_{z=1}^{16} p_z X_{zj} + w(1+esc_j)L_j + rK_j \right] \qquad (9)$$

That is, the domestic output of each sector is subject to a tax at a rate t_j. The production price for sector z is p_z. Finally, esc_j stands for the employers´ social contributions rate.

b) Employers' social contributions (*Resc*):

$$Resc = \sum_{j=1}^{16} esc_j\, w L_j \qquad (10)$$

c) Import taxes (*Rtarif*):

$$Rtarif = \sum_{j=1}^{16} tarif_j\ p_m\, Qm_j \qquad (11)$$

$tarif_j$ is the import tariff rate for sector j, while p_m is the weighted price index of imported products.

d) Value Added Tax (*Rvat*):

$$Rvat = \sum_{h=1}^{9} vat_h \; p_h \; C_h \tag{12}$$

e) Employees´ social contributions (*Ress*):

$$\text{Re}ss = ess \; wL(1-u) \tag{13}$$

f) Income tax ($R\tau$):

$$R\tau = \tau\left[rK + wL(1-u) + cpi \; TPS + TFS - ess \; wL(1-u)\right] \tag{14}$$

Equations (9) to (14) show the taxes included in the benchmark equilibrium of the model. In addition, the Tax on Retail Sales of Some Fuels has been included as a new indirect tax in the two proposed simulations. Regarding its modelling, this tax has been incorporated into the cost structure of "Oil Refining" sector (j_3), without affecting any other production sector. The domestic production of "Oil Refining" in Extremadura is nil and, therefore, its cost structure is very simple because it only shows imports from the rest of Spain.

More specifically, the introduction of the Tax on Retail Sales of some Fuels implies a slight modification of the equation that shows the formation of the "Oil Refining" production price, specified in (15):

$$p_{j3} Q_{j3} = (p_m + trsf_{j3}) Qm_{j3} \qquad (15),$$

where $trsf_{j3}$ is the unitary rate of the new tax.[3] The expression (16) gives the tax revenues:

$$Rtrsf = trsf_{j3}\,Qm_{j3} \qquad (16)$$

Given the special characteristics of the "Oil Refining" sector, the new indirect fuel tax is levied directly on imports, a treatment allowed by Spanish law. On the other hand, in the inner workings of the model, the new tax acts as a compound tax along with the value-added tax (on the consumption side). In this case, there is a distribution of the tax according to the transformation technology that maps the 16 production goods into the 9 consumption goods. We do not make this mapping explicit here but the details are available to the reader upon request.

D) Foreign Sector

The model considers only one foreign sector, being the rest of Spain, the European Union and the rest of the world. Because of the import/export trade and the transfers between this foreign sector and the domestic agents, the regional Extremadurian economy has a deficit with the foreign sector. This deficit must be considered as saving for this sector, in order to achieve the macroeconomic consistency between saving and investment.

E) Labour Market

Capital and labour demands are obtained from conditional factor demand functions, thus minimizing the cost of obtaining value added. For the capital factor, we assume perfectly inelastic supply and therefore this factor is always fully employed. However, the model allows possible rigidities in the labour market, so the unemployment rate may be positive. More precisely, we consider the relationship (17) between the real wage and the unemployment rate:

$$\left(\frac{w}{cpi}\right)=\left(\frac{1-u}{1-u_0}\right)^{1/\beta_d} \tag{17}$$

This formulation of the labour market in CGE modelling is due to KEHOE *et al*. (1995), following the precepts established in OSWALD (1982). The variable *(w/cpi)* represents the real wage; u is the unemployment rate; u_0 is a parameter that reflects the unemployment rate in the benchmark equilibrium; and β_d is a parameter that expresses the sensitivity of the real wage to the unemployment rate.

This last parameter can have values between zero and infinity. If $\beta_d = 0$, the real wage will adjust sufficiently so that the unemployment rate remains constant and equal to the benchmark equilibrium rate. If $\beta_d = \infty$, the situation is exactly the opposite, that is to say, the real wage remains constant and the unemployment rate varies. For intermediate values, higher values of this parameter represent greater salary rigidity. In other words, the sensitivity of the real wage to the unemployment rate diminishes.

In the simulations we shall show later, calculations are carried out for different values of this parameter. Specifically, the extreme values $\beta_d = 0$ and $\beta_d = \infty$ are used, as well as a value from the econometric literature ($\beta_d = 1.25$, see ANDRÉS *et al*., 1990).

F) Equilibrium

The notion of equilibrium that is used in the model is that of the Walrasian competitive equilibrium, extended to include not only producers and households, but also the government and foreign sectors (see, for instance, SHOVEN and WHALLEY, 1992). Specifically, economic equilibrium is determined by a prices vector, an activity-levels vector, and a set of macro variables such that supply equals demand in all markets, with the sole exception being the labour market, as previously mentioned. Further, each one of the economic agents included in the model attains its corresponding optimal choices under the respective budget constraint, *i.e.*, the agents implement their optimal equilibrium solutions.

3. – Database and calibration

The values of the model parameters are obtained by the usual procedure known as calibration. However, first it is necessary to obtain a social accounting matrix (SAM) for the Extremadura economy in order to calibrate the parameters. The last available SAM for this region is for the year 1990, so this was updated to 2000. For this, we applied the cross-entropy method (ROBINSON *et al*., 2001).

The resulting SAM includes 37 accounts. As this matrix has been built to calibrate our CGE model, there is a perfect concordance between the SAM and the model. Thus, the SAM-Extremadura-2000 incorporates the 16 activity sectors and the nine commodities shown in Figure 1. This matrix also contains two accounts for labour and capital factors, an account for households, an aggregate capital account or saving/investment account, an account for the government, six accounts for the taxes considered in the model and, finally, an account for the foreign sector.

The calibration process assumes that the SAM (the base period) represents an initial equilibrium of the economy. That is to say, it determines the parameter values that verify this property. Furthermore, in the benchmark equilibrium, measurement units are normalised so that all the price and activity levels are unitary. For the proposed model, all the parameters can be obtained by calibration, except the unemployment rate for the benchmark equilibrium.[4]

4. - Simulations and results

Once the parameters and the initial values of the variables are computed, we can consider the desired simulations. The first goal of this paper is to quantify the effects on the Extremadurian economy that have been caused by the introduction of the new tax on retail sales of some fuels. In Extremadura, the tax rate applied up to now has been just the national component without any additional regional component.

After simulating the introduction of the tax with only the national tax rate, we consider a distinct second simulation to determine the effects caused by a hypothetical additional regional tax rate, aimed at financing environmental policies. Further, in this second simulation, we impose a reduction in income tax to keep total tax revenue constant.

We have used a mixed rule for the model closure. Firstly, because a new tax is introduced, we consider that the public deficit was endogenously determined by the model. Further, for the foreign sector, the commercial deficit remains fixed at the benchmark equilibrium level, while its activity level may vary.

Before analysing the results, it is important to note that three versions of the model are simulated, because we have considered three different values of the β_d parameter. Therefore, each version corresponds to a different scenario for the labour market.

A) Introduction of the tax on retail sales of some fuels

In this first exercise, we determine the main effects on the Extremadurian economy by the introduction of the tax on retail sales of some fuels, only composed of the national component in this region. Thus, the equations related to this tax, (15) and (16), constitute the only changes in the model with respect to the benchmark equilibrium.

It is important to note that the new tax rate, $trsf_{j3}$, is not a model parameter. On the contrary, this tax rate is endogenously determined by the model so that *Rtrsf* was the value of the actual tax revenue obtained with this tax. Therefore, *Rtrsf* is an exogenous variable in the model. Using 2002 official data, the first year of this tax's application, this tax revenue in Extremadura was 13,863,648 euros. As our database -the updated SAM for Extremadura- refers to 2000, this amount has been deflated to obtain the 2000 figure of 12,980,944 euros.

The results of this first simulation clearly show diminished variations in the variables and therefore, the distortions caused by the tax are not very important. First, we analyse the percentage changes that occur for each price category (see Table 1). It is important to note that, in all the simulations that have been done, wage (*w*) remains constant because it is used as numeraire of the model. In this sense, all the price variations commented on in the paper actually represent relative variations, expressed in relation to numeraire.

Starting from production prices, in every labour market scenario, these prices show clear increases of greater than 8% in "Oil Refining" (j_3). This fact is a logical consequence of the incorporation of the fuel tax in the "Oil Refining" cost structure. It is also important to note the increase in "Transport and communication" (j_{13}), because of this sector's dependence on fuel through intermediate inputs.

In contrast, the higher the wage rigidity (i.e., larger the value of β_d), greater is the reduction in the price of the capital factor, determining lower production prices. In fact, considering the fully flexible wage (β_d = 0), almost all production prices show small increases, while the other two scenarios present generalised reductions. This general result is also observed for the consumption prices, the saving/investment price and the average weighted price of imported products.

Regarding the consumption prices, those more directly related to "Oil Refining", such as "Transport and Communication" (h_7) and "Housing, heating and lighting" (h_4), show increases in all scenarios. In this sense, *cpi* also shows a slight increase in each scenario, again higher for wage flexibility and almost zero for fully flexible unemployment.

Another set of results shows the changes in activity levels (Table 2). For the production sectors, the activity levels generally experience small reductions, again higher for "Transport material" (j_6), "Oil refining" (j_3) and "Transport and communication" (j_{13}). Therefore, the slowing down of the productive activity caused by the introduction of the new tax is evident.

However, there are some exceptions to this general result, because "Construction" (j_{11}) and "Metal and electrical material" (j_5) experience increases in their activity levels. To explain this result, we note that production in both these sectors is generally aimed at investment. Since investment is determined by savings in the model, the introduction of the new tax causes a reduction in the public deficit and an increase in aggregate saving, leading to an increase in the investment activity level between 0.204 and 0.396% that *pulls* the two activity sectors up.

On the other hand, it is possible to observe clear differences among the three versions of the model. Considering the fully flexible wage scenario, the activity levels are clearly higher and so, the slowing down of economic activity seems to be lower.[5] To clarify this result, we use some macroeconomic indicators (see Table 3), starting with the unemployment rate changes. In the case of a fully flexible wage, labour market adjustment occurs via the real wage and not via unemployment. In fact, given our specification for the labour market -equation (17)- unemployment rate u remains constant at the benchmark equilibrium (23.62%). In the other versions of the model, the general reduction in activity levels causes a reduced increase in the unemployment rate. This increase is 0.055 percentage points for $\beta_d = 1.25$, and 0.096 points for $\beta_d = \infty$.

It is also important to note that, although the Extremadurian real GDP exhibits a small decrease in all scenarios, this reduction clearly becomes smaller as wage flexibility increases (0.002% for $\beta_d = 0$ compared with 0.069% for $\beta_d = \infty$).

Table 3 also shows the changes in household welfare caused by the incorporation of the new tax. This table includes the percentage variation of real disposable income, computed as the rate between disposable income and the consumption price index. As is usual, we also present the equivalent variation and the compensating variation, because both measures provide a monetary valuation of these welfare changes.

The considered indicators show welfare reductions for all cases, with the decrease directly related to increases in wage rigidity. That is, a greater wage rigidity causes a greater reduction. Therefore, the scenario of a fully flexible wage is again the scenario with fewer distortions. In the case of $\beta_d = 0$, although households face up to higher saving/investment and consumption prices, their disposable income is also higher and the reductions in saving and consumption are smaller.[6]

Specifically, real disposable income shows a reduction of between 0.135% and 0.165%, while equivalent and compensating variations show approximate welfare losses of between 10.5 and 14.1 millions of euros.

To conclude the first application, we should note that the introduction of the new tax on fuels obviously modifies total tax revenue, R^G, which increases slightly in all scenarios (see Table 4). The fully flexible wage scenario is emphasized again, because it shows the greatest increase in total tax revenues (0.559%). In this labour market scenario, there is also a reduction in production subsidies, as well as a slight increase in the revenues from most taxes. This result clearly contrasts with the situation in the other two scenarios.

B) Introduction of a hypothetical additional regional tax rate compensated by a reduction of the income tax (equivalent tax revenues)

Once the effects caused by the new tax have been determined, in this second simulation we analyse the effects produced by the introduction of a hypothetical additional regional tax rate. Specifically, together with the previous national tax rate, we introduce a regional tax rate aimed at financing 5% of the regional environmental expenditure. In terms of modelling, we accordingly increase the tax revenue *Rtrsf* by 3,691,576 euros obtaining the new figure of 16,672,520 euros. As in the former simulation, *Rtrsf* is a model parameter, while the tax rate $trsf_{j3}$ is an endogenous variable.

In this second simulation, we also propose a simultaneous reduction in income tax, to quantify the effects in a scenario involving constant total tax revenues. This tax is selected to be modified because the Spanish regional governments can change it.[7]

The effects on the different variables are very similar to the ones obtained from the former simulation. In general, the effects derived from the regional tax rate prevail over those caused by the reduction in income tax, that is, introduction of the regional tax rate basically would reinforce the effects of the national tax rate.

A good example can be found in the behaviour of relative prices. In this second simulation, the effects on prices essentially reproduce the data presented in Table 1 above. That is, production and consumption prices increase with a fully flexible wage, whilst the opposite behaviour occurs in the other two labour market scenarios.

Therefore, given the similarities between the two simulations, in this section our basic goal is to compare their respective results, rather than to do a detailed analysis of this second simulation. The tables of simulation results will be presented in a different format in order to fulfil this goal.

With regard to prices, Table 5 shows for both simulations several indicators of changes with respect to the benchmark equilibrium. For production and consumption prices, including *cpi*, the percentage average variations show how the average effects on prices are clearly higher in the second simulation.[8] In fact, increases and reductions in prices are more marked than in the first simulation, hence giving a higher dispersion - observe the variance of the percentage variations. Furthermore, we also notice more variability in the saving/investment price (p_i), the average price of imported products (p_m) and the capital factor price (r).

On the other hand, there are some relevant differences between the two simulations in terms of consumption, especially for the fully flexible wage case (see Table 6). The proposed reduction in income tax and the higher increase produced in public transfers - updated by *cpi*, determine for this second simulation higher disposable incomes than in the first simulation for two of the three labour market scenarios, $\beta_d = 0$ and $\beta_d = 1.25$. In fact, in these two scenarios the reductions in consumption and savings are smaller than the initial ones.[9] Nevertheless, it can be observed that, in any scenario, “Housing, heating and lighting” (h_4) and “Transport and communication” (h_7) decrease more than in the first simulation, due to the higher increase in their consumption prices.

In terms of household welfare, the three indicators – variation in real disposable income, equivalent variation and compensating variation – again reflect welfare losses with respect to the benchmark equilibrium. In addition, it is clear that in the second simulation, as well as the first one, the lower distortions in the economy would happen with a fully flexible wage, not only in terms of household welfare, but also in terms of unemployment rate – no increase for $\beta_d = 0$ - and real GDP - a lower reduction.

Considering all the results shown in Tables 5 and 6, it is also important to note that for the Extremadurian economy, with the exception of the first wage scenario, the second simulation shows worse economic results and higher distortions than the simple introduction of the national tax rate. That is, for the two labour market scenarios that imply higher wage rigidity, the reduction in income tax would not be enough to compensate for the negative effects caused by the incorporation of the regional tax rate.

To conclude the analysis, we show the different tax revenues obtained in the two simulations (see Table 7). Given the nature of this second exercise, total tax revenues (R^G) for each wage scenario should obviously be the same in both exercises.

The results show that, with the exception of the increase in the tax on retail sales of some fuels and the corresponding reduction in income tax, remaining tax revenues are almost constant. We also highlight the fact that the second simulation shows lower revenues for social contributions, due to the increase in the unemployment rate and the reduction in labour factor contracts.

5. – Concluding remarks

In this paper we have tried to measure the effects that the introduction of the Tax on Retail Sales of some Fuels has caused in the Extremadurian economy. Up to now, this tax has been only composed of the national tax rate in this region. The special features of this tax, especially the Regional Governments' capacity to increase the tax rate, indicate the importance of the analysis done in this paper for any regional government.

Starting from the update of a social accounting matrix for Extremadura, we have developed a computable general equilibrium model that allows one to compute the microeconomic and macroeconomic effects.

The results generally show diminished effects, and therefore the distorting effects of the new tax are not very pronounced. Specifically, it is possible to observe an increase in the oil refining production price (relative to wage), as well as in the prices of those commodities closely related to this sector. In addition, the results show a generalized reduction in the activity levels, except in those sectors more directly linked to investment.

It is also important to note that there are evident differences among the three labour market scenarios that we have considered. In fact, the scenario with the higher wage flexibility, although showing higher production and consumption prices, is the scenario with a smaller economic downturn. In this case, it is possible to observe smaller decreases in activity levels, smaller reductions in household welfare and real GDP, and finally no increase in the unemployment rate.

Furthermore, as regional governments can make some decisions on the tax rate, we have also developed an additional second simulation to determine the effects caused by a hypothetical additional regional fuel tax rate. In this case, we have also assumed tax revenue neutrality, achieved by a reduction in the income tax rate. The results show that, firstly, this reduction in income tax causes some differences compared to the first simulation, for example in terms of consumption, and, secondly, the effects of the regional tax rate prevail over the reduction in income tax, basically reinforcing the effects of the national tax rate. In fact, in two of the three labour market scenarios, the observed distortions in the economy would be higher in this second simulation.

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[1] The nine commodities considered in equation (4) are also shown in Figure 1.

[2] As will be commented later, *u* is an endogenous variable that reflects the unemployment rate.

[3] In the benchmark equilibrium of the model, we consider $trsf_{j3} = 0$.

[4] The tax rates introduced in the model are also obtained by calibration, using data of tax revenues included in the Extremadurian SAM. Therefore, they are effective rates instead of nominal rates.

[5] Table 2 shows that, for $\beta_d = 0$, "Agriculture" (j_1), "Energy" (j_2) and "Other industries" (j_{10}) also show increases in their activity levels. The increase in the saving/investment activity level is also clearly higher than in the other scenarios.

[6] See the commodities activity levels in Table 2. It can be also observed that commodities with higher increases in final prices, "Transport and communication" (h_7) and "Housing, heating and lighting" (h_4), experience greater reductions in consumption.

[7] The inclusion of a regional tax rate – without any modification - would be an analogous simulation to the first one. The effects would be qualitatively similar to the ones shown above, although slightly higher.

[8] The introduction of the regional tax would determine a higher increase for "Oil refining" (j_3), from around 8% up to 10.4%. These increases in prices would also be clearly higher for those sectors and commodities that are more directly related to refining, namely, "Transport and communication" (j_{13}), "Housing, heating and lighting" (h_4) and "Transport and communication" (h_7).

[9] It is interesting to observe how consumption increases in a generalized way with fully flexible wage.

Figure 1. Production sectors and commodities

PRODUCTION SECTORS

j_1 -Agriculture
j_2 - Energy
j_3 - Oil refining
j_4 - Chemical products and minerals
j_5 - Metal products and electrical material
j_6 - Transport material
j_7 - Food, beverages, and tobacco industries
j_8 - Textiles, leather, shoes, and clothing
j_9 - Paper and printing
j_{10} - Sundry industrial products
j_{11} - Construction
j_{12} - Recovery and repair, trade and hostelry
j_{13} - Transport and communication
j_{14} - Credit and insurance institutions
j_{15} - Other sales oriented services
j_{16} - Non-sales oriented services

COMMODITIES

h_1 - Food and non-alcoholic drinks
h_2 - Alcoholic drinks and tobacco
h_3 - Clothing and footwear
h_4 - Housing, heating and lighting
h_5 - Furnishings and fittings
h_6 - Medical services
h_7 - Transport and communication
h_8 - Leisure, education and culture
h_9 - Other commodities

Table 1. Introduction of the tax on retail sales of fuels.

Percentage changes in prices

		Labour market scenarios		
		$\beta_d = 0$	$\beta_d = 1.25$	$\beta_d = \infty$
PRODUCTION (p_j)				
j_1	Agriculture	0.009	-0.087	-0.158
j_2	Energy	0.018	-0.063	-0.124
j_3	Oil refining	8.187	8.100	8.036
j_4	Chemistry and minerals	0.072	-0.014	-0.078
j_5	Metal and electrical material	0.026	-0.053	-0.112
j_6	Transport material	0.019	-0.065	-0.127
j_7	Food, drinks and tobacco	0.026	-0.057	-0.118
j_8	Textiles and clothing	0.022	-0.057	-0.116
j_9	Paper and printing	0.028	-0.046	-0.100
j_{10}	Other industries	0.047	-0.026	-0.080
j_{11}	Construction	0.052	-0.002	-0.042
j_{12}	Trade	0.002	-0.075	-0.132
j_{13}	Transport and communication	0.368	0.303	0.255
j_{14}	Credit and insurance	-0.002	-0.050	-0.086
j_{15}	Other sales-oriented services	-0.025	-0.107	-0.168
j_{16}	Non-sales-oriented services	0.019	-0.006	-0.024
COMMODITIES (p_h^F)				
h_1	Food and non-alcoholic drinks	0.015	-0.069	-0.131
h_2	Alcoholic drinks and tobacco	0.018	-0.063	-0.123
h_3	Clothing and footwear	0.011	-0.066	-0.124
h_4	Housing, heating and lighting	0.165	0.087	0.030
h_5	Furnishings and fittings	0.013	-0.051	-0.099
h_6	Medical services	0.025	-0.050	-0.105
h_7	Transport and communication	0.608	0.533	0.478
h_8	Leisure, education and culture	0.010	-0.067	-0.124
h_9	Other commodities	0.004	-0.073	-0.131
cpi	Consumption price index	0.136	0.058	0.000
p_i	Saving/investment price	0.046	-0.014	-0.059
p_m	Average weighted price of imported products	0.023	-0.066	-0.132
PRODUCTION FACTORS				
r	Capital factor	-0.058	-0.179	-0.268
w	Labour factor	Numeraire	Numeraire	Numeraire

Source: Own elaboration. All the numbers included in the tables have been rounded up to three decimals. Therefore, some numbers that are actually close to zero may appear as zero.

Table 2. Introduction of the tax on retail sales of fuels.
Percentage changes in activity levels

		Labour market scenarios		
		$\beta_d = 0$	$\beta_d = 1.25$	$\beta_d = \infty$
PRODUCTION				
j_1	Agriculture	0.035	-0.028	-0.075
j_2	Energy	0.030	-0.041	-0.094
j_3	Oil refining	-0.306	-0.339	-0.364
j_4	Chemistry and minerals	-0.015	-0.055	-0.085
j_5	Metal and electrical material	0.148	0.079	0.027
j_6	Transport material	-0.407	-0.429	-0.445
j_7	Food, drinks and tobacco	-0.015	-0.042	-0.062
j_8	Textiles and clothing	-0.008	-0.027	-0.043
j_9	Paper and printing	-0.012	-0.038	-0.057
j_{10}	Other industries	0.073	0.013	-0.032
j_{11}	Construction	0.330	0.231	0.158
j_{12}	Trade	-0.105	-0.130	-0.149
j_{13}	Transport and communication	-0.159	-0.201	-0.232
j_{14}	Credit and insurance	-0.023	-0.074	-0.111
j_{15}	Other sales-oriented services	-0.089	-0.112	-0.129
j_{16}	Non-sales-oriented services	0	0	0
COMMODITIES				
h_1	Food and non-alcoholic drinks	-0.014	-0.025	-0.034
h_2	Alcoholic drinks and tobacco	-0.017	-0.031	-0.042
h_3	Clothing and footwear	-0.011	-0.028	-0.041
h_4	Housing, heating and lighting	-0.164	-0.182	-0.195
h_5	Furnishings and fittings	-0.012	-0.043	-0.066
h_6	Medical services	-0.024	-0.045	-0.060
h_7	Transport and communication	-0.603	-0.624	-0.639
h_8	Leisure, education and culture	-0.009	-0.028	-0.041
h_9	Other commodities	-0.003	-0.021	-0.034
i	Saving/investment activity level	0.396	0.286	0.204

Source: Own elaboration. The activity level for "Non-sales oriented services" (j_{16}) remains constant due to the closure rule the authors use in the model.

Table 3. Introduction of the tax on retail sales of fuels.

Macroeconomic indicators and household welfare measures

	Benchmark equilibrium	New equilibrium			Variation		
		Labour market scenarios			Labour market scenarios		
		$\beta_d = 0$	$\beta_d = 1.25$	$\beta_d = \infty$	$\beta_d = 0$	$\beta_d = 1.25$	$\beta_d = \infty$
Unemployment rate (%)	23.62	23.62	23.675	23,716	0	0.055	0.096
Real GDP (millions of euros)	9,658.886	9,658.721	9,654.983	9,652.209	-0.002	-0.040	-0.069
Real disposable income (millions of euros)	9,396.293	9,383.606	9,381.993	9,380.796	-0.135	-0.152	-0.165
Equivalent variation (millions of euros)	-	-10.535	-12.561	-14.063	-	-	-
Compensating variation (millions of euros)	-	-10.547	-12.566	-14.061	-	-	-

Source: Own elaboration.

Table 4. Introduction of the tax on retail sales of some fuels.

Tax revenues

	Benchmark equilibrium (millions of euros)	New equilibrium (millions of euros)			Percentage variation		
		Labour market scenarios			Labour market scenarios		
		$\beta_d = 0$	$\beta_d = 1.25$	$\beta_d = \infty$	$\beta_d = 0$	$\beta_d = 1.25$	$\beta_d = \infty$
Taxes on production *(Rt)*	-27.941	-27.893	-27.821	-27.768	-0.173	-0.428	-0.618
Employers social contributions *(Resc)*	892.164	892.185	891.447	890.900	0.002	-0.080	-0.142
Import taxes *(Rtarif)*	0.078	0.078	0.078	0.078	0.024	-0.112	-0.213
Value Added Tax *(Rvat)*	135.697	135.698	135.569	135.473	0.001	-0.094	-0.165
Employees social contributions *(Ress)*	713.574	713.574	713.057	712.673	0	-0.073	-0.126
Income tax ($R\tau$)	620.665	620.671	620.080	619.642	0.001	-0.094	-0.165
Tax on retail sales of some fuels *(Rtrsf)*	-	12.981	12.981	12.981	-	-	-
Total tax revenues (R^G)	2,334.237	2,347.293	2,345.391	2,343.980	0.559	0.478	0.417

Source: Own elaboration.

Table 5. Comparison between first and second simulations.

Percentage variations in prices

	Labour market scenarios					
	$\beta_d = 0$		$\beta_d = 1.25$		$\beta_d = \infty$	
	1st Sim.	**2nd Sim.**	**1st Sim.**	**2nd Sim.**	**1st Sim.**	**2nd Sim.**
PRODUCTION (p_j)						
Average percentage variation	0.558	0.729	0.569	0.729	0.610	0.784
Variance of percentage variations	4.150	6.860	4.137	6.837	4.127	6.821
COMMODITIES (p_h^F)						
Average percentage variation	0.097	0.139	0.118	0.148	0.149	0.192
Percentage variation in *cpi*	0.136	0.190	0.058	0.080	0.000	0.000
Variance of percentage variations	0.039	0.065	0.040	0.065	0.040	0.066
Percentage variation in p_i	0.046	0.071	-0.014	-0.014	-0.059	-0.076
Percentage variation in p_m	0.023	0.046	-0.066	-0.079	-0.132	-0.170
Percentage variation in r	-0.058	-0.052	-0.179	-0.221	-0.268	-0.344

1st Simulation: National tax rate of the new tax on retail sales of some fuels

2nd Simulation: National tax rate + Regional tax rate + Reduction in income tax (equivalent total tax revenues)

Source: Own elaboration. The average percentage variations have been computed by considering the absolute values of the percentage variations respect to the benchmark equilibrium.

Table 6. Comparison between first and second simulations.
Welfare levels and macroeconomic indicators

		Labour market scenarios					
		$\beta_d = 0$		$\beta_d = 1.25$		$\beta_d = \infty$	
		1ª Sim.	2ª Sim.	1ª Sim.	2ª Sim.	1ª Sim.	2ª Sim.
CONSUMPTION AND SAVING							
Percentage variation in Disposable Income (*YD*)		0.001	0.055	-0.094	-0.086	-0.165	-0.188
Percentage variation in Consumption (C_h):							
h_1	Food and non-alcoholic drinks	-0.014	0.019	-0.025	-0.003	-0.034	-0.019
h_2	Alcoholic drinks and tobacco	-0.017	0.017	-0.031	-0.010	-0.042	-0.030
h_3	Clothing and footwear	-0.011	0.026	-0.028	-0.006	-0.041	-0.028
h_4	Housing, heating and lighting	-0.164	-0.172	-0.182	-0.203	-0.194	-0.226
h_5	Furnishings and fittings	-0.012	0.026	-0.043	-0.024	-0.066	-0.060
h_6	Medical services	-0.024	0.009	-0.045	-0.027	-0.060	-0.053
h_7	Transport and communication	-0.603	-0.735	-0.624	-0.771	-0.639	-0.797
h_8	Leisure, education and culture	-0.009	0.027	-0.028	-0.005	-0.041	-0.029
h_9	Food and non-alcoholic drinks	-0.003	0.035	-0.021	0.003	-0.034	-0.019
Percentage Variation in Saving (*S*)		-0.045	-0.016	-0.080	-0.072	-0.106	-0.111
WELFARE LEVELS							
Percentage Variation in Real Disposable Income		-0.135	-0.134	-0.152	-0.166	-0.165	-0.188
Equivalent Variation (millions of euros)		-10.535	-9.789	-12.561	-13.291	-14.063	-15.794
Compensating Variation (millions of euros)		-10.547	-9.804	-12.566	-13.299	-14.061	-15.791
MACROECONOMIC INDICATORS							
Unemployment rate, *u* (%)		23.620	23.620	23.675	23.696	23.716	23.751
Percentage Variation in real GDP		-0.002	-0.002	-0.040	-0.055	-0.069	-0.094

1st Simulation: National tax rate of the new tax on retail sales of some fuels

2nd Simulation: National tax rate + Regional tax rate + Reduction in income tax (equivalent total tax revenues)

Source: Own elaboration.

Table 7. Comparison between first and second simulations.

Tax revenues

TAX REVENUES (millions of euros)	Labour market scenarios					
	$\beta_d = 0$		$\beta_d = 1.25$		$\beta_d = \infty$	
	1ª Sim.	2ª Sim.	1ª Sim.	2ª Sim.	1ª Sim.	2ª Sim.
Taxes on production *(Rt)*	-27.893	-27.935	-27.821	-27.826	-27.768	-27.748
Employers social contributions *(Resc)*	892.185	892.179	891.447	891.168	890.900	890.436
Import taxes *(Rtarif)*	0.078	0.078	0.078	0.078	0.078	0.078
Value Added Tax *(Rvat)*	135.698	135.772	135.569	135.580	135.473	135.443
Employees social contributions *(Ress)*	713.574	713.574	713.057	712.863	712.673	712.349
Income tax *($R\tau$)*	620.671	616.954	620.080	616.855	619.642	616.750
Tax on retail sales of some fuels *(Rtrsf)*	12.981	16.673	12.981	16.673	12.981	16.673
Total tax revenues *(R^G)*	2,347.293	2,347.293	2,345.391	2,345.391	2343.980	2343.980

1st Simulation: National tax rate of the new tax on retail sales of some fuels

2nd Simulation: National tax rate + Regional tax rate + Reduction in income tax (equivalent total tax revenues)

Source: Own elaboration.