TIME USE AND FOOD TAXATION IN SPAIN*

Javier Ferri [1], María Luisa Moltó [1], Ezequiel Uriel [1][2]

(1) Universidad de Valencia

(2) Instituto Valenciano de Investigaciones Económicas (IVIE)

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Abstract

We evaluate the welfare impact of changing VAT on food in a context in which households can produce home meals for own consumption that compete with meals served in restaurants. Home production of meals requires the combination of food and time inputs. The fiscal treatment in home production of both the inputs and the final product differs from market production of meals, generating different channels of inefficiency. We calibrate a simple general equilibrium model for the Spanish economy which identifies three types of consumers according to their income and simulate the effects of some experiments related to how food is taxed. The results suggest that if we focus only on aggregate welfare, the model fails to capture important distributional issues. We also present some caveats to previous simulation results on aggregate welfare that are related to the importance of the elasticity of substitution between food and time in the household production of meals.

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1. Introduction

The seminal idea of Becker (1965) and Gronau (1977) who considered households to behave as enterprises, using time to produce commodities for own consumption has influenced different areas of economic analysis (see Gronau, 1997 for a survey). In public finance, the welfare impact of different taxes depends on how different households combine unpaid work, capital and intermediate goods to produce goods and services ready to be consumed.

The empirical importance of household production for the theory of optimum tax policy has been discussed in previous studies such as Boskin (1975), Sandmo (1990), Kleven et al (2000), Anderberg and Balestrino (2000), and Kleven (2004). Numerical simulations quantifying the effects can be seen in Piggott and Whalley (1996), Piggott and Whalley (2001), and Iorwerth and Whalley (2002). However, the bulk of the existing empirical literature that integrates taxes and household production focuses on pure efficiency aspects and a representative consumer, sidestepping distributional issues, or reducing them to a bare minimum; e.g Piggott and Whalley (1996) distinguish between households with and without children; Anderberg and Balestrino (2000) between low ability and high ability, and Piggott and Whalley (2001) between rich and poor. Therefore, although household production theory has provided many interesting applications to the theory of taxation, the interaction between household production and taxation has not yet been addressed in a full-blown computable general equilibrium model, partly because of the strong statistical requirements involved that can be condensed into the so-called social accounting matrices (SAM)[1].

In this work we use an extended SAM with household production for Spain (see Uriel *et al.*, 2005) to obtain numerical simulations from a computable general equilibrium model to illustrate both efficiency and equity effects related to possible changes in VAT rates applied to restaurants and food in Spain. The main result is that in most of the cases efficiency and equity act in opposite directions and that for the food exemption case, there is a decrease in total efficiency that hides an important gain for the lower end of the income distribution.

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[1] Recently we have been witnessing in Europe a renewed interest in social accounting matrices. One example is the *Leadership Group on Social Accounting Matrices* (SAM-LEG), which was born under the statistical requirements for the implementation of the third phase of the European Monetary Union and has prepared

The model in this paper considers both the market production of meals by restaurants, as well as the preparation of food at home. Restaurant production -the meals served there- compete directly with the meals produced by households themselves, the VAT the latter pay on food being a significant part of their production cost. Both households and restaurants use labour and food to produce meals, but the fiscal treatment of the two types of production is very different. First, restaurants can deduce the VAT levied on food they purchase, while the household production of meals must bear the full amount of VAT that is levied on food, given that it is not a market activity. Second, restaurants must include VAT in their invoices for the service offered, whereas the meals produced by households are exempt. Finally, households must pay a part of the revenue generated in the form of income tax when they dedicate part of their available time to market activities, but they do not pay any amount of income in the form of taxes when they work at home activities. There are, therefore, two sources of distortion in the fiscal treatment of the production of meals that generate inefficiency. One type of distortion refers to the different fiscal treatment of goods of very similar characteristics: homemade meals and those produced by restaurants. Another distortion is due to the inputs required for the production of homemade meals (labour and food) receiving different fiscal treatment.

From the point of view of efficiency, and because time used in household meal production is not taxed, while the distortion between inputs used in household production of meals would be eliminated by making food exempt from VAT, the distortion between market and household production would be increased. A decrease in the VAT charged by restaurants, on the other hand, would reduce the distortion between market and non-market goods but, because government revenue must remain constant[2], it would imply a higher tax rate on market labour and a higher VAT on food. Therefore a decrease in the VAT charged by restaurants would widen the gap distortion between the fiscal treatment of food (which is subsidized) and labour (which is taxed) in the market production of meals, but would also worsen the distortion between food (which is taxed) and labour (which is subsidized) in the household production of food. As a conclusion, making food exempt from VAT or reducing the VAT charged by restaurants creates ambiguous theoretical effects on efficiency terms. Nevertheless, the simulation results by Iorwerth and Whalley

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the guidelines for the construction of social accounting matrices (see SAM-LEG, 2003). Another example is the first estimation of Tjeerd *et al* (2004) of a SAM for the Euro-zone.

[2] Thus, we are interested in evaluating what is known in the literature as an equal yield tax reform (see, for example Shoven and Whalley, 1977, or more recently Bhattarai, 2007).

(2002) suggest that an increase of VAT on food and a reduction of VAT on restaurants would improve the efficiency of the current tax system and would lead to gains in global well-being. As we show below, these results are conditional on the elasticity of substitution between food and time in the household production of meals.

In addition, an increase of VAT levied on food and a reduction in the VAT applied to restaurants could have adverse effects in terms of redistribution, as those households that are economically most disadvantaged would be penalized, due to the fact that they have more meals at home than in restaurants. Below, we divide the consumers into three groups according to their income level. This disaggregation allows us to deal with the economic incidence of different tax reforms. We also explore how increasing inequality affects the election of the amounts of time and food devoted to preparing meals at home.

The paper is organized as follows. In Section 2 the basic model is motivated and presented. Section 3 explains the calibration of the model. In Section 4 the results of the different tax policy experiments are offered, including the replication of Iorwerth's and Whalley's experiments, efficiency and optimal taxation for Spain and some tax incidence considerations. Finally, Section 5 summarizes the paper and suggests future follow-ups to this line of research.

2. The model

The model is similar to that of Iorwerth and Whalley (2002) – IW henceforth- and Kleven *et al.* (2000), but we write it as a decentralized equilibrium problem because it makes the model suitable to easily accommodate more than just one consumer. A detailed account of the model can be found in the Appendix. In particular, we consider that in this simple economy there is an institution (aggregator) which is the owner of total time. This aggregator generates aggregate food (A) and total time available for labour and leisure (L) by means of a transformation function of total aggregate resources $(\overline{G})$

$$G = \xi\left[\tau L^{\frac{\varepsilon+1}{\varepsilon}} + (1-\tau)A^{\frac{\varepsilon+1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon+1}} \qquad (1)$$

The aggregator maximizes total income, which depends on the price of a unit of time (P_{lo}) and the price of food (P_a), subject to the condition (1). This function is concave both in time devoted for labour and leisure as well as in food, thus allowing us to obtain an upward sloping supply curve for food and for units of effective labor. The price index for a unit of aggregate factor endowment (P_g) can be obtained from this problem as a nonlinear combination of (P_{lo}) and (P_a).

The aggregator distributes the total endowment among three equal-size tercile groups of consumers according to some fixed rule. Therefore, each group receives an exogenous endowment G_h at an endogenous price P_g. This means that before transfers, the initial endogenous income for each consumer group $\left(P_g G_h\right)$ replicates what we observe for the Spanish economy. The value of the endowment of each household changes when P_g changes, implying that (P_{lo}) or (P_a) have varied.

Firms in each sector can use labour time (L_j) and food (A_j) for producing output at a unit price P_j by means of a constant elasticity of substitution (CES) technology:

$$X_j = \alpha_j^x \left[\delta_j^x L_j^{\upsilon_j^x} + \left(1-\delta_j^x\right) A_j^{\upsilon_j^x}\right]^{\frac{1}{\upsilon_j^x}} \qquad (2)$$

where the subscript *j* identifies the production sector, with *j*=1 representing the market activities different from restaurants, *j*=2 reflecting the restaurants sector and *j*=3 standing for household production of meals.

However, as in IW, we assume that market production different from restaurants only uses labour, implying that in the previous function $\delta_1^x = 1$ and therefore for *j*=1 we have:

$$X_1 = \alpha_1^x L_1 \qquad (3)$$

Given that the market does not distinguish different quality of time between the three types of households, the market price of a working hour (or market wage) is unique in the economy[3]. However, there is a deviation between the value of leisure (P_{lo}) and the market wage (P_l) caused by the tax levied on income from labour $\left(t_l\right)$. There is no capital in the economy.

Producers in each sector minimize costs for a certain volume of output subject to the technology restrictions, obtaining the conditional factor demands for labour and food and,

[3] It is equivalent to assume that the poorest households are endowed with less time by the aggregator.

hence, the corresponding cost functions in terms of the market prices of a working hour (P_l) and food (P_a).

The government collects direct taxes on labour income obtained from the total supply of time for working $\left(L^{mk}\right)$, at a tax rate t_l; indirect taxes on the value of food used in home produced meals $\left(A_3\right)$, at a tax rate t_a; and indirect taxes on the value of final output of restaurants and other market activities (at tax rates t_2 and t_1, respectively). The government's total tax income is completely returned to households in the form of transfers by means of a fixed rule, so that the distribution of transfers in the model corresponds to what we observe in the Spanish economy. Total income of household *h* $\left(I_h\right)$ is made of transfers received from the government $\left(tr_h\right)$ and income received from the 'aggregator' $\left(P_g G_h\right)$. This income will be used to buy market goods and services, meals at restaurants, home meals and leisure.

Every group of household decides on the consumption of "market goods" (X_{1h}), meals (S_h) and leisure (L_h). Meals can be either bought in restaurants (X_{2h}) or homemade (X_{3h}), and these two goods are not necessarily perfect substitutes. The utility function of a household group *h* can therefore be expressed, in general terms, as:

$$U_h = U_h\left(W_h\left(X_{1h}, S_h\left(X_{2h}, X_{3h}\right)\right), L_h\right) \tag{4}$$

with *h*=1 standing for the lowest income households, *h*=2 for the middle income households and *h*=3 standing for the highest income households. Separability is taken into account in preferences, insofar as the consumer firstly chooses between leisure or consuming goods and services (we call this composite W_h) by minimizing total expenditure (expanded to consider the value of a unit of leisure) subject to the following CES utility function:

$$U_h = \alpha_h^u \left[\delta_h^u W_h^{\upsilon_h^u} + \left(1-\delta_h^u\right) L_h^{\upsilon_h^u}\right]^{\frac{1}{\upsilon_h^u}} \tag{5}$$

A second choice would be between consuming "market goods" and meals. Then, in a second step the household *h* decides between (X_{1h}) and (S_h) by minimizing expenditure in market goods and services subject to the following utility function.

$$W_h = \alpha_h^w \left[\delta_h^w X_{1h}^{\upsilon_h^w} + \left(1-\delta_h^w\right) S_h^{\upsilon_h^w}\right]^{\frac{1}{\upsilon_h^w}} \tag{6}$$

Finally, the consumer chooses optimal consumption of restaurant meals and homemade meals by minimizing the total cost of buying meals subject to the following utility function:

$$S_h = \alpha_h^s \left[\delta_h^s X_{2h}^{\upsilon_h^s} + \left(1 - \delta_h^s\right) X_{3h}^{\upsilon_h^s} \right]^{\frac{1}{\upsilon_h^s}} \qquad (7)$$

The expenditure function associated with the demand of meals is derived from the last optimization problem. This expenditure function (P_{sh}) represents the necessary minimum expenditure to obtain a unit of meals, as a function of the price of goods P_j (for j = 2, 3). Because the quantity and the composition (at restaurant or at home) of meals vary across groups of households, so does the expenditure function. With the expenditure function P_{sh} known, we can work upwards and solve from (6) the expenditure function (P_{wh}) for different goods and services as a function of P_{sh} and P_1. Lastly, the expenditure function per unit of utility P_{uh} is obtained from (5) as a function of (P_{wh}) and (P_l).

The macro closure rules in the model ensure that the public budget is always balanced $(I_{GOV} = 0)$ and that the value of the transfers to households is constant whatever the tax experiment (see section 4).

Tables A1, A2 and A3 in the Appendix summarize the parameters, exogenous variables and endogenous variables of the model. A competitive equilibrium is characterised by a combination of prices and quantities that satisfies the following conditions: a) producers minimise costs subject to technology constraints; b) households maximise utility subject to their income constraint; c) unit profits are zero for all production sectors; d) market for goods, services and factors clear; e) two macro closure rules for government account constraint and for transfers received by households are satisfied. As shown in the Appendix the model characterizing the general equilibrium of this economy is made of 37 equations that are solved for the 37 endogenous variables.

3. The data

The model is calibrated in such a way that the solution for a parameter vector coincides with the benchmark equilibrium represented by the Spanish economy in 1995. To do the matching between the model and the data, we need to characterize, in addition to the market economy, the production of services provided by households through unpaid work. The estimate of time spent on preparing meals at home, as well as the food inputs used in this production is available in the extended social accounting matrix (ESAM-95) for the Spanish economy. The core data of the market side is the last available Input-Output Framework (IOF-95) of National Accounts for Spain. However, in order to establish the correspondence between the income of factors and the different types of households, information from the European household panel survey (ECHP) has been used, whereas the distribution of consumption by household type is obtained from the Spanish household expenditure survey. In addition, and as the main novelty, data from a survey on the use of time provided by the Spanish Women's Institute has been used to estimate working time at home (see Uriel *et al*, 2005, for more details).

This information, nevertheless, requires some adjustments to adapt it to the simplified model presented in this paper. The final data set is shown in Table 1, which is an abridged form of the original SAM. This matrix captures the income flows of interest in a standard way. Households are disaggregated into three groups according to income terciles, with Tercile 1 representing the families at the bottom end of the income distribution and Tercile 3 the families at the top end of the income distribution.

{Insert Table 1}

Rows contain "income" and columns "expenditure". The total for each row coincides with the total for each column, which is a requisite for equilibrium. For example, the first column ventures that the poorest Spanish households spent 593 billion pesetas in restaurants and prepared meals at home worth more than 6 trillion. The value of leisure time was near 40 trillion pesetas for the poorest group of population. As can be seen from the first three columns, there is a positive relationship between market consumption and income that disappears as soon as home production is involved. Overall, nearly seven trillion pesetas worth of food and almost 12 trillion pesetas worth of household labour were used in the home production of meals. The effective tax rates corresponding to the initial information which can be deduced from the data are as follows: $t_1 = 0.1091$; $t_2 = 0.0713$; $t_a = 0.0652$; $t_l = 0.1275$. The initial endowment for each family group and the transfers received from the government can be found in the last three columns.

As all the functions used are of the constant elasticity of substitution type, the only parameter that needs to be specified with information not contained in Table 1 is the elasticity of substitution. In Table 2, the initial elasticities of substitution used for the different levels of production and utility functions in the different experiments are presented. These elasticities are borrowed from IW.

{Insert Table 2}

A high transformation elasticity (ε) is chosen to assure that the food supply curve has a high price elasticity. The substitution elasticities between labour and food in the household production of meals (σ_H) and in restaurants (σ_R) are supposed to be identical, and this fact is captured by a very low elasticity. A reduced wage elasticity is also assumed for the market labour supply (σ_L), while the substitution possibilities in consumption between meals and other market goods (σ_M) are slightly lower than if a Cobb-Douglas type utility function were used.

4. Numerical simulations

VAT in Spain was introduced in 1986 but the legislation has undergone several modifications since then, the last major reform taking place in 1995. As a consequence, VAT is at present levied at three rates in Spain: a general rate of 16%, a low rate of 7% for restaurants, among others, and a very low rate of 4% that affects some kinds of food. Since the sixth directive in 1977, certain steps have been taken towards harmonizing value added tax in the European Union so that the future legislation in the member states related to VAT conforms to the different EU directives. In 1996, the European Commission proposed a programme to establish a definitive VAT system. In 2001, a Commission report provided possible guidelines to be followed in the medium term for harmonizing reduced VAT rates. The proposal consists of establishing a minimum general rate of 15% and two reduced VAT rates to be applied to a set list of goods and services: one reduced rate around the 5% mark and another super-reduced rate that is not specified for those goods and services which, for historical or economic reasons, require differential treatment. Restaurants did not appear in either list, although food was included. However, in 2003, a directive proposal included restaurants in list H, allowing member states to levy a reduced rate on restaurant services.

In order to throw light on the possible effects of a tax reform in Spain related to VAT on food and restaurant meals, we pursue three objectives in this section. First, we replicate some of the IW results and show that extending the sales tax to cover food leads to welfare gains and that an optimal tax scheme involves a higher tax on food than on other goods.

However, with one input good and one consumption good, Anderberg and Balestrino (2000) demonstrate that the input good should be taxed at a higher rate than general consumption if the degree of complementarity in household production is larger than the degree of complementarity in consumption. We then confirm that the more general IW results also depend on the elasticity of substitution between food and time in the household production of meals, coming to be the opposite when the elasticity is high enough. Secondly, we simulate the effects on efficiency and equity of different fiscal experiments related mainly with VAT on food and restaurant meals. The theory of taxation deals with the problem of levy taxes to enhance economic efficiency and to contribute to a fairer distribution of resources. At this point we enlarge the number of consumers to three groups and explore to what extent focusing only on a representative consumer would hide important distributional issues. Finally, we study the effect of changes in the distribution of income in household production, depending on the initial amount of taxes in the economy. This last exercise illustrates that a future increase in income inequality will lead to a reduction in homemade meals.

4.1 Replicating the IW results

We first replicate the base case simulations of Iorwerth and Whalley (2002) for Canada as a touchstone for checking the performance of the model described in section 2. Thus, we have recovered the implicit SAM from the information in their paper which will be used to calibrate the equations of our model, after reducing the number of consumers to just one representative consumer. Besides the focus on a representative consumer, other differences with respect to the Spanish case, which we will analyze later on, are that the Canadian base case equilibrium includes a pre-existing tax on market goods (including restaurant meals) of 15% and that, unlike the Spanish data, there is no tax levied on food for home use. Neither does it include a pre-existing income tax.

We first replicate the base case experiment of IW by means of our decentralized characterization of the economy. The experiment consists of raising an equal yield VAT rate on food (see footnote 2), when the Canadian economy initially has no tax levied on food for home use. A comparison of our results with those provided by IW is shown in Table 3. Both sets of results are essentially the same. However, we do not know the exact deflator used by IW in the equal yield rule so we have taken the expenditure function as the reference and this may be the cause of the very small differences detected.

{Insert Table 3}

The results suggest a small welfare gain when the food exemption is terminated. The consumption of restaurant meals increases and home meal provision decreases. The price of both food and restaurant meals fall. The equal yield tax rate also falls to 13.4%, as compared to 15% in the food exemption base case. The optimal rate on food is much higher than the general rate, because it compensates for the fact that home meals are free of sales tax. A key argument for these results to hold is that the elasticities between food and time in both, household production of meals (σ_H) and market production of meals (σ_R), are identical and very low. This is thought to capture the difficulty of substituting between food and time, relative to that between home and restaurant meals. Therefore, the IW results reflect the intuition that complements of time use should be more heavily taxed (Sandmo, 1990; Anderberg and Balestrino, 2000).

However, the sensitivity results for (σ_H) confirm that as the value of the elasticity rises, welfare gains disappear and the optimal tax rate on food, while positive, can be lower than the average tax rate on market goods. Although it remains an empirical issue, this caveat should be taken seriously, because a higher elasticity of substitution between food and time in the elaboration of meals may be plausible for some income intervals of the population[4].

4.2 Fiscal experiments for the Spanish economy

Now we switch from Canadian to Spanish data as represented in Table 1. In contrast to the previous Canadian results a pre-existing income tax has now been included that creates an additional channel of distortions given that the time devoted to home production is in fact subsidized by the tax on labour time. Another difference is the existence of three VAT rates in the benchmark because the VAT rate on restaurants is distinguished from the VAT rate on the rest of market goods and services. With all this information we calibrate our household disaggregated model and perform a set of sensible fiscal experiments, paying particular attention to efficiency and equity. In all the experiments, tax revenue remained constant in real terms. The constant revenue rule used was included in the model through the following restriction:

$$\vartheta t_1 P_1 X_1 + t_2 P_2 X_2 + t_a P_a A_3 + t_l P_l L^{mk} = \sum_{h=1}^{3} \frac{1}{3} P_{uh} \overline{RTAX} \qquad (8)$$

where *RTAX* is the constant that represents total tax revenue in the base year, ϑ is an endogenous variable that captures changes in the tax pressure, $t_1 P_1 X$ captures government income from VAT on market goods, $t_2 P_2 X_2$ reflects government income from VAT on restaurant sales, $t_a P_a A_3$ stands from government VAT on food (used as input at home production), $t_l P_l L^{mk}$ captures total taxes levied on the value of market time, and $\sum_{h=1}^{3} \frac{1}{3} P_{uh}$ is the deflator used. Thus, we use the expenditure function of the households as the basis for the deflator given that the expenditure function can be considered an ideal consumer price index[5]. The way the rule (8) is written is suitable for performing experiments related to exogenous variation in different tax rates that are offset by endogenous variations in the VAT rate on market goods and services other than restaurants. In some other experiments, however, ϑ could multiply some taxes, but not others, depending on which taxes we want to fit endogenously in order to keep revenue constant.

Table 4 displays the results in the variables of interest for the different tax policy experiments. Tax analysis when household production is present has traditionally focused on the simple case of a representative consumer. However, the government may wish to sacrifice some efficiency in exchange for a more equitable distribution of income. Kleven *et al* (2000) emphasize the ambiguous implications that heterogeneity across households could have for the optimal taxation of services, which is partly due to the different weight of household production in high-income and low-income households. A distributional theoretical framework in which households can substitute time spent on home production for market expenditures was sketched by Sandmo (1990), but no conclusive empirical support in general equilibrium computational techniques has been found. In fact, distributional and efficiency reasons work sometimes in opposite directions (see Auerbach and Hines, 2002). Therefore an important question for tax policy making is the measure of the incidence of the tax - that is, the distribution of the welfare effects within a population. Thus, in Table 4, we introduce household heterogeneity to capture the distributional fairness of the fiscal experiments by grouping households according to income terciles, the first tercile representing the lowest income group. The elasticities of substitution of the three groups are set equal to those of the representative consumer, the difference being the

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[4] As the shadow price of labour increases middle class income groups could substitute food for time in the elaboration of meals, for instance, by eating more fast food at home.

factor endowment and preferences yielding different combinations between leisure, market consumption and household production[6]

One striking point arising from the results is that any sensible departure from the present tax scheme would only provoke slight (per capita) welfare effects, measured as equivalent variations between two utility curves, indicating the tight design of the tax structure in this simple version of the Spanish economy. The aggregate welfare measure is obtained by equally weighting all households. When comparing aggregated welfare with the welfare for each type of household in Table 4, a clear trade-off between efficiency and equity appears in the experiments. We will now comment on each experiment in more detail.

The first column deals with the food exemption case. This experiment is based on the experience of other countries where the fiscal system does not levy tax on food, as is the case in most of the US states, Canada, United Kingdom and Mexico. The exercise sheds some light on the debate over the convenience of introducing the exemption on food in Spain. Although the endogenous tax in this experiment is the tax on market goods, we have checked that these results are robust to the tax we use to compensate in the equal yield rule. The results show that the exemption of VAT on food in Spain would reduce aggregate well-being by an equivalent of approximately 50 billion pesetas. As a result of the change in taxation, household production of meals would increase by 1.8% and home time by 1.1%. On the other hand, restaurant production of meals would drop by 1.5% and the total time allocated to market production would also fall. The disaggregated results for welfare indicate that this measure is strongly progressive, increasing the welfare of the households in the lower end of the income distribution and decreasing welfare for the richest households.

{Insert Table 4}

In the second experiment (column B), effective VAT rates on food and restaurants are equal to a super reduced rate of 4%. According to European Directive proposals this seems to be a plausible future scenario. In view of the fact that both rates in the benchmark are close to the one simulated, the effects on welfare are smaller than in the previous case, although a slight decrease in efficiency does seem to be confirmed. Restaurant production benefits the most from this measure. However, labour for home and market production is

[5] The fact of writing the deflator as a simple average is of minor importance. As we have checked, changing the weights of the average of the expenditure function does not significantly affect the results.
[6] We maintain the assumption of identical household production technology for each household.

reduced due to a substitution of food for labour. In the market case, it is also due to a lower demand of "other market goods and services".

In the third place, we set the VAT rate on restaurant meals to zero echoing the claims of the restaurants sector. In this case the effect on aggregated well being is null. The labour supplied to the market increases slightly at the expense of a larger fall in the time devoted to home production. As a consequence of the reduction in the net price of restaurants this sector expands its production by more than 8.5%.

In column D, the simulation sets a uniform VAT rate for all goods and services. The equal yield flat VAT rate for this simple version of the Spanish economy is shown to be about 10%. As a result of changes in prices, well-being increases by an equivalent of 7 billion pesetas with respect to the base case. While there is practically no effect on household production, the production of meals in restaurants falls by 2.4%, while the production of other market goods rises by 0.5 percentage points. This measure is shown to be regressive, increasing the welfare of the population in the highest part of the income distribution.

The next experiment (column E) in Table 4 captures the effects of a 13% income tax cut, offset by an increase in all the effective VAT rates. A cut of 13% was considered because this is the estimated decrease in the average effective rate by the Spanish Ministry of Economics and Finance as a result of a recent income tax reform bill. Results show that this measure is pretty neutral in efficiency and creates little distortion on production. The main beneficiaries of this measure are the richest households.

The above results are a consequence of isolated experiments that are reflected by changes in certain exogenous parameters of the model related to taxes. However, it is also of interest to tackle the issue of optimal taxation with the model at hand. In column F we change the rate on food and offset by an equal yield VAT on both "other market goods and services" and restaurant meals in order to obtain the combination that maximizes welfare with respect to the initial situation. For this to be achieved, we obtain the general equilibrium corresponding to the different VAT rates and analyze the response of aggregate well-being. Results indicate an optimal VAT rate on food of 0.78, much higher than the average tax rate on market goods. However, the optimal VAT on food would be strongly regressive in terms of the effects on different households.

Finally, in column G we increase the inequality in the distribution of income by augmenting the relative factor endowment of the richest households with respect to the poorest ones by 1%, but hold constant aggregated income. The rise in income inequality overtime has been a fact in most developed economies and we ask what the prediction of the model would be in terms of household production. In this last experiment we hold all tax rates constant, so total tax revenues are allowed to change. Not surprisingly, according to the results, the increase in inequality would favour market production and reduce household production, given that the market goods intensity in the demand of the upper part of the income distribution is higher. This result matches quite well with the observed fact which relates increasing inequality overtime to a decrease in household production (see Hamermesh, 2006).

5. Conclusions

A recurrent subject in public finance has been to measure the potential effects of fiscal reforms in the real world with heterogeneity in the population and a variety of pre-existing distortions. Numerical simulation techniques, and particularly computable general equilibrium models, have contributed to bridging the gap between economic theory and real-world policy analysis. However, although household production theory has provided many interesting applications to the theory of taxation, the implementation of the household production approach has not been previously addressed in a CGE model. This is partly because of the strong statistical requirements involved that can be condensed into the so-called social accounting matrices (SAM).

In this work we have used the last extended SAM with household production for Spain to run different tax policy experiments based on a computable general equilibrium model. First, we have taken the model of Iorwerth and Whalley (2002) as the story line to confirm the key importance on their results of the elasticity of substitution between time and food in the elaboration of meals at home. Regarding the IW model, we have then increased the number of consumers and established some distributional results. We have shown that in most of the cases efficiency and equity act in opposite directions and that for the food exemption case, there is a decrease in total efficiency that hides an important gain for the lower part of the income distribution. Finally, we have illustrated how an increase in inequality in our model predicts a fall in household production as well as an increase in market production, which is in line with what we have observed for most developed countries.

Although the representation of the economy has been kept in a very stylized way, there are some follow-ups to this research which are straightforward. They aim at a more realistic representation of the economy, by incorporating capital and different intermediate inputs both in the market and in the household production, by increasing the number of consumers, and by considering different household production functions with different technologies across households.

Corresponding author:

Javier Ferri.
University of Valencia.
Facultad de Economía.
Avda de los Naranjos s.n.
46022, Valencia
Spain.
e-mail: francisco.ferri@uv.es

Appendix: Parameters, variables and equations of the model

{Insert Tables A1, A2, and A3}

The model is composed of the following equations determined by zero profit conditions, market clearing conditions, identities and the macroeconomic closure rules:.

Zero profit conditions

Perfect competition and free entry imply that firms do not have extraordinary profits, so in the following equations unitary revenue is on the left hand side of the equations and unitary cost on the right.

$$P_j = \left(\alpha_j^x\right)^{-1}\left[\left(\delta_j^x\right)^{\eta_j^x} P_l^{\left(1-\eta_j^x\right)} + \left(1-\delta_j^x\right)^{\eta_j^x} P_a^{\left(1-\eta_j^x\right)}\right]^{\frac{1}{1-\eta_j^x}} \quad \text{(A.1)}$$

for $j = 2,3$. When $j = 1$ then $\delta_1^x = 1$ and therefore for the market sector we have:

$$P_1 = \frac{P_l}{\alpha_1^x} \quad \text{(A.2)}$$

$$P_{uh} = \left(\alpha_h^u\right)^{-1}\left[\left(\delta_h^u\right)^{\eta_h^u}\left(P_{wh}\right)^{\left(1-\eta_h^u\right)} + \left(1-\delta_h^u\right)^{\eta_h^u}\left(\left(1-t_l\right)P_l\right)^{\left(1-\eta_h^u\right)}\right]^{\frac{1}{1-\eta_h^u}} \quad \text{(A.3)}$$

$$P_{wh} = \left(\alpha_h^w\right)^{-1}\left[\left(\delta_h^w\right)^{\eta_h^w}\left(\left(1+t_1\right)P_1\right)^{\left(1-\eta_h^w\right)} + \left(1-\delta_h^w\right)^{\eta_h^w}\left(P_{sh}\right)^{\left(1-\eta_h^w\right)}\right]^{\frac{1}{1-\eta_h^w}} \quad \text{(A.4)}$$

$$P_{sh} = \left(\alpha_h^s\right)^{-1}\left[\left(\delta_h^s\right)^{\eta_h^s}\left(\left(1+t_2\right)P_2\right)^{\left(1-\eta_h^s\right)} + \left(1-\delta_h^s\right)^{\eta_h^s}\left(P_3\right)^{\left(1-\eta_h^s\right)}\right]^{\frac{1}{1-\eta_h^s}} \quad \text{(A.5)}$$

$$P_g = \xi^{-1}\left[\tau^{-\varepsilon}\left(\left(1-t_l\right)P_l\right)^{1+\varepsilon} + \left(1-\tau\right)^{-\varepsilon} P_a^{1+\varepsilon}\right]^{\frac{1}{1+\varepsilon}} \quad \text{(A.6)}$$

Market clearing conditions

These conditions imply that demand equals supply for each good, service and factor. Supply is on the left hand side while the right captures demand. Equation (A.12) represents the budget constraint, P_{uh} being the minimum cost at a given commodity prices of buying one unit of utility (the expenditure function) and I_h the total income of the representative household. Equation (A.13) is the supply of food as appositive function of the relative price between food and leisure. Equations (A.14) and (A.15) are the clearing conditions for total time and food.

$$X_1 = \sum_{h=1}^{3} \left(\alpha_h^w\right)^{-1} \left[\left(\delta_h^w\right) + \left(1-\delta_h^w\right) \left(\frac{\delta_h^w P_{sh}}{\left(1-\delta_h^w\right)\left(1+t_1\right)P_1} \right)^{\left(1-\eta_h^w\right)} \right]^{\frac{\eta_h^w}{1-\eta_h^w}} W_h \qquad \text{(A.7)}$$

$$S_h = \left(\alpha_h^w\right)^{-1} \left[\left(\delta_h^w\right) \left(\frac{\left(1-\delta_h^w\right)\left(1+t_1\right)P_1}{\delta_h^w P_{sh}} \right)^{\left(1-\eta_h^w\right)} + \left(1-\delta_h^w\right) \right]^{\frac{\eta_h^w}{1-\eta_h^w}} W_h \qquad \text{(A.8)}$$

$$X_2 = \sum_{h=1}^{3} \left(\alpha_h^s\right)^{-1} \left[\left(\delta_h^s\right) + \left(1-\delta_h^s\right) \left(\frac{\delta_h^s P_3}{\left(1-\delta_h^s\right)\left(1+t_2\right)P_2} \right)^{\left(1-\eta_h^s\right)} \right]^{\frac{\eta_h^s}{1-\eta_h^s}} S_h \qquad \text{(A.9)}$$

$$X_3 = \sum_{h=1}^{3} \left(\alpha_h^s\right)^{-1} \left[\left(\delta_h^s\right) \left(\frac{\left(1-\delta_h^s\right)\left(1+t_2\right)P_2}{\delta_h^s P_3} \right)^{\left(1-\eta_h^s\right)} + \left(1-\delta_h^s\right) \right]^{\frac{\eta_h^s}{1-\eta_h^s}} S_h \qquad \text{(A.10)}$$

$$W_h = \left(\alpha_h^u\right)^{-1} \left[\left(\delta_h^u\right) + \left(1-\delta_h^u\right) \left(\frac{\delta_h^u \left(1-t_l\right)P_l}{\left(1-\delta_h^u\right)P_{wh}} \right)^{\left(1-\eta_h^u\right)} \right]^{\frac{\eta_h^u}{1-\eta_h^u}} U_h \qquad \text{(A.11)}$$

$$P_{uh} U_h = I_h \qquad \text{(A.12)}$$

$$\frac{A}{L} = \left(\frac{\tau}{1-\tau} \frac{P_A}{\left(1-t_l\right)P_l} \right)^{\varepsilon} \qquad \text{(A.13)}$$

$$\begin{aligned} L = {} & \frac{X_1}{\alpha_1^x} + \left(\alpha_2^x\right)^{-1} \left[\left(\delta_2^x\right) + \left(1-\delta_2^x\right) \left(\frac{\delta_2^x P_a}{\left(1-\delta_2^x\right)P_l} \right)^{\left(1-\eta_2^x\right)} \right]^{\frac{\eta_2^x}{1-\eta_2^x}} X_2 \\ & + \left(\alpha_3^x\right)^{-1} \left[\left(\delta_3^x\right) + \left(1-\delta_3^x\right) \left(\frac{\delta_3^x \left(1+t_a\right)P_a}{\left(1-\delta_3^x\right)\left(1-t_l\right)P_l} \right)^{\left(1-\eta_3^x\right)} \right]^{\frac{\eta_3^x}{1-\eta_3^x}} X_3 \qquad \text{(A.14)} \\ & + \sum_{h=1}^{3} \left(\alpha_h^u\right)^{-1} \left[\left(\delta_h^u\right) \left(\frac{\left(1-\delta_h^u\right)P_{wh}}{\delta_h^u \left(1-t_l\right)P_l} \right)^{\left(1-\eta_h^u\right)} + \left(1-\delta_h^u\right) \right]^{\frac{\eta_h^u}{1-\eta_h^u}} U_h \end{aligned}$$

$$A=\left(\alpha_2^x\right)^{-1}\left[\left(\delta_2^x\right)\left(\frac{\left(1-\delta_2^x\right)P_l}{\delta_2^x P_a}\right)^{\left(1-\eta_2^x\right)}+\left(1-\delta_2^x\right)\right]^{\frac{\eta_2^x}{\left(1-\eta_2^x\right)}}X_2$$

$$+\left(\alpha_3^x\right)^{-1}\left[\left(\delta_3^x\right)\left(\frac{\left(1-\delta_3^x\right)\left(1-t_l\right)P_l}{\delta_3^x\left(1+t_a\right)P_a}\right)^{\left(1-\eta_3^x\right)}+\left(1-\delta_3^x\right)\right]^{\frac{\eta_3^x}{\left(1-\eta_3^x\right)}}X_3 \tag{A.15}$$

Identities

The following equations introduce definitions. Equation (A.16) defines the demand for food in the household sector. Equation (A.17) represents the supply of labour for market activities. (A.18) defines the public deficit/superavit. Equation (A.19) introduces the income of household *h*, whereas (A.20) establishes the gap between the price of a unit of time in market activities and at home.

$$A_3=\left(\alpha_3^x\right)^{-1}\left[\left(\delta_3^x\right)\left(\frac{\left(1-\delta_3^x\right)\left(1-t_l\right)P_l}{\delta_3^x\left(1+t_a\right)P_a}\right)^{\left(1-\eta_3^x\right)}+\left(1-\delta_3^x\right)\right]^{\frac{\eta_3^x}{\left(1-\eta_3^x\right)}}X_3 \tag{A.16}$$

$$L^{mk}=\frac{X_1}{\alpha_1^x}+\left(\alpha_2^x\right)^{-1}\left[\left(\delta_2^x\right)+\left(1-\delta_2^x\right)\left(\frac{\delta_2^x P_a}{\left(1-\delta_2^x\right)P_l}\right)^{\left(1-\eta_2^x\right)}\right]^{\frac{\eta_2^x}{1-\eta_2^x}}X_2 \tag{A.17}$$

$$I_{GOV}=t_1P_1X_1+t_2P_2X_2+t_aP_aA^{hh}+t_lP_lL^{mk}-\sum_{h=1}^{3}tr_h \tag{A.18}$$

$$I_h=P_g\overline{G}_h+tr_h \tag{A.19}$$

$$P_{lo}=P_l\left(1-t_l\right) \tag{A.20}$$

Macro closure rules

The following equations close the model. (A.21) ensures that the public budget is balanced and (A.22) means that public income and thus transfers to households, are constant in real terms.

$$I_{GOV} = 0 \tag{A.21}$$

$$\vartheta\, t_1 P_1 X_1 + t_2 P_2 X_2 + t_a P_a A^{hh} + t_l P_l L^{mk} = \sum_{h=1}^{3} \frac{1}{3} P_{uh} \overline{RTAX} \tag{A.22}$$

Equations (A.1) to (A.20) determine a model with 37 equations that is solved for 37 endogenous variables (see Table A3 below)

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TABLES

Table 1. ***Social accounting matrix with household production of meals***

		Home			M. prod	Restaur	H.meals	Food	M. labour	H. labour	Labour	Leisure	F. endow	VAT	TING
		Tercile 1	Tercile 2	Tercile 3											
Home	Tercil 1												51,138	666	392
	Tercil 2												60,660	1,505	1.197
	Tercil 3												74,813	3,321	4.241
M. prod		6,115	13,046	28,034											
Restaur		593	1,658	4,169											
H. meals		6,262	5,456	6,894											
Food						2,803	6,860								
M. labour					42,551	3,189									
H. labour							11,752								
Labour									39,910	11,752					
Leisure		39,226	43,202	43,278											
F. endow								9,243			51,662	125,706			
VAT					4,644	428		420							
TING									5,830						

Billions of pesetas

M. prod: "market goods"; Restaur: restaurant meals; H. meals: Home meals; M. labour: Market labour; H. labour: Home labour; F. endow.: Factorial endowment; VAT: Revenue from VAT; TING: Revenue from income tax.

Table 2. ***Substitution elasticities used in the calibration***

Elasticity	*Value*
Transformation elasticity between food and units of effective labour (ε)	5.0
Substitution elasticity between food and labour in restaurant production (σ_R)	0.3
Substitution elasticity between food and labour in home production (σ_H)	0.3
Substitution elasticity between restaurant meals and homemade meals (σ_S)	1.5
Substitution elasticity between leisure and consumption (σ_L)	0.2
Substitution elasticity between meals and "market goods" (σ_M)	0.6

Table 3. ***Simulation results compared with I-W***

	Our model results	Iorwerth-Whalley [1]	σ_H=0.15	σ_H=3	σ_H=5	σ_H=10
Welfare gain (Hicksian EV in 1992 $bill)	0.15	0.15	0.16	-0.04	-0.13	-0.24
Optimal tax rate	23.0%	23.0%	28.3%	5.2%	3.6%	2.4%
Equal yield tax rate on food	13.4%	13.3%				
% Increase in restaurant meals	5.39%	5.59%				
% Increase in home meals	-2.87%	-2.86%				
% Change in net of tax price food	-0.84%	-0.8%				
% Change in gross of tax price food	12.48%	NA				
% Change in net of tax price of restaurants	-0.28%	NA				
% Change in gross of tax price of restaurants	-1.63%	-1.8%				
% Change in time allocated to home production	-1.76%	-1.76%				

(1) Iorwerth and Whalley (2002). Table 2 page 174

NA: Not available

Table 4. ***Numerical Results of Different Fiscal Policy Experiments***

	(A)	(B)	(C)	(D)	(E)	(F)	(G)
Aggregated welfare gain (Hicksian EV bill.pesetas)	-50	-16	0	18	7	197	74
Welfare gain tercile 1 (Hicksian EV bill.pesetas)	20	6	-4	-9	-3	-213	-75
Welfare gain tercile 2 (Hicksian EV bill.pesetas)	-4	-2	-3	2	0	-29	1
Welfare gain tercile 3 (Hicksian EV bill.pesetas)	-66	-20	7	25	10	439	148
% Increase in restaurant meals	-1.498	3.053	8.653	-2.323	0.096	21.742	0.204
% Increase in home meals	1.806	0.038	-1.501	-0.349	-0.268	-16.223	-0.053
% Increase in other market goods and services	-0.618	-0.463	-0.552	0.512	0.116	4.737	0.156
% Change in time allocated to home production	1.114	-0.197	-1.467	-0.027	-0.160	-10.960	-0.052
% Change in time allocated to market	-0.676	-0.215	0.093	0.312	0.132	5.898	0.159
% Change in gross of tax price food	-5.823	-2.128	0.301	2.951	0.985	64.230	-0.007
% Change in net of tax price food	0.317	0.243	0.301	-0.264	-0.074	-1.996	-0.007
% Change in gross of tax price of restaurants	0.139	-2.818	-6.532	2.516	0.115	-5.816	-0.010
% Change in net of tax price of restaurants	0.139	0.107	0.132	-0.116	-1.026	-0.895	-0.010
% Change in gross of tax price of market goods	1.047	0.794	0.959	-0.849	-0.188	-7.269	-0.012
% Change in net of tax price of market goods	-0.018	-0.013	-0.017	0.014	-1.860	0.075	-0.012
Equal yield tax rate on "market goods"	12.091	11.805	11.993	9.953	12.799	2.777	
Equal yield tax rate on restaurants				9.953	8.365	1.815	
Equal yield tax rate on food				9.953	7.649	78.500	

(A): Exemption from VAT payments on food; (B) Setting VAT on food and VAT on restaurants at the same rate=0.04; (C) Setting VAT on restaurants to zero; (D) Uniform VAT rates; (E) 13% income tax cut; (F) Optimal tax food; (G): 1% increase in inequality, holding constant aggregated income.

In experiments (A) to (F), tax revenue remains constant in accordance with an equal yield rule for the government.

Table A1. *Parameters in the model*

α	Scale parameter in the CES production function
ξ	Scale parameter in the CET production frontier
δ	Share parameter
η	Elasticity of substitution parameter
υ	Parameter related with the elasticity of substitution $\eta = \frac{1}{1-\upsilon}$
ε	Elasticity of transformation parameter

Table A2. *Exogenous variables*

$\overline{G}_h$	Time endowent for household h
t_1	Indirect tax rate on X_1
t_2	Indirect tax rate on X_2
t_a	Indirect tax rate on food
t_l	Tax rate on labour income
tr_h	Transfers from the government to household h

Table A3. ***Endogenous variables***

X_j	Production index for the j sector
S_h	Meals composite for household h
W_h	Consumption composite for household h
U_h	Welfare index for household h
A	Aggregate production of food
L	Total number of hours available to work or to self-consumption
L^{mk}	Total supply of hours to work
A^{hh}	Total demand of food to home production of meals
P_j	Price of the good in the j sector
P_a	Price of food
P_l	Market price of the working hour
P_{lo}	Price of the leisure hour
P_{sh}	Price for the meals composite
P_{wh}	Price index for consumption composite
P_{uh}	Price index for welfare
P_g	Price index for aggregate factor endowment
I_h	Income for household h
I_{GOV}	Net government income
ϑ	Endogenous multiplier for the tax rate