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Redistributive effects of indirect taxes: comparing arithmetical and behavioral simulations in Uruguay[1]

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Abstract

In this brief paper we compare the redistributive effect of a VAT reform using an arithmetical and a behavioral microsimulation model. We analyze the effects of the elimination of the VAT for a basket of goods which is intensively consumed by the poorest population. Our microsimulations are based on data from the expenditure survey. The behavioral model uses the Quadratic Almost Ideal Demand System (QUAIDS) proposed by Banks *et al* (1997). Our results indicate that the change in the VAT implies a redistributive effect of small magnitude. The comparison of redistributive effects under the arithmetic and the behavioral simulation reveals that they are very similar.

Palabras clave: redistribución fiscal, desigualdad de ingresos, impuestos.

Resumen

En este breve artículo se compara el efecto redistributivo de una reforma en el IVA utilizando un modelo de miscrosimulación aritmético y uno comportamental. Se analizan los efectos de la eliminación del IVA para una canasta de bienes que se consumen más intensamente por la población de menores ingresos. Las microsimulaciones se basan en datos provenientes de la encuesta de gastos. El modelo de comportamiento utiliza el denominado *"Quadratic Almost Ideal Demand System"* (QUAIDS) propuesto por Banks *et al* (1997). Nuestros resultados indican que el cambio en el IVA produce un efecto redistributivo de pequeña magnitud. La comparación de los efectos redistributivos entre la simulación aritmética y la comportamental revela que son muy similares.

Keywords: fiscal redistribution, income inequality, taxes.

JEL classification codes: D31, H23, H20

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Introduction

The literature that analyzes the redistributive effect of taxes and/or public benefits using microsimulations is quite extended. Indeed, microsimulations constitute a useful tool to assess the distributional impact of policy changes (see Bourguignon and Spadaro, 2006). In this paper, we use microsimulations to analyze the redistributive impact of the elimination of the Value Added Tax (VAT) rate applied to specific goods that make up a large share of consumption of low income population.

Most of the ex ante analysis of changes in taxes and transfers, is undertaken using arithmetical models. A well known limitation of these models is that they only include the rules which determine the outcome of economic policy, but they do not include behavioral relations. This implies that results obtained from such models are assuming that population does not change its consumption pattern as a result of the modification of indirect taxes. This may be a strong assumption, as the variation in indirect taxation results in variation in consumer prices, and may probably lead to variations in the demand.

In this paper we compare results from an arithmetical and a behavioral model used to evaluate a change in VAT. The behavioral microsimulation is based on the estimation of a demand system using the Quadratic Almost Ideal Demand System (QUAIDS) proposed by Banks et al (1997). Our analysis is based on data from the combination of household and expenditures surveys. We assume that changes in indirect taxes are fully incident on consumers, and that all expenditure is formal (zero evasion). We present the metohodological details of the microsimualtion in section I, and discuss our main results in section II.

I. Methodological aspects

To undertake welfare analysis that takes into account demand responses, we first estimated income and price elasticities for a limited number of baskets of goods. These estimations were done using the Quadratic Almost Ideal Demand System (QUAIDS) proposed by Banks *et al* (1997).

Following Blank *et al* (1997), we estimate a model of consumer demand, considering Engel curves that include on the right hand side log income and add higher order income terms. Based on an empirical analysis of Engel curve relationship for different goods for the UK, the authors show that although the traditional definition of expenditure share over the logarithm of deflated income or total expenditure provides a reasonable approximation for some goods (for example for the food share curve), non linear behaviour is evident or other goods (for example clothing). On this basis, they argue that coefficients of the higher order income terms have to be included in the estimation, allowing goods to be luxuries at some income levels and necessities at others. This proposed quadratic logarithmic model nests the Almost Ideal (AI) model of Deaton and Muelbauer (1980) and the Translog model of Jorgenson et al (1982).

Household's expenditure shares on basket *i* are denoted as:

$$w_i = \frac{p_i q_i}{m} \qquad (1)$$

being p_i the price and q_i the quantity of good *i*, and *m* household's total expenditure. If the number of goods is N, then $\sum_{i=1}^{N} w_i = 1$, and each expenditure share can be estimated as:

$$w_i = \alpha_i + \sum_{j=1}^{N} \gamma_{ij} \ln p_j + \beta_i \ln\left[\frac{m}{a(p)}\right] + \frac{\lambda_i}{b(p)}\left[\ln\left[\frac{m}{a(p)}\right]\right]^2 + \varepsilon_i \qquad (2)$$

being *p* a vector of prices and ε the error term.[2]

The price index *a(p)* has a translog form, being homogenous of degree one in prices:

$$\ln a(p) = \alpha_0 + \sum_{i=1}^{N} \alpha_i \ln p_i + \frac{1}{2}\sum_{i=1}^{N} \sum_{j=1}^{N} \gamma_{ij} \ln p_i \ln p_j \qquad (3)$$

and *b(p)* is a price aggregator function (homogenous of degree zero in prices):

$$b(p) = \prod_{i=1}^{N} p_i^{\beta_i} \qquad (4)$$

Considering equation (1), the parameters have to fulfil the conditions:

[2] Note that the QUAIDS model reflected in (2) can turn into the AI model when the parameters λ are zero across all equations.

$$\sum_{i=1}^{N}\alpha_i = 1\ ;\ \sum_{i=1}^{N}\beta_i = 0;\ \sum_{i=1}^{N}\lambda_i = 0 \text{ and } \sum_{i=1}^{N}\gamma_{ij} = 0 \text{ for all } j.$$

By differentiating equation (2) with respect to ln m and ln p_j, we obtain:

$$\mu_i = \frac{\partial w_i}{\partial \ln m} = \beta_i + \frac{2\lambda_i}{b(p)}\left[\ln\left[\frac{m}{a(p)}\right]\right]$$

$$\mu_{ij} = \frac{\partial w_i}{\partial \ln p_j} = \gamma_{ij} - \mu_i\left(\alpha_j + \sum_k \gamma_{jk}\ln P_k\right) - \frac{\lambda_i\beta_j}{b(p)}\left[\ln\left[\frac{m}{a(p)}\right]\right]^2$$

The budget elasticities are given by:

$e_i = \dfrac{\mu_i}{w_i} + 1$, and it can be higher or lower than one at different levels of expenditure, allowing for a good to be luxury or necessity depending on the households' total expenditure.

The uncompensated price elasticities are given by:

$$e_{ij}^u = \frac{\mu_{ij}}{w_i} - \delta_{ij}$$

with δ_{ij} being the Kronecker delta, that gets the value of 1 if i=j and 0 otherwise. The compensated or Hicksian price elasticities are calculated through the Slutsky equation:

$$e_{ij}^c = e_{ij}^u + w_j e_i$$

Our estimations are based on the income information reported by the Household Survey (HS) collected by the Institute of Statistics (INE) in Uruguay in 2008. Specifically, the HS informs about labor income, transfers and other income for every member of the household. Given that the HS does not include information about household spending, we combine this survey with the Expenditure Survey (ES), collected throughout November 2005 and October 2006 by the INE (see chapter 8 in this volume for more details).

We estimate an eight demand equation model, and the estimation is done using an extension of the *nlsur* STATA command.[3] [4] We classify the expenditure in nine baskets. One of them corresponds to services; we do not consider it in the demand system to avoid

[3] We are thankful to Carlos Urzua for providing us the STATA code for this extension.
[4] These equations do not include demographic variables, usually introduced to control for heterogeneity across households.

the usual problem of lack of report of data on unit values. The other eight ones represent 62% of expenditure and 58% of the VAT. The description of these eight composite goods, their expenditure and VAT are reported in Table 1. We report the expenditure by decile in Table A1.

Table 1. Distribution of expenditure and VAT between baskets

Basket	VAT tax	Total spending (%)	VAT (%)
1. Basket of low income population	10%	7,2	6,7
2. Food and beverage	Exempt and 10%	3,5	1,9
3. Food and beverage	22%	8,6	15,5
4. Apparel and shoes	22%	4,2	7,5
5. Furniture and building	Exempt and 10%	20,9	0,2
6. Furniture and building	22%	10,7	17,7
7. Entertainment	Exempt and 10%	2,8	1,1
8. Entertainment	22%	4,2	7,2
9. Services	Exempt, 10% and 22%	37,9	42,2
Total		100	100

Source: based on household expenditure survey

Note: Most of the sales are taxed by the basic VAT rate of 22%. A rate of 10% applies to certain basic goods and services such as basic food (bread, meat, chicken, etc), medicines and transportation. Finally, a series of goods and services are zero-rated (for example milk, water, books). The main principle behind the assignation of different rates schedule is whether the good is considered essential or luxury.

The price of each composite good is calculated as:

$$P = p_1^{a_1} \times \dots\dots\dots \times p_n^{a_n}$$

where a_i represents the spending on good i in relation to total spending on the composite good.

To carry out our simulations, we define the following income variables:

(0) Ypre: Original income before taxes including labor income (wages, salaries, self employment income), pensions and capital income. Contributions to the social security and income tax are included in Ypre.

(1) Ypost true VAT=Ypre-ITt

where the subindex *t* indicates the “true” variable and IT denotes the indirect taxes.

For simulations of changes in indirect taxes, we define:

(2) Ypost sim=Ypre-ITs

where the subindex s indicates the simulated variable.

The analysis of the redistributive impact of the actual VAT is done by comparing (1) and (0). The effect of the proposed tax reform (indirect taxes) is reflected by comparing (1) with (2). In the arithmetical model, ITs comes from changing the VAT rate and assuming that consumption remains unchanged, whereas in the behavioral model, the change in consumption due to the change in prices is included in the simulation.

To perform the redistribution analysis, we calculate de Gini index of both distributions and its difference, that is, the Reynolds-Smolensky index. We also calculate two progressivity indexes: the Kakwani and Suits index.

II. Results

As expected, the price elasticity is negative for all baskets considered (see the diagonal in the Table 2). The consumption basket of low income population is substitute of those baskets that reflect consumption in other food (basket 2 and 3) and is complementary to other goods.

Table 2. Price and cross-price elasticities

Basket	**Elasticity**							
	1	2	3	4	5	6	7	8
1.Basket of low income population	-0,968	0,203	0,107	-0,017	-0,008	-0,001	-0,048	-0,221
2.Food and beverage	0,545	-1,224	0,187	-0,006	0,002	0,017	-0,04	-0,241
3.Food and beverage	0,183	0,106	-1,023	0,003	0,003	-0,022	0,009	-0,081
4.Apparel and shoes	0,076	0,037	0,058	-0,633	-0,015	-0,016	0,013	0
5.Furniture and building	0,242	0,112	0,158	-0,093	-0,468	0,002	0,016	-0,114
6.Furniture and building	0,098	0,049	0,017	-0,017	0,003	-0,648	-0,006	-0,019
7.Entertainment	0,004	0,01	0,092	0,03	0,018	0,006	-0,591	0,013
8.Entertainment	-0,046	-0,031	-0,031	-0,025	-0,019	-0,027	-0,021	-0,994

Source: based on household expenditure survey

The Kakwani and Suits index indicate that the VAT tax is regressive, whereas the Reynolds Smolensky index indicates that it has a negative redistributive effect (table 3). [5] The elimination of the VAT for the consumption basket of poor population implies a decrease in the average tax rate (and hence a decrease in tax revenue). Under the arithmetical model this decrease is higher (the average tax rate is 4.1 whereas it was 4.9 in the baseline).

According to the arithmetical model, the regressivity of the VAT decreases when we eliminate the tax for the consumption basket of low income population. We also observe that the negative redistributive effect is weaker: the pos-tax Gini is 0.527 in the baseline and 0.525 after the reform.

Table 3. Redistributive impact of changes in VAT

	Baseline	Arithmetic model	Behavioral model
Pre-tax Gini	0,518	0,518	0,518
Post-tax Gini	0,527	0,525	0,525
Average tax rate	0,049	0,044	0,041
Reynolds-Smolensky net redis. Effect	-0,009	-0,007	-0,007
Kakwani progressivity index	-0,168	-0,15	-0,149
Reranking	0	0	0
Suits progressivity index	-0,19	-0,171	-0,17
Change in total tax revenue (in %)	-.-	-6,4	-9,6

In the arithmetical model, the consumption of the basket of the low income population declines 9%. When we introduce the possibility of behavioural reactions, it only decreases 1.1%. Regarding the progressivity and redistributive impact of indirect taxes, the results are similar than the obtained under the arithmetical and the behavioral.

[5] Results from the arithmetical model differ from those presented in chapter 8 because expenditure in services is excluded from the analysis. Another methodological difference is that in this exercise we only consider eight consumption baskets, as a limited number is needed in order to estimate the QUAIDS.

III. Conclusions

In this paper, we performed an arithmetical and behavioural simulation model to assess the redistributive effect of the elimination of the VAT of a basket consumed by the low income population. We find that the negative redistributive effect of VAT declines under the simulated regime. The proposed change in the VAT implies an equalizing change in the distribution, but the magnitude is very small. Though in the behavioural model the patterns of consumption change, the global effects are almost the same than those obtained under the arithmetic model.

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Annex

Table A.1 Expenditure by composite goods (%)											
Deciles	1	2	3	4	5	6	7	8	9	10	Total
Basket of low income population	19,6	18,1	17,3	16	14,9	13,6	12,3	10,7	8,7	5,7	11,5
Food and beverage (exempt & 10%)	9,5	8,6	7,8	7,4	6,9	6,3	5,8	5,2	4,7	3,2	5,6
Food and beverage (22%)	13,8	14,8	14,2	14,4	14,7	14,8	14,7	14,8	14,6	11,8	13,9
Apparel and shoes	6,7	6,7	6,5	6,7	6,6	6,6	6,9	6,7	7	7	6,8
Furniture and building (exempt & 10%)	26,3	27,2	28,2	29,6	30,4	31,7	32,2	34,2	35,7	40,2	33,7
Furniture and building (22%)	16,8	16,9	17,4	17,2	17,1	17,1	17,3	16,7	16,6	17,4	17,1
Entertainment (exempt & 10%)	2,6	2,6	2,8	2,6	3,2	3,5	4	4,1	5,3	7	4,5
Entertainment (22%)	4,5	5,3	5,6	6,1	6,4	6,5	7	7,4	7,4	7,7	6,8
Total expenditure	100	100	100	100	100	100	100	100	100	100	100

Source: based on household expenditure survey