A Microsimulation on Tax Reforms in LAC Countries: A New Approach Based on Full Expenditures

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Abstract

In this article we propose a new method to estimate price effects on micro cross-sectional data using full prices derived from Household Budget and Time Use surveys. We use behavioral microsimulations by subpopulations to analyze the redistributive impact of changes in the Value Added Tax (VAT) rate of Ecuador and Guatemala, taking into account the domestic production of the household. The data used for the analysis comes from the matching of Ecuadorian surveys containing separately monetary and time expenditures, as well as from a Gutemalan survey containing both monetary and time expenditures.

JEL Classification: D04, D11, D12, D13

1 Introduction

In welfare analysis, the study of demand patterns is a relevant feature for microsimulations; thus, to know how individuals respond, in terms of their demand for goods and services, to changes in income and prices proves to be, in the literatture, an important tool for the design of public policy. Analysis of the distributional impact and welfare costs of indirect taxes reforms are mostly undertaken using arithmetical models. The most commonly used sources are time series and cross-sectional data. Price elasticities estimated on macroeconomic time-series are generally considered as being not robust to the specification of the demand system and to the estimation method. They suffer from aggregation biases and lack of microeconomic information, and moreover the stationarity conditions are generally rejected for long term series. Also, estimation from

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macro data gives no information on the change of price effects according to the household characteristics such as the age or cohort of the family head, the family structure or its level of being. The great limitation of these models is the strong assumption that population does not change its consumption pattern as a result of these policy changes, which makes distributive analysis quite difficult, specially when we need to know what segments of the population would be the most affected in the case of a particular reform.

In this paper, we use microsimulations to analyze the redistributive impact of changes in the structure of the Value Added Tax (VAT) rate of Ecuador and Guatemala once household domestic production is taking into account. The specific features of these countries make the analysis particularly interesting in terms of economic policy. Roughly speaking poverty affects 40% of the population and the level of inequality is among the highest in Latin America. Moreover, there seems to exist in the literature no estimations of income and price elasticities using micro-data in Ecuador and Guatemala. The main contributions of this paper are: First, to introduce in the estimation the domestic production of the household through the incorporation of the "full price" proposed by Gardes (2013), and second, to overcome the usual problems that come with micro data and that face most of LAC surveys as explained below.

By using micro data from national surveys, we are able not just to get a picture of the population as a whole, but also to differentiate it by income level, age, and family structure, all important dimensions for distributive analysis. Our simulation exercise is based on data reported by households, which usually present some shortcomings. The first one is data availability. The record of prices and quantities of the goods and services used by the households is rarely available for all commodity groups. Indeed, in most of the cases we would have unit values for the purchased food items only, turning the estimation of consumer demand almost impossible for the other goods and services. Since prices were not provided in the corresponding surveys, we construct them using a method that allows us to obtain unit values for each commodity group, and to estimate full income and full price elasticities by subpopulations. The behavioral microsimulation is based on the estimation of the Almost Ideal Demand System proposed by Deaton and Muelbauer (1980). The data used for the analysis comes from the combination of Household Expenditures and Time Use surveys.

The paper is organized as follows. Section 2 gives an overview of the main policy instruments of the Ecuadorian and Guatemalan tax-benefit system. Section 3 presents the microsimulation model, and Section 4 displays the main results and concludes.

2 The Ecuadorian and Guatemalan Tax System

Ecuador

As in most of the developing countries, the major characteristic of the Ecuadorian tax system is the fact that indirect taxes constitute the main source of tax revenue. Until 2007, more than 20% of the total revenue of the non-financial public sector came from a single tax, the Value Added Tax (VAT). After this year, the VAT represents around 15% of this revenue since the rise in oil prices increased the fraction of the oil revenues on the governmental budget, that passed from being 25 to 40 percent of the total revenue. Currently, and in particular during the surveys period 2006-2007, the general VAT rate was 12%. There are some exceptions on food items, agricultural inputs, medical goods, books, government purchases, education, and some professional services for which there is a zero rate tax or tax exemptions.

Guatemala

Guatemala suffered from a civil war that last for 36 years and which only ended in 1996 with a peace treaty that closed a painful chapter in Guatemalan history. The first point to highlight in the Guatemalan case, is that the tax revenue of the Central Government has never been greater than 12 percent of the GDP, despite the several tax reforms that have been implemented over the years. Around 75 percent of this revenue comes from indirect taxes, being among these the most important the VAT. Currently, as in the case of Ecuador, the VAT rate is 12%. There are, as well, some exceptions with a zero rate and tax exemptions, as is the case for food, non-piped water, education , and the export of goods.

3 The Model

This section is divided in four parts. First of all, we describe the model. Second, we discuss how we carried out the computation of the behavioral change associated with price variations. Third, we present a summary of the work done in the construction of the full price proposed by Gardes (2013). Finally, we give an overview of the dataset and the procedures that were implemented on it before the simulation.

3.1 Model

To undertake welfare analysis that takes into account demand responses to changes in prices, we use the Almost Ideal specification (an estimation using the quadratic form on log-income gives very similar results as concerns price coefficients with some complication in the estimation method, see Banks et al. (1997), and Gardes et al. (2005)). A bias affects the estimates of price coefficients because of the endogeneity of the price index used in the AI specification, which can be corrected using the approximate formulas proposed by Pashardes

(1993). The AIDS is the most commonly used model to estimate demand elasticities. One of the main advantages of the model is that even if the model is nonlinear, one can use a Stone price index to approximate the AI model to its linear version LAIDS, so as to facilitate estimation. All estimations are performed under symmetry and homogeneity constraints.

We estimate by Seemingly Unrelated Regression model, composed of eight demand equations for Ecuador and seven for Guatemala, considering Engel curves that include on the right hand side of the equation the log of instrumented expenditure, log of prices, and standard socio-economic characteristics of the households. Expenditure was classified in to nine (respectively eight) goods. The adding-up restriction is imposed by cancelling one of the n equations according to Barten's theory. The description of these aggregated goods, their average budget shares and VAT are reported in Table ? in Appendix.

3.2 Simulation of Behavioral Changes

In order to simulate the consumers reaction to the tax change, it is assumed that household preferences can be represented by the above AI demand system estimated for the whole population. Demand (expenditure), for each of the consumption groups, is given by:

$$w_i = \alpha_i + \beta_i log\left(\frac{y}{m}\right) + \sum_j^n \gamma_{ij} logp_j + \lambda_i Z + \varepsilon_i$$

Where $i = 1, ..., n$ denotes de good, y the household expenditure, p the price of the good, and Z some socio-economic characteristics of the household.

Broadly speaking, once the above estimation has been carried out, the estimated parameters of the Engel curves are used to calculate income and price elasticities[1], and to compute the changes in consumption due to monetary prices variations (under the assumption that the full price is an indicator of scarcity of the good and its effect on consumption can be used to compute the effect of a change of the monetary price). The carried out simulations generate information for each household in the data set, it can be performed under several definitions of equivalent[2] income, and for several policy changes concerning taxes and benefits, which facilitates the computation of distributional measures. Results for the status quo and the post-reform scenarios are given in Tables 3 and 4 for the whole sample and for sub-populations.

The use of full prices allow us to distinguish two different scenarios for the consumer problem. In the first one, we consider two indirect maximization programs, one for the monetary endowments and another for the time allocation. While in the second one, we assume that there is only one utility function

[1] See Apendix 1 for Full Price and Income Elasticity formula

[2] Equivalent income = Household net income / $\sqrt{n}$, where n is the number of persons in the household.

depending on full expenditures to be maximized by the agent. The first scenario is more likely to apply in lower income groups, as their monetary constraint is stronger. Higher income groups have the possibility to substitute between the monetary and time spheres more freely. Therefore, we perform the simulations under these two different hypothesis.

Limitations

We assume that Consumers absorb the totality of the effect that tax changes have on prices, we do not take into account tax evasion due to informal consumption, and we do not consider the tax over deposits or any other capital income.

We should consider that what the model is primarily aimed at is to quantify the potential impact of different policy reforms by simulating the change in consumption patterns of the population under study, taking into account the household domestic production through the valuation of time spent in different activities (in a Beckerian framework).

3.3 Definition of full prices

Full prices are defined as the ratio of full expenditure over the monetary expenditure: with monetary price for commodity (activity) i as p_i , monetary expenditure units: $p_i x_{ih}$. The time-use price writes $\omega_h t_{ih}$ or $smic.t_{ih}$ according to the time valuation by the average opportunity cost for household ω_h or by the minimum wage rate. The monetary expenditure is $\omega_h t_i$ and full expenditure: $(p_i + \omega_h t_{ih})x_{ih}$ or $(p_i + smic.t_{ih})x_{ih}$ depends on households characteristics by means of its time participation to activity i: t_{ih} and its opportunity cost for time ω_h. We can measure the full price for activity i by the ratio of full expenditures over their monetary component: $\pi_{ih} = \frac{(p_i+\omega_h t_{ih})x_i}{p_i x_{ih}} = \frac{p_i+\omega_h t_{ih}}{p_i} = 1 + \frac{\omega_h t_{ih}}{p_i}$, which no longer depends on the quantity consumed x_{ih}

Note that, under the assumption of a common monetary price p_i for all households, this ratio contains all the information on the differences of full prices through ω_h and t_{ih} (for instance its logarithm in the AI specification is approximatively equal to $\frac{\omega_h t_{ih}}{p_i}$ for small values of this product). Possible endogeneity in the full demand equations (between full expenditure for i: $(p_i + \omega_h t_{ih})x_{ih}$ and the vector of full prices $\frac{p_k+\omega_h t_{kh}}{p_k}$ for all commodities k) is corrected by defining prices by the alternative valuation (for instance minimum wage when full expenditures are computed with the opportunity cost).

3.4 The datasets

The data sets used in the model were built using the Guatemalan National survey about conditions of quality of life (ENCOVI) for the year 2000, which contains information on both monetary expenditure and tim use, and the Family Expenditure Survey (ECV) for the year 2006 for Ecuador. But, as the ECV

does not contain time use data and this information is needed in order to construct the full prices, a separate survey, the National Survey of Employment and Unemployment (ENEMDU) for the year 2007 was also used. Tables 5 and 6 on the Appendix detail the main characteristics of these surveys.

In both datasets, the sampling unit is a dwelling or housing structure, and information regarding the household or households occupying each dwelling is collected. In despite of this, the datasets display some socio-economic and demographic information, separately, for all individuals in the sample; therefore, in order to get the household total, we aggregate the information over all the individual members of the household. Incomes reported in the surveys are gross of taxes, and they are disaggregated in such a way that information regarding social benefits such as holiday bonus, the thirteenth and fourteen wages, and contributions to social security can be recovered. There are three sources of labor income: main job, secondary job, and other jobs; and different sources of non-labor income. For the present analysis, all type of income sources (labor, pension, rent, private and public transfer, etc.) are considered.

Some adjustments are made in the construction of the Ecuadorian and Guatemalan data sets from the original surveys data. First, we work with a reduced sample of households that have either no-children or children aged less than 16 years old. Second, given that some pension and governmental transfer incomes are mistakenly reported, we impute the official value for these cases. Third, the incomes of children less than ten years old are not included in the total value of the household income. Fourth, in the surveys there is a variable that assigns to every individual a position within the household; that is, the individual may be the head of the household, a spouse, a child, etc. Households with individuals assigned with the condition "domestic employee" are withdrawn of the sample because we cannot assume income pooling within the family since these individuals do not constitute a member of the family. The elimination of these households allows us to avoid possible problems related with economies of scale generated by the presence of domestic employees. Fifth, prices were not provided in the corresponding surveys, but the definition of full price allowed us to obtain unit values for each commodity group. Since unit values are generally assumed to reflect quality effects (an expensive bread may have a higher quality) , following Cox et al. (1986), we adjusted for quality differences among households by regressing unit values on selected sociodemographic characteristics, such as region, household size, and household income. Sixth, since not all households purchased all commodities during the survey period, prices were not observed for non-consuming households. Whenever this was the case, the mean price was used instead.

Seventh, we regroup time activities on nine categories for Ecuador, and 8 categories for Guatemala, that are compatible with the monetary expenditure ones: Personal Care-Time Personal Care Expenditure, Health Care-Health Care Expenditure, Eating and Cooking Time - Food Expenditure, House Maintenance Time Dwelling Expenditures, Clothing Maintenance-Time Clothing Expendi-

tures, Education Time Education Expenditure, Transportation Time Transportation Expenditures, Leisure Time- Leisure Expenditures, and Miscellaneous Time - Miscellaneous Expenditures. Finally, two methods have been used to value the time spent on domestic activities. First, this value is simply the official minimum wage rate for this period in Ecuador and Guatemala. Second, when the time is supposed to be perfectly exchangeable between market and non market activities, the opportunity cost of non-market work is computed as the expected hourly wage rate on the labor market for not working individuals (estimated separately for man and woman using the two-steps Heckman method). Both valuation methods are adjusted for income taxes and the estimated numbers of working days and hours. As mentioned in the previous section, Guatemala suffered from a civil war that last for 36 years and which only ended in 1996. By the year 2000 we consider that all the prices distortions created by the civil war (i.e. rise in the price of inter-regional transport, scarcity of some primary commodities, etc) had already disappear, so that would not be a problem while performing the estimations.

4 Results

As expected, the own-price elasticity is negative for all considered goods (see the diagonal in Tables 1 and 2), and significantly different from zero. The estimates range from -1 and 0 which seems as correct estimations. However, if we compare to the macroeconomics estimations that oscillate between -0.1 and -0.3; our elasticities values are much higher. As we have already pointed out elasticities derived from macroeconomic data face measurement errors and possible aggregation bias, such low estimates implies a very small elasticity on demand which would not be appropriate in most of the cases. We also observe that the correction of quality decreases the magnitude of the elasticities estimates, for both full price elasticities and monetary goods elasticities (Not shown in the tables). The effective decrease is around 15-20% of the elasticity value. This decrease is consistent with the theory as the quality is included on the price, so once the quality effect is corrected the elasticity is smaller.

Regarding the estimation of the LAIDS with and without the separability constraint, we observe a large distance between the 2 estimations. The price elasticity parameters under strong separability have smaller magnitude than those estimated without the latter restriction.We therefore have important suspicions of non separability. The assumption of strong separability can be parametrically tested by comparing the prices elasticities computed with under separability constrains to those estimated without that assumption. The latter test was performed for the Guatemala dataset and the likelihood differences were highly significant, as a result we conclude on the not strong separability between categories. Therefore, Frisch method to calculate price elasticities by means of income elasticities and the flexibility of income (inverse of the income elasticity of the marginal utility of money) cannot be used here.

Table 1. Full Cross-Price Elasticities for the whole sample, Ecuador

	Cross-Price Elasticities								
Commodity Groups	Food	Housing	Transport	Clothing	Personal Care	Health	Education	Leisure	Others
Food	-1.079	0.543	0.377	0.318	0.293	0.704	-0.087	0.263	0.523
Housing	0.160	-1.354	0.111	0.097	0.077	0.138	0.142	0.072	0.089
Transport	0.056	0.057	-1.201	0.047	0.037	0.065	-0.004	0.040	0.046
Clothing	0.045	0.046	0.044	-1.103	0.033	0.050	0.028	0.037	0.048
Personal Care	0.482	0.428	0.411	0.382	-0.661	0.460	0.711	0.411	0.362
Health	0.076	0.050	0.047	0.038	0.030	-1.780	0.059	0.041	0.091
Education	-0.011	0.060	-0.003	0.025	0.053	0.068	-1.168	0.069	0.011
Leisure	0.146	0.136	0.148	0.148	0.138	0.211	0.309	-0.919	0.136
Others	0.060	0.035	0.035	0.039	0.025	0.096	0.011	0.028	-1.335

Notes: -All respective elasticities are calculated using the sample means of the data.
-Price elasticities are estimated under symmetry and homogeneity constrains.

Table 2. Full Cross-Price Elasticities for the whole sample, Guatemala

	Cross-Price Elasticities							
Commodity Groups	Food	Housing	Transport	Clothing	Personal Care	Health	Education	Leisure
Food	-0.925	0.612	0.476	0.439	0.284	0.611	0.313	0.253
Housing	0.393	-0.936	0.154	0.228	0.149	0.026	0.190	0.195
Transport	0.061	0.030	-1.192	0.024	0.058	0.038	0.051	0.054
Clothing	0.061	0.050	0.027	-0.880	0.028	-0.033	0.031	-0.003
Personal Care	0.290	0.237	0.468	0.201	-0.651	0.398	0.172	0.263
Health	0.031	0.002	0.015	-0.012	0.020	-1.357	0.009	0.005
Education	0.067	0.063	0.086	0.047	0.036	0.040	-0.797	0.039
Leisure	0.041	0.049	0.068	-0.003	0.041	0.015	0.029	-0.804

Notes: -All respective elasticities are calculated using the sample means of the data.
-Price elasticities are estimated under symmetry and homogeneity constrains.

We calculate Marshallian combined demands, that include both an income effect and a price effect. As expected, in the estimation with an uniform increase in tax for all goods (not shown in tables) the changes due to cross price variation are cancelled due to homogeneity constraints. The total changes are therefore very small as they only reflect the income effect.

Tables 3 and 4 shows the composition of household expenditure before and after the increase of 5% in the VAT of food, by income group. By comparing the results among different income groups, we see how households change the amount allocated to the different consumption commodities, in particular, households in all income groups reduce their expenditure on food by a 2% in average for Ecuador, and 1% for Guatemala. The small changes in consumption for the other commodities are attributed to the cross price and income effects

Table 3. Ecuador: Household Expenditure under Status Quo and Reform 2

Spending in Consumption: Status Quo (American Dollar)					
Variable/ Income Group	1	2	3	4	5
Food	892.42	1,072.67	1,291.01	1,533.94	1,963.23
Housing	127.93	178.24	263.73	389.81	808.68
Transport	84.87	119.65	184.05	265.49	608.90
Clothing	55.24	74.53	109.40	160.21	303.50
Personal Care	29.37	47.68	63.86	89.61	167.10
Health	100.86	111.36	152.96	233.95	400.24
Education	33.33	58.74	74.43	122.36	263.72
Leisure	59.45	93.45	153.14	232.51	460.26
Others	51.89	91.70	148.55	287.98	795.95

Spending in Consumption: Reform 2 (American Dollar)					
Variable/ Income Group	1	2	3	4	5
Food	874.64	1,049.66	1,253.65	1,486.69	1,900.10
Housing	133.31	186.45	275.27	404.81	840.97
Transport	86.55	121.97	187.55	267.45	609.43
Clothing	57.26	75.49	112.17	163.87	305.50
Personal Care	30.32	49.16	66.23	91.75	171.77
Health	104.96	114.26	159.02	242.38	410.04
Education	34.18	61.78	79.53	127.46	268.02
Leisure	61.20	96.78	156.66	235.41	463.56
Others	53.84	94.04	154.76	299.14	801.94

Table 4. Guatemala: Household Expenditure under Status Quo and Reform 2

Spending in Consumption: Status Quo (Quetzal)					
Variable/ Income Group	1	2	3	4	5
Food	450.22	639.08	905.61	1,274.66	3,108.93
Housing	256.51	341.93	551.20	860.95	5,161.91
Transport	29.85	39.22	73.20	142.32	1,206.22
Clothing	42.19	60.55	88.50	133.98	459.12
Personal Care	28.97	44.09	75.92	142.61	591.51
Health	22.23	30.34	47.44	81.28	333.36
Education	25.23	36.34	64.48	118.16	389.45
Leisure	12.51	17.58	30.61	63.91	513.26

Spending in Consumption: Status Quo (Quetzal)					
Variable/ Income Group	1	2	3	4	5
Food	441.71	624.92	886.31	1,239.88	2,940.22
Housing	260.81	350.17	562.18	880.82	5,262.15
Transport	30.69	40.29	75.34	144.85	1,208.41
Clothing	42.93	61.66	90.20	136.28	465.55
Personal Care	29.70	45.29	77.50	145.02	603.32
Health	22.75	30.81	48.30	82.66	343.84
Education	25.79	36.86	65.41	119.25	394.19
Leisure	12.55	17.89	30.68	64.32	512.98

Conclusions

In this paper, we performed a behavioral simulation model to assess the redistributive effect of a uniform increase of the VAT for all consumed goods, or an increase of 5% in the VAT of food. The model calculates the changes in consumption and the new distribution of total expenditure on the nine (respectively eight) different consumption groups among the households.

The results indicate that full elasticities differ from the monetary ones in a significant way, suggesting that the incorporation of domestic production through the valuation of time can have a relevant impact on the outcomes and the design of public policy.

Work in Progress:

- Same Computations for Colombia.
- Computation of the Utility and Well Being of the subpopulations before and after the reforms, under different taxation schemes.
- Calculations under compensated elasticities.

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Appendix I

Formula for the full income elasticity **(Gardes, 2013)**

Supposing that full expenditures follow an independent optimization scheme, based either on a utility function or a cost function, implies a total substitution between time and monetary household's expenditures. It is more plausible to suppose that two independent optimization exist for monetary and for time allocations. If for instance, the cost function can be defined to be Piglog so that both demands are specified as an Almost Ideal Demand System (with different parameters), it implies the following:

$$w_{im} = \alpha_i + \beta_i log\left(\frac{y_{mh}}{m_h}\right) + Z_{ih}\gamma_i + \varepsilon_{ih}$$

With w_{im} the monetary budget share, y_{mh} the household monetary income, m_h the price index and Z_{ih} other explanatory variables (prices, socio-economic characteristics), and the same for the time budget share w_{it}. The budget share for full expenditures w_{if} can be written in terms of the monetary and time budget shares:

$$w_{if} = \frac{y_m w_{im} + y_t w_{it}}{y_m + y_t}$$

and the resulting demand equation for full expenditure gives an income coefficient:

$$\beta_f = \frac{1}{1+k}\left[w_m\left(\hat{\beta}_m - k\right) + w_t\left(k\hat{\beta}_t - 1\right)\right]$$

with $k = \frac{\partial \bar{y}_t}{\partial \bar{y}_m}$

Therefore, the income elasticity $E_{if} = 1 + \frac{\beta_{if}}{w_{if}}$ writes in term of the monetary and time elasticities:

$$E_{if} = E_{im}\frac{w_{im}}{w_{if}} * \frac{1}{1+k} + E_{it}\frac{w_{it}}{w_{if}} * \frac{k}{1+k}$$

Appendix II

Descriptive Statistics

Table 5. Descriptive Statistics (Ecuador, whole sample)

	Socio-Economic Variables				
Variables	Obs	Mean	Std. Dev	Min	Max
Income per capita	7482	4150.378	4029.857	173	29983.8
Household Size	7482	3.342	1.6961	1	13
Age HH	7482	42.4722	16.0774	12	98
% Urban households	7482	0.5887	0.4921	0	1
Ave. Number of children	7482	1.5949	1.5137	0	11
% Couples	7482	0.7666	0.423	0	1
Primary Education	7482	0.533	0.4989	0	1
Secondary Education	7482	0.3077	0.4616	0	1
Tertiary Education	7482	0.1593	0.366	0	1

Notes: -Ecuador data is shown in local currency, US dollars .

Table 6. Descriptive Statistics (Guatemala, whole sample)

	Socio-Economic Variables				
Variables	Obs	Mean	Std. Dev	Min	Max
Income per capita	5042	7190.993	14135.41	0	398436.1
Household Size	5042	4.6858	2.216	1	14
Age HH	5042	41.6014	14.4017	16	98
% Urban households	5042	0.4651	0.4988	0	1
Ave. Number of children	5042	2.8611	2.099	0	12
% Couples	5042	0.1327	0.3392	0	1
Primary Education	5042	0.7798	0.4144	0	1
Secondary Education	5042	0.1628	0.3692	0	1
Tertiary Education	5042	0.0573	0.2325	0	1

Notes: -Guatemala data is shown in local currency, quetzales . 1 US dollar=7.7632 quetzales in year 2000.