ENSAYOS

sobre política económica

How Can Tax Policies and Macroeconomic Shocks Affect the Poor? A Quantitative Assessment Using a Computable General Equilibrium Framework for Colombia

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Revista ESPE, No. 46-II Edición Especial 2004
Páginas 450-519

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¿Cómo políticas tributarias y choques macroeconómicos afectan a los pobres? Una medición cuantitativa utilizando un modelo de equilibrio general computable para Colombia

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El autor agradece los comentarios de Juan Mauricio Ramírez, Alfredo Sarmiento, Alejandro Gaviria, Manuel Ramírez, John Cockburn, Juan Carlos Echeverry, Orlando Gracia, Gabriel Piraquive, Carlos de Miguel, André Hofman, Joaquim Bento de Souza, Paula Jaramillo, Álvaro Perdomo y Óscar Valencia. El autor de igual manera agradece la ayuda y el apoyo de Michele Bantz durante los meses en que fue elaborado este estudio. Todos los errores u omisiones son responsabilidad únicamente del autor.

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Documento recibido el 30 de abril de 2004; versión final aceptada el 14 de octubre de 2004.

Resumen

Durante la década pasada, particularmente después de la recesión de la economía colombiana de 1998-99, economistas desarrollaron un renovado interés en el análisis y la evaluación de los cambios en bienestar inducidos por políticas públicas y choques económicos. Los instrumentos que existían hasta el momento para realizar este tipo de ejercicios, carecían o excluían en la mayoría de los casos, de información microeconómica detallada, relevante para el entendimiento y la determinación de los canales a través de los cuales los choques macroeconómicos afectan la estructura de la distribución del ingreso en Colombia. Como resultado, esta investigación tiene por objetivo cerrar esta brecha mediante el uso de un modelo estático y aplicado de equilibrio general en el cual el enlace micro-macro fue construido a través de la reconciliación de los datos de la encuesta de calidad de vida de 1997 con los agregados económicos del sistema de cuentas nacionales. Específicamente, al introducir 8.701 hogares dentro de una estructura macroeconómica consistente, el modelo produjo indicadores de pobreza y de distribución del ingreso para distintos segmentos de la población en cuatro simulados escenarios: una reducción unilateral de aranceles, una tasa de IVA general para todos los productos, una caída de los flujos entrantes del resto del mundo a la economía, y un aumento de las obligaciones del Gobierno con el resto del mundo.

A pesar de la simple estructura Arrow-Debreu utilizada aquí, los resultados estimados son cualitativa y cuantitativamente importantes, especialmente, en la medición de la inequidad y los cambios de pobreza que pueden aparecer como respuesta a choques exógenos.

Clasificación JEL: C68, D58, I32.

Keywords: *pobreza, microsimulaciones, modelos de equilibrio general aplicados.*

Comentarios: Óscar Mauricio Valencia.

How Can Tax Policies and Macroeconomic Shocks Affect the Poor? A Quantitative Assessment Using a Computable General Equilibrium Framework for Colombia

Claudio R. Karl E. *

During the past decade, particularly after the 1998-99 Colombian economic recession, economists have developed a renewed interest in the analysis and evaluation of welfare changes induced by public policies and economic shocks. The existing instruments to do this kind of exercises have usually lacked or excluded detailed microeconomic information that is relevant in the understanding and determination of the channels through which macroeconomic shocks affect the income distribution structure in Colombia. As a result, this research intends to fulfill this gap by presenting a simple static applied general equilibrium model in which a micro-macro link was built by reconciling the 1997 quality of life survey data with aggregates of the national

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The author thanks the comments of Juan Mauricio Ramírez, Alfredo Sarmiento, Alejandro Gaviria, Manuel Ramírez, John Cockburn, Juan Carlos Echeverry, Orlando Gracia, Gabriel Piraquive, Carlos de Miguel, André Hofman, Joaquim Bento de Souza, Paula Jaramillo, Álvaro Perdomo and Óscar Valencia. The author also thanks Michele Bantz for the help and support during the several months in which this study was elaborated. All errors and omissions are solely responsability of the author.

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Document received April 30th 2004; final version accepted october 14th of 2004.

accounts system. Specifically, by introducing a set of 8,701 households within a consistent macroeconomic framework, the model is able to produce poverty and income distribution indicators for specific segments of the population in four simulated scenarios: a reduction of tariffs, a general VAT rate for all products, a fall of the foreign inflows and a rise of the government obligations with the rest of the world.

Despite the simple Arrow-Debreu structure implemented here, the estimated results are qualitatively and quantitatively important, specially in measuring the inequality and poverty changes that can arise as response of exogenous shocks.

Keywords: poverty, microsimulations, applied general equilibrium models.

JEL Classification: C68, D58, I32.

I. INTRODUCTION

Over the past few years there has been a renewed interest in analyzing and quantifying the distributive effects of policy decisions and economic shocks in terms of poverty reduction and welfare improvements. After enjoying a sustained positive economic growth, the recession of the late nineties, triggered by the economy's vulnerability to international markets fluctuations, the credit crunch and the unsustainable trend of public expenditure and indebtedness[1], led to several changes in the economy, especially in terms of social welfare. Urban unemployment reached historic levels in 1999 when it rose almost ten percentage points above the observed rate in 1995 (8.7%). National poverty rate climbed from 50.3% in 1997 to 59.8% in 2000; the poverty gap increased seven points to 0.5[2]. Income inequality between the poorest 20% of the population and the richest 20% rose from 23 in 1997 to 26.3 in 2000[3].

Although this economic reversal was the result of the economic performance displayed by the country and the region during that period of time, policy makers

1 See Echeverry (2001) for a complete description of the economic events of the past decade.

2 The poverty gap is the standard deviation of the effective income of the poor people to the poverty line.

3 Baldión and Baltazar (2001)

had a significant role by taking the necessary decisions to correct the downward tendency. As a matter of fact, most of the decided strategies to reduce fiscal deficit were related to increasing tax revenues and in a lesser extent, reduction of expenditures, from which social investment was not an exemption[4]. Notwithstanding, if these measures had not been taken, the deterioration of the social indicators could have been worse than what was observed in those years.

Despite those facts, Colombia made a sustained effort in raising social public expenditure over the last decade (an annual growth rate of 3.5%), which has been a considerable help to the poor and the reduction of inequality. Complete elementary education (for children between 12 and 17 years old) rose from 78% in 1988 to 89% in 1999. The share of the population with health care increased from 23.7% in 1993 to 57.2% in 2000[5].

According to the government, in the following years Colombia will enjoy of a modest positive growth of around 4%, supported by i) increases of nontraditional exports and the positive effects of free trade agreements with the United States, the Andean Community and Mercosur; ii) the rationalization of public expenditure, specifically, operating costs from the reduction of the government size, which will free local resources for investment; and iii) a better economic outlook for foreign investment. At the same time, a significant rise of the public external debt service (thereby increases in the tax rates), social security costs and the deterioration of internal military conflict, are expected.

Given all these changes in the economy, it is important to understand which channels are the most efficient ones when it comes to assess policy effects over poverty and income distribution. Some economists have provided answers regarding this matter by using microeconomic methodologies that consider the household or individual income as functions of socioeconomic characteristics (e. g. age, schooling years, marital status) and income variables (e. g. rents, social transfers). Other researchers following Orcutt's works on microsimulations[6], have been able to improve their findings by linking their microeconomic assumptions and information into a macroeconomic framework. This allowed them to evaluate in detail, the

[4] Fiscal austerity affects the budget of social programs, hence, less resources are destined to social investment and the improvement of the quality and size of the existent activities.

[5] Sarmiento *et al.* (2000) and Baldión and Baltazar (2001).

[6] Taken from Davies (2003).

consequences upon welfare of policy and economic shocks experiments, specifically, between and within specific groups of the population[7] .

The present study is not only motivated by this latter line of work of linking an economy-wide framework with microeconomic behavior information (i.e. CGE-microsimulation approach), but also by the increasing need to evaluate the effects upon the economy and welfare of economic shocks as such that happened at the end of the last decade in Colombia. Therefore, the main objectives are, first, to present a simple computable general equilibrium (CGE) model in which the micro-macro link was done through reconciling microeconomic information from the 1997 quality of life survey with data from the system of national accounts; and second, to show how the model improves the welfare analysis by including socioeconomic indicators related to poverty and income distribution, dismissed from previous policy studies.

Technically, the model is for a neoclassical small open economy, in which households and firms are the only maximizing agents. Based on macroeconomic aggregates given by a social accounting matrix, it has one government level, one capital account and 17 different production sectors that demand 10 types of labor inputs, two types of capital and three types of mixed composite from both capital and labor. The main contribution of the research is that the model details 8,701 households that can be differentiated and classified according to their characteristics and endowments, thereby giving the instrument not only a great flexibility to analyze the effects of tax policies and economic shocks over specific clusters of households, but also some insight about welfare changes within and between these groups.

Therefore, the mentioned framework served to assess the effects over inequality and poverty in four simulations: i) an unilateral reduction of tariffs; ii) a general VAT rate for all goods; iii) a 50% fall in the external inflows, and iv) a 22% increase in the government obligations with the rest of the world. The first two experiments -tax policies-, depicted mixed effects on different segments of the population though in line with the expected theoretical behavior. The latter two were done in order to evaluate the consequences of macroeconomic shocks similar to the ones experienced during the late nineties. As expected, the impact of

[7] Ramírez *et al*. (1975), Lora and Ramírez (1990), Ocampo *et al*. (2003) and Bussolo and Lay (2003), between others.

these macroeconomic shocks on welfare was largely negative even in this partial analysis. Hence, even though the model is quite simple, the results are a point of departure in the analysis of the economic policies and macroeconomic shocks over income distribution variables.

The document is organized as follows. Section II presents a succinct outlook of the evolution of some socioeconomic indicators during the nineties. In section III, a quick description about the existing methods to build the micro-macro link is given as preamble for the methodology in section IV. In this part, the database and the CGE model used for the simulations presented in section V are described in great detail. Section VI presents some final remarks about this research and few ideas about the further works that can be done departing from this small step.

II. AN OUTLOOK OF THE SOCIOECONOMIC INDICATORS DURING THE PAST DECADE

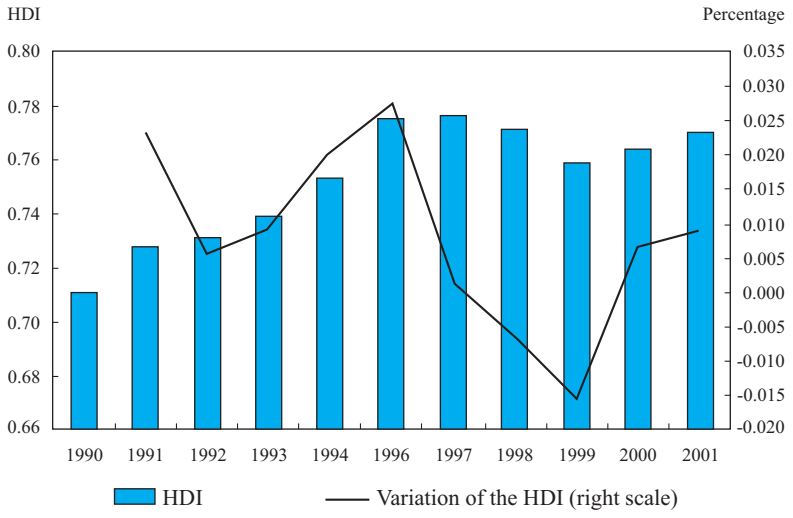
Colombia achieved significant advances in terms of socioeconomic development during the nineties. The Human Development Index (HDI) designed by the United Nations Development Program (UNDP) and measured by the National Planning Department of Colombia (DNP), increased 8.4% between 1990 and 2001, mostly due to the institutional arrays and public expenditure that promoted a better access to social services (Graph 1)[8].

According to *Misión Social* of the DNP, the new resources from the decentralization reforms promoted enhancements in the net enrollment rates between 1993 and 2000 (Table 1). Elementary net enrollment rate increased from 75.2% to 83.6% during those years. High school net enrollment rose from 47.8% to 62.7% between 1993 and 2000, though its gross rate augmented as a result of the rising unemployment and the economic crisis at the end of the decade. As a consequence, the compound education rate (which combines elementary, high school and college enrollment rates) rose from 0.59 in 1990 to 0.68 in 2001, with a

[8] Particularly, health and education indicators improved due to changes caused by the Law 60th of 1994 and the Law 100th of 1993. The former, modified by the Law 715th of 2001, established the specific resources that the national and local governments had to spend in social services, specifically, in education and health. The latter, reformed the social security sector, specially, by changing the scheme of subsidies to the supply of services to one that favored the demand.

Graph 1

Human Development Index (HDI)



Source: Misión Social, UNDP.

Table 1

Gross and Net Enrollment Rates

	1993	1997	2000
Elementary			
Gross enrollment	110.4	114.8	111.2
Net enrollment	75.2	83.5	83.6
Difference	35.2	31.3	27.6
High school			
Gross enrollment	68.0	80.4	84.2
Net enrollment	47.8	61.1	62.7
Difference	20.2	19.3	21.5

Source: Misión Social, DNP.

peak in 1997 of 0.72[9]. Consistently, illiterate population decreased from 10.8 to 7.5 during the same period of time.

Health indicators also showed improvements during the last decade. In 2000, the number of people with health insurance was 57.2%; 8.8% of the total belonged to the poorest 20% of the total population. In Table 2, it can be seen that people of the first quintile with health insurance augmented from 528,283 in 1993 to 3,248,955 in 2000, with a peak in 1997 of 4,052,475.

The life expectancy increased almost 4 years, from 67.8 in 1990 to 71.9 years in 2001[10].

In a broader view, income indicators showed a positive trend in reducing poverty until 1997 when economic phenomena, like the real estate crisis and the 1998-99 recession, had important effects over the welfare of the population. Per capita purchase power parity (PPP) GDP increased significantly from US$5,461 in 1991 to US$6,174 ten years later, with a peak of US$7,344 in 1997 (Graph 2).

Table 2
Population with Health Insurance

Quintile	1993	1997	2000
1	528,283	4,052,475	3,248,955
2	1,349,623	4,296,587	3,321,082
3	2,026,569	4,781,450	4,006,373
4	2,407,533	4,634,566	4,512,236
5	2,460,038	4,936,741	5,987,950
Total	8,772,046	22,701,819	21,076,596

Source: Misión Social, DNP.

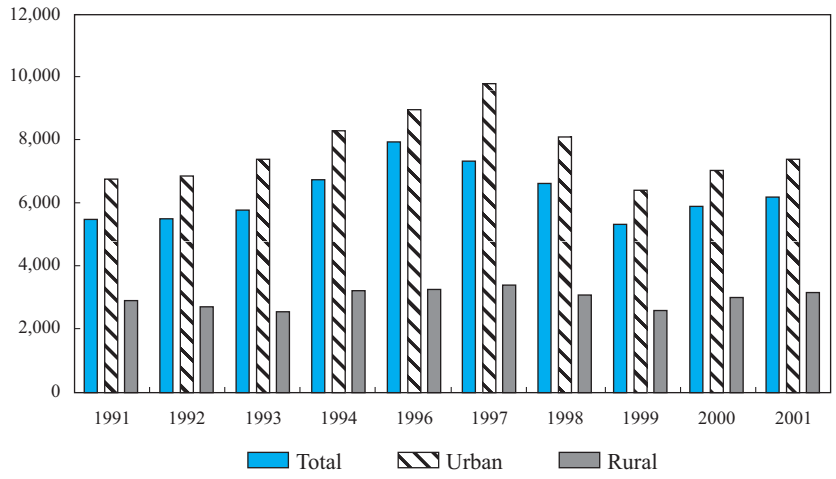
9 *Misión Social* of the DNP.

10 *Ibid.*

Graph 2

Per capita GDP

(Purchase Power Parity Dollars)



Source: Misión Social, UNDP.

Poverty rate diminished steadily until 1997 when the mentioned events broke the tendency and rose the indicator to almost 60% in 2000 (Graph 3). Similarly, the poverty gap index decreased from 0.47 in 1994 to 0.44 three years later, and augmented again to 0.50 in 2000 (Table 3). Specifically, the indicator rose from 0.41 to 0.45 in urban areas and from 0.55 to 0.58 in rural areas for the same years; in both cases the rates showed their lowest values in 1997.

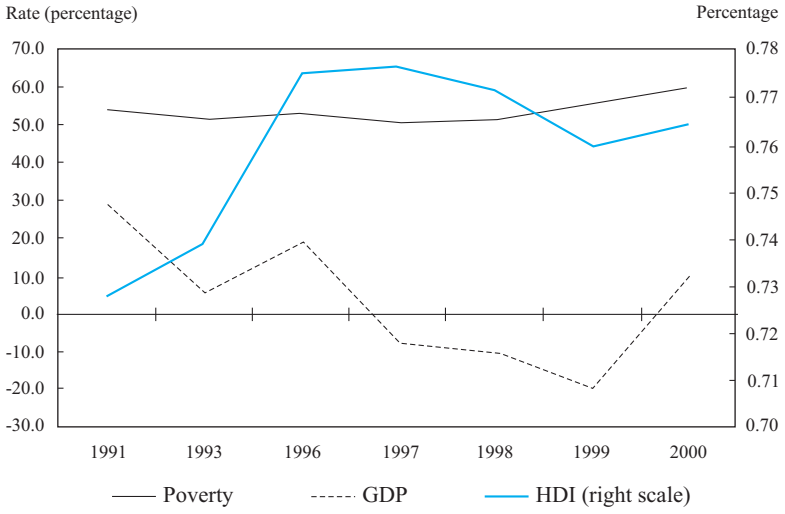
Given the behavior of the poverty rate and gap, the poverty severity index had to evolve in a similar trend during the decade: from 1994 to 1997 the indicator diminished to 0.06 for the national level and to 0.28 and 0.13 for urban and rural population, respectively (Table 4). Between 1998 and 2000, dispersion increased to higher levels than the ones observed in 1994.

Finally, the Gini coefficient kept its increasing trend during all the nineties, from 0.54 in 1990 to 0.56 in 2000.

Graph 3

Poverty, HDI and Growth Rate of Per Capita GDP

(Purchase Power Parity Dollars)



Source: Misión Social, UNDP.

Table 3

Poverty Gap Rate

	Total	Urban	Rural
1994	0.470	0.413	0.552
1995	0.449	0.401	0.522
1996	0.464	0.381	0.574
1997	0.437	0.346	0.542
1998	0.473	0.396	0.578
1999	0.484	0.412	0.592
2000	0.503	0.453	0.581

Source: DANE, GCV-DDS-DNP.

Table 4
Poverty Severity Rate

	Total	Urban	Rural
1994	0.102	0.273	0.155
1995	0.106	0.264	0.150
1996	0.093	0.316	0.166
1997	0.063	0.279	0.134
1998	0.098	0.355	0.162
1999	0.119	0.302	0.165
2000	0.146	0.337	0.187

Source: DANE, DNP.

III. SMALL REFERENCE ABOUT THE INSTRUMENT

Most development macroeconomists and policy analysts over the world use a variety of tools to provide quantitative policy assessments, ranging from simple statistical equations to detailed economy-wide optimization decision models. As such, some of these instruments depict a shallow income distribution analysis, while others have been developed "in order to understand the channels through which adjustment policies affect the poor and the possible tradeoffs that poverty reduction strategies may entail regarding the sequencing of policy reforms, particularly between short-term stabilization policies and structural measures"[11] .

Any analysis regarding the consequences of economic shocks or the implementation of public policies on poverty and inequality requires an economy-wide framework that incorporates considerable detail on how households behave, earn and spend their receipts. However, there is just a small set of instruments that can really allow to elaborate the mentioned kind of analysis: computable general equilibrium (CGE) models are one class within this set that provide disaggregated results at the microeconomic level within a consistent macroeconomic framework[12] .

[11] Agénor *et al*. (2002).

[12] For a complete explanation about this kind of modeling, refer to Shoven and Whalley (1992) and Ginsburgh and Keyzer (2002).

Despite their utility, traditional CGE models, which rely on the representative agent assumption, can only simulate the impacts of shocks on a small set of households commonly differentiated through their income structure. As a consequence, they cannot produce any kind of results in terms of poverty and only help to evaluate the evolution of inequalities between groups.

Less conventional CGE approaches incorporate intra-group information through the estimation of income and expenditure distributions from survey data, hence, allowing some enhancements in the income inequality analysis. Notwithstanding, given that these estimated functions are assumed to be constant, they cannot evaluate welfare changes within specific groups[13] . This is the methodology taken by Decaluwé, Patry and Savard (1998) and Decaluwé, Dumont and Savard (1999), who built a CGE model for an archetype development economy and analyzed poverty and income distribution by supposing that the intra-group income distribution takes the form of a beta distribution.

In recent years, economists have been able to improve the poverty and income distribution analysis by fully or partially integrating microeconomic behaviors with an economy-wide structure model, either (a) by reconciling survey data with macroeconomic aggregates (i.e. representative household group approach, RHG) or (b) by designing microeconomic models that interact with CGE and macro models (i.e. real household approach)[14] . The latter approach is clearly provided by the works of Robilliard, Bourguignon and Robinson (2001) for Indonesia, Bussolo and Lay (2003) for Colombia and Savard (2003) for the Philippines. The former is exemplified by Cogneau (1999) for Antananarivo, Cogneau and Robilliard (2000) for Senegal and Cockburn (2001) for Nepal, among others.

Without any doubt, the work of Robilliard *et al.* (2001) represents better the first approach. The authors built in one side, a standard CGE model with endogenous labor supply, in which they simulate the effects of policies over the households and

[13] The methodology is applied in countries or cases either where there is not enough information to implement any of the two following techniques, or when the problems have to be analyzed dynamically.

[14] As stated by Davies (2003), microeconomic behavioral models are essential in modeling the distributive effects of taxes and transfers, though lack of the broader view of the economic activity changes. Conversely, CGE and macro models in general, provide the macroeconomic environment but do not have the required detail for the distributional analysis. By linking both types of models, it is possible to eliminate the mentioned deficiencies.

the labor market. In the other side, they designed an income generation model conformed by two Mincerian wage and rent equations, a set of behavioral equations where the individuals determine their working state and two identities, one for the price index and another one for the household total income. By extracting from the CGE model the prices and quantities of equilibrium, they introduce changes to the household's income and behavioral equations, and thus, evaluate the impact of simulated policies over the income distribution, labor state and poverty reduction indicators. Notwithstanding, this approach can fail as the aggregation of microeconomic decisions can be inconsistent with the macroeconomic behavior modeled in the CGE. Savard (2003) improved this procedure by building an algorithm, which basically, creates a loop between both models until convergence is reached.

The second approach is based on merging microeconomic information of households and individuals, taken from surveys, with national account aggregates, depicted in a social accounting matrix. With the resulting data set, a CGE model is built, supported in some cases, by econometric estimations to improve the microeconomic behaviors. Cogneau and Robilliard (2000) implemented this technique, modeling explicitly the behavior of 4,508 households and using statistical estimations for the wage and private consumption determination. In addition, they presented a set of income distribution and poverty indicators, which in the past could have only be estimated accurately in presence of big sets of households, like in surveys.

Although both methods are plausible in terms of modeling efforts, this study implements the second approach as the aggregation problem is solved directly, hence, allowing the existence of a unique equilibrium.

IV. METHODOLOGY

A. DATABASE

The basis of a good microsimulation model requires a detailed database on a large representative sample of firms or households, in which all relevant information about receipts and expenses, beside socioeconomic characteristics is included. Notwithstanding, there is just a small set of surveys that comes close to the needs of this type of exercises. In most cases, information has to be gathered from different sources, which are not always reconcilable.

In Colombia, there are just three surveys that almost fulfill the mentioned requirements for the household case: the 1993 national survey of socioeconomic characteristics (Casen) and the 1997 and 2003 quality of life surveys[15] . Although all three share more or less, the same qualitative information, 1993 Casen has the smallest set of questions. 1997 and 2003 quality of life survey are more alike, though the latter was not accessible to the public during the initial stages of this study. Therefore, the 1997 survey was used for this exercise.

The 1997 quality of life survey was designed and carried out by the *Misión Social* of the National Planning Department of Colombia, based on the World Bank's methodology for this kind of instruments[16] . Conformed by a sample of 10,290 households, it had a coverage of 88.6% of the national territory and a questionnaire that involves the most important aspects of labor market, income and expenses of these agents. After cleaning some unreliable information, a smaller sample of 8,701 households was obtained and the monetary variables were set to be adjusted according to the size of expenditures. That is, it was assumed that expenses were measured accurately while the receipts were undervalued given the incentives of households of not revealing them correctly.

Based on Robilliard and Robinson (1999), the negative difference between receipts and expenses was used to inflate the former by distributing it according to the income shares; the positive difference was considered households savings. Having done this, the information was reorganized to match the structure of the macroeconomic variables included in a social accounting matrix (SAM).

As known, a social accounting matrix is defined as an arrangement of macroeconomic accounts that captures the transfers and transactions done by agents that belong to a socioeconomic system in a specific moment in time[17]. Technically, it is a square matrix in which the rows represent the receipts and the columns the expenses. Therefore, given the fact that the income should equal the expenditure for each agent and the economy as a whole, the row sum must equal its corresponding column sum.

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15 There are other instruments such as the national household surveys and the 1994 urban income and expenditure survey that can be used for this kind of modeling. However, since they have to be complemented with additional microeconomic information, the probability of error increases.

16 Living Standard Measurement methodology.

17 King (1985).

By using the available information to date of the System of National Accounts (SNA) in Colombia, a macro SAM was built for the year 2000, which includes a great detail in the tax structure[18] . The SAM has an initial structure of 59 activities and commodities, 3 primary factors of production (labor, capital and a mixed composite of both inputs[19]), 3 types of firms, 1 representative household, one account for government, one account for the rest of the world, one capital account and more than fifty tax instruments[20] .

In order to make consistent both data sets, first, it was assumed that the macroeconomic information was measured with error, while the microeconomic data was accurate or had been adjusted to be accurate. Second, activities and commodities were classified to match the sectors considered within the survey[21] . As a consequence, the new macro SAM has just 17 activities and commodities as follows:

- Agriculture, livestock, fishing and forestry
- Mining
- Food industry
- Textile industry
- Wood industry
- Paper industry
- Chemistry industry
- Mineral industry
- Machinery
- Other industries
- Utilities
- Construction and building activities
- Transportation
- Communications
- Financial services
- Real estate
- Social services

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18 This process is described technically by Guzmán and Prada (2002).

19 This factor is based on the mixed income account considered in the SNA.

20 Karl (2004).

21 It is important to note that while receipts registered in the quality of life survey can be classified according to the firm's activity (i.e. ISIC-3), the expenses are not categorized by items but regarding their use. Therefore, a correlative between ISIC-3 classification and those type of expenses was made.

Third, labor input was disaggregated according to socioeconomic characteristics that were considered relevant[22]: rural/urban, informal / formal[23] and wage/non-wage earners. Urban work was further categorized between skilled and non-skilled labor according to the standard use of schooling years. Consequently, labor categories are as follows:

- Rural salaried work (*REM01*),
- Rural non wage work (*REM02*),
- Urban informal non skilled wage work (*REM03*),
- Urban informal non skilled non wage work (*REM04*),
- Urban informal skilled wage work (*REM05*),
- Urban informal skilled non wage work (*REM06*),
- Urban formal non skilled wage work (*REM07*),
- Urban formal non skilled non wage work (*REM08*),
- Urban formal skilled wage work (*REM09*), and
- Urban formal skilled non wage work (*REM10*)

The mixed composite of labor and capital was classified in rural (*IMX01*), urban informal (*IMX02*) and urban formal (*IMX03*) inputs. The capital input account (*K*) was not modified since detailed information at the activity level about firm and household's supply is not available.

Finally, household accounts were replaced by the aggregation of the microeconomic data obtained from the survey[24], following the methodology proposed by Cockburn and Cloutier (2002). As a consequence of these changes, the SAM became unbalanced and statistical processes had to be used in order to recover this required property.

Although there is a vast literature on how social accounting matrices should be balanced, recent techniques are based on the entropy approach developed by Golan *et al.* (1996)[25]. This method has become popular because of its philosophy

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22 See Appendix 1.

23 Workers are part of the urban informal sector if they are: i) independent workers that are not professionals or technicians, ii) owners or wage-earners of firms with less than 10 workers, iii) servants or non-earner family workers, and iv) not affiliated to social security.

24 Though obvious, the information extracted from the 1997 survey was inflated to 2000 current prices.

25 Taken from Jensen and Karl (2004). For a complete reference on the topic, see Fofana *et al*. (2002).

to make use of all prior available information and its applicability to under determined problems including the construction of SAM datasets. Therefore, the process can get as simple as the common RAS or least square methods or as complex as described by Robinson, Cattaneo and El-Said (1998), whom developed a stochastic cross entropy method. Here, a deterministic cross entropy approach was implemented as described in detail in Appendix 2, where an aggregation of the final SAM is also depicted (Table A2.2).

The final database has the above mentioned characteristics though 8,701 households have been included within the SAM.

B. COMPUTABLE GENERAL EQUILIBRIUM MODEL

As it was mentioned earlier, the micro simulation approach helps to understand the key determinants and mechanisms of inequality and poverty. In order to assess the effects of certain policy or to evaluate the impacts of economic shocks, it is necessary to incorporate the microeconomic results within an economy-wide framework. Therefore, one of the most appealing tools for this kind of counterfactual analysis are the computable general equilibrium (CGE) models, giving their ability to produce disaggregated results at the microeconomic level that are consistent with a macroeconomic framework.

In Colombia, CGE models had their first steps with the works of Ramírez *et al*. (1975) and Lora and Ramírez (1990). The former, one of the first CGE prototypes in Latin America, encompassed three modules: one demographic model in which mortality, birth and fecundity rates were determined; one economic model in which the macroeconomic variables and prices were estimated and shocked; and a health/education module in which the shocks applied in the previous module determined the demand for these services, which in turn, fed the demographic module.

Lora and Ramírez (1990), *Microeconomía, distribución del ingreso y sector informal*, built a simple applied general equilibrium model, in line with the standard methodology, which was the first approach in Colombia to understand the effects of economic shocks on the labor market, specifically, on informality. Thereby, it had an unique disaggregation of the labor force that still prevails as one of the most popular.

Based on both works, studies such as Ramírez and Prada (1995 and 1996), Bussolo (1999), Ramírez *et al*. (1999) and Hernández *et al*. (2001), among others, helped to develop this kind of instruments in the country over the past decade. During the last couple of years, the National Planning Department (DNP) and the Ministry of Finance of Colombia, in conjunction with the University of Colorado at Boulder, built and implemented two standard models (one dynamic and the other static) for tax policy analysis[26] . Both models are based on a set of national account identities such that the solutions are consistent with the basic macroeconomic balances and the country national accounts. In addition, through the use of structural forms and assumptions, these two models created a framework in which fiscal policy scenarios can be simulated and their effects quantified.

The purpose of this section is to present a standard CGE model for a small open economy, based on the works of Rutherford and Light (2002 a, b) and Lofgren *et al.* (2002). By standard it is understood that this model is based on the usual Arrow-Debreu framework, static and where financial assets and transactions are not considered[27] .

1. Production

Each producer (whom is represented by an activity) is assumed to maximize profits, defined as the difference between earned revenues and the costs of factors and intermediate inputs. There are J sectors, indexed by j, that produce I goods, indexed by i, which can be either offered in the domestic market D_{ji}, or exported to the rest of the world, E_{ji}, according to a constant elasticity of transformation (CET), η.

$$Y_{ji} = \left[\gamma_{ji} D_{ji}^{\delta_{ji}} + (1 - \gamma_{ji})E_{ji}^{\delta_{ji}}\right]^{\frac{1}{\delta_{ji}}}$$

where $\delta_{ji} = 1 - \frac{1}{\eta_{ji}}$ is the parameter of substitution, and γ_{ji} is the share of good i offered domestically by sector j from its total output.

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[26] Rutherford and Light (2002 a, b).

[27] Though it is well understood the effects of accessing and consuming financial assets in social welfare, building a financial CGE model is not plausible given the lack of microeconomic information about the household demand and supply of these commodities.

The total production of j, Y_j, depends on the optimal combination of intermediate goods and the value added from factor contributions. This can be described by a Leontief production function:

$$Y_j = \min \left[i \min_i \left(\frac{X_{ji}}{a_{ji}} \right), \frac{V_j}{b_j} \right] \text{ where}$$

$$V_j = \left(\sum_n L_{nj} \right)^{\alpha} K_j^{\beta} \left(\sum_m MX_{mj}(L_j, K_j) \right)^{\zeta}$$

is the value added in sector j, composed n types of labor (L), capital (K) and m types of mixed composites of both factors ($MX(L,K)$); X_{ji} is the set of intermediate consumption goods, and (a_{ji}, b_i,) are participation shares. It is assumed that $\alpha + \beta + \zeta = 1$. Tables A3.3 and A3.4 in Appendix 3 present the percentage composition of the value added.

Intermediate demand of sector j for good i, X_{ji}, is a CES-Armington aggregation of domestic and imported varieties[28] , such that:

$$X_{ji} = \left[v_{ji} M_{ji}^{\theta_{ji}} + (1 - v_{ji}) D_{ji}^{\theta_{ji}} \right]^{\frac{1}{\theta_{ji}}}$$

where $\theta_{ji} = 1 - \frac{1}{\sigma_{ji}}$ is the inverse of the elasticity of substitution between imported and domestic produced good i demanded by j, σ_{ji}, and v_{ji} is the share of imports within the composite.

2. Factors of Production

Unlike most of the available CGE models in Colombia, the production sectors require three types of production factors: labor, capital and a mixed composite of both. Inputs are set based on the mentioned detail in the previous section. That is, labor factors are classified in 10 types according to its location (i.e. urban/rural), segment of the market (i.e. formal/informal) and between wage/non-wage earners;

[28] Armington's approach (1969) assumes that imported intermediate inputs demand is separable from domestic produced intermediate inputs (i.e. imperfect substitution). This allows to explain the demand for similar products without losing their basic difference (i.e. origin).

urban labor is further categorized between skilled/unskilled work based on the schooling years attained by each member of the labor force.

The mixed composite is classified in rural, urban informal and urban formal categories (m = 3). Capital input is differentiated between sector specific and perfectly mobile in order to account the decreasing scale effects that exists in some activities; Table A4.4 presents this disaggregation[29] .

3. Households

The disaggregation of households within the CGE model is done according to the data work described in the previous section. That is, there are 8,701 households that are differentiated according to their socio-economic characteristics, endowments and income level. Notwithstanding, each one of them behaves as a maximizing representative agent, keeping the Arrow-Debreu assumption for a unique equilibrium.

The utility function for the household h is depicted by a Cobb-Douglas index over i composite goods of domestic (CD) and imported (CM) varieties.

$$U_h(CD_h,\ CM_h) = \prod_i C_{hi}(CD_{hi}, CM_{hi})^{\alpha_{hi}}$$

where the Armington good i demanded by h, C_{hi}, is defined as:

$$C_{hi}(CD_{hi},\ CM_{hi}) = \left[\ \beta_{hi} CD_{hi}^{\rho_{hi}} + (1 - \beta_{hi})\, CM_{hi}^{\rho_{hi}}\right]^{1/\rho_{hi}}$$

and $\sigma_{DM} = \dfrac{1}{\rho - 1}$ is the elasticity of substitution between domestic and imported goods for all h and i.

As a result, household h chooses an optimal demand for each kind of good based on the following optimization problem:

Max $U_h(CD_h, CM_h)$

[29] It is assumed that activities such as agriculture, mining, chemicals, machinery and communications require specific types of capital inputs that cannot be used by other activities.

subject to

$$r(1 - \tau_k)K_h + \sum_n w_n L_{hn}(1 - \tau_L) + \sum_m pmx_m\,(MX_{hm}\,(L_{hn}, K_h)) + B_h^H$$

$$= \sum_i (\,p_i^D CD_{hi} + p_i^M CM_{hi})(1 + \tau_i^C) + S_h$$

where K_h, L_{hn} and MX_{hm} are the endowments of capital, labor and mixed composite, respectively; B^H, the transfers received from the rest of the world; S_h, the resources destined for investment (i.e. savings); r, the rate of capital return; w_n, the wage rate for labor n; pmx_m, the price of the mixed composite m; p^D and p^M, the prices for goods produced domestically and imported; and τ^C, τ_K and τ_L, the tax rates over consumption, capital and labor earnings, respectively.

4. Government

The government levies taxes on production, consumer demand, factor returns and imports, and receives transfers from the rest of the world; it spends its resources by demanding domestic and import goods, while gives subsidies to some activities and goods. It is assumed that it keeps constant its savings. Since it is not consider a maximizer agent, government's behavior is determined by the following identity:

$$\sum_j \tau_j^V VA_j + \sum_i p_i\, M_i \tau_i^M + \sum_h \sum_i (\,p_i^D CD_{hi} + p_i^M CM_{hi})\tau_i^C + \sum_h \tau_K\, rK_h$$

$$+ \sum_h \sum_n w_n L_{hn} \tau_L + DT + B^G = \sum_i (\,p_i^D GD_i + p_i^M GM_i)\tau_i^C + govsav$$

where DT is the sum of the revenues gotten from taxes over the production, net of subsidies; τ^V and τ^M are taxes on factor inputs and tariffs, respectively; GD_i and GM_i are the public demands for domestic and imported goods; B^G, the external transfers and $govsav$ the public deficit or surplus.

Given the large set of taxes included in the SNA, it is necessary to classify them according to their purpose. As a consequence, the tax instruments used in this model are as follows:

- Payroll taxes (*PYRL*),
- Tariffs (*TM*),
- Excise taxes (*TXS*),

- Value added taxes (*VAT*),
- Parafiscal or social-contribution taxes paid by firms (*TP*),
- Labor taxes (*TL*),
- Commercial and industrial taxes (*TCM*),
- Other indirect taxes (*TIF*),
- Other indirect taxes on production (*TY*)

In addition, the model includes sector (*SSUB*) and product (*PSUB*) subsidies. Tables A3.5 and A3.6 in Appendix 3 present the implicit tax rates and their revenues, respectively, in the benchmark.

5. Market Clearing and Zero Profit Condition

Market equilibrium requires that supply equals demand for all traded goods. That is, given optimal prices and quantities, there is an unique equilibrium for domestic output, imports, exports and all primary factor markets (labor, capital and the mixed composite).

The market clearing condition for market *i* is given by:

$$D_i + M_i = \sum_j X_{ij} + \sum_h C_{hi} + G_i$$

The factor markets for the mixed composite, labor and capital are such that:

$$\sum_j MX_{mj} = \sum_h MX_{hm} \qquad \forall\ m$$

$$\sum_j L_{nj} = \sum_h L_{hn} \qquad \forall\ n$$

$$\sum_j K_j = \sum_h K_h$$

The equilibrium condition of the balance of payments requires that the value of the imports equals the value of exports plus the exogenous capital inflows (*B*):

$$\sum_i p_i^M M_i = \sum_i p_i^E E_i + B + rowsav$$

where. $B = \sum_h B_h^H + B^G$. The prices of imports (p^M) and exports (p^E) are functions of the real exchange rate (*pfx*); and, the current account deficit or surplus, *rowsav*,

is taken as fixed. This identity determines the rest of the world behavior in the model.

Given the Arrow-Debreu framework (perfect competition and free entry assumptions), there is a zero-profit condition in equilibrium. This implies that for a given activity *j*, the output net of indirect taxes (τ^Y), must equal the costs of primary factor inputs (gross of value-added tax, τ^V_j), plus the total cost of intermediate inputs (gross of taxes on intermediate demand, τ^I_j):

$$\sum_i (1 - \tau_i^Y)(p_i^D D_i + p_i^E E_i)$$

$$= (1 + \tau^V)\left[rK + \sum_n w_n L_n + \sum_m pmx_m MX_m(K, L)\right]$$

$$+ \sum_i (1 + \tau_i^I)(p_i^D X_i^D + p_i^M X_i^M) \qquad \forall j$$

where X_i^D and X_i^M stand for intermediate goods produced domestically and by the rest of the world, respectively.

As *n*-1 markets are in equilibrium, the n^{th} market, investment, must equal total savings. Given the static nature of the model, investment is considered as another good. Additionally, since public and foreign savings are assumed to fixed, household savings are also constant. Hence, the value of investment has to adjust to equal savings, that is, this model has a "savings-driven" closure.

C. ELASTICITIES

In any applied general equilibrium model, the elasticities represent an important aspect of the modeling process since they determine the microeconomic behavior of the markets and production. In most cases, these parameters are estimated using econometric models or calibrated according to the available database (i.e. SAM). In Colombia, there are two works that can be used for this purpose. The first, made by Hernández (1998), presents estimations of the Armington elasticities for eight production sectors (i.e. agriculture, mining, food industry, capital goods, commerce, transportation, light and intermediate consumption goods). The second study, made by Barrera (2001), documents estimations of the Armington elasticities and CET elasticities for 30 of the SNA production sectors[30].

Knowing the estimation problems that exists in both reports[31] , this study combines the results of Hernández and Barrera for the Armington and CET elasticities, the latter approximated in most cases with the national average estimation. Table 5 presents the mentioned parameters.

Table 5
Behavioral Parameters

Commodity	σ_{DM} 1/	η 2/
Agriculture, livestock, fishing and forestry	0.54	0.29
Mining	0.00	1.62
Food industry	0.15	0.37
Textile industry	1.16	0.37
Wood industry	1.37	0.01
Paper industry	1.01	0.50
Chemistry industry	1.28	0.87
Mineral industry	0.24	0.86
Machinery	1.08	0.56
Other industry	1.30	0.37
Utilities	5.20	0.37
Construction and building activities	0.00	0.00
Transportation	1.02	0.37
Communications	0.21	0.37
Financial services	1.90	0.37
Real estate	0.13	0.37
Social services	0.85	0.37

1/ Armington elasticity.
2/ CET elasticity.
Source: Hernández (1998), Barrera (2001).

30 CET elasticities captures the relationship between production for the domestic market and for the rest of the world.

31 Both studies report estimation problems in some Armington elasticities (i.e. mining sector depicts a negative parameter). In addition, Barrera's estimations of CET elasticities were not statistically significant for most of the sectors though for the whole economy they were.

V. SIMULATIONS

By adopting this kind of CGE-microsimulations modeling, it is not only possible to evaluate how each individual or type of household is affected by policies and macroeconomic shocks, but also to deduct some ideas about welfare changes that can occur between and within these agents. In specific, the methodology allows to characterize each household according to its income, expenditure, dependency ratio[32], geographical location (i.e. rural/urban areas and municipalities), and socioeconomic characteristics of the household head (i.e. sex, age, schooling years, working state, etc.), *inter alia*.

As a consequence, this study attempts to simulate the effects of tax policies and macroeconomic shocks, not only on the whole set of households but also on specific groups characterized by their vulnerability given by the empirical evidence[33]. In particular, income distribution and poverty indicators are analyzed for the following sets of households:

- Total households
- Poor households
- Poor informal households (*SGROUP01*)
- Poor informal households with female heads (*SGROUP02*)
- Poor rural households (*SGROUP03*)
- Poor formal households (*SGROUP04*)
- Poor households with female heads and high dependency ratio (*SGROUP05*)
- Poor households with more than 2 children younger than 6 years old (*SGROUP06*)
- Poor households in which their heads have an attained education inferior to 7.68 years[34] (*SGROUP07*)
- Poor households in which their heads have an attained education superior to a national average of 7.68 (*SGROUP08*)

Poverty was defined in the usual manner, though poverty line was drawn exogenously at PPP US$3.25, the observed level in 2000 according to the UNDP,

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[32] Dependency ratio is defined as the relation between the number of children with less than 12 years old and adults older than 65 that do not work, and the number of working member of the household.

[33] World Bank (2002).

[34] Based on the 1997 Quality of Life Survey, the average attained education of the household head was 7.68 years.

based on the 1985 estimation of US$1 made by the International Monetary Fund (IMF) and the World Bank (WB). Consequently, the poverty rate was 36.6% or 13.8 millions of people (Table A3.7).

In detail, this study initially presents an scenario in which Colombia reduces unilaterally its tariffs by 50% (*TARIFF*). The idea behind this simulation is to try to give some preliminary answers to a current topic that has been discussed intensively, and where social components have been left aside as a result of the lack of the necessary *ex-ante* instruments for a deep welfare evaluation of the changes.

Secondly, it is analyzed the effects of unifying the VAT rates (*VATSHK*) as an economic decision to reduce the distortion of taxing differently each commodity (see Table A3.5).

Finally, it is analyzed two consequences separately of the last recession. First, a 50% fall of the rest of the world inflows (*ROWSHK*) as a proxy of the observed 1998-99 reduction of the foreign direct investment. Second, the increase of the government obligations with the rest of the world in 22% (*GOVSHK*), an experiment that tries to approximate some of the effects of the rising levels of public debt service upon the public finances and the general economy.

The analysis of each simulation is done using the usual macroeconomic information (i.e. changes in production, consumption and prices) and standard poverty and income distribution indicators, such as the Foster-Green-Thorbecke measures (i.e. poverty incidence, gap and severity), Gini coefficient, relative deviation from the mean household income and the variation coefficient. Benchmark (BENCH) analysis is presented in Appendix 3. The model was solved as a set of non linear equations in a mixed complementarity problem, programmed in GAMS (i.e. General Algebraic Modeling System)[35] . The simulation results are included in Appendix 4.

It is important to note that any conclusion drawn from this model is just a point of departure in the analysis. Its static nature combined with the assumption of perfect competition in all sectors, either undervalue or overvalue any estimated result.

[35] The solution algorithm is explained in detail by Ferris and Munson (1998).

A. UNILATERAL REDUCTION OF TARIFFS BY 50%

One of the most common simulations in recent years with CGE models is the reduction of tariffs as a result of a free trade agreement or just simply a change in the country's globalization trends. This model is limited in presenting accurate quantitative effects for these kind of policies given its basic assumptions of not considering international trade flows endogenously, imperfect competition, rigidities or specific functional forms for the productive sectors, *inter alia*. However, the results are still quiet relevant in giving a direction and plausible "lower" bound of the possible changes in the Colombian economy[36] .

In the model, a reduction in tariffs promoted an increase in most of the imported commodities, specially from sectors like agriculture, wood, textiles, the aggregation of other industries and utilities[37] . Therefore, sectoral production fell in half of the cases (Table A4.1), where the biggest change was observed in the activity "other industries" (-1.38%), basically, small low-tech manufacturing production. As a result, the demand for primary factors of production diminished, and thus, an increase in their prices was observed (Table A4.4), excluding rural inputs, which almost kept invariable.

Even though the rise in production prices (Table A4.5), the significant inflow of imports reduced the level of the consumer price index (CPI), thus, depreciating the real exchange rate and promoting the exports of goods and services (tables A4.6 and A4.2, respectively). This in turn, decreased some of the losses in production generated by the policy. GDP varied marginally (0.01%) with respect to the benchmark (Table A4.7).

Given the fact that no income adjustments were made for the losses in tariff receipts, tax revenues were reduced in 3.2%. Table A4.8 shows that most of this loss was due to the sharp fall of tariff revenues (48.8%). The rest of taxes adjusted accordingly to their correlation with the shock. Consequently, this loss of resources conveyed to a reduction in public expenditures (-2.93%).

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[36] In order to see pure tariff reduction effects, it was assumed that the government do not adjust its finances by increasing other taxes rates, hence public consumption must fall.

[37] Even though there is a positive variation in the latter two types of imports (2.39% and 2.59%, respectively), the size of the increases is marginal given their import shares within the total supply of goods in the domestic markets.

The fall in commodity prices as a result of the rise in the total supply of goods, beneficiated households with a greater consumption. In the aggregate, these agents had a total gain in welfare of 0.68% or 718.98 thousand of millions of pesos relative to the benchmark (Table A4.9). Income distribution indicators did not show significant changes, though household variance coefficient (a measure of income dispersion), increased by 0.69% (Table A4.12). Similarly, Gini coefficient rose from 0.513 in the benchmark, to 0.515.

The ratio of poor people decreased 0.78%, similar to household count ratio, which varied -0.42% (Table A4.12). The poverty gap for the whole sample fell 0.64%, while the poverty severity decreased 0.69%.

Within the analyzed households groups, all of them showed null or positive gains in welfare (tables A4.14 and A4.15). Poverty intensity had a general marginal reduction, particularly for those with more than two children (younger than 6 years old) and those whose head worked in the formal sector (-0.81% and -0.85%, respectively). Poor households with female head that worked at the urban informal labor market and with a high dependency ratio were the most vulnerable to the policy (Table A4.13). Welfare gains in average for all analyzed poor groups were around 0.2% (Table A4.15).

In consequence, it seems that a reduction in tariff is a pro-poor policy in most of the cases. However, the small gains in social welfare and the increase in the income dispersion led to think that without the proper social net, the costs can be greater than the benefits in terms of income distribution. In addition, the counterfactual of this experiment is to raise other taxes in order to keep at least constant public consumption, situation that possibly is even more costly according to these simplistic assumptions.

B. GENERAL VAT RATE OF 10%

One of the recommendations of the 2002 National Income Mission was to standardize the VAT rates for all commodities. Based on efficiency, such reform of the tax system will improve the economy not only by reducing distortions, but also decreasing the administrative costs. At the same time, theory and evidence show it would cause a reduction on welfare by affecting all goods without distinction, hence, increasing the vulnerability of the poor.

As it can be seen in Table A3.5, each commodity is subject to a different implicit rate given its technologic level and tax regime. Hence, a standardized "nominal" VAT rate of 10% needs to be adjusted to the data. By using the implicit weighed average rate depicted in Table A3.6, and the fact that in 2000 the VAT rate was 15%, it was assumed that the general implicit VAT rate was 3.2%. Additionally, it was assumed that in order to keep constant the level of expenditure, the government raised the tax over fim`s capital revenues.

In consequence, the new unique VAT rate should affect positively all those goods previously taxed with higher rates; conversely, commodities not subject initially to this tax or with a lower rate will be affected negatively. This is observed in Table A4.1, where sectors such as textiles, paper industry, communication and financial services had significant increases in their production. Agricultural activities, food industry, construction and utilities account some of the sectors that had their production diminished.

The adjustments in production, in conjunction with a fall in the consumer price index, promoted variations in the trade flows. That is, given a depreciation of the real exchange rate (3.47%), the gains from the tax policy, promoted augments in exported goods such as textiles (0.40%), mining industries (1.26%) and services, excluding communications (Table A4.2). Similarly, the general VAT rate conveyed an increase of the imports in sectors like mining (0.68%), textiles (5.43%), paper industry (2.27%), other industries (7.21%) and communications (6.97%), between others[38].

Since the VAT rate was smaller than the initial average rate, and despite its broader base, its revenues fell 57.2%. Conversely, the positive effects on production, exports and imports reflected in positive variations on the rest of tax revenues, excluding pay-roll taxes (Table A4.8). Even though, revenues from taxing capital augmented 3.1%, which in conjunction with the rest keep constant the level of expenditures, total tax revenues fell more than 15%.

Real factorial prices increased as response to the reduction in the consumer price index, despite the positive adjustments in the production[39] (Table A4.4). Rural

[38] The reason of this behavior lies in the fact that the mentioned goods had an initial higher VAT rate than the average.

[39] Since factor supply is fixed, increases in production convey augments in the demand for primary factors.

primary factors had the smaller variations (i.e. around 1%), while all urban factors and capital augmented more than 3%.

As a consequence of the adjustments in the factorial markets, and that the tax over capital is paid by households, welfare adjusted to account to these changes. In the aggregate, welfare gains, measured as the equivalent variation, summed 90 thousand millions of pesos or a 0.1% increase regarding the benchmark (Table A4.9). Notwithstanding, the number of poor households rose as a result of the increases in taxes. The number of poor households augmented by 3,886, while the poor population fell 45,270 (Table A4.10)[40] . Poverty gap and severity augmented 1.1% and 1.8%, respectively; Gini coefficient increased from 0.51 to 0.57, a half percentage point variation (Table A4.12).

Within the analyzed poverty groups, households with female head and high dependency ratio were the most vulnerable to the policy as their number increased 2.3% (Table A4.13). Households whose head had an attained education higher than the average, were the second most vulnerable group as their number rose 1.0% while their poverty gap and severity augmented 0.8% and 1.2%, respectively. Households whose head worked in the formal labor markets, were the less affected by the policy as their number as well as the rest of the measures diminished. Similar situations can be observed for households whose head either worked in the informal market or had an attained education less than average (Table A4.11). The welfare losses for the whole set of poor households accounted to 110.7 thousand of millions of pesos; poor rural households and those whose head had an attained education less than average depicted welfare losses by 1.3% and 1.0% regarding their levels in the benchmark.

As results stand, a generalized VAT rate lower than the observed average, compensated with an increase in the tax over capital, had positive effects over most of the production sectors, while affecting negatively social welfare. That is, even though real factorial prices increased higher than the consumer price index, the simulated tax policy ultimately diminished household consumption levels and receipts, reducing the welfare of the poor as most of the goods of their consumption bundles were now taxed without distinction. In consequence, the decision of

[40] This due to the fact that the per capita income, estimated from the household income, increased marginally regarding the initial values.

implementing this kind of measure needs to include social elements in order to correct the negative effects observed here.

C. REDUCTION OF FOREIGN SAVINGS IN 50%

The observed crisis at the end of the last decade conveyed several changes in the Colombian economy. One of the most clear aspects -and consequences- was the drastic reduction of the foreign direct investment in the country.

As difficult as it is to simulate all the effects that can cause such macroeconomic shock, it is possible to observe and somehow generate a qualitative measurement about it[41] . Foreign savings enter in the model through exogenous transfers (i.e. endowments) to the domestic agents. In this sense, a reduction in the inflows received by the firms seems to be an appropriate shock that replicates *one* of the conditions observed during the last crisis. Notwithstanding, given the static nature of the model, the impact on investment is not observed and thus, an important element of the analysis is left out.

Arbitrarily, it is chosen a 50% reduction in the external inflows received by the firms. This implies a reduction of 24.8% of the total inflows of the economy (Table A4.6). Therefore, aggregate demand must fall relative to the benchmark: total household consumption diminished 3.2 billions of pesos (-3.1%), while public expenditure fell 4.86%. GDP decreased 0.35% to 150.7 billions of pesos (Table A4.7).

Additionally to the adjustment in the aggregate demand, the reduction of foreign inflows in the economy had two complementary effects on commodity markets: first, a depreciation of the real exchange rate (Table A4.6), which promoted exports and reduced imports (tables A4.2 and A4.3, respectively). Second, an adjustment of the supply from domestic to foreign oriented; that is, a reduction in the goods offered in the domestic markets and an increase of exports. Total domestic production augmented (Table A4.1), especially in machinery, chemical and textile industries, which depicted the higher responses (8.9%, 7.2% and 6%, respectively). Sectors that showed negative behavior as an effect of the reduction in private

[41] Note that, in general terms, this exercise is not concerned with the reasons why a reduction of external savings occur. Rather, it is intended to measure the impact of such phenomenon.

demand were: agriculture (-1.0%), food industry (-2.3%), construction and building (-0.7%), communications (-0.3%), real estate (-2.6) and social services (-1.7%). Both production prices and the consumer price index showed mostly positive variations (tables A4.5 and A4.6).

Given the net positive adjustment in total production, primary factors' demand increased, which in turn, reduced their prices (Table A4.4). Rural and informal factors showed the most negative variations.

The augment in production conveyed an increase in most of tax revenues, excluding taxes over excise consumption, labor and capital (Table A4.8). In detail, tariff and valued added taxes rose significantly as an effect of the adjustments in production. Total net tax revenues grew 0.68%.

As it can be seen in Table A4.10, this macroeconomic shock drove more agents below the poverty line: the number of poor people and households grew 1.9% and 2.5%, respectively. Poverty gap increased 4.5% and poverty severity passed from 0.085 to 0.090, a rise of 6%. Within poverty groups, households with more than two children (*SGROUP06*) and whose head had more attained schooling years than the average showed the higher variations (Table A4.13). For the former, the number of people and households below the poverty line rose 3.9% and 4.3%, respectively; the poverty gap and severity indicators augmented in the same order, 1.8% and 2.2%. Their equivalent variation depicted a 6.4% reduction in their disposable resources for consumption (Table A4.15).

Households whose head had a higher attained education than the average increased their incidence within the poor by almost 2%; that is, their number rose from 628.7 to 657.1 thousand. Their poverty severity index augmented 6.5%, while their gap 4.4%. Households located in rural areas and those whose head either worked in the informal labor markets or had less attained schooling years than the average had a reduction in their incidence within the poor: the poverty incidence indicator (i. e. FGT(2)) fell 0.14%, 0.89% and 0.5%, respectively.

The significant losses in welfare depicted in tables A4.14 and A4.15, conveyed improvements in the dispersion indicators as every household was worse off than in the benchmark. Household and individual variance coefficient diminished 5.4% and 5.0%, respectively. Conversely, Gini coefficient increased 0.3% regarding the benchmark, given the difference in the household endowments.

The above results have shown how important these transfers are to the economy and more important, to the households' welfare. Poverty and income distribution indicators rose significantly as response to the shock, thereby depicting the degree of vulnerability of the households.

D. INCREASE OF GOVERNMENT OBLIGATIONS WITH THE REST OF THE WORLD IN 22%

One of the main characteristics of the past economic recession (for not to say its trigger), was the significant size of government expenditure. While in 1992, the government spent 99% of the total receipts, by 1999 it spent 133.5%[42] . Most of this imbalance was due to its size and increasing external obligations: payroll expenses represented 78.8% of total public expenditure in 1999, a 47.6% increase from the observed levels in 1992; debt service increased from 9.7% to 24.7% of total public receipts for the same years.

Given the structure of the model (i.e. closures), it is not possible to simulate the effects of an increase in the public consumption directly[43] . However, it is feasible to shock the public finances by rising its obligations with the rest of the world. This is in line with the empirical evidence as it was not only a phenomenon observed during the 1998-99 recession but also a fact of the later years: based on official estimates (i.e. DNP and the Central Bank), debt service increased yearly almost 22% since 2000. Therefore, arbitrarily it is assumed that governmental outflows augmented 22%[44] . Additionally, it is supposed that the government raises taxes in order to keep constant its expenditure, which basically is a tax reform response as observed during 1999 and the following years[45] .

Given this last assumption, public consumption was kept constant (Table A4.8), while tax revenues rose 21.2%, mostly due to a significant increase in the VAT

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42 DEE-DNP (2002).

43 Based on the Arrow-Debreu framework, all markets are adjusted endogenously.

44 It is important to note, that given that the model excludes all financial flows, the best approximation its through the mentioned fixed exogenously transfers.

45 In order to keep constant public expenditure, it was imposed an equal-yield restriction over the government finances. Specifically, as the economy is affected by shocks, the VAT rate will vary in order to adjust the tax receipts to the fixed consumption level. Although this seems unrealistic as there are other tax instruments to do it, this allows to control through one channel the possible changes in the public balance.

receipts of 80.5%. Conversely, other tax revenues fell in general excluding tariffs, which augmented 1.8%.

The augment of transfers to the rest of the world, hence, a reduction of the net inflows, and beside the increase in the VAT rate to keep constant the level public consumption, conveyed a 5% reduction in private demand (Table A4.9). As results, consumer price index rose 0.72% and the production that is essentially for the domestic market fell: agriculture (-0.12%), food industry (-1.57%), utilities (-0.79%), real estate (-1.22%) and social services (-1.73%). Conversely, given the rise in the real exchange rate, which promoted a rise in exports and a reduction in most of the imports (tables A4.2 and A4.3, respectively), affected positively the production in sectors like mining (3.11%), machinery (12.26%), chemical industry (8.12%), among others. As a consequence of these adjustments, GDP fell 0.51% to 150.5 billions of pesos (Table A4.7).

The net positive adjustment in production conveyed a rise in the factorial demands, thereby decreasing labor and capital prices. Table A4.4 shows that wages fell between 5.3% (for urban informal skilled non wage workers) and 7.7% (for urban informal unskilled non wage earners). The mixed composite prices decreased almost 6% for the rural input, 6.2% for the urban informal and 6.5% for the urban formal. The price of capital varied negatively 7.3%.

The fall in input prices (the main transmission mechanism), affected negatively the welfare, specially for the poor. The total income for the whole set of households decreased 5.3 billions of pesos (Table A4.9); the total loss for the poor was 511.6 thousand of millions of pesos or a 7.9% negative variation relative to the benchmark (tables A4.14 and A4.15).

Total poverty incidence rose for both households and individuals, in 5.5% and 3.7%, respectively. Poverty gap broadened more than 5.8% and severity got deeper by 6.8%. Comparatively, individual relative income measures increased 0.2%, while individual variance coefficient decreased in more than 3.6%; Gini coefficient varied 0.3% (Table A4.12).

Tables A4.11 and A4.13 show that most affected poor households were the ones whose head had an attained education greater than the average (8.9%), followed by those that worked in the formal labor markets (7.8%). Poor households with more than two children also augmented 7.8%, while their incidence within the

total poor rose 2.2%. In contrast, households whose head had an attained education lower than the average level and those located in rural areas decreased their shares within the poverty: the FGP (1) or poverty incidence indicators fell 0.8% and 1.4%, respectively (Table A4.13).

As the results stand, the rise of government obligations combined with tax reforms and no reductions in the expenditure levels, had the expected negative effects over welfare: poverty increased drastically as well as the vulnerability of the households, measured with the gap and severity indicators. In consequence, the control of government indebtedness structure is a quiet significant variable as poverty can be affected significantly by it.

VI. CONCLUDING REMARKS

This research have shown how straightforward is to link microeconomic information with a macroeconomic framework. More important, by combining data from the 1997 quality of life survey and using a standard CGE model, it was possible to built an instrument that improved the analysis of the effects of different types of policies and economic shocks upon welfare by incorporating income distribution and poverty measures. That is, by using this new tool in the evaluation of diverse exogenous economic shocks, the analysis of within group changes was plausible. The flexibility of the instrument to choose any kind of household and include it within the analysis, allows policy makers to answer questions from specific groups that in often occasions, was not possible to do straightforwardly.

A unilateral 50% reduction in tariffs improves the welfare in most segments of the population. The small social gains led to think that replacing tariff revenue losses with resources raised from adjustments in other tax instruments will in some cases, generates losses in welfare. However, these results are just a point of departure for this kind of analysis as several other variables were not taken into account.

A generalized VAT rate is quite attractive as it simplifies and reduces the administration costs. A VAT rate smaller than average even has positive effects over production, exports and imports. However, as welfare improves in the aggregate, the evidence showed that poverty groups can be affected negatively. Consequently, this policy of the 2002 National Income Mission should be analyzed

in more detail, specially, when taxing basic need products can increase poverty and vulnerability of those already near and below the line.

As in other studies, the macroeconomic shocks analyzed here (features of the 1998-99 economic recession) had important contributions to the reduction of the observed welfare in those years. In both cases, the effects over the economy were significant as not only they proved to be triggers of the increases in the poverty and inequality indicators but also for depicting the degree of vulnerability of specific groups of the population. In the case of the government shock, compensating outflows with increases in tax revenues had even more perverse effects on poverty and the general social welfare.

In conclusion, a model with these characteristics can improve significantly the tax policy and macroeconomic analysis in Colombia by incorporating poverty and income distribution variables as important constraints at the moment of taking decisions. Further work in this line is easily accomplished by including to this framework small rigidities as unemployment, minimum wage or other relevant characteristics that the researcher considers key features of his/her analysis.

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APPENDIX 1

1997 QUALITY OF LIFE SURVEY - LABOR STATISTICS

The 1997 Quality of Life survey reported a total national population of 39,535,424 people, which were distributed in 9,415,984 households. The labor force was composed by 13,654,068 people, whom 26.17% were part of the rural segment, 24.75% to the urban informal sector and 49.09% to the urban formal segment[1] .

Table A1.1 shows the composition of the rural labor force by attained educational level. As it can be seen, rural workers were fairly distributed between each level of education in 1997. More than 80% of the rural force had attained elementary education or less. Contrarily, less than 6% of the workers had attained higher education.

Labor force by informality clearly shows a different quantitative results given by attained educational level (Table A1.2). Formal wage workers with elementary or less education represented only 18.32% of the whole group, while informal wage workers with the same attained education were almost 50%. By the same token,

Table A1.1

Rural Labor Force by Attained Educational Level

Type of labor	Elementary or less	High school	Higher education
Wage worker	1,358,438.0	255,314.0	102,113.0
Non-wage worker	1,562,651.0	243,991.0	50,574.0
Wage worker **(*)**	79.0	15.0	6.0
Non-wage worker **(*)**	84.0	13.0	3.0

(*) Percentage.
Source: 1997 Quality of Life survey.

[1] Workers are part of the urban informal sector if they are: i) independent workers that are not professionals or technicians; ii) owners or wage-earners of firms with less than 10 workers; iii) servants or non-earner family workers, and iv) not affiliated to social security. In consequence, 33.52% of the urban labor force was in the informal sector during 1997.

Table A1.2

Labor Force by Informality and Attained Educational Level

Type of labor	Elementary or less	High school	Higher education
Formal wage worker	872,467.0	2,122,693.0	1,767,574.0
Formal non-wage worker	650,518.0	817,728.0	471,263.0
Informal wage worker	574,597.0	523,910.0	112,277.0
Informal non-wage worker	362,189.0	136,406.0	44,561.0
Formal wage worker **(*)**	18.3	44.6	37.1
Formal non-wage worker **(*)**	33.5	42.2	24.3
Informal wage worker **(*)**	47.5	43.3	9.3
Informal non-wage worker **(*)**	66.7	25.1	8.2

(*) Percentage.
Source: 1997 Quality of Life survey.

24% of the formal non wage earners had more than 12 years of education and only 8.2% of the informal non wage workers had similar attained level of education.

These facts become more evident if the analysis is made according to the labor force composition by activity (Table A1.3). As it can be seen, most of the activities that can be considered rural relayed heavily and uniformly on labor force with low levels of education. Notwithstanding, activities considered urban (i.e. manufacturing industries, utilities and services) had a divergent labor composition.

As a consequence, it seems relevant to analyze the labor force by geographical location, type of work and informality. In addition, urban force requires to be further analyzed by attained educational level, and so classified between skilled and non skilled work[2].

[2] Non skilled labor force is composed by workers with 12 or less of schooling years. Contrarily, skilled labor is composed by workers with higher education.

Table A1.3

Labor Force by Activity and Attained Educational Level

(Percentage)

Activity	Elementary or less	High school	Higher education	Total
Agriculture	87.8	9.5	2.7	100.0
Forestry	86.3	13.7	0.0	100.0
Fishing	78.1	20.6	1.3	100.0
Coal mining	26.8	39.6	33.6	100.0
Oil production	13.3	36.7	50.0	100.0
Metal mining	94.2	5.8	0.0	100.0
Other mining	80.4	12.5	7.1	100.0
Food production	40.8	42.0	17.2	100.0
Textiles	32.2	53.7	14.1	100.0
Wood industry	39.9	52.4	7.8	100.0
Paper industry	12.0	54.0	34.0	100.0
Chemical industry	11.1	54.9	34.0	100.0
Mining industry	35.4	46.3	18.3	100.0
Iron and steel industry	31.6	53.9	14.5	100.0
Machinery	29.1	58.2	12.7	100.0
Other manufacturing industry	28.1	56.3	15.6	100.0
Electricity and natural gas	20.5	45.6	33.9	100.0
Water and sewage	16.6	53.6	29.9	100.0
Construction	49.2	39.4	11.4	100.0
Wholesale commerce	18.3	52.9	28.7	100.0
Retail commerce	36.2	49.6	14.3	100.0
Restaurants	49.2	38.9	11.9	100.0
Transportation	34.1	51.3	14.6	100.0
Communications	15.2	41.0	43.8	100.0
Financial services	3.2	28.2	68.7	100.0
Insurance services	0.1	28.3	71.6	100.0
Real estate	17.3	34.6	48.1	100.0
Armed forces	8.3	42.8	48.9	100.0
Waste services	50.3	28.5	21.2	100.0
Social services	9.6	33.9	56.5	100.0
Fun services	28.8	47.9	23.3	100.0
Repair services	53.9	36.7	9.4	100.0
International organizations	0.0	50.0	50.0	100.0

Source: 1997 Quality of Life survey.

APPENDIX 2

SAM BALANCING TECHNIQUE

The general cross entropy method specifies a metric (the cross entropy objective function) which is used to minimize the distance between the final distribution (p_k) and the prior distribution (q_k), subject to moment restrictions. In the application of this method to balance the raw SAM, the prior distribution (q_k) is made up of column shares of the matrix, while the moment restrictions ensures that row and column sums remain identical for every account of the balance SAM.

The general minimum cross entropy problem with moment restrictions is given by:

$$\text{Min } I(p,q) = \sum_{k=1}^{K} p_k \ln\left(\frac{p_k}{q_k}\right)$$

such that

$$\sum_{k=1}^{K} p_k f_t(x_k) = y_t \qquad , t = 1,...T$$

$$\sum_{k=1}^{K} p_k = 1$$

where (x_k) are fixed vectors related to each individual probability point, (y_t,f_t) are scalars and functions related to each individual moment restriction. Additionally, it is possible to incorporate additional economic related restrictions in order to improve the efficiency of the balancing process.

Given that the raw or unbalanced SAM is likely to include large differences in scale between entries and accounts such that the method does not have a close-form solution, a program was designed that not only includes the objective function but the first order conditions of optimality, the moment conditions and the economic related conditions. In addition, it was necessary to introduce restrictions on the

possible changes that could have the households accounts. The programs were made in GAMS and the used solver was MINOS 5, which seems to work better for this kind of routines. Tables A2.1 to A2.3 present aggregations of the unbalanced SAM, balanced SAM and the percentage adjustment between them.

Table A2.1

Unbalanced Aggregated SAM

	Activities	Commodities	Labor	Mixed Input	Capital	Government	Firms	Households	ROW	S - I	Total
Activities		280,252,563									280,252,563
Commodities	118,906,103					37,057,145	202,859	105,361,938	37,023,190	23,942,033	322,493,268
Labor	55,730,038								9,643		55,739,681
Mixed input	16,518,551								739		16,519,290
Capital	54,278,163										54,278,163
Government	3,485,454	13,549,798			5,938,443	27,825,085	29,168,919	2,514,844			82,482,543
Firms					38,326,145	21,184,262	64,348,930	4,186,389	5,736,393		133,782,119
Households			67,239,106	25,911,765	8,856,638	5,878,625	27,753,592				135,639,726
ROW		33,285,777	-11,499,426				7,437,541	1,612	4,610,024		33,835,528
S - I						-1,486,758	18,101,204	23,574,943	-2,020,013	23,942,033	62,111,409
Total	**248,918,309**	**327,088,138**	**55,739,680**	**25,911,765**	**53,121,226**	**90,458,359**	**147,013,045**	**135,639,726**	**45,359,976**	**47,884,066**	**1,177,134,290**

Table A2.2

Balanced Aggregated SAM

	Activities	Commodities	Labor	Mixed Input	Capital	Government	Firms	Households	ROW	S - I	Total
Activities		265,574,750									265,574,750
Commodities	127,447,167	0				24,118,580	16,469	105,361,938	31,829,476	27,457,328	316,230,958
Labor	55,730,038								9,643		55,739,681
Mixed Input	25,911,025								739		25,911,764
Capital	52,902,071										52,902,071
Government	3,584,449	13,127,274			6,080,090	27,319,633	26,941,590	2,514,844			79,567,880
Firms					37,965,342	24,344,446	66,654,506	4,186,389	5,698,583		138,849,266
Households			67,239,106	25,911,765	8,856,638	5,878,625	27,753,592				135,639,726
ROW		37,528,934	-11,499,426				8,230,807	1,612	4,604,540		38,866,467
S - I						-2,093,404	9,252,303	23,574,943	-3,276,514	27,457,328	54,914,656
Total	**265,574,750**	**316,230,958**	**55,739,680**	**25,911,765**	**52,902,070**	**79,567,880**	**138,849,267**	**135,639,726**	**38,866,467**	**54,914,656**	**1,164,197,219**

Table A2.3

Percentage Adjustment

	Activities	Commodities	Labor	Mixed Input	Capital	Government	Firms	Households	ROW	S - I	Total
Activities		-5.2									-5.2
Commodities	7.2					-34.9	-91.9	0.0	-14.0	14.7	-1.9
Labor	0.0								0.0		0.0
Mixed Input	56.9								0.0		56.9
Capital	-2.5										-2.5
Government	2.8	-3.1			2.4	-1.8	-7.6	0.0			-3.5
Firms					-0.9	14.9	3.6	0.0	-0.7		3.8
Households			0.0	0.0	0.0	0.0	0.0				0.0
ROW		12.8	0.0				10.7	0.0	-0.1		14.9
S - I						40.8	-48.9	0.0	62.2	14.7	-11.6
Total	6.7	-3.3	0.0	0.0	-0.4	-12.0	-5.6	0.0	-14.3	14.7	1.0

APPENDIX 3

FORENSIC ANALYSIS

In the benchmark, the model reports a GDP of 151.3 billions of pesos at current prices of 2000[1] . By components, household and public consumptions correspond to 69.7% and 15.9% of the GDP. Total investment was 18.2% of the GPD, and the commercial deficit, 5.7 thousands of millions of pesos (-3.8% of GDP). Table A3.1 depicts these results.

Table A3.2 shows the composition of each activity in terms of its production and trade size. As it can be seen, rural activities that include agriculture, forestry, fishing and livestock, assigns almost 80% of its production to the domestic market while exporting the rest, which accounts 15.5% of the total exports. Contrarily, mining sector, which includes oil, coal and other minerals, assigns less than 30% of its production to the domestic market; its share of the total exports is 36.9%. Social services production (i.e. health, education, public administration, between others) has a share of 35.8% of the GDP, which almost entirely assigns to the domestic market.

Table A3.1

Macroeconomics Aggregates

(Thousand of millions of pesos)

	Level	Share
GDP	151,254.9	100.0
Household Consumption	105,361.9	69.7
Firms Consumption	16.5	0.0
Public Consumption	24,118.6	15.9
Investment	27,457.3	18.2
Exports	31,829.5	21.0
Imports	37,528.9	24.8
X - M	-5,699.5	-3.8

[1] It is important to remember that this value as well as the rest, is smaller than DANE original number given the used balancing technique in order to adjust the SAM to the microeconomic information.

Table A3.2
Production Shares
(Percentage)

	D / (D + X)	M / (D + M)	X / (D + M)	Y / GDP	X / SUM(X)
Agriculture, livestock, fishing and forestry	78.2	13.4	64.2	8.6	15.5
Mining	29.4	15.8	92.8	6.4	36.9
Food industry	88.1	8.5	59.3	8.4	8.1
Textile industry	69.4	28.6	52.5	2.8	7.0
Wood industry	93.7	4.4	59.6	0.4	0.2
Paper industry	87.9	23.1	31.3	1.9	1.9
Chemical industry	66.0	50.8	33.3	3.6	10.0
Mining industry	80.5	33.0	33.0	2.6	4.1
Machinery	70.0	80.8	9.3	1.6	3.8
Other industry	83.6	35.5	26.3	1.6	2.1
Utilities	99.2	2.5	23.7	4.9	0.3
Construction and building activities	100.0	0.0	0.0	5.9	0.0
Transportation	83.9	17.9	46.8	6.1	8.0
Communications	93.3	5.4	55.9	2.0	1.1
Financial services	98.7	7.9	13.6	4.3	0.5
Real estate	100.0	0.0	0.0	3.5	0.0
Social services	99.8	1.6	9.6	35.8	0.5

Nomenclature: D (domestic production), X (exports), M (imports) and Y (domestic production).

Tables A3.3 and A3.4 present the demand for primary factors by activities in terms of value added shares. As expected, agricultural activities are intensive in rural wage labor and rural mixed composite. Comparatively, mining and financial services demand urban formal unskilled wage work and both types of capital. Machinery production required 41% of the value added in urban formal unskilled labor, 10.8% in informal mixed composite factor and 14.6% in both kinds of capital.

As in any tax incidence analysis, a great detail in tax instruments is considered inside the model. Table A3.5 presents the implicit rates by activity[2]; Table A3.6

[2] Labor taxes are not presented given that there is an implicit rate for each household included in the model.

Table A3.3

Labor Shares of Value Added

(Percentage)

	REM01	REM02	REM03	REM04	REM05
Agriculture, livestock, fishing and forestry	36.2	3.6	3.9	0.0	0.0
Mining	0.7	0.0	0.0	0.0	0.0
Food industry	1.8	0.0	1.9	0.0	0.1
Textile industry	0.5	0.2	4.8	0.0	0.2
Wood industry	1.9	1.7	17.0	0.0	7.0
Paper industry	0.3	0.0	0.3	0.0	0.0
Chemical industry	0.3	0.0	0.2	0.0	0.0
Mining industry	3.0	0.1	0.1	0.0	0.1
Machinery	2.2	0.0	6.1	0.0	1.2
Other industry	0.0	0.0	0.3	0.0	0.1
Utilities	0.6	0.1	0.0	0.0	0.0
Construction and building activities	1.9	0.4	2.5	0.3	0.6
Transportation	0.9	0.2	3.9	0.0	0.7
Communications	0.5	0.0	0.9	0.0	0.0
Financial services	0.2	0.0	0.2	0.0	0.0
Real estate	0.5	0.0	0.5	0.3	0.0
Social services	3.0	0.3	4.4	0.1	0.7

	REM06	REM07	REM08	REM09	REM10
Agriculture, livestock, fishing and forestry	0.0	3.8	0.4	0.8	0.0
Mining	0.0	2.4	10.1	0.0	0.0
Food industry	0.0	17.4	14.9	2.1	0.0
Textile industry	1.4	29.4	12.9	1.3	0.6
Wood industry	0.0	24.4	7.8	0.4	16.3
Paper industry	0.0	26.2	18.4	0.0	0.0
Chemical industry	0.0	13.7	22.1	0.5	0.7
Mining industry	0.0	19.4	24.0	0.0	0.0
Machinery	0.4	41.0	17.4	0.8	0.0
Other industry	0.0	5.5	1.1	0.0	0.0
Utilities	0.0	7.0	10.5	0.0	0.4
Construction and building activities	0.0	13.4	11.0	0.4	0.2
Transportation	0.0	17.7	12.2	2.3	1.5
Communications	0.0	8.8	15.8	0.0	0.0
Financial services	0.3	8.7	31.3	0.8	0.6
Real estate	0.1	12.1	19.3	0.8	4.2
Social services	0.3	18.4	20.8	1.0	0.8

Nomenclature: rural salaried work (REM01), rural non-wage work (REM02), urban informal non skilled wage work (REM03), urban informal non skilled non-wage work (REM04), urban informal skilled wage work (REM05), urban informal skilled non-wage work (REM06), urban formal non skilled wage work (REM07), non-wage work (REM08), urban formal skilled wage work (REM09), and urban formal skilled non-wage work (REM10).

reports for each instrument, the tax base, revenue and weighed implicit rate. As observed in Table A3.6, most of the tax revenue is get through VAT and excise taxes (TXS). Taxes on labor (TL), the only instrument that affects directly household income, had a revenue of 1.4 billions of pesos at current prices of 2000. VAT revenues were more than 3 times the labor tax revenues (8.2 billions of pesos), which are mostly obtained from mineral activities, communication services textiles and some heavy industries.

Poverty and income distribution indicators are calculated based on the standard definition of poverty; poverty line is draw exogenously at PPP US$3.25, which was the observed level in 2000 according to the UNDP. The model reports in the benchmark the usual Foster-Green-Thorbecke measures (i.e. head count, incidence and severity), Gini coefficient and, the relative deviation and variance coefficient

Table A3.4

Mixed Composite and Capital Shares of Value Added

(Percentage)

	IMX01	IMX02	IMX03	Mobile K	Specific K
Agriculture, livestock, fishing and forestry	25.4	0.9	8.4	8.5	8.0
Mining	1.0	0.3	0.4	48.7	36.5
Food industry	0.5	3.9	3.0	54.5	0.0
Textile industry	0.8	11.8	18.5	14.1	3.5
Wood industry	2.5	13.5	4.0	3.5	0.0
Paper industry	0.0	0.2	3.4	51.3	0.0
Chemical industry	0.0	0.6	1.4	23.0	37.5
Mining industry	1.0	2.1	0.9	49.3	0.0
Machinery	0.0	10.8	5.4	2.6	12.0
Other industry	0.8	8.6	3.1	80.5	0.0
Utilities	0.4	0.9	2.3	77.9	0.0
Construction and building activities	2.3	17.9	9.7	39.5	0.0
Transportation	2.7	22.6	24.0	11.3	0.0
Communications	0.1	1.0	0.7	28.8	43.3
Financial services	0.9	2.3	2.1	52.7	0.0
Real estate	0.0	1.4	11.7	49.1	0.0
Social services	1.1	8.7	13.1	27.2	0.0

Nomenclature: rural mixed composite (IMX01), urban informal mixed composite (IMX02), urban formal mixed composite (IMX03), sector specific capital (Specific K) and mobile capital (Mobile K).

Table A3.5

Implicit Tax Rates

(Percentage)

	PYRL	TM	TXS	VAT	TP
Agriculture, livestock, fishing and forestry	0.0	13.6	0.0	0.0	1.9
Mining	6.8	1.6	15.1	14.5	0.3
Food industry	2.4	8.0	4.3	5.2	0.0
Textile industry	2.3	6.6	0.0	11.0	0.0
Wood industry	0.2	4.6	0.0	1.0	0.0
Paper industry	4.4	4.0	0.0	8.8	0.0
Chemical industry	4.0	3.9	0.0	4.2	0.0
Mining industry	3.3	4.5	0.0	7.8	0.0
Machinery	2.5	4.9	0.0	10.6	0.0
Other industry	40.4	8.9	0.0	12.3	0.0
Utilities	6.0	3.4	0.0	0.0	0.0
Construction and building activities	0.8	0.0	0.0	0.0	0.2
Transportation	1.5	0.1	0.1	2.2	0.0
Communications	6.9	0.0	0.0	25.0	0.0
Financial services	6.5	0.0	0.0	9.6	0.0
Real estate	0.0	0.0	0.0	0.1	0.0
Social services	2.4	0.0	0.0	1.0	0.0

	TCM	TIF	TY	SSUB	PSUB
Agriculture, livestock, fishing and forestry	0.0	0.0	0.0	0.0	0.4
Mining	0.3	0.5	0.0	0.2	0.0
Food industry	0.8	0.6	0.0	0.0	0.1
Textile industry	0.6	0.4	0.0	0.0	0.2
Wood industry	0.2	0.1	0.0	0.0	0.1
Paper industry	0.8	0.6	0.0	0.0	0.1
Chemical industry	0.7	0.5	0.0	0.0	0.4
Mining industry	0.8	0.6	0.0	0.0	0.2
Machinery	0.6	0.5	0.0	0.0	0.0
Other industry	0.8	0.6	0.0	0.0	0.1
Utilities	0.0	0.5	0.1	1.0	0.0
Construction and building activities	0.4	0.4	0.0	0.1	0.0
Transportation	0.5	0.6	0.1	0.0	0.0
Communications	0.6	0.6	0.1	0.2	0.0
Financial services	1.2	0.9	0.2	3.4	0.0
Real estate	0.4	0.0	0.0	0.0	0.0
Social services	0.8	0.4	0.1	0.1	0.0

Nomenclature: payroll taxes (PYRL), tariffs (TM), excise taxes (TXS), value added taxes (VAT), parafiscal or social-contribution taxes (TP), labor taxes (TL), commercial and industrial taxes (TCM), other indirect taxes (TIF) and other indirect taxes on production (TY).

of the household receipts with respect to the household's mean income. As Table A3.7 shows, the benchmark data replicates quite well the mentioned indicators given the evidence depicted in the works of Baldión and Nina (2001), Baldión (2001) and the World Bank (2002).

Table A3.6

Benchmark Tax Summary

	Tax Base (*)	Revenue (*)	Rate
Payroll taxes	55,730.0	1,402.6	2.5
Tariffs	37,528.9	1,839.7	4.9
Excise taxes	284,401.5	2,911.7	10.3
Value added taxes	156,954.3	8,151.7	4.8
Social-contribution taxes	260,136.8	481.7	1.6
Labor taxes	55,730.0	1,407.2	2.5
Commercial and industrial taxes	265,574.8	1,578.6	0.8
Other indirect taxes on commodities	265,574.8	1,174.7	0.5
Other indirect taxes on production	265,574.8	138.9	0.1
Sectorial subsidies	265,574.8	-710.3	-2.1
Product subsidies	284,401.5	-257.5	-0.3

(*) Thousand of millions of pesos.

Table A3.7

Poverty and Income Distribution Indicators

Poor people	13,811,130.0
Poor Households	3,080,850.0
Individual Incidence	0.36
Household Incidence	0.34
Poverty Gap	0.16
Poverty Severity	0.09
Individual Relative Deviation	0.69
Household Relative Deviation	0.75
Individual Variance Coefficient	325.00
Household Variance Coefficient	2,354.33
Gini Coefficient	0.51

APPENDIX 4

SIMULATION RESULTS

Table A4.1

Production

(Percentage Variation)

	TARIFF	VATSHK	ROWSHK	GOVSHK
Agriculture, livestock, fishing and forestry	-0.2	-1.3	-1.0	-0.1
Mining	0.3	-0.2	2.7	3.1
Food industry	-0.3	-0.9	-2.3	-1.6
Textile industry	-0.4	1.3	6.0	7.6
Wood industry	-0.3	-0.3	1.1	1.5
Paper industry	-0.5	0.9	0.1	-0.3
Chemical industry	0.1	0.7	7.2	8.1
Mining industry	0.3	0.3	3.9	3.8
Machinery	-0.5	-1.5	8.9	12.3
Other industry	-1.4	-1.2	2.0	3.5
Utilities	0.1	0.2	0.4	-0.8
Construction and building activities	0.1	-0.3	-0.6	-0.6
Transportation	0.4	1.9	3.5	1.8
Communications	0.2	3.6	-0.3	-3.6
Financial services	0.4	1.8	2.0	0.4
Real estate	0.1	-2.4	-2.6	-1.2
Social services	-0.1	0.0	-1.7	-1.7

Nomenclature: tariff reduction scenario (TARIFF), general VAT simulation (VATSHK), foreign savings reduction scenario (ROWSHK) and augment of the government outflows (GOVSHK).

Table A4.2

Exports (Percentage Variation)

	TARIFF	VATSHK	ROWSHK	GOVSHK
Agriculture, livestock, fishing and forestry	0.1	-0.2	2.1	2.9
Mining	0.4	-0.5	3.1	3.9
Food industry	0.1	-1.1	1.9	3.6
Textile industry	0.0	0.4	9.6	12.7
Wood industry	-0.3	-0.3	1.2	1.7
Paper industry	0.1	0.2	5.5	6.7
Chemical industry	0.9	1.3	10.6	11.8
Mining industry	1.2	0.9	12.5	12.6
Machinery	-0.5	-1.4	8.7	12.0
Other industry	-0.9	-2.8	5.2	8.7
Utilities	0.5	1.7	4.4	2.5
Transportation	0.8	3.9	6.8	3.4
Communications	0.5	-1.2	4.3	6.2
Financial services	0.8	1.7	7.0	6.3
Social services	0.4	0.9	2.8	2.8

Nomenclature: tariff reduction scenario (TARIFF), general VAT simulation (VATSHK), foreign savings reduction scenario (ROWSHK) and augment of the government outflows (GOVSHK).

Table A4.3

Imports (Percentage Variation)

	TARIFF	VATSHK	ROWSHK	GOVSHK
Agriculture, livestock, fishing and forestry	2.3	-4.1	-9.2	-8.0
Mining	0.2	0.7	1.8	1.2
Food industry	0.1	-0.8	-4.4	-4.4
Textile industry	1.2	5.4	-12.9	-18.5
Wood industry	1.0	-1.6	-16.3	-18.1
Paper industry	0.4	2.3	-9.8	-12.9
Chemical industry	0.0	-0.9	-2.8	-2.6
Mining industry	0.1	-0.2	-0.8	-0.7
Machinery	0.2	1.1	-3.2	-4.6
Other industry	2.4	7.2	-10.0	-16.4
Utilities	2.6	-19.3	-42.9	-36.6
Transportation	-1.0	-5.1	-7.8	-3.7
Communications	-0.1	7.0	-3.4	-10.0
Financial services	-1.9	2.5	-20.9	-25.6
Social services	-1.1	-2.0	-11.3	-11.5

Nomenclature: tariff reduction scenario (TARIFF), general VAT simulation (VATSHK), foreign savings reduction scenario (ROWSHK) and augment of the government outflows (GOVSHK).

Table A4.4

Factor Prices

(Percentage Variation)

	TARIFF	VATSHK	ROWSHK	GOVSHK
Rural salaried work	0.0	1.3	-3.4	-6.4
Rural non-wage work	0.0	1.2	-3.5	-6.6
Urban informal non skilled wage work	0.2	3.0	-2.4	-6.5
Urban informal non skilled non-wage work	0.3	2.4	-3.6	-7.7
Urban informal skilled wage work	0.2	3.2	-2.2	-6.5
Urban informal skilled non-wage work	0.2	3.6	-1.2	-5.3
Urban formal non skilled wage work	0.3	3.4	-1.3	-5.6
Urban formal non skilled non-wage work	0.4	3.6	-0.9	-5.4
Urban formal skilled wage work	0.3	3.1	-2.1	-6.3
Urban formal skilled non-wage work	0.3	2.7	-2.4	-6.5
Rural mixed composite	0.0	1.2	-2.9	-6.0
Urban informal mixed composite	0.3	3.5	-1.7	-6.2
Urban formal mixed composite	0.3	3.1	-2.2	-6.5
Capital	0.3	3.1	-2.7	-7.3

Nomenclature: tariff reduction scenario (TARIFF), general VAT simulation (VATSHK), foreign savings reduction scenario (ROWSHK) and augment of the government outflows (GOVSHK).

Table A4.5

Production Prices

(Percentage Variation)

	TARIFF	VATSHK	ROWSHK	GOVSHK
Agriculture, livestock, fishing and forestry	0.3	-0.3	0.6	-1.2
Mining	1.4	3.7	11.9	9.2
Food industry	0.4	4.0	0.6	-4.3
Textile industry	0.4	5.8	1.3	-4.7
Wood industry	0.3	2.5	-1.4	-5.3
Paper industry	0.5	4.7	2.4	-2.4
Chemical industry	0.4	2.8	7.8	5.2
Mining industry	0.3	2.7	2.5	0.2
Machinery	0.2	5.2	4.2	-0.8
Other industry	0.4	8.7	3.7	-3.7
Utilities	0.3	-0.7	0.7	0.7
Construction and building activities	0.3	-0.2	0.8	-0.3
Transportation	0.3	-2.1	2.7	5.1
Communications	0.6	17.7	-1.0	-15.8
Real estate	0.3	3.8	-1.7	-6.1
Financial services	0.3	2.6	-2.0	-5.9
Social services	0.3	1.0	-0.7	-3.0

Nomenclature: tariff reduction scenario (TARIFF), general VAT simulation (VATSHK), foreign savings reduction scenario (ROWSHK) and augment of the government outflows (GOVSHK).

Table A4.6

Other Variables

(Percentage Variation)

	TARIFF	VATSHK	ROWSHK	GOVSHK
Real exchange rate	1.5	3.5	12.1	9.7
Consumer price index	-1.4	-0.2	2.3	0.7
ROW transfers	1.3	2.9	-24.9	-29.0

Nomenclature: tariff reduction scenario (TARIFF), general VAT simulation (VATSHK), foreign savings reduction scenario (ROWSHK) and augment of the government outflows (GOVSHK).

Table A4.7

Gross Domestic Product

	TARIFF	VATSHK	ROWSHK	GOVSHK
Level 1/	151,269.5	151,378.5	150,732.9	150,484.4
Change 2/	0.0	0.1	-0.4	-0.5

Nomenclature: tariff reduction scenario (TARIFF), general VAT simulation (VATSHK), foreign savings reduction scenario (ROWSHK) and augment of the government outflows (GOVSHK).
1/ Thousand of millions of pesos.
2/ Percentage.

Table A4.8

Total Tax Revenues and Public Consumption

(Percentage Variation)

	TARIFF	VATSHK	ROWSHK	GOVSHK
Payroll taxes	0.4	4.1	0.1	-4.8
Tariffs	-48.8	3.8	5.4	1.8
Excise taxes	1.4	0.2	-2.4	-1.0
Value added taxes	-0.8	-57.2	4.7	80.5
Social-contribution taxes	0.3	-1.1	0.9	-0.1
Labor taxes	0.3	3.2	-1.4	-5.7
Tax on capital	0.3	3.1	-2.7	-7.3
Commercial and industrial taxes	0.3	2.6	1.0	-2.2
Other indirect taxes on commodities	0.4	2.9	2.3	-0.8
Other indirect taxes on production	0.3	2.5	-1.0	-4.3
Sectorial subsidies	0.6	3.8	0.8	-3.7
Product subsidies	0.5	0.3	2.0	1.2
Total tax income	-3.3	-15.4	0.7	21.2
Total public expenditure	-2.9	0.0	-4.9	0.0

Nomenclature: tariff reduction scenario (TARIFF), general VAT simulation (VATSHK), foreign savings reduction scenario (ROWSHK) and augment of the government outflows (GOVSHK).

Table A4.9

Total Households Welfare - Equivalent Variation

	TARIFF	VATSHK	ROWSHK	GOVSHK
Total Gains **(*)**	719.0	90.8	-3,221.2	-5,257.6
Percentage variation	0.7	0.1	-3.1	-5.0

Nomenclature: tariff reduction scenario (TARIFF), general VAT simulation (VATSHK), foreign savings reduction scenario (ROWSHK) and augment of the government outflows (GOVSHK).
(*) Thousand of millions of pesos.

Table A4.10

Poverty and Inequality Measures - All Households

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Poor Population	13,811,130.0	13,703,218.0	13,765,860.0	14,074,687.0	14,317,896.0
Poor Households	3,080,850.0	3,067,861.0	3,084,736.0	3,156,570.0	3,250,581.0
Incidence	0.3	0.3	0.3	0.3	0.4
Gap	0.2	0.2	0.2	0.2	0.2
Severity	0.1	0.1	0.1	0.1	0.1
Individual Relative Deviation	0.7	0.7	0.7	0.7	0.7
Household Relative Deviation	0.8	0.8	0.8	0.8	0.8
Individual Variance Coefficient	325.0	327.1	314.0	308.7	313.3
Household Variance Coefficient	2,354.3	2,370.7	2,258.4	2,227.3	2,273.9
Gini Coefficient	0.5	0.5	0.6	0.5	0.5

Nomenclature: benchmark (BENCH), tariff reduction scenario (TARIFF), general VAT simulation (VATSHK), foreign savings reduction scenario (ROWSHK) and augment of the government outflows (GOVSHK).

Table A4.11

Poverty Measures per Household Groups

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Poor informal households SGROUP01					
Poor Population	1,808,817.0	1,801,809.0	1,822,731.0	1,858,491.0	1,938,101.0
Poor Households	540,618.0	538,866.0	545,283.0	548,955.0	571,110.0
Incidence (*)	0.175	0.176	0.177	0.174	0.176
Gap (*)	0.039	0.039	0.039	0.040	0.040
Severity (*)	0.018	0.018	0.018	0.019	0.019
Poor informal households with female head SGROUP02					
Poor Population	405,918.0	405,918.0	404,594.0	419,461.0	440,126.0
Poor Households	145,065.0	145,065.0	145,207.0	148,455.0	154,607.0
Incidence (*)	0.047	0.047	0.047	0.047	0.048
Gap (*)	0.013	0.013	0.013	0.013	0.013
Severity (*)	0.007	0.007	0.007	0.007	0.007
Poor rural households SGROUP03					
Poor Population	5,717,142.0	5,686,286.0	5,745,352.0	5,876,772.0	6,031,396.0
Poor Households	1,421,049.0	1,415,358.0	1,427,804.0	1,453,976.0	1,478,196.0
Incidence (*)	0.461	0.461	0.463	0.461	0.455
Gap (*)	0.258	0.258	0.260	0.262	0.258
Severity (*)	0.144	0.144	0.146	0.148	0.146
Poor formal households SGROUP04					
Poor Population	1,414,141.0	1,402,067.0	1,396,001.0	1,443,597.0	1,506,486.0
Poor Households	427,809.0	423,370.0	426,386.0	443,303.0	461,351.0
Incidence (*)	0.139	0.138	0.138	0.140	0.142
Gap (*)	0.032	0.032	0.032	0.033	0.034
Severity (*)	0.014	0.014	0.014	0.015	0.015
Poor households with female head and high dependency ratio SGROUP05					
Poor Population	508,544.0	508,408.0	520,699.0	518,046.0	537,630.0
Poor Households	130,952.0	130,884.0	133,915.0	134,087.0	140,020.0
Incidence (*)	0.043	0.043	0.043	0.042	0.043
Gap (*)	0.015	0.015	0.015	0.015	0.015
Severity (*)	0.008	0.008	0.008	0.008	0.008

Table A4.11 (continuation)

Poverty Measures per Household Groups

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Poor households with more than 2 children SGROUP06					
Poor Population	2,900,361.0	2,877,053.0	2,911,495.0	3,014,261.0	3,143,453.0
Poor Households	499,123.0	495,372.0	503,589.0	520,637.0	538,058.0
Incidence **(*)**	0.162	0.161	0.163	0.165	0.166
Gap **(*)**	0.065	0.065	0.066	0.067	0.066
Severity **(*)**	0.032	0.032	0.032	0.033	0.033
Poor households - attained education lower than average SGROUP07					
Poor Population	9,133,681.0	9,090,751.0	9,119,225.0	9,371,587.0	9,652,807.0
Poor Households	2,452,083.0	2,441,953.0	2,450,081.0	2,499,508.0	2,565,280.0
Incidence **(*)**	0.796	0.796	0.794	0.792	0.789
Gap **(*)**	0.351	0.351	0.353	0.355	0.351
Severity **(*)**	0.196	0.196	0.198	0.201	0.198
Poor households - attained education higher than average SGROUP08					
Poor Population	1,851,300.0	1,841,039.0	1,870,059.0	1,939,098.0	2,040,312.0
Poor Households	628,767.0	625,908.0	634,655.0	657,062.0	685,301.0
Incidence **(*)**	0.204	0.204	0.206	0.208	0.211
Gap **(*)**	0.051	0.050	0.051	0.053	0.052
Severity **(*)**	0.023	0.023	0.024	0.025	0.024

Nomenclature: benchmark (BENCH), tariff reduction scenario (TARIFF), general VAT simulation (VATSHK), foreign savings reduction scenario (ROWSHK) and augment of the government outflows (GOVSHK).
(*) The FGT indexes refer to the number of households of the group relative to all poor households.

Table A4.12

Percentage Changes in Poverty and Income Measures
All Households

	TARIFF	VATSHK	ROWSHK	GOVSHK
Poor Population	-0.8	-0.3	1.9	3.7
Poor Households	-0.4	0.1	2.5	5.5
Gap	-0.6	1.1	4.5	5.8
Severity	-0.7	1.8	6.0	6.8
Individual Relative Deviation	0.0	0.2	0.4	0.3
Household Relative Deviation	0.1	0.0	0.3	0.3
Individual Variance Coefficient	0.7	-3.4	-5.0	-3.6
Household Variance Coefficient	0.7	-4.1	-5.4	-3.4
Gini Coefficient	0.1	0.5	0.3	0.3

Nomenclature: tariff reduction scenario (TARIFF), general VAT simulation (VATSHK), foreign savings reduction scenario (ROWSHK) and augment of the government outflows (GOVSHK).

Table A4.13

Percentage Changes in Poverty Measures per Household Groups

	TARIFF	VATSHK	ROWSHK	GOVSHK
Poor informal households				
SGROUP01				
Poor Population	-0.387	0.769	2.746	7.147
Poor Households	-0.324	0.863	1.542	5.640
Incidence **(*)**	0.098	0.736	-0.894	0.124
Gap **(*)**	-0.458	0.747	3.103	2.315
Severity **(*)**	-0.524	1.147	4.957	4.217
Poor informal households with female head				
SGROUP02				
Poor Population	0.000	-0.326	3.336	8.427
Poor Households	0.000	0.098	2.337	6.578
Incidence **(*)**	0.423	-0.028	-0.118	1.013
Gap **(*)**	-0.245	0.163	1.484	0.614
Severity **(*)**	-0.257	0.251	2.817	2.281
Poor rural households				
SGROUP03				
Poor Population	-0.540	0.493	2.792	5.497
Poor Households	-0.400	0.475	2.317	4.021
Incidence **(*)**	0.021	0.349	-0.137	-1.410
Gap **(*)**	-0.176	0.667	1.264	-0.222
Severity **(*)**	-0.246	1.474	2.820	0.897
Poor formal households				
SGROUP04				
Poor Population	-0.854	-1.283	2.083	6.530
Poor Households	-1.038	-0.333	3.622	7.840
Incidence **(*)**	-0.619	-0.458	1.136	2.209
Gap **(*)**	-0.495	-0.346	3.606	4.378
Severity **(*)**	-0.534	-0.383	4.487	5.537
Poor households with female head and high dependency ratio				
SGROUP05				
Poor Population	-0.027	2.390	1.868	5.719
Poor Households	-0.052	2.263	2.394	6.925
Incidence **(*)**	0.371	2.134	-0.062	1.342
Gap **(*)**	-0.227	0.284	1.551	0.276
Severity **(*)**	-0.342	1.006	3.269	2.169

Table A4.13 (continuation)

Percentage Changes in Poverty Measures per Household Groups

	TARIFF	VATSHK	ROWSHK	GOVSHK
Poor households with more than 2 children SGROUP06				
Poor Population	-0.804	0.384	3.927	8.381
Poor Households	-0.752	0.895	4.310	7.801
Incidence **(*)**	-0.331	0.768	1.808	2.172
Gap **(*)**	-0.335	0.652	2.237	1.330
Severity **(*)**	-0.477	1.613	4.179	2.844
Poor households attained education lower than average SGROUP07				
Poor Population	-0.470	-0.158	2.605	5.684
Poor Households	-0.413	-0.082	1.934	4.616
Incidence **(*)**	0.009	-0.208	-0.511	-0.846
Gap **(*)**	-0.185	0.388	1.095	-0.116
Severity **(*)**	-0.249	1.084	2.453	0.858
Poor households attained education higher than average SGROUP08				
Poor Population	-0.554	1.013	4.743	10.210
Poor Households	-0.455	0.936	4.500	8.991
Incidence **(*)**	-0.033	0.809	1.993	3.300
Gap **(*)**	-0.513	1.164	4.370	3.506
Severity **(*)**	-0.565	2.294	6.495	4.932

Nomenclature: tariff reduction scenario (TARIFF), general VAT simulation (VATSHK), foreign savings reduction scenario (ROWSHK) and augment of the government outflows (GOVSHK).
(*) The FGT indexes refer to the number of households of the group relative to all poor households.

Table A4.14

Income Gain or Loss

(Thousand of millions of pesos)

	TARIFF	VATSHK	ROWSHK	GOVSHK
Total Poor	27.894	-110.701	-454.767	-511.642
SGROUP01	6.427	-23.675	-91.127	-100.608
SGROUP02	1.456	-5.662	-22.674	-24.696
SGROUP03	10.692	-69.354	-204.381	-208.565
SGROUP04	4.811	-9.955	-75.076	-91.938
SGROUP05	1.162	-3.798	-19.028	-21.109
SGROUP06	4.410	-21.204	-79.502	-87.476
SGROUP07	21.944	-78.415	-326.960	-375.156
SGROUP08	5.950	-32.286	-127.807	-136.485

Nomenclature: tariff reduction scenario (TARIFF), general VAT simulation (VATSHK), foreign savings reduction scenario (ROWSHK) and augment of the government outflows (GOVSHK).

Table A4.15

Income Percentage Change

	TARIFF	VATSHK	ROWSHK	GOVSHK
Total Poor	0.2	-1.0	-6.9	-7.9
SGROUP01	0.2	-0.5	-6.5	-8.0
SGROUP02	0.2	-0.3	-6.3	-7.9
SGROUP03	0.2	-1.4	-7.1	-7.9
SGROUP04	0.3	0.8	-6.2	-8.2
SGROUP05	0.2	-0.9	-6.4	-7.2
SGROUP06	0.3	-0.4	-6.4	-7.7
SGROUP07	0.2	-1.0	-7.0	-7.9
SGROUP08	0.3	-0.9	-6.9	-7.9

Nomenclature: tariff reduction scenario (TARIFF), general VAT simulation (VATSHK), foreign savings reduction scenario (ROWSHK) and augment of the government outflows (GOVSHK).

Comentarios sobre el texto *How Can Tax Policies and Macroeconomic Shocks Affect the Poor? A Quantitative Assessment Using a Computable General Equilibrium Framework for Colombia*

Óscar Mauricio Valencia *

El artículo presenta un análisis cuantitativo del efecto de diferentes choques macroeconómicos, desde la perspectiva del equilibrio general, sobre la pobreza y la distribución del ingreso. El desarrollo del tema es indudablemente un aporte para la literatura colombiana porque permite integrar el análisis distributivo al de la asignación de los recursos en un contexto donde los agentes toman decisiones racionales.

Este documento expone unos breves comentarios acerca de la metodología de microsimulaciones presentada en el artículo y sus implicaciones sobre el entendimiento del problema de la pobreza y de desigualdad. Los comentarios se dividen en: implicaciones metodológicas e implicaciones teóricas.

I. IMPLICACIONES METODOLÓGICAS

La metodología de microsimulaciones sugerida por el autor está basada en la construcción de una matriz de contabilidad social que integra la información macro

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de la estructura productiva de la economía y la información micro de las condiciones socioeconómicas de los hogares. En el caso colombiano, los datos macro se tomaron de las cuentas nacionales del año 2000 y los datos micro se obtuvieron de la encuesta de calidad de vida para el año de 1997. Acorde con esta información, se construye una matriz de contabilidad social que contiene 8.701 hogares, clasificados por sus dotaciones de capital, trabajo y condiciones socioeconómicas.

Posteriormente, adoptando como base la matriz de contabilidad social, se calibra un modelo de equilibrio general computable estático. En este modelo, las firmas y los hogares toman sus decisiones de manera descentralizada en un ambiente de competencia perfecta donde los hogares son dueños de las firmas. El modelo contiene una estructura desagregada de impuestos que permite hacer un análisis de incidencia tributaria a nivel distributivo. El Gobierno recibe recursos provenientes de los impuestos y mantiene un presupuesto balanceado.

Sobre esta estructura, la metodología anterior implica lo siguiente:

a) Los hogares sólo se han diferenciado por sus dotaciones iniciales, las preferencias de todos los hogares se presentan a través de la misma función de utilidad.

b) Dentro del modelo, los efectos distributivos se dan vía precios. Los choques de política afectan los precios relativos, el valor de las dotaciones iniciales y la restricción presupuestaria de cada uno de los agentes.

c) Debido a la naturaleza estática del modelo, los efectos distributivos asociados a la acumulación de capital se ignoran, esto implica que el comportamiento de los agentes no genera una distribución endógena del ingreso dentro del modelo.

II. IMPLICACIONES TEÓRICAS

En esta subsección se analizan las implicaciones que tiene el instrumento utilizado para evaluar la desigualdad y la pobreza. La economía que asume el modelo de equilibrio general es una economía de mercado, en donde los agentes transan bienes y dotaciones entre ellos, esto implica que la definición de pobreza está determinada en términos del nivel de y/o gasto de cada uno de los agentes. Sin

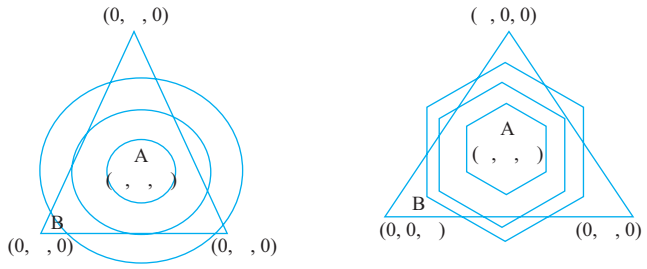
embargo, es importante advertir que pobres no solo son los que no alcancen a tener un determinado nivel de ingreso sino también aquellos a los que se les excluye del mercado, que no tienen acceso a ciertos derechos de propiedad, o el nivel de capacidades necesario que les permita acceder al mercado.

El anterior punto conduce a tener cuidado con las estadísticas que está utilizando el modelo para evaluar los efectos sobre la pobreza y la desigualdad. Blakorby y Donalson [1978], Maddock [1986] y Cowell [1998] muestran que cada índice completo de desigualdad tiene implícita una función de bienestar y cada función de bienestar social puede utilizarse para construir un índice de desigualdad. En este sentido, el modelo al utilizar diferentes medidas de distribución está haciendo diversos juicios éticos sobre la desigualdad, lo cual podría sesgar los resultados del efecto de diferentes choques macroeconómicos sobre la distribución del ingreso.

Bajo un mismo índice, varias funciones de bienestar social generan varias distribuciones del ingreso indiferentes entre sí [Maddock, 146]. En el caso del artículo, los efectos sobre la desigualdad se evalúan a través del coeficiente de GINI y el coeficiente de variación, estos indicadores asumen curvas de indiferencia distintas. Para entender esto, las curvas de indiferencia de cada uno de los indicadores, se dibujan en un *simplex*, en donde los vértices representan diferentes estados distributivos. Las curvas de indiferencia en el caso del GINI son en forma de pentágono, mientras que las del coeficiente de variación son círculos. En ambos casos, a medida que las curvas de indiferencia se acerquen al centro del *simplex,* la desigualdad se disminuye.

Tomemos, por ejemplo, el caso del siguiente conjunto de distribución, sobre cuatro alternativas posibles $(0, \alpha, 0)$, $(\alpha, 0, 0)$, $(0, 0, \alpha)$, (α, α, α), donde α representa el nivel total de ingreso. El punto *A* en ambos gráficos, es el mismo estado de distribución. En ambos indicadores, en una situación, por ejemplo, como la *B*, la tasa marginal de sustitución entre diferentes niveles de ingreso favorece a aquellos que tengan estructuras igualitarias del ingreso, y en consecuencia, penaliza a los de más bajos ingresos.

En tal sentido, a pesar de que el modelo replique una distribución exógena acorde con la estructura de la base de datos, los resultados que se utilizan para evaluar la desigualdad y la pobreza llevan implícitas consideraciones éticas que pueden generar un velo sobre los resultados; por lo tanto, desde el punto de vista teórico es conveniente utilizar el índice de entropía generalizada de Atkinson [1970], que



Fuente: Blackorby y Donalson (1978), Maddock (1986).

caracteriza la desigualdad a partir de una función de bienestar social que permita capturar el juicio de valor de quien está analizando la desigualdad en la distribución.

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