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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June 2, 2004

Abstract

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 result, this research intends to fulfill this gap by presenting a simple static applied general equilibrium model in which a micro-macro link is built by reconciling the 1997 quality of life survey data with aggregates of the national 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 uniform 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 qualitative and quantitative important, specially in measuring the inequality and poverty changes that can arise as response of exogenous shocks.

*The author thanks the comments of Juan Mauricio Ramírez, Alfredo Sarmiento, Alejandro Gaviria, Manuel Ramírez, John Cockburn, Juan Carlos Echeverry, Orlando Gracia, Gabriel Piraquive, Paula Jaramillo, Alvaro Perdomo and Oscar 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 responsibility of the author.

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 those years, policy makers 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 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 the 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, it is expected a significant rise of the public external debt service (thereby increases in the tax rates), social security costs and the deterioration of internal militar conflict.

Given all these changes in the economy, it is important to understand which chan-

[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)

[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).

nels 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 a function 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 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. microsimulations), 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 the welfare changes within and between these groups.

Therefore, the mentioned framework served to assess the effects over inequality and poverty of 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. 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 effects on welfare were largely negative even in

[6]Taken from Davies (2003).

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

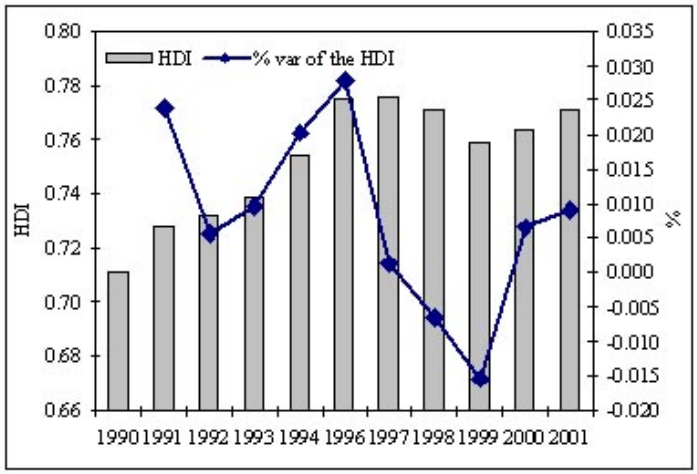
this partial analysis. Thus, even though the model is quite simple, the results are a point of departure in the analysis of the economic policies and macroeconomic shocks over income distribution variables.

The document is organized as follows. Section 1 presents a succinct outlook of the evolution of some socioeconomic indicators during the nineties. In section 2, a quick description about the existing methods to built the micro-macro link is given as preamble for the methodology in section 3. In this part, the database and the CGE model used for the simulations presented in section 4 are described in great detail. Section 5 presents some final remarks about this research and few ideas about the further works that can be done departing from this small step.

1 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 Program for the Development (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 (figure 1)[8].

Figure 1: Human Development Index (HDI)



[8]Particularly, health and education indicators improved due to changes caused by the Laws 60^{th} and 100^{th} of 1993. The former -modified by the Law 715^{th} 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.

According with *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 result of the rising unemployment and the economic crisis at the end of the decade. As result, 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 high in 1997 of 0.72[9]. Contrarily, illiterate population decreased from 10.8 to 7.5 during the same period of time.

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	80.4	84.2
Net enrollment	47.8	61.1	62.7
Difference	20.2	19.3	21.5

Source: Misión Social, DNP.

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 seemed that people of the first quintile with health insurance augmented from 528,283 people in 1993 to 3,248,955 people in 2000, with a peak in 1997 of 4,052,475.

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.

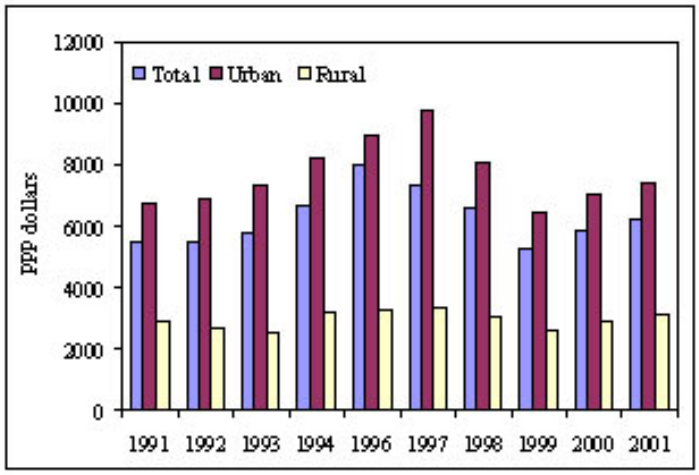
The life expectancy increased almost 4 years by passing from 67.8 in 1990 to 71.9 years

[9] *Misión Social* of the DNP.

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 population welfare. Per capita power parity purchase (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.

Figure 2: Per capita GDP (in PPP dollars)



Poverty rate diminished steadily until 1997 when the mentioned events broke the tendency and rose the indicator to almost 60% in 2000 (figure 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). In specific, 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 had their lowest values in 1997.

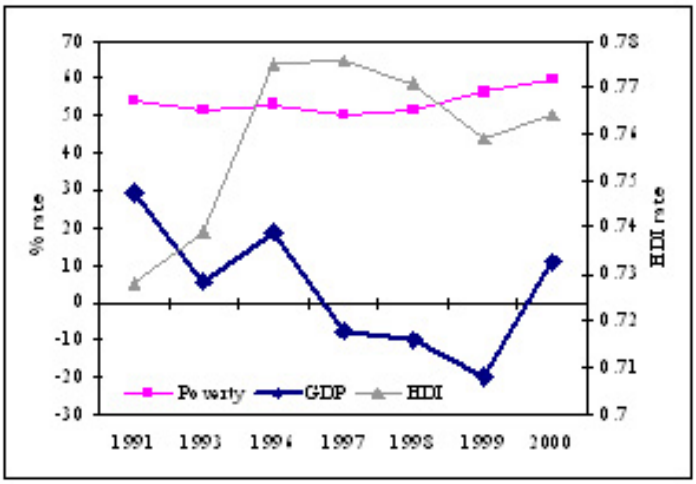
Table 3: Poverty Gap Rate

(%)	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, DNP.

[10]Ibid.

Figure 3: Poverty, HDI and growth rate of per capita GDP (in PPP dollars)



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.

Table 4: Rate of Poverty Severity

(%)	Total	Urban	Rural
1994	0.1021	0.2730	0.1547
1995	0.1058	0.2638	0.1504
1996	0.0925	0.3158	0.1660
1997	0.0627	0.2794	0.1340
1998	0.0977	0.3554	0.1620
1999	0.1188	0.3017	0.1650
2000	0.1457	0.3373	0.1870

Source: DANE, DNP.

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

2 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 instru-

ments depicts a shallow income distribution analysis, while other 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 allows 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].

Despite their utility, traditional CGE models -which relies 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 consequence, they cannot produce any kind of result 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), whom 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 or (b) by designing microeconomic models that interact with CGE and macro models (i.e. micro-macro link)[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

[11] Agénor et al. (2002).

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

[13] The methodology applies in countries or cases when there is not enough information to implement any of the following two techniques.

[14] As stated by Davies (2003), microeconomic behavioral models are essential in modelling the distributive effects of taxes and transfers, though lack of the broader view of the economic activity changes. Conversely, CGE and macro models 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.

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, between a few others.

Without a doubt, the work of Robilliard et al. (2001) represents better the first approach. The authors built in one side, a standard CGE model with the possibility of unemployment, in which they simulate the effects of policies over the households and 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 other 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 modelled in the CGE. This was solved by Savard (2003) by improving the 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, with econometric estimations to improve the microeconomic behaviors. Cogneau and Robilliard (2000) implemented this technique, modelling 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 modelling efforts, this study implements the second approach as the aggregation problem is solved directly, hence, allowing the existence of a unique equilibrium.

3 Methodology

3.1 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 always are not reconcilable.

In Colombia, there are just three surveys that almost fulfill the mentioned requirements: 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 accesible to the public during the initial stages of this study. Therefore, 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 accordingly 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. 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.

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, though a great detail in the tax structure was included[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].

[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 modelling. However, since they have to be complemented with additional microeconomic information, the probability of error increases.

[16]Living Standard Methodology.

[17]King (1985).

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

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

[20]Karl (2004).

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 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

Third, labor input was disaggregated according to socioeconomic characteristics that were considered relevant[22]: rural/urban, informal/formal 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),

[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 expenses was made.

[22] See appendix A.

- 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. Capital input account (K) was not modified since detailed information at the activity level about firm and household's decisions is not available.

Finally, household accounts were replaced by the aggregation of the microeconomic data obtained from the survey[23], following the methodology made by Cockburn and Cloutier (2002). As 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)[24]. This method has become popular because of its philosophy to bring all available information prior building the SAM data set, while keeping its fundamental accounting identities. 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 B, where an aggregation of the final SAM is also depicted (table 10).

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

3.2 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

[23]Though obvious, the information extracted from the 1997 survey was inflated to 2000 current prices.
[24]Taken from Jensen and Karl (2004). For a complete reference on the topic, see Fofana et al. (2002).

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, other studies such as Ramírez and Prada (1995 and 1996), Bussolo (1999), Ramírez et al. (1999) and Hernández et al. (2001), 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[25]. 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 (2002a,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[26].

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

[26] 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.

3.2.1 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 i sectors that produce two kind of goods: domestic consumption goods, D_i, and exports, E_i, which are imperfect substitutes and have a constant elasticity of substitution, η. Formally,

$$Y_i = \left[\gamma_i D_i^{\delta} + (1-\gamma_i) E_i^{\delta}\right]^{\frac{1}{\delta}}$$

where $\delta = 1 + \frac{1}{\eta}$ and γ_i is the domestic good share of total production supplied by sector i.

Notwithstanding, the production depends on the combination of intermediate goods and the value added from factor contributions. This can be described as

$$Y_i = \min\left[\min_j \left(\frac{x_{ji}}{a_{ji}}\right), \frac{v_i}{b_i}\right]$$

where

$$v_i = \left(\sum_n L_{ni}\right)^{\alpha} K_i^{\beta} \left(\sum_m MX_{mi}(L_i, K_i)\right)^{\zeta}$$

is the value added in sector i from n types of labor (L), capital (K) and m mixed composites of both factors ($MX(L,K)$); x_{ji} is the intermediate consumption good and (a_{ji} , b_i) are participation shares. It is assumed that $\alpha + \beta + \zeta = 1$. Tables 14 and 15 in annex C present the percentage composition of the value added.

Intermediate demand for good i is a CES Armington aggregation of domestic and imported varieties[27]:

$$A_i = \left(\nu_i M_i^{\theta} + (1-\nu_i) D_i^{\theta}\right)^{\frac{1}{\theta}}$$

where $\theta = 1 + \frac{1}{\sigma}$ and ν is the share of imports within the composite.

3.2.2 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

[27] Armington approach assumes that imported intermediate inputs demand is separable from domestic produced intermediate inputs. That is, firms first decide on how much inputs they should buy from the rest of the world (i.e. imports); then, they determine the optimal mix of imported and domestic goods given the import price. This allows to explain the demand for similar products without losing their basic difference (i.e. origin).

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

The mixed composite is classified in rural, urban informal and urban formal categories. Capital input is differentiated between sector specific and perfectly mobile in order to account some of the decreasing scale effects that exists in some activities; table 15 presents this disaggregation[28].

3.2.3 Households

The disaggregation of households within the CGE model is done according to the detail 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.

Household utility is depicted by a Cobb-Douglas index over i composite goods of domestic and imported varieties.

$$U(c^D, c^M) = \prod_i C_i(c_i^D, c_i^M)^{\alpha_i}$$

where the Armington good is defined as:

$$C_i(c_i^D, c_i^M) = \left[\beta_i \left(c_i^D\right)^\rho + (1-\beta_i)\left(c_i^M\right)^\rho\right]^{1/\rho}$$

and $\sigma_{DM} = \frac{1}{1-\rho}$ is the elasticity of substitution between domestic and imported goods.

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

$$\textbf{Max} \qquad U(c^D, c^M)$$

subject to

$$r(1-\tau_K)K + \sum_n w_n L_n(1-\tau_L) + \sum_m pmx_m(MX_m(L_n, K)) + B^H = \sum_i \left(p_i^D c_i^D + p_i^M c_i^M\right)(1+\tau_i^C) + \sum_i p_i^D \bar{I}_i$$

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

where K, L_n and MX_m are the capital, labor and mixed composite endowments; B^H, the transfers received from the rest of the world; c^D, the domestic good consumption; c^M, the imported good consumption; I^D, the domestic investment[29]; r, the rate of capital return; w_n, the wage rate for labor n; pmx_m, the price of the mixed composite m; p, the price of each type of consumption and investment; and τ^C, τ_K and τ_L are the tax rates for consumption, capital and labor earnings, respectively.

3.2.4 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, giving subsidies to some activities, and keeps constant its savings. Since it is not assumed as a maximizer agent, government's behavior is determined by the following identity:

$$\sum_i \tau_i^V VA_i + \sum_i p_i M_i \tau_i^M + \sum_i \left(p_i^D c_i^D + p_i^M c_i^M\right) \tau_i^C + \tau_K K + \sum_n w_n L_n \tau_L + DT + B^G = \sum_i \left(p_i^D G_i^D + p_i^M G_i^M\right) + govsav$$

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; G_i^D and G_i^M 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 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 (TP),
- labor taxes (TL),
- commercial and industrial taxes (TCM),

[29]Given the static nature of the model, resources destined to investment are fixed by a savings-driven assumption. This will be explained in detail in the market clearing section.

- other indirect taxes (TIF),
- other indirect taxes on production (TY)

In addition, the model includes sector (SSUB) and product (PSUB) subsidies. Tables 16 and 17 in annex C present the implicit tax rates and their revenues, respectively, in the benchmark.

3.3 Market Clearing and Zero Profit Condition

Market equilibrium requires that supply equal 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 and capital).

The market clearance condition for domestic output is:

$$D_i = \sum_j X_{ij}^D + c_i^D + G_i^D,$$

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

$$\sum_i MX_i = \sum_m MX_m$$
$$\sum_i L_i = \sum_n L_n$$
$$\sum_i K_i = K$$

Finally, the zero condition of the balance of payments requires that the value of the imports equals the value of exports plus the exogenous capital inflows (B):

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

where $B = B^H + B^G$. Note that $p^M = p^E = pfx$, which is the real exchange rate. In order to keep the total external savings (B) fixed, pfx have to be flexible.

Given the Arrow-Debreu framework -perfect competition and free entry assumptions, there is a zero excess profits in equilibrium. This implies that the output prices net of indirect taxes must equal the costs of primary factor inputs (gross of value-added tax), plus the total cost of intermediate inputs (gross of taxes on intermediate demand):

$$(1-\tau_i^Y)(p_i^D D_i + p_i^E E_i) =$$
$$(1+\tau_i^V)\left[rK_i + \sum_n w_n L_n i + \sum_m pmx_m MX_{mi}(K,L)\right] + \sum_j (1+\tau_{ji}^I)\left(p_j^D X_{ji}^D + p_j^M X_{ji}^M\right)$$

As $n-1$ markets are in equilibrium, the n^{th} market, investment, must equal total savings. In other words, the value of investment has to adjust to equal savings, which is fixed; this is what is call a "savings-driven" balance.

3.4 Elasticities

In any applied general equilibrium model, the elasticities represent an important aspect of the modelling 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, CET elasticities and value-added 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. Value-added elasticities are taken from Dimaranan et al (2002). Table 5 presents the mentioned parameters.

4 Simulations

By adopting this kind of CGE-microsimulations modelling, 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

[30] CET elasticities captures the relationship between production for the domestic market and for the rest of the world. Value-added elasticities establish the technologic composite relation between capital and labor factors within the production.

[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 and value-added elasticities were not statistically significant for most of the sectors though for the whole economy it was.

Table 5: Behavioral Parameters

	σ^1_{DM}	η^2	φ^3_{KL}
Agriculture, Livestock, Fishing and Forestry	0.54	0.286	0.24
Mining	0	1.624	0.2
Food industry	0.15	0.365	1.12
Textile industry	1.16	0.365	1.26
Wood industry	1.37	0.01	1.26
Paper industry	1.007	0.5	1.26
Chemistry industry	1.276	0.87	1.26
Mineral industry	0.243	0.86	1.26
Machinery	1.084	0.56	1.26
Other industry	1.295	0.365	1.26
Utilities	5.2	0.365	1.26
Construction and Building activities	0	0	1.26
Transportation	1.018	0.365	1.68
Communications	0.213	0.365	1.26
Financial services	1.9	0.365	1.26
Real estate	0.132	0.365	1.26
Social services	0.85	0.365	1.26

[1] Armington elasticities

[2] CET elasticities

[3] Value-added elasticities

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.), between others.

As 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)

[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).

- poor households with female heads and high dependency ratio (SGROUP05)
- poor households with more than 2 children of less 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 is defined in the usual manner, though poverty line is draw exogenously at PPP US$3.25, the observed level in 2000 according to the UNDP.

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 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 uniforming the VAT rates (VATSHK) as an economic decision to reduce the distortion of taxing differently each commodity (see table 16).

Finally, it is analyzed two consequences separately of the last recession. First, a 50% fall of the rest of the world inflows (ROWSHK) as 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 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 through 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 annex C. Simulations results are included in annex D.

It is important to note that any conclusion draw 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.

- *Unilateral reduction of tariffs by 50%*

One of the most common simulations in recent years with CGE models is the reduction of tariffs as 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 of

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

these policies given its basic assumptions of not considering international trade endogenously, imperfect competition, rigidities or specific functional forms for the productive sectors. However, the results are still quiet relevant in giving a direction and plausible lower bound of the possible changes in the Colombian economy[35].

In the model, a reduction in tariffs promoted an increase in imported goods and services, specially in sectors like agriculture, wood, textiles and the aggregation of other industries and utilities. Therefore, sectoral production fell in half of the cases (table 19), where the biggest change was observed in the activity "other industries" (-1.37%), basically, small low-tech manufacturing production. As result, the demand for primary factors of production diminished, and thus, an increase in their prices was observed (table 22), excluding rural inputs, which became cheaper.

Even though the rise in some sectoral production prices (table 23), 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 24 and 20, 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 26).

Given the fact that no income adjustments were made for the losses in tariff receipts, tax revenues were reduced in 3.2% (table 27). As shown in table 28, most of this loss was due to the sharp fall of tariff revenues (from 1.22% to 0.62% of the GDP). The rest of taxes adjusted accordingly to their correlation with the shock. Consequently, this loss of resources conveyed to a reduction in public expenditures (-2.94%).

The fall in commodity prices as 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 718.72 thousand of millions of pesos relative to the benchmark (table 30). Income distribution indicators did not show significant changes, though household variance coefficient -a measure of income dispersion, increased by 0.51% (table 33). Similarly, Gini coefficient rose half percentage point (0.56%) to 0.514.

The poverty head count ratio decreased 0.3%, similar to household count ratio, which varied -0.51% (table 33). The poverty gap for the whole sample fell 0.51%, while the poverty severity decreased 0.4%.

Within the analyzed households groups, all of them showed positive gains in welfare (tables 35 and 36). Poverty intensity had a general marginal reduction, particularly those with more than two children (of less than 6 years old) and those whose head works in the formal sector (-1.6%). Households located in rural areas and those whose head had an attained education lower than the average, were the most vulnerable to the policy. In fact, for both cases, the FGT measures showed marginal increases (table 34).

[35] 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.

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.

- *General VAT rate of 13%*

One of the most important recommendations of the 2002 National Income Mission was to uniform 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 seem in table 16, each commodity is subject to a different implicit rate given its technologic level and the tax laws. Hence, a uniform "nominal" VAT rate of 13% needs to be adjusted to the data. By using the implicit global rate depicted in table 17, it is assumed that the general implicit VAT rate was 4.5%.

In consequence, the new VAT rate should affect positively all those goods previously taxed with higher rates; conversely, commodities not subject previously to this tax or with a lower rate will be affected negatively. This is observed in table 19, where sectors such as textiles, paper industry, communication and financial services had sharp increases in their production. Agricultural activities, food industry, construction and utilities account some of the sectors that had their production diminished.

The augments in production, in conjunction with a rise in the consumer price index, promoted an increase in the exchange of goods and services with the rest of the world. The appreciation of the real exchange rate (-1.45%) seemed not enough to reverse some of the gains in output (table 20): exports fell in sectors such as agriculture (-2.76%), mining (-0.02%), food industries (-3.26%), chemical industries (-1.32%) and utilities (-1.15%)[36]. Comparatively, table 21 shows that imports increased in most activities, but particularly, in textiles (4.33%), wood industries (2.30%) and communications (9.18%).

Given the VAT rate was smaller than the average rate -and despite its broader base, its revenues fell more than 10% to 7.2 billions of pesos. Comparatively, the rise in imports was not reflected in increases of the tariff revenues; as well, the excise taxes did not augment, even though, most of the production activities increased its levels (table 27). The total

[36]Even though no elasticity analysis is presented here, it can be deducted that the positive results in exports with an appreciation of the real exchange rate are due to cross-price elasticities and expansion effects of the supply response.

tax revenue, net of subsidies, fell marginally from 17.88 to 17.18% of the GDP. Therefore, public expenditure decreased 3.6%.

As result of the adjustment in production, primary factor prices decreased, specially sharp for rural labor, which fell more than 5% (table 22). The prices of urban skilled non wage labor for both formal and informal segments were the only two that experienced positive results though marginally (0.1% and 0.5%, respectively). In addition, the rural mixed composite price had a significant fall of 5.9%, while the ones for urban informal and formal decreased 0.33% and 0.66%, in the same order. The price of capital fell 0.62% with respect to the benchmark.

As consequence of the mentioned fall in the primary factor prices, households income decreased, thus, rising the poverty. The total poor population increased almost 1%, while poor households rose 1.2% (table 33). The poverty gap varied marginally from 0.24 to 0.25, an increase of 3%. Poverty severity also had a positive variation by increasing from 0.142 to 0.147. Gini coefficient was basically constant (i.e. 0.05% variation).

Within the analyzed poverty groups, rural households were the biggest losers as their disposable income for consumption fell 4%. As result, not only their head count rose 1.7%, but also their gap grew 1.4% and the severity index augmented 2.3%. Households that belong to group 8 (i.e. whose head attained more education years than the average) were the second losers as their number increased by 1.4% and the severity augmented 3.3%. Households with more than two children increased their dispersion by a similar magnitude (3.1%), though their incidence within all poor diminished 0.35%.

As results stand, a uniform VAT rate smaller than the average had positive effects over the most of the production sector, while affecting negatively social welfare as no discrimination of commodities is done. In order words, as some positive consequences can improve the global welfare (table 30), some groups -specially those around the poverty line, will move downward and increase the general levels of poverty. Therefore, even though modifying an instrument such as this seems attractive, welfare changes are an important argument against its imposition.

- *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. Foreign savings enter in the model through fixed exogenous transfers to the domestic agents. In this sense, a reduction in the transfers 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, effects on investment are 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 25). Therefore, aggregate demand must fall: relative to the benchmark, total household consumption diminished 3.2 billions of pesos (-3.10%), while public expenditure fell 4.78%. GDP decreased 0.36% to 150.7 billions of pesos.

Given the contraction of the aggregate demand two effects are generated. First, a fall in the consumer price index that in turn, triggered a depreciation of the real exchange rate and, consequently, a promotion of exports and a reduction of the imports (tables 20 and 21, respectively).

Second, a contraction of the supply, which basically, increased the production prices and reduced the demand for primary factors; wages were adjusted downward given their inelasticity of supply (tables 22 and 23)[37].

Notwithstanding, the promotion of exports was not only compensated with deviations of goods destined to the domestic market but with an increase of the national production: textiles sector grew 6.69%; mining, 0.56%; chemical production, 9.16%; machinery, 12.02%. Comparatively, restaurant and hotel services fell 2.53% while social services -1.54%. More results are shown in table 19.

Given the fall in consumption, excise tax revenues fell drastically (-7.86%), while VAT receipts increased by 10.6% (table 27). Total net tax revenues grew 1.7% (from 27.0 to 27.5 billions of pesos).

As it can be seemed in table 31, this macroeconomic shock drove more people and households below the poverty line: the number of poor people and households grew 2.2% and 1.8%, respectively. Poverty gap increased 3.6%; poverty severity passed from 0.142 to 0.149, a rise of almost 4.9%. Within poverty groups, the households whose head worked in the formal sector and that had more schooling years than the average were the ones that showed the higher changes (table 34). For the former group, the number of people and households below the poverty line rose in both cases, more than 4%. The poverty gap and severity augmented 3.9% and 4.9%, respectively. The equivalent variation depicted a 5.7% reduction in the disposable resources for consumption.

Contrarily to what was expected, households with female head and high dependency ratio were the less vulnerable to the shock. The number of households and people below the poverty line fell 1% and 1.2%; incidence within all poor diminished 2.7%. Even though this group was affected as much as the rest (which can be observed in the augment of the poverty gap and severity), the fact that their income came exclusively from the returns of

[37]This kind of shock in a static model should not generate significant movements in inputs demand. Therefore in this sense, an adjustment in input prices is the adequate answer of the supply.

labor and mixed composite and from the exogenous transfers, made them less exposed to the consequences of the shock[38]. That is, given the flexibility in prices, the fall in factor prices was more than compensated by the rise in the real exchange rate.

The significant losses in welfare depicted in tables 34 to 36, conveyed improvements in the dispersion indicators as every household was worse off than in the benchmark. Household and individual variance coefficient diminished 5.7% and 5.2%, respectively. Gini coefficient increased 0.5% regarding the benchmark.

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.

- *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%[39]. Most of this imbalance was due to its size and increasing external obligations: payroll expenses represented 78.8% of total expenditure in 1999, a 47.6% increase from the observed levels in 1992; debt service increased from 9.7% to 24.7% for the same years.

Given the structure of the model, it is not possible to simulate the effects of an increase in the public consumption directly[40]. 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%[41]. 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[42].

Given this last assumption, public consumption was kept constant (table 29), while tax revenues rose 23.3%, mostly due to an increase in the VAT receipts of 88.9% (table 27). Conversely, other tax revenues from tariffs and indirect taxes on commodities, fell as result

[38] This conclusion was drawn from the analysis of the data and the model assumptions.

[39] DEE-DNP (2002).

[40] Based on the Arrow-Debreu framework, all markets are adjusted endogenously.

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

[42] 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.

of reductions in households consumption (-4.9%).

The augment of transfers to the rest of the world, the rise of taxes -specially the VAT, and the consequent reduction of the aggregate demand conveyed a depreciation of the real exchange rate (7.47%) as consumer prices fell. This in turns favored exports and affected negatively imports (tables 20 and 21). Most of the exports increased sharply: textiles grew 9.5% while machinery and chemical industry rose by 15.9% and 10.2%, respectively; mining sector depicted the smallest variation (0.46%).

Given the exports promotion effects, the negative behavior of imports and the significant increase in the VAT rates, beside the fall of private demand, domestic production showed mixed results. While textiles, chemicals and machinery increased their output significantly, sectors like food industry, communications, construction and other services changed negatively (table 19). For this simulation, GDP fell 0.33% to 150.7 billions of pesos (Table 26).

As consequence, supply for primary factors varied in favor of the promoted production sectors, thereby decreasing their prices. Table 22) shows that wages fell between 4.1% (for urban informal skilled non wage workers) and 5.1% (for urban informal unskilled non wage earners). The mixed composite prices decreased almost 4.3% for the rural input, 4.2% for the urban informal and 4.4% for the urban formal. The price of capital varied negatively 4.8%.

The fall in input prices -the main transmission mechanism, affected negatively the welfare of households, specially of the poor. The total income for the set of all households decreased 3.7 billions of pesos (table 30); the total loss for the poor was 598 thousand of millions of pesos or a 5.6% variation relative to the benchmark (tables 35 and 36). Table 34 shows that the most affected poor households were the ones whose head had an attained education greater than the average (3.9%), followed by those located in the rural areas of the country (1.3%).

Total poverty incidence rose for both households and individuals, in 2.1% and 2.2%, respectively. Poverty gap broadened more than 2.8% and severity got deeper by 3.6%. Comparatively, individual relative income measures increased 0.2%, while individual variance coefficient decreased in more than 2.3%; Gini coefficient varied 0.5% (table 33).

Within the poor, the number of households whose head has a higher than average education increased by almost 4%, followed by the formal and informal households (table 32). Poor households with more than two children augmented 1.3%, though their incidence within the total poor diminished in almost 1%. Similar situation was observed with households whose head has an attained education lower than the average level: the head and household count rose 1.9% and 1.5%, respectively; FGP(1) or poverty incidence within the total poor fell 0.6% (table 34).

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.

5 Concluding Remarks

This research have shown how straightforward is to link microeconomic information with a macroeconomic framework. More important, by combining the data from the 1997 quality of life survey and the 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 the lost tariff revenues with resources from the adjustment of 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 have not been taken into account.

A uniform 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 an important contribution 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 unem-

ployment, minimum wage or other relevant characteristics that the researcher considers key features of his/her analysis.

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A 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[43].

[43] 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

Table 6 shows the composition of the rural labor force by attained educational level. As it can be seem, 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.

Table 6: Rural labor force by attained educational level

Type of labor	Elementary or less	High school	Higher education
Wage worker	1,358,438	255,314	102,113
Non-wage worker	1,562,651	243,991	50,574
Wage worker	79%	15%	6%
Non-wage worker	84%	13%	3%

Labor force by informality clearly shows a different quantitative results given by attained educational level (table 7). 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, 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.

Table 7: Labor force by informality and attained educational level

Type of labor	Elementary or less	High school	Higher education
Formal wage worker	872,467	2,122,693	1,767,574
Formal non-wage worker	650,518	817,728	471,263
Informal wage worker	574,597	523,910	112,277
Informal non-wage worker	362,189	136,406	44,561
Formal wage worker	18.32%	44.57%	37.11%
Formal non-wage worker	33.54%	42.16%	24.30%
Informal wage worker	47.46%	43.27%	9.27%
Informal non-wage worker	66.68%	25.11%	8.20%

These facts become more evident if the analysis is made according to the labor force composition by activity (table 8). As it can be seem, 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 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[44].

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.

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

Table 8: Labor force by activity and attained educational level

Activity	Elementary or less	High school	Higher education	Total
Agriculture	87.81%	9.49%	2.70%	100.00%
Forestry	86.28%	13.72%	0.00%	100.00%
Fishing	78.09%	20.63%	1.28%	100.00%
Coal Mining	26.81%	39.60%	33.59%	100.00%
Oil Production	13.33%	36.72%	49.95%	100.00%
Metal Mining	94.23%	5.77%	0.00%	100.00%
Other Mining	80.42%	12.45%	7.13%	100.00%
Food production	40.84%	41.98%	17.18%	100.00%
Textiles	32.17%	53.69%	14.14%	100.00%
Wood Industry	39.85%	52.37%	7.78%	100.00%
Paper Industry	12.03%	53.95%	34.02%	100.00%
Chemical Industry	11.10%	54.86%	34.04%	100.00%
Mineral Production	35.37%	46.31%	18.32%	100.00%
Iron and Steel Industry	31.58%	53.89%	14.54%	100.00%
Machinery	29.09%	58.19%	12.72%	100.00%
Other Manufacturing Ind.	28.11%	56.27%	15.62%	100.00%
Electricity and Nat. Gas	20.51%	45.59%	33.89%	100.00%
Water and Sewage	16.56%	53.55%	29.89%	100.00%
Contruction	49.17%	39.41%	11.42%	100.00%
Wholesale commerce	18.34%	52.93%	28.73%	100.00%
Retail commerce	36.17%	49.57%	14.26%	100.00%
Restaurants	49.21%	38.94%	11.85%	100.00%
Transportation	34.11%	51.31%	14.58%	100.00%
Communications	15.21%	41.01%	43.77%	100.00%
Financial Services	3.19%	28.15%	68.66%	100.00%
Insurance Services	0.12%	28.28%	71.60%	100.00%
Real Estate	17.30%	34.62%	48.07%	100.00%
Armed Forces	8.28%	42.79%	48.93%	100.00%
Waste services	50.34%	28.47%	21.19%	100.00%
Social services	9.63%	33.91%	56.47%	100.00%
Fun Services	28.80%	47.91%	23.29%	100.00%
Repair Services	53.90%	36.69%	9.41%	100.00%
Int'l Organizations	0.00%	50.00%	50.00%	100.00%

B 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

is composed by workers with higher education.

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:

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

such that

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

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

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 was made in GAMS and the used solver was MINOS5, which seems to work better for this kind of routines. Tables 9 to 11 present aggregations of the unbalanced SAM, balanced SAM and the percentage adjustment between them.

C Forensic Analysis

In the benchmark, the model reports a GDP of 151.3 billions of pesos at current prices of 2000[45]. 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 12 depicts these results.

Table 13 shows the composition of each activity in terms of its production and trade size. As it can be seem, rural activities that include agriculture, forestry, fishing and livestock, assigns almost 80% of its production to the domestic market while exporting the rest, which

[45]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 adjust the SAM to the microeconomic information.

Table 9: 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		16,519,291
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	55,739,681	25,911,765	53,121,226	90,458,359	147,013,045	135,639,726	45,359,976	47,884,066	1,177,134,291

Table 10: 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 Income	25,911,025								739		25,911,765
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			79,567,881
Firms					37,965,342	24,344,446	66,654,506	4,186,389	5,698,583		138,849,267
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	55,739,681	25,911,765	52,902,071	79,567,881	138,849,267	135,639,726	38,866,467	54,914,656	1,188,483,175

Table 11: Percentage Adjustment

	Activities	commodities	Labor	Mixed Input	Capital	Government	Firms	Households	ROW	S - I	Total
Activities		(5.24)									(5.24)
Commodities	7.18					(34.92)	(91.88)	0.00	(14.03)	14.68	(1.94)
Labor	-								0.00		-
Mixed Input	56.86								-		56.86
Capital	(2.54)										(2.54)
Government	2.84	(3.12)			2.39	(1.82)	(7.64)	(0.00)			(3.53)
Firms					(0.94)	14.92	3.58	-	(0.66)		3.79
Households			0.00	-	-	(0.00)	(0.00)				-
ROW		12.75	0.00				10.67	(0.00)	(0.12)		14.87
S - I						40.80	(48.89)	0.00	62.20	14.68	(11.59)
Total	6.69	(3.32)	0.00	-	(0.41)	(12.04)	(5.55)	-	(14.32)	14.68	0.96

Table 12: 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

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.

Tables 14 and 15 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 16 presents the implicit rates by activity[46]; table 17 reports for each instrument, the tax base, revenue and global implicit rate. As observed in table 17, 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 revenue was more than 3 times the labor tax revenues (8.2 billions of pesos), which is 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 of the household receipts with respect to the households' mean income. As table 18 shows, the benchmark data replicates quite well the

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

Table 13: Production Shares (%)

	D/(D+X)	M/(D+M)	X/(D+M)	Y/GDP	X/SUM(X)
Agriculture, Livestock, Fishing and Forestry	78.21	13.44	64.22	8.56	15.53
Mining	29.36	15.78	92.77	6.38	36.94
Food industry	88.11	8.47	59.31	8.36	8.12
Textile industry	69.38	28.55	52.49	2.79	6.98
Wood industry	93.70	4.36	59.58	0.37	0.19
Paper industry	87.93	23.11	31.34	1.88	1.85
Chemistry industry	66.00	50.82	33.26	3.60	10.00
Mineral industry	80.49	33.02	32.96	2.58	4.12
Machinery	69.95	80.75	9.29	1.55	3.81
Other industry	83.59	35.48	26.31	1.57	2.11
Utilities	99.22	2.47	23.71	4.90	0.31
Construction and Building activities	100.00	0.00	0.00	5.86	0.00
Transportation	83.91	17.88	46.82	6.07	7.99
Communications	93.30	5.37	55.87	1.95	1.07
Financial services	98.67	7.92	13.55	4.30	0.47
Real estate	100.00	0.00	0.00	3.47	0.00
Social services	99.82	1.62	9.64	35.80	0.51

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

mentioned indicators given the evidence depicted in the works of Baldión and Nina (2001), Baldión (2001) and the World Bank (2002).

Table 14: Labor Shares of Value Added (%)

	REM01	REM02	REM03	REM04	REM05	REM06	REM07	REM08	REM09	REM10
Agriculture, Livestock, Fishing and Forestry	36.2	3.6	3.9	0.0	0.0	0.0	3.8	0.4	0.8	0.0
Mining	0.7	0.0	0.0	0.0	0.0	0.0	2.4	10.1	0.0	0.0
Food industry	1.8	0.0	1.9	0.0	0.1	0.0	17.4	14.9	2.1	0.0
Textile industry	0.5	0.2	4.8	0.0	0.2	1.4	29.4	12.9	1.3	0.6
Wood industry	1.9	1.7	17.0	0.0	7.0	0.0	24.4	7.8	0.4	16.3
Paper industry	0.3	0.0	0.3	0.0	0.0	0.0	26.2	18.4	0.0	0.0
Chemistry industry	0.3	0.0	0.2	0.0	0.0	0.0	13.7	22.1	0.5	0.7
Mineral industry	3.0	0.1	0.1	0.0	0.1	0.0	19.4	24.0	0.0	0.0
Machinery	2.2	0.0	6.1	0.0	1.2	0.4	41.0	17.4	0.8	0.0
Other industry	0.0	0.0	0.3	0.0	0.1	0.0	5.5	1.1	0.0	0.0
Utilities	0.6	0.1	0.0	0.0	0.0	0.0	7.0	10.5	0.0	0.4
Construction and Building activities	1.9	0.4	2.5	0.3	0.6	0.0	13.4	11.0	0.4	0.2
Transportation	0.9	0.2	3.9	0.0	0.7	0.0	17.7	12.2	2.3	1.5
Communications	0.5	0.0	0.9	0.0	0.0	0.0	8.8	15.8	0.0	0.0
Financial services	0.2	0.0	0.2	0.0	0.0	0.3	8.7	31.3	0.8	0.6
Real estate	0.5	0.0	0.5	0.3	0.0	0.1	12.1	19.3	0.8	4.2
Social services	3.0	0.3	4.4	0.1	0.7	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), urban formal non skilled non wage work (REM08), urban formal skilled wage work (REM09), and urban formal skilled non wage work (REM10).

Table 15: Mixed Composite and Capital Shares of Value Added (%)

	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
Chemistry industry	0.0	0.6	1.4	23.0	37.5
Mineral 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 16: Implicit Tax Rates (%)

	PYRL	TM	TXS	VAT	TP	TCM	TIF	TY	SSUB	PSUB
Agriculture, Livestock, Fishing and Forestry	0.00	13.56	0.00	0.01	1.85	0.00	0.04	0.03	0.00	0.39
Mining	6.76	1.62	15.05	14.50	0.25	0.25	0.50	0.00	0.20	0.01
Food industry	2.40	7.95	4.29	5.15	0.00	0.82	0.60	0.00	0.00	0.13
Textile industry	2.33	6.61	0.00	10.95	0.00	0.58	0.42	0.00	0.00	0.24
Wood industry	0.24	4.61	0.00	1.04	0.00	0.20	0.14	0.00	0.00	0.11
Paper industry	4.44	3.96	0.00	8.83	0.00	0.76	0.59	0.00	0.00	0.08
Chemistry industry	3.96	3.87	0.00	4.23	0.00	0.70	0.50	0.00	0.00	0.37
Mineral industry	3.33	4.49	0.00	7.80	0.00	0.78	0.60	0.00	0.00	0.16
Machinery	2.47	4.86	0.01	10.64	0.00	0.63	0.49	0.00	0.00	0.03
Other industry	40.40	8.85	0.00	12.32	0.00	0.84	0.64	0.00	0.00	0.08
Utilities	5.96	3.35	0.00	0.00	0.00	0.01	0.47	0.07	1.00	0.00
Construction and Building activities	0.81	0.00	0.00	0.00	0.18	0.43	0.40	0.00	0.11	0.00
Transportation	1.48	0.14	0.10	2.23	0.00	0.54	0.62	0.06	0.00	0.00
Communications	6.93	0.00	0.00	25.01	0.00	0.56	0.62	0.13	0.22	0.00
Financial services	6.46	0.00	0.00	9.57	0.00	1.15	0.91	0.16	3.37	0.00
Real estate	0.00	0.00	0.00	0.13	0.00	0.40	0.03	0.00	0.00	0.00
Social services	2.41	0.00	0.02	1.01	0.00	0.78	0.40	0.09	0.12	0.00

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).

Table 17: Benchmark Tax Summary

(Thousand of millions of pesos)

	Tax Base	Revenue	Global Rate (%)
Payroll taxes	55,730.04	1,402.61	2.52
Tariffs	37,528.93	1,839.72	4.90
Excise taxes	284,401.48	2,911.67	1.02
Value added taxes	156,954.32	8,151.69	5.19
Social-contribution taxes	260,136.77	481.69	0.19
Labor taxes	55,730.04	1,407.15	2.52
Commercial and industrial taxes	265,574.75	1,578.55	0.59
Other indirect taxes on commodities	265,574.75	1,174.71	0.44
Other indirect taxes on production	265,574.75	138.90	0.05
Sectorial subsidies	265,574.75	-710.32	0.00
Product subsidies	284,401.48	-257.49	-0.09

Table 18: Poverty and Income Distribution Indicators

	Indicator
Poor people	19,672,967
Poor Households	4,490,298
Individual Incidence	0.516
Household Incidence	0.494
Poverty Gap	0.244
Poverty Severity	0.142
Individual Relative Deviation	0.708
Household Relative Deviation	0.753
Individual Variance Coefficient	207.319
Household Variance Coefficient	2,354.332
Gini Coefficient	0.513

D Simulation Results

D.1 Sectoral results

Table 19: Production (% Variation)

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Agriculture, Livestock, Fishing and Forestry	0.00	-0.16	-3.19	-0.73	0.05
Mining	0.00	0.07	0.12	0.56	0.46
Food industry	0.00	-0.25	-2.54	-2.20	-1.06
Textile industry	0.00	-0.39	4.88	6.69	5.67
Wood industry	0.00	-0.31	0.27	1.22	1.21
Paper industry	0.00	-0.48	2.48	0.07	-0.09
Chemistry industry	0.00	0.15	-1.08	9.16	7.21
Mineral industry	0.00	0.29	0.85	4.12	2.83
Machinery	0.00	-0.10	3.54	12.02	11.44
Other industry	0.00	-1.37	3.47	2.09	2.56
Utilities	0.00	0.08	-1.10	0.41	-0.33
Construction and Building activities	0.00	0.06	-0.29	-0.61	-0.45
Transportation	0.00	0.37	0.93	3.34	1.30
Communications	0.00	0.17	6.77	-0.22	-2.57
Financial services	0.00	0.37	3.19	2.01	0.36
Real estate	0.00	0.13	-0.97	-2.53	-0.81
Social services	0.00	-0.05	-0.34	-1.54	-1.13

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

Table 20: Exports (% Variation)

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Agriculture, Livestock, Fishing and Forestry	0.00	0.19	-2.76	2.62	2.33
Mining	0.00	0.05	-0.02	0.28	0.46
Food industry	0.00	0.16	-3.26	2.16	2.80
Textile industry	0.00	0.03	4.73	10.51	9.39
Wood industry	0.00	-0.30	0.30	1.38	1.34
Paper industry	0.00	0.10	2.64	5.86	5.13
Chemistry industry	0.00	1.06	-1.32	13.19	10.24
Mineral industry	0.00	1.32	2.71	13.30	9.58
Machinery	0.00	0.62	4.28	16.72	15.91
Other industry	0.00	-0.82	3.34	5.57	6.40
Utilities	0.00	0.53	-1.15	4.62	2.15
Transportation	0.00	0.80	2.10	6.77	2.61
Communications	0.00	0.55	3.36	4.64	4.16
Financial services	0.00	0.85	3.53	7.29	4.65
Social services	0.00	0.41	-0.39	3.16	2.25

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

Table 21: Imports (% Variation)

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Agriculture, Livestock, Fishing and Forestry	0.00	2.24	-4.34	-9.49	-6.00
Mining	0.00	0.10	0.46	1.26	0.49
Food industry	0.00	0.08	-2.00	-4.50	-3.13
Textile industry	0.00	1.13	4.33	-13.59	-13.80
Wood industry	0.00	0.88	2.30	-16.92	-13.66
Paper industry	0.00	0.31	1.60	-10.17	-9.52
Chemistry industry	0.00	0.02	-0.27	-2.91	-1.95
Mineral industry	0.00	0.15	0.02	-0.67	-0.42
Machinery	0.00	0.16	0.79	-3.27	-3.28
Other industry	0.00	2.32	2.95	-10.44	-12.12
Utilities	0.00	2.21	0.36	-44.13	-29.36
Transportation	0.00	-1.05	-3.19	-8.23	-3.32
Communications	0.00	-0.09	9.18	-3.54	-7.11
Financial services	0.00	-2.13	1.44	-21.95	-19.63
Social services	0.00	-1.12	-0.17	-11.62	-8.57

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

Table 22: Factor Prices (% Variation)

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Rural salaried work	0.00	-0.13	-5.26	-3.85	-4.55
Rural non wage work	0.00	-0.15	-5.45	-3.87	-4.55
Urban informal non skilled wage work	0.00	0.07	-0.73	-2.51	-4.35
Urban informal non skilled non wage work	0.00	0.15	-0.96	-3.69	-5.08
Urban informal skilled wage work	0.00	0.09	-0.56	-2.43	-4.32
Urban informal skilled non wage work	0.00	0.06	0.50	-1.56	-3.63
Urban formal non skilled wage work	0.00	0.12	-0.11	-1.77	-3.88
Urban formal non skilled non wage work	0.00	0.19	0.09	-1.90	-4.14
Urban formal skilled wage work	0.00	0.13	-0.81	-2.28	-4.23
Urban formal skilled non wage work	0.00	0.16	-0.67	-2.61	-4.34
Rural mixed composite	0.00	-0.13	-5.90	-3.57	-4.29
Urban informal mixed composite	0.00	0.14	-0.33	-2.12	-4.22
Urban formal mixed composite	0.00	0.12	-0.66	-2.49	-4.39
Capital	0.00	0.14	-0.62	-2.97	-4.82

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

Table 23: Price of Production (% Variation)

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Agriculture, Livestock, Fishing and Forestry	0.00	0.17	-2.97	0.04	-0.71
Mining	0.00	1.41	-1.37	12.58	7.48
Food industry	0.00	0.30	0.75	0.28	-2.83
Textile industry	0.00	0.23	-1.62	0.87	-3.21
Wood industry	0.00	0.12	-0.12	-1.76	-3.56
Paper industry	0.00	0.39	-2.03	2.22	-1.46
Chemistry industry	0.00	0.34	-1.13	7.32	3.73
Mineral industry	0.00	0.16	-3.33	2.31	0.34
Machinery	0.00	0.12	-2.86	3.98	-0.29
Other industry	0.00	0.26	-1.64	3.55	-2.27
Utilities	0.00	0.17	-1.19	0.50	0.63
Construction and Building activities	0.00	0.17	-2.07	0.53	-0.04
Transportation	0.00	0.23	-4.57	2.64	3.68
Communications	0.00	0.36	7.70	-1.37	-10.50
Financial services	0.00	0.09	-2.32	-2.15	-4.19
Real estate	0.00	0.14	-0.82	-2.42	-4.05
Social services	0.00	0.13	-1.27	-1.03	-1.96

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

Table 24: Real Exchange Rate (% Variation)

BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
0.00	1.40	-1.45	12.38	7.47

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

Table 25: Row Transfers (% Variation)

BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
0.00	1.26	-1.42	-24.83	-19.50

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

Table 26: Gross Domestic Product

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
LEVEL*	151,254.86	151,268.16	151,367.95	150,707.80	150,749.60
CHANGE(%)	0.00	0.01	0.07	-0.36	-0.33

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

* Values in thousand of millions of pesos.

D.2 Public Finance Results

Table 27: Total Tax Revenue

(Thousand of millions of pesos)

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Payroll taxes	1,402.61	1,405.27	1,417.68	1,385.53	1,347.91
Tariffs	1,839.72	940.56	1,809.41	1,938.91	1,871.99
Excise taxes	2,911.67	2,924.77	2,876.76	2,682.56	2,885.20
Value added taxes	8,151.69	8,152.15	7,273.00	9,013.06	12,710.88
Social-contribution taxes	481.69	482.39	455.49	484.24	482.05
Labor taxes	1,407.15	1,408.81	1,396.72	1,377.14	1,349.42
Tax on capital	8,930.27	8,942.48	8,874.70	8,664.65	8,499.72
Commercial and industrial taxes	1,578.55	1,581.55	1,563.10	1,591.44	1,558.99
Other indirect taxes on commodities	1,174.71	1,178.05	1,163.98	1,199.64	1,171.01
Other indirect taxes on production	138.90	139.18	137.81	137.15	135.00
Sectorial subsidies	-710.32	-713.23	-710.09	-712.56	-693.08
Product subsidies	-257.49	-258.37	-255.89	-262.39	-260.59
TOTAL	27,049.15	26,183.60	26,002.67	27,499.35	31,058.51

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

Table 28: Tax Revenue Share of GDP

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Payroll taxes	0.93	0.93	0.94	0.92	0.89
Tariffs	1.22	0.62	1.20	1.29	1.24
Excise taxes	1.93	1.93	1.90	1.78	1.91
Value added taxes	5.39	5.39	4.80	5.98	8.43
Social-contribution taxes	0.32	0.32	0.30	0.32	0.32
Labor taxes	0.93	0.93	0.92	0.91	0.90
Tax on capital	5.90	5.91	5.86	5.75	5.64
Commercial and industrial taxes	1.04	1.05	1.03	1.06	1.03
Other indirect taxes on commodities	0.78	0.78	0.77	0.80	0.78
Other indirect taxes on production	0.09	0.09	0.09	0.09	0.09
Sectorial subsidies	-0.47	-0.47	-0.47	-0.47	-0.46
Product subsidies	-0.17	-0.17	-0.17	-0.17	-0.17
TOTAL	17.88	17.31	17.18	18.25	20.60

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

Table 29: Public Expenditure (% Variation)

BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
0.00	-2.94	-3.61	-4.78	0.00

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

D.3 Household results

Table 30: Total Households Welfare - Equivalent Variation

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Total Gains*	0.00	718.72	901.56	-3,268.49	-3704.90
% variation	0.00	0.68	0.86	-3.10	-3.52

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

* Values expressed in thousand of millions of pesos

Table 31: Poverty and Inequality Measures – All Households

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Poor Population	19,672,967	19,614,533	19,858,834	20,114,978	20,100,818
Poor Households	4,490,298	4,467,418	4,543,317	4,572,451	4,586,698
Incidence	0.494	0.491	0.499	0.503	0.504
Gap	0.244	0.243	0.251	0.253	0.251
Severity	0.142	0.141	0.147	0.149	0.147
Individual Relative Deviation	0.708	0.708	0.711	0.710	0.709
Household Relative Deviation	0.753	0.753	0.760	0.755	0.755
Individual Variance Coefficient	207.319	208.372	206.744	196.455	202.635
Household Variance Coefficient	2,354.332	2,367.439	2,354.256	2,220.559	2,304.909
Gini Coefficient	0.513	0.514	0.513	0.516	0.516

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

Table 32: Poverty Measures Changes (%) per Household Groups

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Poor informal households - SGROUP01					
Poor Population	3,280,867	3,239,849	3,323,665	3,283,892	3,382,804
Poor Households	857,252	852,684	868,862	866,438	877,587
Incidence*	0.191	0.191	0.191	0.189	0.191
Gap*	0.050	0.050	0.051	0.051	0.051
Severity*	0.026	0.026	0.026	0.027	0.026
Poor informal households with female head - SGROUP02					
Poor Population	622,427	615,279	622,941	627,756	627,756

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 32: Poverty Measures Changes (%) per Household Groups (continued...)

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Poor Households	198,218	195,908	198,806	198,195	198,195
Incidence*	0.044	0.044	0.044	0.043	0.043
Gap*	0.015	0.015	0.015	0.015	0.015
Severity*	0.008	0.008	0.009	0.009	0.008
Poor rural households - SGROUP03					
Poor Population	7,663,986	7,653,794	7,794,545	7,779,027	7,795,526
Poor Households	1,805,376	1,802,900	1,829,451	1,824,668	1,829,387
Incidence*	0.402	0.404	0.403	0.399	0.399
Gap*	0.274	0.274	0.277	0.277	0.274
Severity*	0.165	0.165	0.169	0.169	0.167
Poor formal households - SGROUP04					
Poor Population	3,012,345	2,959,356	3,039,418	3,154,233	3,087,974
Poor Households	836,644	823,582	846,632	870,820	858,724
Incidence*	0.186	0.184	0.186	0.190	0.187
Gap*	0.047	0.047	0.048	0.048	0.048
Severity*	0.022	0.022	0.023	0.023	0.023
Poor households with female head and high dependency ratio - SGROUP05					
Poor Population	712,577	701,401	718,418	704,027	715,003
Poor Households	181,074	177,987	183,021	179,301	182,338
Incidence*	0.040	0.040	0.040	0.039	0.040
Gap*	0.017	0.017	0.017	0.017	0.017
Severity*	0.010	0.010	0.010	0.010	0.010
Poor households with more than 2 children - SGROUP06					
Poor Population	4,687,217	4,655,620	4,728,628	4,743,983	4,750,325
Poor Households	787,602	781,833	794,130	794,005	796,674
Incidence*	0.175	0.175	0.175	0.174	0.174
Gap*	0.079	0.079	0.080	0.080	0.079
Severity*	0.042	0.042	0.044	0.044	0.043
Poor households - attained education lower than average - SGROUP07					
Poor Population	13,447,904	13,373,307	13,633,773	13,655,787	13,705,352
Poor Households	3,352,231	3,340,486	3,389,559	3,399,309	3,403,969
Incidence*	0.747	0.748	0.746	0.743	0.742
Gap*	0.377	0.377	0.382	0.382	0.379
Severity*	0.225	0.225	0.230	0.231	0.228
Poor households - attained education higher than average - SGROUP08					
Poor Population	3,807,854	3,767,416	3,858,077	3,939,466	3,974,635
Poor Households	1,138,067	1,126,932	1,153,758	1,173,142	1,182,729

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 32: Poverty Measures Changes (%) per Household Groups (continued...)

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Incidence*	0.253	0.252	0.254	0.257	0.258
Gap*	0.070	0.070	0.072	0.073	0.072
Severity*	0.034	0.034	0.035	0.036	0.035

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 33: Poverty Measure Changes (%) – All Households

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Poor Population	0.000	-0.297	0.945	2.247	2.175
Poor Households	0.000	-0.510	1.181	1.830	2.147
Gap	0.000	-0.510	2.995	3.564	2.861
Severity	0.000	-0.401	3.878	4.891	3.550
Individual Relative Deviation	0.000	-0.446	0.383	0.268	0.117
Household Relative Deviation	0.000	0.028	0.957	0.243	0.239
Individual Variance Coefficient	0.000	0.076	-0.277	-5.240	-2.259
Household Variance Coefficient	0.000	0.508	-0.003	-5.682	-2.099
Gini Coefficient	0.000	0.557	0.050	0.491	0.544

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

Table 34: Poverty Measures Changes (%) per Household Groups

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Poor informal households - SGROUP01					
Poor Population	0.000	-1.250	1.304	0.092	3.107
Poor Households	0.000	-0.533	1.354	1.072	2.372
Incidence*	0.000	-0.023	0.172	-0.744	0.221
Gap*	0.000	-0.120	1.409	2.401	1.701
Severity*	0.000	-0.178	2.660	4.236	2.639

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 34: Poverty Measures Changes (%) per Household Groups (continued...)

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Poor informal households with female head - SGROUP02					
Poor Population	0.000	-1.148	0.083	0.856	0.856
Poor Households	0.000	-1.165	0.297	-0.012	-0.012
Incidence*	0.000	-0.659	-0.874	-1.808	-2.113
Gap*	0.000	0.032	0.743	1.093	0.679
Severity*	0.000	-0.006	2.125	2.553	1.615
Poor rural households - SGROUP03					
Poor Population	0.000	-0.133	1.704	1.501	1.716
Poor Households	0.000	-0.137	1.334	1.069	1.330
Incidence*	0.000	0.374	0.151	-0.747	-0.800
Gap*	0.000	0.087	1.359	1.203	0.265
Severity*	0.000	0.023	2.259	2.707	1.063
Poor formal households - SGROUP04					
Poor Population	0.000	-1.759	0.899	4.710	2.511
Poor Households	0.000	-1.561	1.194	4.085	2.639
Incidence*	0.000	-1.057	0.013	2.215	0.482
Gap*	0.000	-0.214	2.387	3.918	2.904
Severity*	0.000	-0.229	3.489	4.971	3.711
Poor households with female head and high dependency ratio - SGROUP05					
Poor Population	0.000	-0.674	0.820	-1.200	0.340
Poor Households	0.000	-0.732	1.075	-0.979	0.698
Incidence*	0.000	-0.224	-0.104	-2.758	-1.418
Gap*	0.000	-0.052	0.961	1.476	0.354
Severity*	0.000	-0.106	2.234	3.177	1.407
Poor households with more than 2 children - SGROUP06					
Poor Population	0.000	-1.568	0.883	1.211	1.346
Poor Households	0.000	-1.705	0.829	0.813	1.152
Incidence*	0.000	-1.201	-0.348	-0.998	-0.974
Gap*	0.000	-0.028	1.929	2.105	1.102
Severity*	0.000	-0.064	3.109	3.763	2.044
Poor households - attained education lower than average - SGROUP07					
Poor Population	0.000	-0.555	1.382	1.546	1.914
Poor Households	0.000	-0.350	1.114	1.404	1.543
Incidence*	0.000	0.160	-0.066	-0.418	-0.591
Gap*	0.000	0.060	1.175	1.223	0.388
Severity*	0.000	0.007	2.087	2.532	1.116
Poor households - attained education higher than average - SGROUP08					

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 34: Poverty Measures Changes (%) per Household Groups (continued...)

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Poor Population	0.000	-1.062	1.319	3.456	4.380
Poor Households	0.000	-0.978	1.379	3.082	3.924
Incidence*	0.000	-0.471	0.196	1.230	1.740
Gap*	0.000	-0.189	2.428	3.992	2.618
Severity*	0.000	-0.230	3.254	5.774	3.369

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 35: Income Gain or Loss

(Thousand of millions of pesos)

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Total Poor	0.000	64.139	-372.186	-739.435	-598.843
SGROUP01	0.000	15.371	-54.836	-135.852	-121.872
SGROUP02	0.000	2.986	-15.986	-27.677	-25.299
SGROUP03	0.000	19.810	-198.600	-272.953	-204.359
SGROUP04	0.000	15.216	-55.001	-180.074	-137.961
SGROUP05	0.000	11.573	-74.876	-139.292	-112.149
SGROUP06	0.000	2.542	-12.610	-24.550	-21.248
SGROUP07	0.000	46.659	-290.654	-491.141	-398.728
SGROUP08	0.000	17.480	-81.532	-248.294	-200.115

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

Table 36: Income Percentage Change (%)

	BENCH	TARIFF	VATSHK	ROWSHK	GOVSHK
Total Poor	0.000	0.288	-3.610	-6.396	-5.571
SGROUP01	0.000	0.312	-3.065	-5.763	-5.440
SGROUP02	0.000	0.277	-3.566	-5.471	-5.470
SGROUP03	0.000	0.260	-4.014	-6.643	-5.539
SGROUP04	0.000	0.335	-2.827	-5.777	-5.624
SGROUP05	0.000	0.321	-3.784	-6.023	-5.491
SGROUP06	0.000	0.334	-3.346	-5.360	-4.567
SGROUP07	0.000	0.286	-3.728	-6.434	-5.545
SGROUP08	0.000	0.297	-3.156	-6.250	-5.669

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