FUNDACION PARA LA EDUCACION SUPERIOR Y EL DESARROLLO

EQUITY AND EFFICIENCY COSTS OF RAISING TAX REVENUE IN COLOMBIA

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Abstract

This paper examines the Colombian tax system as it is represented in the 1997 social accounts. We implement an economic model based on these data and evaluate the welfare cost of raising additional government revenue. Our model includes several income classes, permiting us to consider both the efficiency and equity consequences of tax changes. We implement a money-metric social welfare function to to evaluate the economic cost of public funds obtained through capital income taxes, excise taxes, import tariffs, and value-added taxes. Selected value added and excise tax reforms represent efficient and equitable sources of additional public revenue in both the short- and long-run. Independent of the need for additional revenue, economic efficiency could be improved through the adoption of more uniform tariffs and value-added taxes, but some movements toward uniformity may adversely affect poorer households.

JEL classification: D58, H22
Key words: Tax incidence, Applied general equilibrium

1 Introduction

In this paper we explore the economic consequences of raising additional public funds in Colombia. Our analysis is motivated by a directive from the "Mission for Public Income" which is managed by the Fedesarrollo. The mission itself was developed in response to persistent fiscal deficits over the last five years. Two chapters in this volume describe the Colombian fiscal situation: Bird, Poterba, and Slemrod discuss the current deficit and debt, while Arbelaez and Roubini consider debt sustainability. In general, they find that tax revenues should increase by about 2% of GDP in order to maintain fiscal stability. Our work considers how it might be possible to raise these funds.

Two percent of GDP represents 3.4 trillion Colombian pesos[1] or approximately 1.6 billion US dollars. If this burden is spread equally across households, the additional burden equals $38 per head or $177 per family per year. An average calculation such as this may be misleading because there is a high degree of income inequality in Colombia. Income for the poorest 10% of the population is 1% of GDP, and income for the richest 10% of the population is 44% of GDP. If we calculate the approximate burden proportional to income rather than population, the poorest decile would need to contribute about $13 per household per year, while the richest households would contribute $1,120 per household.[2] This paper reports on calculations which provide more precise calculations of these "back of the envelope" estimates. Any change in tax rates induces changes in the prices of both goods and factors, resulting in heterogeneous impacts on households, depending on their sources of income and expenditure patterns. Tax reforms interact with the existing tax base. Consistent evaluation of economic effects requires a model which portrays various tax instruments and the behavioral responses of consumers and producers.

To quantify the burden of higher taxes we consider a wide range of tax-scenarios. Our ultimate goal is to charaterize a *sustainable* combination of taxes which will eliminate the current fiscal shortfall at least cost. There are a

variety of angles from which "least-cost" can be defined. The usual efficiency concerns tend to favor those tax instruments which apply to a broad base of goods, in particular those goods which have a relatively low elasticity of demand. Equity concerns prompt us to also consider how consumption patterns and factor earnings differ between the rich and the poor in Colombia. Each tax reform we consider has a different impact for the rich versus the poor. The source of these household differences depends on two separate channels: consumption and factor income. Differences in consumption bundles imply that changes in goods prices have heterogeneous impacts on households. Differences in sources of income also imply that the welfare cost of tax reforms for an individual household will depend on factor price impacts. In some scenarios we compute the relative importance of each channel in order to decompose our estimates. Tax-sustainability is yet another angle to consider. To identify how the revenue yield and tax-burden might evolve over time we calculate short-run and steady-state outcomes for various tax scenarios. Short-run optimal taxes invariably point to capital income taxation because in the short-run, both investment and capital stock are fixed. However, in the long-run, investment and capital stock are highly responsive to the rate of return. Optimal tax reforms in the steady-state tend to avoid income/capital levies because the investment response is large and polies which reduce aggregate income lower output and welfare for rich and poor alike.

Value-added taxes appear to be the most useful instrument to raise additional funds. The average cost of funds for increases in VAT taxes is low in both the short and long time horizons. One reason for the lower cost is that the tax base for the VAT is about three times larger than for other taxes. A VAT reform which eliminates "exemptions" (zero tax for certain commodities) increases tax efficiency and raises substantial revenues, but it is somewhat regressive because most of the current exemptions are for basic food and shelter, goods which constitute a large share of income for the poor. If we measure efficiency with a utilitarian welfare metric which sums consumption impacts equally across households, the average cost of funds in the long run is relatively low (1.15) for the VAT reform.

Consumption falls by 15% more than tax revenues increase in this scenario. The efficiency gains come at the cost of equity on a proportional basis consumption of the poor households falls by 58% more than does their share of the tax revenue increase.

A proportional increase in existing VAT rates is slightly less regressive than eliminating VAT exemptions, but it is also substantially less efficient. The average cost of funds for poor households with a 40% increase in existing rates is lower than eliminating exemptions. In the long-run, however, the aggregate cost of funds of a proportional VAT increase is substantially higher, with an average cost of funds equal to 1.63.

When equity is the primary concern, less efficient tax instruments might be preferred to the VAT. For example, the average cost of funds with a capital income tax is lower in the short-run than an increase in value added taxes. Capital income taxes are efficient in the short run because investment and capital supply are fixed. However, the long-run effect of increased capital income taxation is reversed. In the long run, the economic cost of capital income taxes increases from 0.86 to 3.39, and revenues fall from 1.5 percent of GDP to 0.9 percent of GDP. Under the steady-state (long-run) assumption, investment and capital adjust until the price of capital equals the long-run return.[3]

A sectoral analysis shows how some excise taxes, particularly taxes on refined petroleum products (RFP), are relatively efficient and offer a high yield. Demand for RFP is inelastic because refined petroleum is a necessary input to ground transportation, which in turn is (by assumption) required in fixed proportions to most commercial and trade activities. The low price elasticity of demand (around 0.2) allows the government to act as if it were a monopoly, choosing lower quantities, but substantially higher prices, which increases total revenues.

Import tariffs are among the least efficient source of revenue in the long run. Table 13 reports results from an exercise where 1% of GDP is raised through import tariffs, the ACF for poor households is 2.38 and the social ACF is 2.20.

These costs are substantially higher than VAT (1.38/1.36) or excise taxes (1.48/1.62). Moving toward uniform import tariffs can increase tax efficiency somewhat, but the overall efficiency of tariff revenues remains low. There are other obstacles to tariffs presented by ongoing international trade negotiations. The impending Free Trade of the Americas Agreement, and a near-term bilateral trade agreement with the United States make import tariffs an unlikely candidate for future revenues.

Direct income taxes produce the second-largest revenue stream next to the VAT. According to Table 1, *corporate* income taxes (*capital income* taxes) represent 88% of total income tax collections, while *personal* taxes (mostly labor taxes) represent only 12% of income tax collections. This is not surprising since there are only a few thousand corporate taxpayers with large tax bills, and there are millions of individual taxpayers. Enforcement is much easier for corporate income. We conduct several scenarios which consider corporate income taxes, which are labeled in this paper as capital income taxes. We chose to abstract from the economic effects of personal income taxes on labor supply, because this tax stream only represents 740 Billion Pesos, or 4.4% of government tax collections.

The *net progressivity* of a particular tax reform depends on the disposition of the resulting revenues. While there are a range of ways in which public transfers might be employed to improve equity, we chose to avoid conjecturing on the form of expenditure policies. We consider only two of the likely spending possibilities, using the funds to pay off the government debt load or using the funds to expand military action.

The following section of the paper describe the formulation of a computable general equilibrium (CGE) model for Colombia using Social Accounting data from 1997.[4] We use the 1997 accounts because they offer a more detailed representation of the Colombian economy than the more recent 1999 social accounts (Rutherford and Light (2002)).

We do not attempt to model non-standard aspects of indirect taxation such as

tax avoidance or corruption. For concreteness, we formulate a static/steady-state model with constant-returns to scale. It is our intention to provide Colombian policy-makers with a clear and detailed framework to consider raising additional public funds.

Section 2 describes the data underlying the model's tax structure as compiled in the 1997 Colombian national accounts. We focus on the sectoral and instrument structure of tax revenue as is represented in the model. Section 3 presents a schematic overview of the economic flows in the CGE model, leaving the algebraic model formulation and details to an appendix. Section 4 lays out our formal framework for assessing the welfare effects of tax reform using the computed equilibrium values and highlights the equity-efficiency tradeoffs which can arise. Finally, detailed model results are presented in section 5. The appendix also contains tables which characterize the base year (1997) economic accounts. These tables include sectoral output, factor-intensity, and consumption-shares as well as factor income and consumption shares across households.

2 Tax Structure

Colombia's tax structure has evolved over the past twenty years as has the tax structure of many other developing countries. Government revenue comes primarily from taxes on consumption, corporate income, and imports. Because many Colombians live below the poverty line, and because much of the labor supply is "informal," personal income tax collections account for only 8% of total government revenues. This contrasts with OECD countries which on average collect 30-50% of total revenues from income taxation. Tax evasion and informal businesses often force Colombian decision makers to make tax-policy decisions on the basis of feasibility and enforcibility rather than economic efficiency. Value-added taxes, corporate income taxes, excise taxes and import tariffs currently compose 80% of total government revenues. A breakdown of major

revenue sources for 1997 can be seen in Table 1. Figure 1 displays the major tax revenue streams for the biggest industries. Value-added and excise taxes on beverages, refined petroleum products and trucking constitute a substantial share of revenue. A large number of sectors collect negligible shares of tax revenue.

Table 1: Summary statistics for major revenue streams

	Revenues		Base	Tax Rates	
	(B)	%	(T)	Collected	Posted
VAT	5,600	33.3	86.0	6.5	5-45
Corporate Taxes	4,340	25.8	19.7	22.0	35
Excise Taxes	2,090	12.4	45.9	4.6	30
Import Tariffs	1,390	8.3	22.4	6.2	5-200
Payroll Taxes	970	5.8	57.9	1.7	
Indirect Output Taxes	910	5.4	139.3	0.6	
Local / State Taxes	810	4.8	139.3	0.5	
Individual Income Taxes	740	4.4	57.9	1.3	17-35
Production Subsidies	-30	-0.2	16.9	-0.2	
Total	16,826	100.0			
Social Security Payments	6,554		139.3	4.7	
Central Government Income:	20,140				
Local Government Income:	12,500				
Social Security Outlays:	9,509				

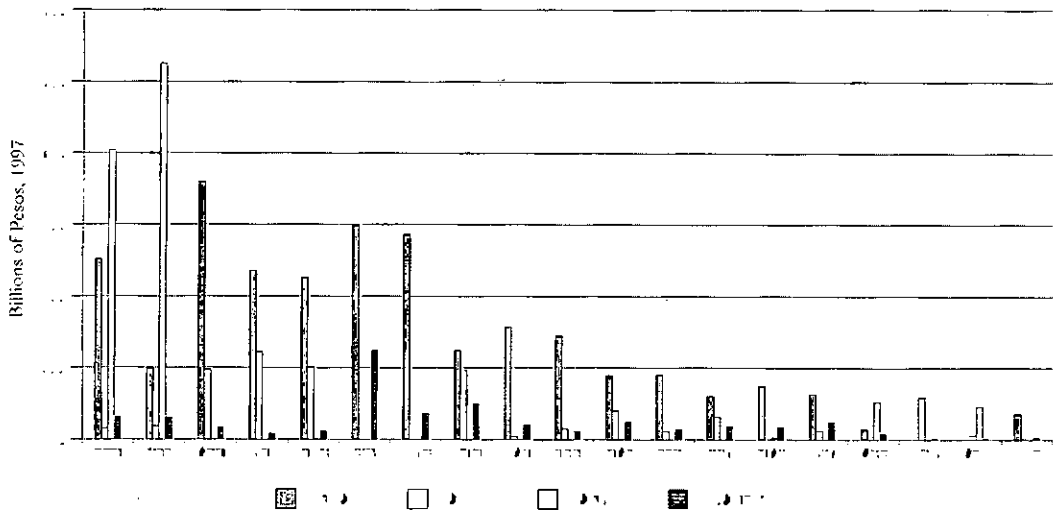
Based upon 1997 social accounts from the Colombian Ministry of Finance.

(B) indicates billions of 1997 Colombian Pesos. (T) indicates trillions of Pesos.

2.1 VAT Taxes

Value-added taxes generate one-third of overall tax revenues, and eight individual sectors generate 70% of total VAT revenues. Communications, transportation equipment (autos), and furniture are major contributors with collection rates between 4% (Chemicals) to 19% (Communications) of sales. Collections on

Figure 1: Indirect tax revenues



Identifier	Description	Identifier	Description
BEV	Beverages	MTL	Basic metal products
RFP	Refined petroleum products	PPR	Paper products
TRK	Trucks other transportation machinery	PLS	Plastics
MCH	Machinery	HTL	Hotels and Lodging
FIN	Financial Services	GLS	Glass products
COM	Post and telecommunications	TNF	Tourism
CHM	Basic chemical products	CRO	Other crops
CTH	Finished clothing	TBC	Tobacco
FRN	Furniture	CCL	Chocolate products with sugar

beverages, clothing, machinery, and financial services are also key sources of VAT revenues. A summary of sectoral production and taxes is shown in Table 2.

Table 2: Major sectors for VAT revenue (1997)

	Revenue	Base	Rate	%
Trucks and transportation machinery	721	6,195	11.6	12.9
Financial Services	599	12,220	4.9	10.7
Post and telecommunications	573	4,087	14.0	10.2
Beverages	504	6,398	7.9	9.0
Light machinery and electric products	471	7,026	6.7	8.4
Machinery	453	4,930	9.2	8.1
Finished clothing	315	3,459	9.1	5.6
Furniture	290	2,641	11.0	5.2
Remaining 51 sectors	1,674	169,351	1.0	29.9
Total	5,601	216,308	0.0	100.0

We calculate the VAT as the ratio of tax revenues to domestic production and imports, minus rebates for intermediate inputs.

Revenue and Base values are listed in Billions of Colombian Pesos.

We model the VAT as a rebated-invoice system. Firms are refunded any VAT taxes paid for intermediate inputs to production. By law, there are seven different VAT rates (0%, 8%, 10%, 16%, 20%, 35%, and 45.6%). Most of the goods are subject to the 16% rate. A low imputed rate in the data can imply high levels of tax exemptions, low official rates, high levels of intermediate inputs, and/or high levels of tax evasion. Because there exist several different tax rates, it can be difficult to determine the how much of the VAT is being evaded. [5]

2.2 Import Tariffs

In 1991 Colombia underwent a process of commercial liberalization that lead to an overall reduction in tariff rates, producing a typical tariff rate of 11%. The 1997 dataset shows sectoral tariff rates between 0-17%, with the highest rates on

agricultural products (crops, and dairy), and low rates on intermediate inputs to production (machinery and transportation equipment) or goods with no competing domestic producers (certain minerals and finished clothing). Similar to the VAT, collections are typically below the posted tariff rates. The current tariff structure reflects political power of farming interests and the common perception among Colombians that certain intermediate inputs are vital to economic growth and should not be taxed. Major sectoral contributors to overall tariff revenues are shown in Table 3. Similar to the VAT structure, most tariff revenues are raised from only a handful of sectors.

Table 3: Major sectors contributing to import tariff revenues (1997)

	Revenues (B)	Base (B)	Rate %	Share %
Light Machinery and Electric Products	246	4,576	5.4	17.6
Machinery	203	2,668	7.6	14.6
Basic Chemical Products	193	3,477	5.6	13.9
Various Crops	118	1,073	11.0	8.5
Trucks and transportation machinery	195	2,744	7.1	14.0
Other 53 sectors	437	9,323	4.7	31.4
Total	1,392	23,860	0.0	100.0

Source: 1997 social accounts.

2.3 Indirect and Excise Taxes

There are two types of indirect taxes in Colombia: 1) output taxes, which usually support local governments, and 2) excise taxes for goods such as alcohol, gasoline and tobacco. In our model we these production taxes are represented by a single output tax rate, t_y. In the 1997 dataset, this tax mostly represents local efforts to collect tax revenues.

Table 4: Excise taxes

	Revenues (B)	Base (B)	Rate %	Share %
Refined petroleum products	1051	3886	27.0	50.3
Beverages	808	6,398	12.6	38.7
Tourism	104	2,443	4.2	5.0
Tobacco	93	885	10.5	4.4
Other 53 sectors	34	202,696	-	1.6
Total	2,089	216,308	-	100.0

Table 5: Key sectors for output tax revenues (1997)

	Revenues (B)	Base (B)	Rate %	Share %
Commercial Margins	140	15,227	0.9	15.3
Financial Services	105	11,272	0.9	11.5
Ground transportation	55	8,378	0.7	6.0
Public administration	52	15,197	0.3	5.7
Other 53 sectors	560	149,437	0.4	61.5
Total	911	199,511	-	100.0

The posted tax rates for beverages are between 30% and 38%, depending on the drink and in the alcoholic content. For tobacco products, the excise tax rate is 10%. RFP (gasoline) has two excise taxes, one national and one local. The national rate is 30% and the local rate is typically 5%.

2.4 Income Taxes

A common income tax code applies to individuals and firms. Currently, there are three marginal income tax rates: 20%, 29% and 35%. Individuals who earn more than six times the minimum wage begin paying at the lowest rate. Firm profits are

either exempt from taxes, or they pay 35% in retained earnings domestically.[6] Combined individual and corporate income taxes collect as much in revenues as the VAT. Most of these revenues come from corporate income taxes (4.3 trillion pesos), rather than individual income taxes (0.7 trillion pesos). Despite substantial collections, there are several untaxed classes of firms, including non-profit organizations and public service providers such as the water, electric and gas companies.

Individual income tax revenues are low, despite high tax rates, indicating a high rate of avoidance. It appears that only formal sector workers, such as government employees actually pay full income taxes. Most other workers are either exempt from income taxes or work on an "informal" basis. This leads to a very small base for personal income tax collections. Although the official marginal income tax rate is between 20% and 35%, the collected rate, imputed from the 1997 accounts, is only 1.94% of total (formal) labor supply.

Table 6: Income tax structure

	Firms	Individuals
Revenues (B)	4,340	740
Average Tax Rate	20%	2%
Posted Rate	35%	(20,29,35)%
Minimum Income		5× Min Wage

For individuals, 30% of income is exempt from taxation.

Payroll taxes and the Colombian pension system have become worrisome among most regional economists. Payroll taxes are specially-earmarked fees paid partly by employers and partly by employees. Social security is the largest payroll tax, with 6.5 trillion pesos collected in 1997, more than any other single tax. Other payroll taxes include the SPSA (Severence Pay Savings Account), a withholding which places 8.3% of wages into an individual account to be used for severance pay

upon separation from the firm. This portion of the payroll bill seems less like a tax and more like forced savings. Also included is the 1.6% *SENA* contribution for education and training, and some smaller fees for child care, benefits, and vacation. We do not explicitly consider payroll taxes in this chapter. A separate chapter by Alm and Lopez considers the burden of existing payroll taxes and what, if anything, should be done.

2.5 Parafiscal Taxes

Several "earmarked" taxes are collected through official channels and used for a specific purposes. In Colombia, these earmarked levies are called "parafiscales." Some examples of parafiscal taxes are the coffee export tax which is collected by the coffee producer's guild, the CERT. These revenues are then allocated by the guild. This earmarked fund has been successful, and has spurred the creation of other funds, such as the "Cuota Arrozera" (Rice Quota), a tax levy in the rice sector specifically earmarked for price supports. It is difficult to determine how distorting these taxes are, or whether the collections are used wisely. For example, part of the CERT fund has been used to subsidize consumer coffee prices in Colombia. Parafiscal taxes are included in our dataset, but they are treated as lumpsum transfers in the model.

3 The Model

Our model for Colombia represents an Arrow-Debreu economy with constant returns-to-scale and perfect competition. The numerical equations are based on parameters derived from the 1997 Colombian national accounts. This dataset distinguishes 57 industries, government, and 10 representative households. Economic equilibrium is characterized by a set of prices and levels of production in each industry for which market demand equals supply for all commodities;

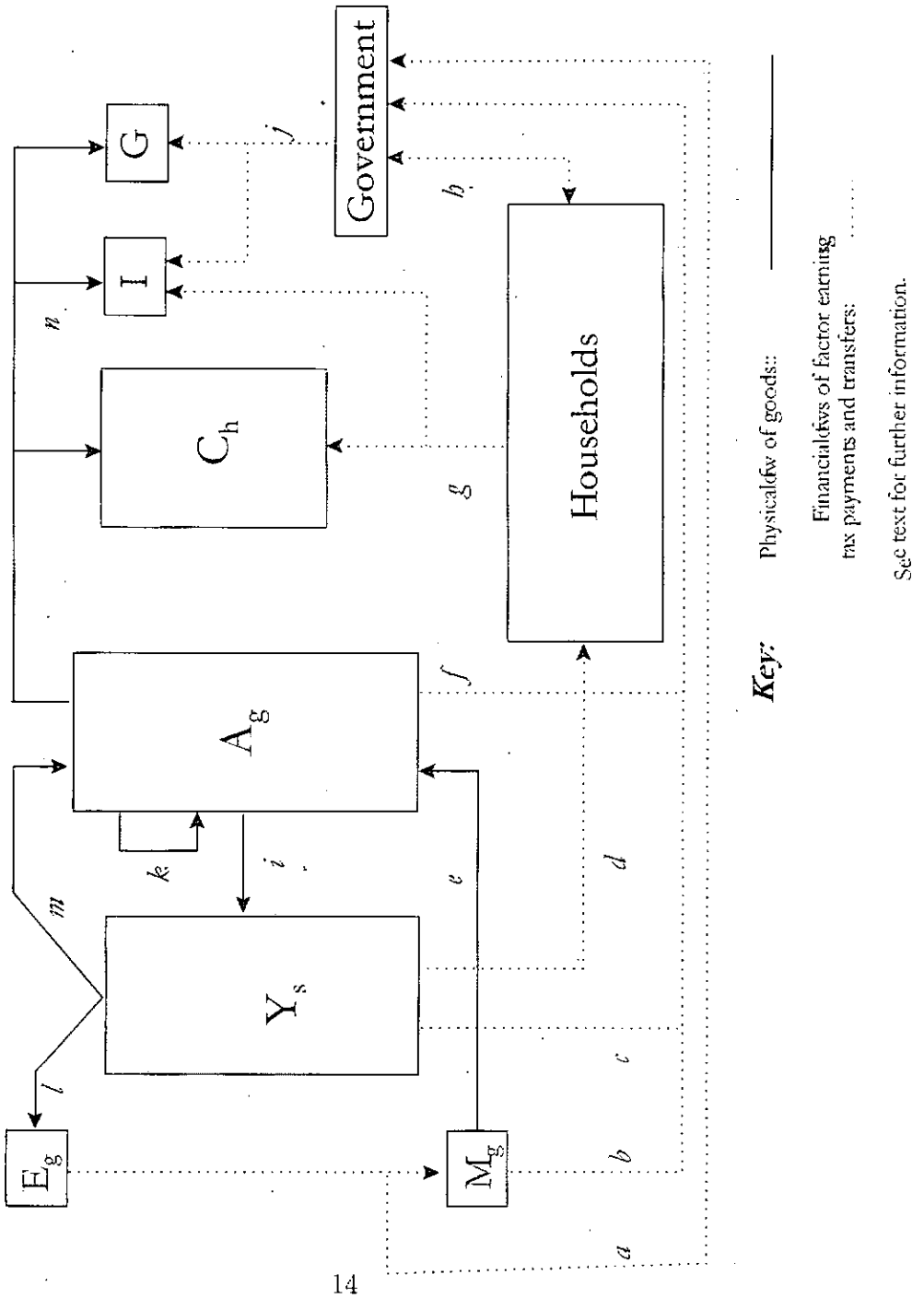
producers maximize profits taking prices as given, and private and public expenditures are equal to income. The supply side of the model is based on perfect competition: there is free entry, and all technologies exhibit constant returns to scale. Colombia is represented as a small open economy with fixed relative prices of imports and exports in world markets. These assumptions imply that no producer earns a positive economic profit at equilibrium prices. Following Mathiesen (1985) we formulate and solve the model as a complementarity problem[7] with three types of equilibrium conditions: market clearance, zero profit, income balance. In addition the model accommodates analysis of both the static and steady-state welfare implications of policy reforms through alternative representations of the capital stock.

Logical components of the dataset and model and their inter-relationships are shown in Figure 1. This flow chart portrays the key elements in the model. Economic transactions involve domestic production and international trade in commodities. The model accounts for final demand decisions by households, investment and government expenditure. The solid lines in the figure correspond to *physical flows* of goods. The dotted lines in the figure correspond to *financial flows* related to primary factor earnings, taxes and capital account transactions.

We will use Figure 1 to characterize both the base year dataset and the underlying general equilibrium framework. We first introduce the labelled boxes in this diagram, and we subsequently relate flows in this diagram to tables summarizing the base year dataset.

In order to help establish a sense of proportions about the relative magnitude of different elements of the economy we have drawn the *areas* of individual boxes in Figure 1 to correspond with the relative magnitude of associated economic transactions in 1997. $\boxed{Y_s}$ characterizes domestic production. Total output from domestic production represents 198 trillion Peso, of which 164 trillion corresponds to primary factor value-added. Many (48 of 57) sectors produce more than a single commodity. For most sectors, however, the primary product accounts for over 90%

Figure 2: Structure of goods and financial flows



of output.

$\boxed{A_g}$ represents aggregate goods supply. Domestic and imported goods are combined to supply the domestic market, including intermediate demand, final demand, and trade and transportation margins. Aggregate supply is roughly 220 trillion pesos.

$\boxed{C_h}$ accounts for consumption decisions by households. Ten households are distinguished in the dataset, and aggregate final demand for goods is 136 trillion Pesos.

$\boxed{E_g}$ and $\boxed{M_g}$ correspond to international trade flows. There were 16.9 trillion Pesos of exports and 25.2 trillion Pesos of imports recorded in the 1997 data.

$\boxed{I}$ and $\boxed{G}$, respectively, correspond to investment and public demand for goods, which had base year values of 25.5 and 24.2 trillion Pesos, respectively.

$\boxed{Households}$ and $\boxed{Government}$ correspond to budget-constrained agents. Households earn income by selling labor and capital services as well as through transfers and net payments from the government. The government collects taxes on various economic activities and devotes those resources to investment, public sector demand and net capital market transactions with the rest of the world. In the computational investigations reported below we evaluate the economic cost of raising tax revenue in order to increase government imports, holding domestic public provision constant. Marginal and inframarginal increases in the public budget are associated with changes in net public purchases from abroad.

We conclude our summary of the basic model structure by going though the set of individual flows a through m which are identified in Figure 1. Detailed statistics concerning base year data which are referred to tables in Appendix A.

a represents household factor earnings from production. Labor earnings are differentiated by location (urban-rural), skill-level, and nature of employment (formal, traditional, contract, salaried, non-salaried etc). Specific data

summarizing these transactions are presented in Tables A-4, A-7 and A-8.

b Household consumption demand is represented in the model through Cobb-Douglas utility functions calibrated to base year consumption shares. Tables A-6 presents expenditure shares by household. While there are certain goods for which demand increases with income (RLS) or decrease with income (CRO), the data generally suggest greater variability in factor income shares than in expenditure shares.

c Domestic output is roughly 200 trillion Pesos. Production for the domestic market is represented as an imperfect substitute for exports, with an elasticity of transformation equal to four. Table A-4 provides GDP and factor use statistics for the 15 largest production sectors. Taxes which apply to domestic production and are levied on a proportional basis on the output from Y_s. These include local taxes (TCM), indirect business taxes (TIF), subsidies and other taxes. VAT taxes are rebated on intermediate inputs to Y_s.

d Aggregate supply (A_g) is roughly 220 trillion Pesos. Output to the domestic market is sold as transport margins (own use by A_r, flow k) or intermediate demand (Y_s, flow i).

e Imports and domestic goods are differentiated though an Armington aggregate with an elasticity of substitution equal to 4. The value of imports was 25.2 trillion Pesos, roughly one tenth of aggregate demand on an economy-wide basis. Import demands by commodity for some of the larger markets are presented in Table A-5.

f Exports are supplied jointly with domestic products by Y_s. Exports by commodity for some of the larger markets are presented in Table A-5.

g Investment demand is exogenous in the static model, and it is adjusted proportionally with the capital stock in the steady-state formulation. As is

apparent in Table A-5, more than 50% of the value of investment is composed of purchases of construction services, CON and CVL.

h The value of base year imports exceeds the value of base year exports by roughly 8 trillion Pesos. This current account deficit is reflected in a capital account surplus. In order to perform welfare analysis in static CGE framework, it would be customary to hold the value of capital flows constant. We do so with the base year trade deficit, however in the tax revenue simulations where the government income is varied, we assume that the value of public provision is held constant and all excess revenue is spent for repayment of international debt.

i Tariffs are applied on imports. The base year tax revenue, base and implicit rates are presented in tables A-2, A-1 and A-3.

j Tax revenues accruing from the aggregate supply activity include value-added taxes (VAT), excise taxes (TXS), parafiscal taxes (PARA) and export subsidies (CRT).

k Tax revenue from domestic production includes local taxes (TCM), indirect taxes on firms (TIF), and payroll taxes (TP). Payments by government to producers include subsidies (SUB) and rebates of value-added taxes on intermediate inputs (VAT).

l Household income taxes (except taxes on capital and labor) are treated as lumpsum transfers. These transfers are denominated in units of foreign exchange, hence tax policy reforms which affect the real exchange rate result in small adjustments in the value of lump-sum trasnfers.

m Government demand for services and investment are held constant in most simulations. In those cases where tax increases are used to fund increased government spending, we have assumed that marginal increases in public expenditure are in terms of imported goods and services.

3.1 Elasticity Choices

Tax collections, relative prices, and quantities (values) are known quantities supplied in the national accounts data. The final data requirements are now the specification of curvature in various CES functions for production, consumption, and labor supply. To choose these elasticities, we rely upon past studies (for other countries), and admittedly, conventional wisdom. Table 7 lists the default elasticity choice for each parameter.

Table 7: Elasticities and other parameter choices

σ^A_{DM}	Elasticity of Substitution between imports and domestically produced goods in Armington production.	4
η_X	Elasticity of Transformation between domestic and export markets	4
σ^Y_{VA}	Labor/Capital elasticity in value-added	1
σ^Y_{ij}	Elasticity of substitution between intermediate inputs	0
σ^C_{ij}	Elasticity of substitution between goods i and j in final demand	1
σ_{LES}	Labor-leisure elasticity	1
$\sigma_{c,les}$	Elasticity of demand between leisure and consumption	0.5

As economists, we often make decisions based upon judgement and experience. Choosing appropriate parameter values for various elasticities is one such exercise. In our approach, we use values which have been accepted previously in other models from the literature. The Armington elasticity values, σ^A_{DM} are taken to be 4. This value is in-line with estimates in previous studies, such as Cox and Harris (1986), where $\sigma^A_{DM} \in (1.1, 4.85)$. There are few studies for the output elasticity of transformation between domestic markets and exports, η_X, and we assume it is equal to the Armington elasticity. Our choice for Leontieff intermediate input demand is standard. The Cobb-Douglass structure for value-added taken here has been questioned in the development literature, some economists believe that the value is closer to zero for some goods. A more elaborate formulation for consumption could have included Stone-Geary preferences, especially if we wanted

to focus upon poverty effects. Finally, we choose unity to be the elasticity between labor and leisure, and $\frac{1}{2}$ to be the elasticity between leisure and consumption.

Because some parameter choices have a larger impact upon the results, CGE models typically contain some sort of *sensitivity analysis*. We have conducted several sensitivity analyses, but only report those for which the parameters matter.

It is worth noting that the most important parameters in the model are the tax-instruments, and not the elasticities. These values are taken from the data as average collected rates, but they often do not represent the *marginal rates* that drive household and firm decisions. To quantify the bias from using average collected rates instead of marginal rates is a more subtle exercise than measuring elasticities, and is therefore often ignored in the CGE literature. Willner and Granqvist (2002) consider the effect of average versus marginal tax rate changes and how it impacts distribution and efficiency of the overall tax system, but they use a theoretical model rather than a CGE model. Also, Padovano and Galli (2002) point out the importance of using marginal tax rates rather than average rates in the taxation-growth literature.

4 Individual and Social Welfare

This section explains how we measure individual and social welfare. We first describe the calculation for individual equivalent variation (EV). Using the EV measure, we can calculate the marginal cost of funds (MCF). Our nomenclature is to use the "MCF" acronym for small changes in tax rates (marginal changes), and to use the "ACF" acronym (meaning: the *average* cost of funds) for larger, discrete tax reforms.

Social welfare requires calculations for both efficiency and equity. In order to calculate a social welfare function, the individual cost-of-funds measures are mapped using a function which depends upon a single parameter, $\sigma \in [0, \infty]$.

Lower values for σ should be considered when there is a low tolerance for in-equality, and higher values should be considered when in-equality is less important than overall efficiency.

4.1 Individual Welfare

The most useful measures of welfare changes are the compensating-variation (CV) and equivalent-variation (EV)[8], because they are money-metric. EV is used in our model for convenience.

The equivalent variation compares utility as a function of price in a comparative-static analysis. The standard equation for this is:

$$EV = E\left(U^n, p_i^n\right) - E\left(U^0, p_i^0\right)$$

where $E\left(U^n, p_i^n\right)$ is the expenditure necessary to achieve utility level U^n with prices p_i^n. The compensating variation measures the net revenue of a planner who must compensated the consumer for the price charge after it occurs, bringing her back to her original utility level U^0.

To measure the Marginal Cost of Funds, we use the equivalent variation (EV) as a money-metric for the cost of taxation[9]. This is divided by the change in government revenues, (Δ(G)), and multiplied by -1[10]:

$$MCF = -[EV/\Delta(G)]$$

An MCF of 1.2 means that consumption falls by 120% of the collected revenues. A lump-sum tax has an MCF of unity, and taxes which also reduce inter-sectoral distortions can have values less than one but greater than zero.

4.2 Social Welfare

We define the social welfare function on the basis of a particular cardinalization of individual utility. Consistent with conventional microeconomic theory, an individual utility function is assumed to be monotonic and concave, so $u'(c) > 0$ and $u''(c) < 0$. Once such function which has this property is the isoelastic function:

$$u(c) = \frac{c^{1-1/\sigma} - 1}{1 - 1/\sigma},$$

provided that $\sigma > 0$.

The individual utility function provides a starting point for defining a social welfare function across multiple households. This simply involves an evaluation of the household-weighted average of individual utilities. When household h has per-capita consumption c_h and numbers N_h, then social welfare could be written:

$$\begin{aligned} \hat{W} &= \sum_h N_h u(c_h) \\ &= \sum_h N_h \frac{c_h^{1-1/\sigma} - 1}{1 - 1/\sigma} \end{aligned}$$

Maximization of $\hat{W}$ is equivalent to maximization of:

$$W = \left(\sum_h \theta_h \left(\frac{c_h}{\bar{c}_h} \right)^\rho \right)^{1/\rho}$$

when $\rho = 1 - 1/\sigma$ and $\theta_h \propto N_h \bar{c}_h^\rho$. Given that that the θ's are defined only to a scale factor, we simply use the normalization:

$$\theta_h = \frac{N_h \bar{c}_h^\rho}{\sum_{h'} N_{h'} \bar{c}_{h'}^\rho}$$

so that $\sum_h \theta_h = 1$. This normalization and scaling choice assures that $W(\bar{c}) = 1$, and $W(\lambda c) = \lambda W(c)$. This last property indicates that a 1% increase in W is equivalent to an *equiproportional* 1% increase in the consumption of all households. In other words, this is a *money-metric* social welfare function.

Now, suppose that households are ranked in increasing income, so $\bar{c}_1 < \bar{c}_2 < \ldots < \bar{c}_H$. The definition of θ_h is unchanged if we multiply the numerator and denominator by a constant, $\bar{c}_1^{-\rho}$. We then have:

$$\theta_h = \frac{N_h(\bar{c}_h/\bar{c}_1)^\rho}{\sum_{h'} N_{h'}(\bar{c}_{h'}/\bar{c}_1)^\rho}$$

Consider then the structure of this social welfare function as $\sigma \to 0$ and $\rho \to -\infty$. A decrease in σ represents an increasing aversion to inequality. When base year consumption for household 1 is the smallest, and the relative ranking of households does not change in the course of subsequent experiments, we find:

$$\lim_{\rho \to -\infty} \theta_h = \begin{cases} 1 & h = 1 \\ 0 & h > 1 \end{cases}$$

Hence, in the case of complete aversion to inequality (Rawlsian preferences), maximization of social welfare amounts to maximizing the welfare of the lowest income household:

$$\lim_{\sigma \to 0} W(c) = \frac{c_1}{\bar{c}_1}$$

This is a local result, as for large shocks, the identity of the lowest utility household might change. In the case of large shocks, the utility function would be defined as:

$$W(c) = \min_h \frac{c_h}{\bar{c}_1}$$

The isoelastic function also simplifies when the tolerance for inequality increases. In the limit as $\sigma \to \infty$, the function represents Utilitarian preferences:

$$\lim_{\sigma \to \infty} W(c) = \sum_h \theta_h \left(\frac{c_h}{\bar{c}_h}\right) = \frac{\sum_h N_h c_h}{\sum_h N_h \bar{c}_h}$$

This social welfare function values increase in aggregate consumption, regardless of which household benefits.

5 Results

We asses the welfare cost of raising additional government revenue from several angles. The first half of this section examines the potential yield and tax incidence for each of the major tax streams. We compare the revenues raised and cost of funds for a proportional increase to existing rates. The second half takes a more detailed look at individual sectors, welfare differences across households, and specific tax-reform packages. Throughout this section, we report the cost of funds, revenues raised, and the yield.

Table 8 lists several possible tax reform packages for raising additional funds. Rows correspond to specific tax reforms of which we have two types. "Differentiated reforms" consist of changes in relative tax rates, while "proportional reforms" involve multiplicative scaling of existing tax rates. A tax reform has implications for public revenue. The first two columns in Table 8 describe the change in government revenue from each reform, both in Trillions of Pesos and as a percentage of GDP. The next column describes the economic cost of the reform, defined as the aggregate Hicksian equivalent variation in income as a percentage of GDP. The final two columns convey economic cost as a percentage of the value of revenue raised, a value we refer to as the "average cost of funds". Two columns are presented, one which refers to the aggregate economic cost – the change in aggregate welfare divided by the value of increased revenue. The second column indicates the welfare cost for the poorest household, providing an index of the equity effect of the tax reform.

Value-added taxes appear to be the most consistent and efficient target for raising additional funds. The 1997 VAT base for sectors with positive VAT collections was 86 trillion pesos. The corresponding base for import tariffs and excise taxes was 22.4 trillion and 45.9 trillion pesos, respectively. If the VAT base is expanded to include all sectors, then the base broadens to 121.7 trillion pesos. Table 9 shows the current and potential tax base for major tax streams.

Table 8: Selected tax reform options for Colombia

	Revenue		Welfare		Cost of Funds	
	(T)	(% GDP)	(T)	(%GDP)	Poor	Aggregate
Short-Run Results						
Differentiated Reforms						
VAT5	1.9	1.3	- 1.9	- 1.2	1.34	0.97
TM10	0.8	0.5	- 0.8	- 0.6	1.00	1.10
RFP15	1.1	0.7	- 1.2	- 0.8	0.94	1.12
ALL	3.7	2.5	- 3.9	- 2.6	1.17	1.05
Proportional Reforms						
VAT×1.4	2.3	1.5	- 2.4	- 1.6	0.80	1.08
TM×1.4	0.4	0.3	- 0.5	- 0.4	1.14	1.23
TK×1.4	2.2	1.5	- 1.9	- 1.3	0.25	0.86
Long-Run Results						
Differentiated Reforms						
VAT5	1.8	1.2	- 2.1	- 1.4	1.58	1.15
TM10	0.7	0.5	- 1.2	- 0.8	1.79	1.70
RFP15	1.0	0.7	- 1.4	- 0.9	1.27	1.39
ALL	3.5	2.3	- 4.6	- 3.1	1.54	1.33
Proportional Reforms						
VAT×1.4	2.0	1.3	- 3.3	- 2.2	1.49	1.63
TM×1.4	0.4	0.2	- 0.8	- 0.5	2.27	2.11
TK×1.4	1.3	0.9	- 4.3	- 2.9	3.22	3.39

Scenario Definitions:

VAT5 Increase VAT rate by 5% for previously exempt commodities.

TM10 Increase all import tariff rates to a minimum of 10%.

RFP15 Increase excise tax rate on refined petroleum products from 35% to 50%.

ALL Combination of VAT5, TM10, and RFP15.

VAT×1.4 Increase existing VAT rates by 40%

TM×1.4 Increase existing tariff rates by 40%

TK×1.4 Increase existing capital income tax rates 40%

Table 9: Current and potential tax base for major tax streams (T)

	VAT	Import Tariffs	Excise Taxes	Capital Income
Current Base	86.0	22.4	45.9	19.7
Potential Base	121.7	23.8	205.8	19.7

Trillions of 1997 Pesos.

In order to collect an additional 1% of GDP by simply scaling up existing tax rates would require VAT rates to increase by about 30%. This means that the central rate would need to rise from 16% to 20.8%. Similar collection rates would imply a 30% increase in capital income taxes, a 50% increase in excise taxes, or a 178% increase in import tariffs. A more sensible strategy would be to broaden the tax base by including previously untaxed goods, and to move to a more uniform VAT and tariff structure. Such an approach is likely to be much more efficient and would not require draconian rate increases.

Excise taxes, especially upon refined petroleum products (gasoline), exhibit a low average cost of funds and a high potential for revenue collections. Because gasoline is a necessary input to production and is a luxury good in consumption it has a low elasticity of demand. Furthermore, since Colombia is a net oil exporter, gasoline has a high elasticity of supply. This market creates a situation where the yield for excise taxes is high (near 100%) and the distortion is small. Excise taxes are discussed in more detail in section 5.1.4.

5.1 Impact of Increasing Existing Rates

We compute the impact of increasing the current tax rates for VAT, capital income, excise, and import tariffs. Tax rates are increased between 20% and 100% and we list the results for both the short-run (static) and long-run (steady-state) assumptions. The results for these scenarios are listed in Tables 10 and 11. We

find that the value-added tax raises the most revenues and has the lowest efficiency cost in the long-run. This result is not surprising, given that the tax-base for this instrument is the largest, and that the existing collected rates are relatively low. In each table, we list the ACF(σ), revenues raised as a percent of GDP, and the yield.[11] A brief discussion for each tax stream follows.

Table 10: Impact of a proportional increase of existing tax rates: Static-Model

Value-Added Taxes

	ACF(σ)			Revenue		
Rate	0	1	∞	Pesos(T)	%GDP	%Yield
×1.2	0.79	0.94	1.06	1.0	0.7	87
×1.4	0.79	0.95	1.07	2.0	1.3	87
×1.6	0.80	0.96	1.08	2.9	2.0	87
×1.8	0.81	0.97	1.09	3.9	2.6	86
×2.0	0.82	0.98	1.10	4.8	3.2	86

Excise Taxes

	ACF(σ)			Revenue		
Rate	0	1	∞	Pesos(T)	%GDP	%Yield
×1.2	1.12	1.14	1.14	0.4	0.3	96
×1.4	1.13	1.14	1.14	0.8	0.5	98
×1.6	1.15	1.15	1.15	1.3	0.8	101
×1.8	1.16	1.16	1.16	1.7	1.2	103
×2.0	1.17	1.17	1.17	2.2	1.5	107

Import Tariffs

	ACF(σ)			Revenue		
Rate	0	1	∞	Pesos(T)	%GDP	%Yield
×1.2	1.14	1.16	1.22	0.2	0.1	77
×1.4	1.14	1.16	1.23	0.4	0.3	76
×1.6	1.15	1.17	1.24	0.6	0.4	74
×1.8	1.16	1.18	1.25	0.8	0.5	73
×2.0	1.16	1.19	1.26	1.0	0.7	72

Capital Income Taxes

	ACF(σ)			Revenue		
Rate	0	1	∞	Pesos(T)	%GDP	%Yield
×1.2	0.24	0.56	0.86	0.9	0.6	92
×1.4	0.24	0.57	0.86	1.8	1.2	92
×1.6	0.25	0.57	0.86	2.6	1.8	91
×1.8	0.26	0.57	0.87	3.5	2.3	91
×2.0	0.26	0.58	0.87	4.3	2.9	91

5.1.1 Value-added tax

Relative to the other tax steams, the VAT raises the most revenues for a proportional rate hike. For example, a 20% increase in existing VAT rates yields 0.7% of GDP for the government in a relatively progressive manner. If we only consider the poorest decile in Colombia (i.e., when $\sigma = 0$) the ACF(0) is less than unity. This indicates that consumption for the poorest household falls by less than the revenues raised.

In the steady-state calculation (Table 11), revenues fall about 10% compared to the static scenario. Although VAT revenues fall over time, they should be considered a "sustainable" source because collections remain relatively high after capital and labor have fully adjusted.

5.1.2 Capital income taxes

In the short-run, capital income taxes are the most efficient instrument for raising government funds. Because the short-run capital supply is fixed, taxes on capital are equivalent to a lump-sum tax. However, in the long-run, the welfare cost of capital income taxation is dramatically higher. The higher cost of funds listed in Table 11 shows how the ACF for capital jumps from less than one in the short-run to more than three in the long-run.

In the steady-state model, investment is allowed to respond to the lower net-of-tax return so that the optimal level of investment falls by as much as 30% as a result of the tax. Long-run investment is expected to fall in this manner until the equilibrium price of investment equals the net-of-tax return to capital. As the stock of capital deteriorates, so does the capital income tax base. Capital income tax revenues fall by 45% in the long run, from 0.7% of GDP to 0.4% (at $\times 1.2$).

Table 11: ACF with steady-state assumption

Value-Added Taxes

	ACF(σ)			Revenue		
Rate	0	1	∞	Pesos(T)	%GDP	%Yield
$\times 1.2$	1.48	1.58	1.62	0.9	0.6	78
$\times 1.4$	1.49	1.58	1.62	1.7	1.2	77
$\times 1.6$	1.50	1.60	1.64	2.6	1.7	77
$\times 1.8$	1.52	1.61	1.65	3.4	2.3	77
$\times 2.0$	1.54	1.63	1.66	4.3	2.9	76

Excise Taxes

	ACF(σ)			Revenue		
Rate	0	1	∞	Pesos(T)	%GDP	%Yield
$\times 1.2$	1.36	1.35	1.32	0.4	0.3	92
$\times 1.4$	1.37	1.36	1.33	0.8	0.5	94
$\times 1.6$	1.38	1.37	1.35	1.2	0.8	96
$\times 1.8$	1.39	1.38	1.36	1.7	1.1	99
$\times 2.0$	1.41	1.40	1.37	2.1	1.4	102

Import Tariffs

	ACF(σ)			Revenue		
Rate	0	1	∞	Pesos(T)	%GDP	%Yield
$\times 1.2$	2.25	2.17	2.11	0.2	0.1	65
$\times 1.4$	2.27	2.18	2.11	0.4	0.2	64
$\times 1.6$	2.28	2.19	2.12	0.5	0.3	63
$\times 1.8$	2.30	2.20	2.13	0.7	0.5	61
$\times 2.0$	2.31	2.22	2.15	0.8	0.6	60

Capital Income Taxes

	ACF(σ)			Revenue		
Rate	0	1	∞	Pesos(T)	%GDP	%Yield
$\times 1.2$	2.93	3.10	3.16	0.6	0.4	59
$\times 1.4$	3.11	3.26	3.30	1.1	0.7	55
$\times 1.6$	3.36	3.49	3.51	1.5	1.0	52
$\times 1.8$	3.68	3.79	3.78	1.8	1.2	48
$\times 2.0$	4.10	4.18	4.15	2.1	1.4	43

5.1.3 Import Tariffs

We find import tariffs to be a relatively poor source of government funds. From Table 10, we see that potential revenues from this source are small relative to the VAT, where the same proportional scaling only raises one-fifth ($\frac{1}{5}$) of the total revenues. At the same time, the ACF for import tariffs is about 25% higher than the VAT in most cases.

The main reason we find import tariffs costly is the relatively *selective* base upon which these taxes are applied. Import tariff rates appear to be motivated mainly by comparative-advantage and protection concerns, rather than revenues. Agriculture, dairy, and select capital imports are taxed heavily, while intermediate inputs to production face a small burden. The total potential tax base for imports is 23.8 trillion pesos, which is small compared to the potential VAT base of 122 trillion. Total import tariff collections were about 1.4 trillion Pesos. The average implicit tariff rate was 6 percent in 1997, with individual rates between zero and 25%. Posted rates varied widely, with low or zero rates for intermediate inputs to production and rates up to 200% for some agricultural products.

5.1.4 Excise Taxes

Most excise tax revenues are from alcoholic beverages, refined petroleum, and tobacco. Figure 5.1.4 shows that in 1997 revenues from alcoholic beverages and refined petroleum alone contributed about 1.2% of GDP, while the combination of remaining excise revenues (tobacco and sporting events) counted for less than 0.1% of GDP. Thus, a proportional increase in excise taxes is catamount to raising taxes for gasoline and alcoholic beverages. Raising taxes on alcoholic beverages or gasoline is not expected to be popular, but it would contribute substantially to government revenues.

We found the Colombian excise tax case interesting because the yield from

this tax stream is large compared to all of the other taxes. In Table 10, a 20% rate increase yields (20% $\times$ 0.96) additional revenues. The initial curiosity of such a high yield for this tax prompted us to look further into the demand for these goods.

We found the high yield to be consistent with the combination of low demand elasticity and a high supply elasticity. Since we assume that ground transportation is a perfect complement in production (it produces trade and transport margins), and gasoline is the largest variable cost for transportation, we see that refined petroleum has a very low price elasticity of demand (see Figure). Along this portion of the demand function, the tax increase causes quantity demanded to fall, but also causes the equilibrium price steeply. In effect, raising the ad-valorem excise tax rate on refined petroleum increases price and tax yields enough to compensate for the reduced demand. This response is similar to a monopoly choosing a lower quantity in return for higher prices.

Excise taxes share the same tax base as value-added taxes in final consumption, but excise taxes also include intermediate demand by firms.

5.2 Raising a Fixed Amount Revenue Target

Instead of raising each tax by a fixed amount, here we compare the cost of raising an identical amount of revenue across different taxes. Each tax is increased until an additional one percent of GDP is raised. Using our measure of GDP from the model, one percent of GDP equals about 1.6 Trillion 1997 pesos or 1.26 Billion 1997 US dollars.[12] Tables 12 and 13 show current tax revenues, the relevant tax base, and how much each tax stream would need to increase in order to raise one percent of GDP.

As we saw in section 5.1, value added taxes here are relatively efficient when considering either the short run or the new steady-state. Like before, wel also see that capital income taxes are efficient in the short-run, but have dubious long-term consequences. Excise taxes have a much higher yield (around 150%) and they are

Table 12: Welfare comparison for and additional 1% of GDP

	Excise Taxes	VAT Taxes	Import Tariffs	Capital Taxes
Initial Revenues (T)	2.1	5.6	1.4	4.8
Target Revenues (T)	3.5	7.0	2.8	6.2
Revenue Increase (%)	66	25	100	29
Existing Tax Base (T)	45.9	86.0	22.4	19.7
Required Rate Increase (%)	46	25	146	26
Cost of Additional Funds				
Poorest Households	1.13	0.80	1.17	0.24
Average	1.15	1.07	1.28	0.86
Tax Revenues:				
% of GDP	1.0	1.0	1.0	1.0
Yield (%)	144	101	67	114
Household Equivalent Variation (%):				
H1 (Poorest)	-1.25	-0.88	-1.30	-0.27
H2	-1.30	-0.94	-1.26	-0.36
H3	-1.24	-0.96	-1.26	-0.46
H4	-1.26	-0.99	-1.25	-0.47
H5	-1.25	-1.00	-1.25	-0.54
H6	-1.29	-1.07	-1.34	-0.62
H7	-1.25	-1.09	-1.35	-0.72
H8	-1.30	-1.18	-1.44	-0.89
H9	-1.23	-1.15	-1.40	-0.84
H10 (Richest)	-1.30	-1.35	-1.53	-1.41

Existing tax rates are increased proportionally using the *static* model.

Table 13: Welfare comparison for 1% additional revenues in the Steady-State

	Excise Taxes	VAT Taxes	Import Tariffs	Capital Taxes
Initial Revenues (T)	2.1	5.6	1.4	4.8
Target Revenues (T)	3.5	7.0	2.8	6.2
Revenue Increase (%)	66	25	100	29
Existing Tax Base (T)	45.9	86.0	22.4	19.7*
Rate Increase (%)	48	28	181	45
Cost of Additional Funds				
Poorest Household	1.38	1.48	2.38	3.30
Average	1.36	1.62	2.20	3.46
Tax Revenues:				
% of GDP	1.0	1.0	1.0	1.0
Yield (%)	139	90	55	65
Household:				
H1 (Poorest)	-1.52	-1.64	-2.64	-3.65
H2	-1.58	-1.72	-2.60	-3.81
H3	-1.52	-1.71	-2.53	-3.78
H4	-1.53	-1.74	-2.52	-3.83
H5	-1.52	-1.73	-2.47	-3.82
H6	-1.55	-1.79	-2.55	-3.88
H7	-1.51	-1.79	-2.53	-3.93
H8	-1.53	-1.81	-2.50	-3.81
H9	-1.45	-1.75	-2.42	-3.62
H10 (Richest)	-1.49	-1.85	-2.32	-3.89

Existing tax rates are increased proportionally using the *steady-state* model.

*Note that the tax base for capital falls between 6%-30% in the steady-state calculation.

relatively efficient, even though most of the additional revenue comes from beverages and refined-petroleum. Import tariffs remain the most costly means of raising revenue.

In the first three rows of tables 12 and 13 we can see the initial tax revenues, the tax base, and the required rate increase necessary to obtain the revenue target. The base for value added taxes is twice as large as the next largest tax stream (excise taxes) with a tax base of 86.0 trillion pesos. This amount is 2/3 of the value of final consumption in Colombia, which reflects the fact that in theory, the VAT is a tax on final consumption. Total imports which were taxed in the base year were valued at 22 trillion pesos, with initial revenues of 1.4 trillion. In order to raise an additional 1.6 trillion pesos, existing tax rates would need to be tripled. Such action is extremely distortionary. Average welfare falls by 1.6 to 2.6 percent when tariffs are used and the ACF(σ) is highest, between 1.3 and 2.3. We see a dramatic increase in the ACF for import tariffs in the steady-state model because the return to capital falls substantially for some sectors who face higher import materials costs. In the steady-state, after investment is allowed to adjust, these sectors produce less and have higher prices.

Excise taxes must be increased by 52% in order to raise revenues from the initial level of 2.1 trillion pesos to a new level of 3.7 trillion. Since the price elasticity of demand is low for both alcoholic beverages and refined petroleum products, the ACF is close to unity despite a sharp increase in tax rates.

Individual household welfare is reported in this section so that the reader can make a clear connection between individual welfare changes and the ACF(σ) function. As described in section 4.2, when $\sigma = 0$, the ACF reflects the utility change for the poorest segment of the population. In the VAT static scenario, the ACF(σ) is 0.793, and the percentage EV for the poorest household (H1) is -0.94%. In this case the social welfare function simplifies to $\theta = 1$, so that

$$W = \left(\frac{c_{H1}}{c^0_{H1}}\right) \cdot \sum_{H1}^{H10} c^0_H.$$

We compute total consumption at 134.5 trillion pesos, so that the change in consumption divided by the change in revenues (i.e., the ACF($\sigma = 0$)) equals $\frac{-0.94 \times 134.5}{1.6} = 0.79$. Higher values for σ can be computed in a similar fashion.

5.3 Welfare Impact Decomposition

Welfare differences across households come from different consumption patterns and different factor returns. Previous experience (Tarr and Rutherford [2002]) has shown that factor returns typically determine most of the heterogeneity between agents for a given policy change. This is also the case here.

In order to identify how consumption profiles and factor returns influence individual welfare changes, we impose uniformity upon consumption patterns and factor earnings. Then we compare the welfare estimates given in tables 10 and 11 against welfare when consumption or earnings are uniformly distributed. The results from this experiment are listed in Table 14.

Using the steady-state model, VAT and Capital income taxes are the most progressive. In both cases, it is different consumption profiles which seem to determine the progressivity of a certain tax. Since existing VAT rates are zero for food and other staple goods, a proportional increase of existing VAT rates places most of the incidence onto higher-incomes. The VAT scenario becomes more regressive when *consumption* profiles are uniform across households. Capital income taxation appears to grow more progressive under uniform earnings and more regressive with uniform consumption. This would imply that the difference in tax burden between households occurs through the consumption channel, rather than through factor earnings. We see that the ACF($\sigma = 0$) for the VAT increases from 1.48 to 1.69 when we move to uniformity in consumption, and that ACF($\sigma = 0$) moves from 2.93 to 2.48 under the capital income tax when we move to uniformity in factor earnings. The summary finding here is that the consumption heterogeneity between households accounts for most of the

progressivity in taxation rather than factor earnings, and that consumption and earnings profiles are not dramatically different for the first eight household classes.

5.4 Gains from Tax Rate Uniformity

So far we have only discussed proportional increases within the existing tax structure. A more desireable tax reform package would raise additional revenues, while at the same time improving efficiency of the overall tax system. Efficiency can be improved by harmonizing the tax rates, or by including sectors which were previously exempt from the tax.

In table 15, we show the ACF(σ) of raising between one and three percent of GDP in additional revenues. Note that three percent of GDP implies approximately 30% in additional revenues for the government. This implies that existing distortions among VAT and import tariffs are substantial, and that a combined tax reform which moves toward uniformity and at the same time increases revenues can be welfare improving. In the VAT, moving toward uniformity allows the government to collect 1% in additional revenues with an ACF of less than unity.

¿From an equity viewpoint, the results from table 15 are slightly progressive. The progressivity in the VAT has been preserved, even when uniformity is imposed, because we have only included those goods which are already subject to the VAT. We could alternatively select to impose a tax upon *all* sectors in the economy. This would increase efficiency because the overall tax base would broaden, but it would be substantially less equitable, since those goods which would be included (groceries and staple items) are necessary goods among poorer households.

5.5 Marginal Analysis

Finally, we approach the taxation problem from yet another angle. In this section, we itemize the *marginal* cost of funds from each tax stream, for each sector. The MCF calculations shown in Table 16 report the cost of funds, revenues raised, and vote ratio for a 1% increment in the existing tax rate by sector. The vote ratio is the percentage of the population who would "vote" to increase a particular sectoral tax if they have neutral preferences between own consumption and government provision. It is calculated as the percentage of the population who whose consumption falls by less than the increase in government revenues (i.e., $MCF < 1$).

Looking at the vote column, most sectors which yield a relatively large revenue would also win a ballot initiative. Items with a low incidence of final consumption by the poor are likely to win votes. For example, motor vehicles (TRK), heavy machinery (OMC), and financial services (FIN) have relatively low final consumption shares, especially among the poor. Each of these sectors receives more than 90% approval. Other goods, such as clothing, textiles, and beverages receive voter approval below 7%. Not surprisingly, the sectors with the highest voter approval are those sectors where taxation is both progressive and relatively efficient.

The excise tax applies to only five sectors. While both refined oil products and the tourism sectors garner broad support, taxes on beverages, tobacco and processed meat and fish are unpopular because of their regressivity. Notice that the taxes on basic consumption goods are relatively efficient from a utilitarian viewpoint.

The MCF results for import tariffs reflect the high rates of protection for Colombian farmers and dairy producers. Collected import tariff rates in 1997 for dairy products were 18% and for basic crops were 11%. Consequently, the import-tariff MCF for these goods is high. Producers are protected from them, but

most poor consumers would prefer lower prices for these staple items. Similar to the VAT results, higher tariffs on cars, trucks and heavy machinery would be preferred by most of the country's population because these items are not key inputs into final demand. Except for automobiles, most intermediate inputs garner a low import tariff as a means to increase industrial production and probably as a result of concentrated lobbying on the part of select firms.

6 Conclusions and Directions for Further Work

In order to increase government revenues by two percent of annual GDP, the Colombian government may consider the following options:

- Broaden the VAT base by including several new sectors of the economy, such as food items and health care. An increase from 0% to 5% for food and some services, the Colombian government can expect to raise about 1.3% of GDP.
- Harmonize import tariffs and the VAT. Simply moving toward a single rate for import tariffs or the VAT lowers the burden of raising additional revenues. With uniform tax rates, the cost of raising one percent of additional revenues equals 0.75, or 0.75% of GDP.
- Increase excise taxes upon refined petroleum products (RFP). An increase for gasoline from 30% to 45% will raise approximately 0.8% of GDP.
- Increases in capital income taxes may raise substantial revenues in the near term, but these taxes will discourage capital formation over time. We suggest that capital income taxes are already high and should not be increased. Specific tax exemptions for special interest groups should not be allowed. Eliminating tax exemptions could increase corporate income tax revenues substantially.

In general we find that taxes upon final consumption are most efficient and sustainable because final consumption is relatively inelastic. We are aware that increasing taxes on consumption implies a shift from labor into leisure for some households. Unfortunately, these are requisite tradeoffs which must always be made in order to raise additional funds.

During the construction of this paper, several important considerations have been raised but not addressed. For one, we would like to point out the need for the Colombian government to generate more consistent and accurate accounting data. It appears that the Ministry of Finance is responsible for developing this data, yet there does not exist a budget for handling and checking national accounts data. An additional full-time position devoted to compiling and constructing national accounts and household surveys is needed ensure accurate and consistent data.

Several important features in the Colombian government were omitted here for brevity. We do not focus upon labor or unemployment. These topics warrant a separate, standalone analysis. Markets for capital and firm structure are also treated simply in order to maintain focus upon the direct effects of taxation. A more detailed analysis of capital markets and firms can be found in the chapter by Echevarria in this volume.

Most importantly, we have not considered the potentially enormous positive impact of increased peace and security. If the current administration uses some of the additional funds to wage a successful campaign to halt terrorist guerilla activity - the benefits of higher foreign direct investment, lower human-capital flight, and increased tourism are likely to outweigh the tax-related distortions by several orders of magnitude. We consider the economic impact of the current civil strife in a forthcoming paper for the Department of National Planning.

Table 14: Uniform earnings versus uniform consumption as source of welfare differences

Profile	ACF(σ) 0	1	∞	Revenue Pesos(T)	%GDP	%Yield
Value-Added Taxes						
Heterogeneous	1.48	1.58	1.62	0.9	0.6	78
Uniform Consumption	1.69	1.66	1.62	0.9	0.6	78
Uniform Earnings	1.31	1.50	1.61	0.9	0.6	78
Excise Taxes						
Heterogeneous	1.36	1.35	1.32	0.4	0.3	92
Uniform Consumption	1.35	1.35	1.32	0.4	0.3	92
Uniform Earnings	1.20	1.28	1.32	0.4	0.3	92
Import Tariffs						
Heterogeneous	2.25	2.17	2.11	0.2	0.1	65
Uniform Consumption	2.32	2.21	2.11	0.2	0.1	65
Uniform Earnings	2.02	2.05	2.09	0.2	0.1	65
Capital Income Taxes						
Heterogeneous	2.93	3.10	3.16	0.6	0.4	59
Uniform Consumption	3.18	3.22	3.17	0.6	0.4	59
Uniform Earnings	2.48	2.89	3.14	0.6	0.4	59

Comparison is for a 20% proportional increase in existing tax rates ($\times 1.2$) using the steady-state model.

Table 15: Tax revenues with uniform VAT rates using the static model

ACF(σ)			Revenue	
0	1	∞	Pesos(T)	%GDP
Uniform VAT				
1.02	0.99	0.97	1.5	1%
1.20	1.23	1.24	3.0	2%
1.27	1.31	1.32	4.5	3%
Uniform Import Tariff				
1.14	1.34	1.45	1.5	1%
1.39	1.51	1.58	3.0	2%
1.49	1.59	1.64	4.5	3%
Uniform VAT and Import Tariff				
0.74	0.75	0.75	1.5	1%
1.14	1.18	1.19	3.0	2%
1.28	1.31	1.33	4.5	3%

Only pre-existing taxes are used to compute an average tax rate. Sectors with zero initial collections are not included.

Table 16: Marginal cost of funds for selected sectors

	MCF			Revenue	θ
Value-Added Taxes					
Trucks and Transport	1.60	1.76	2.03	721	0
Financial Services	1.19	1.36	1.47	599	0
Post & Telecom	1.01	1.21	1.34	573	0
Beverages	1.55	1.45	1.32	504	0
Electrical & Machinery	2.23	2.31	2.30	471	0
Machinery	2.51	2.63	2.64	453	0
Clothing	1.06	1.23	1.14	315	8
Furniture	0.96	1.30	1.52	290	14
Chemical products	1.21	1.14	1.01	249	16
Refined Petroleum	1.72	1.75	1.87	200	0
Paper products	1.49	1.47	1.38	182	0
Basic Metal Products (	2.42	2.60	2.64	179	0
Hotels & Restaurants	0.75	1.05	1.08	149	26
Glass products	2.73	2.72	2.68	127	0
Plastics	1.54	1.51	1.41	122	0
Excise Taxes					
Refined Petroleum	1.21	1.29	1.35	1051	0
Beverages	1.58	1.47	1.32	808	0
Tourist Infrastructure	0.80	1.04	1.24	104	47
Tobacco	1.68	1.35	1.13	93	8
Processed Meat & Fish	1.16	1.07	0.90	20	25
Import Tariffs					
Electrical & Machinery	2.24	2.33	2.33	246	0
Machinery	2.56	2.68	2.69	203	0
Trucks and Transport	1.62	1.78	2.07	195	0
Chemical products	1.28	1.16	1.01	193	16

*Existing rate is increased by one percent.

**θ equals the percentage of population for which the cost of an additional peso is less than one.

Notes

[1]Out estimates use the 2000 GDP measure of 170 trillion Pesos.

[2]Number of households by income group is provided to the authors by the Ministry of Finance, and is based upon the Household Living Survey conducted in 1997.

[3]This assumption is identical to assuming that in the long run, Tobin's q returns to unity.

[4]See Cepeda, López and Ripoll (1994), for a survey of Computable Gèneral Equilibrium models built for Colombia.

[5]Then the difference between the posted rates and tax collections (net of rebates) in the model could provide an approximation of the level of VAT evasion. An interesting extension of the existing model would be to examine the economic determinants of tax evasion.

[6]Foreign firms pay a 7% tax on earnings remitted from other countries.

[7]Complementarity problems are used to represent firm and consumer optimization. The approach is similar to using the Karush-Kuhn-Tucker conditions to characterize optimality of a constrained nonlinear program. Ferris and Munson (2000) describe the solution method and Rutherford (1995) describes economic applications of this method.

[8]See Shoven and Whalley (1992, for other welfare measures as: equivalent variation, and equivalent and compensating surpluses.

[9] The equivalent variation is the change in her wealth that would be *equivalent* to the price change in terms of its welfare impact

[10]Devarajan, Thierfelder and Suthiwart-Narueput (2001) use a similar proxy to measure the MCF.

[11]The percentage yield of a tax equals the actual revenues raised compared with a proportional increase in existing revenues from the tax-stream. For example, a yield of 0.9 indicates that a $Y\%$ increase in the rate incurs a $(0.9 \times Y)\%$ increase in revenues.

[12]Officially released GDP measures were approximately 122 Trillion Pesos in 1997. The exchange rate used for 1998 is 1,260 Colombian Pesos per US Dollar.

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Appendix

A Equilibrium

The economic equilibrium model follows Mathiesen (1985) who translates the Arrow Debreu general equilibrium model as a nonlinear complementarity problem (see also Scarf (1973)). Set and variable nomenclature for the model is presented in Table 17.

Table 17: Model notation

Set Indices

s, g	Sectoral and commodity indices
ℓ	Labor type index

Prices

w_ℓ	Wage rate for labor type ℓ
$\tilde{w}_{\ell,s}$	User cost of labor type type ℓ in sector s, gross of payroll taxes, $\tilde{w}_{\ell,s} = w_\ell(1 + t^w_{\ell,s})$
r^K	Rental price of capital
p^Y_g	Supply price of good g (gross of excise and VAT)
e	The real exchange rate
$\tilde{p}^M_g, \tilde{p}^E_g$	Import and export prices, c.i.f. and f.o.b., defined in units of foreign exchange
$\tilde{p}^M_g$	Tariff-ridden price of imports in domestic prices, $\tilde{p}^M_g = e\tilde{p}^M_g(1 + t^M_g)$.
$\tilde{p}^Y_{gs}$	User output price, net of tax, $\tilde{p}^Y_{gs} = p^Y_g(1 + t^Y_s)$

Activity Levels

Y_s	Production activity level
A_g	Aggregate supply to domestic and export markets
C_h	Aggregate consumption demand by household h
K	Capital stock
I	Investment
G	Public demand

Table 17: Model notation (cont.)

Cost and Revenue Functions

$c_s(\tilde{w}, r^K)$	Unit cost of value-added in sector s (Y_s)
$r^Y_{gs}(\tilde{p}^Y_r, \tilde{p}^X_g, a^M_{gs})$	Unit revenue per unit of aggregate supply ($Y_{s,g}$)
$r^A_g(\tilde{p}^A_r)$	Unit revenue for aggregate supply (A_g)
$c^A_g(p^Y_g, \tilde{p}^M_g)$	Unit cost of aggregate supply (A_g)
$c^C_h(p^A)$	Unit cost of final consumption (C_h)

Leontief Demand and Supply Coefficients

a^M_{gs}	Output of good g per unit activity of sector s, the *make matrix.*
a^U_{gs}	Input of good g per unit activity of sector s, the *use matrix.*
a^G_g	Demand for good g per unit of government activity
a^I_g	Demand for good g per unit of aggregate investment
$a^u_{gg'}$	Trade and transport margin net demand per unit aggregate supply of good g'

Other Exogenous Data

B_G, B_h	Capital account flows associated with government and households

A.1 Arbitrage Conditions

All production activities in the model are represented by constant-returns-to-scale technologies, and we further assume free entry and exit. As a consequence, all profits are driven to zero and the price of output reflects the cost of inputs. The following sets of equations are therefore used to define the equilibrium:

A.1.1 Domestic Production

The production sector Y_s has an associated zero profit condition relating the user value of output with the cost of intermediate inputs and primary factor inputs:

$$\sum_g \tilde{p}^Y_{gs} a^M_{gs} = \sum_g \tilde{p}^A_{gs} a^U_{gs} + c_s(\tilde{w}_{\ell s}, r^K)$$

The user price of output, $\tilde{p}^Y_{gs}$, differs from the market price, p^Y_g, as a result of local taxes (TCM), other indirect taxes (TIF), and subsidies. The user cost of inputs, $\tilde{p}^A_{gs}$, differs from the market price, p^A_g, due to the refund of sectoral VAT payments on intermediate inputs. Payroll taxes drive a wedge between the marginal produce of labor, ($\tilde{w}_{\ell s}$ and the market wage rates, (w_ℓ.

A.1.2 Aggregate Supply

Aggregate supply to the domestic and export markets is composed of domestic production, imports and trade/transport margins. In equilibrium, the value of output equals the cost of input:

$$R^A_g(\tilde{p}^A_g, \tilde{p}^X_g) = c^A_g(\tilde{p}^Y_g, \tilde{p}^M_g) + \sum_{g'} p^A_{g'} a^\mu_{gg'}$$

A range of taxes affect the the aggregate supply activity. Excise and VAT taxes are levied on output, lead a divergence of $\tilde{p}^A_g$ from p^A_g. Export subsidies

apply to some goods, causing $\tilde{p}_g^X$ to fall above the market price, p_g^X. Parafiscal are applied on inputs of domestically produced goods, causing $\tilde{p}_g^Y$ to differ from p_g^Y, and tariffs are applied to imports, causing $\tilde{p}_g^M$ to differ from the market price, p_g^M.

A.1.3 Consumption Cost

The expenditure function for each household, p_h^C, is a nested CES function with a Cobb-Douglass aggregate consumption bundle for commodity consumption which trades against leisure consumption.

$$p_h^C = c_h^C(p^A, \tilde{w}_{\ell h})$$

In this function, p^A denotes the price of each commodity and $\tilde{w}_{\ell h}$ is the after-tax shadow value of leisure.

A.1.4 Cost of Investment

The investment price equals the sum of each final commodity price, weighted by the value-share for that commodity as an input to investment. This linear relationship reflects Leontief technology in the investment sector.

$$p^I = \sum_g a_g^I p_g^A$$

A.1.5 Cost of Public Provision

Like investment, the cost of public provision is a weighted sum of final commodity prices. The share of each price depends upon the input quantity for each commodity as represented in the 1997 Colombian national accounts.

$$p^G = \sum_g a_g^G p_g^A$$

A.2 Market Clearance Conditions

Supply-demand conditions apply to all goods and factors. Shephard's Lemma states that the compensated demand and supply functions are equal the gradients of the associated unit cost and unit revenue. We exploit this relationship to avoid defining compensated demand and supply functions explicitly.

A.2.1 Domestic Output

The sum of domestic production of good s times the benchmark output of good g by sector s must equal the demand for this good by the Armington aggregate production sector. A_g represents the level of aggregate output for good g, and $\frac{\partial c_g^A}{\partial p_g^Y}$ is the compensated demand for good g according to Shephard's Lemma.

$$\sum_s Y_s a_{gs}^M = A_g \frac{\partial c_g^A}{\partial p_g^Y}$$

A.2.2 Domestic Demand

Total aggregate output for good g must be sufficient to supply demand by various consumers. The Armington production sector demands good g as an intermediate input, domestic producers, Y_s, demand good g as an intermediate input in fixed proportions according to the share parameter a_{gs}^U.

$$A_g = \sum_{g'} a_{gg'}^{\mu} A_{g'} + \sum_s a_{gs}^U Y_s + \sum_h \frac{\partial c_h^C}{\partial p_g^A} + G a_g^G + I a_g^G$$

Households demand g for final consumption according to the relative price of g. Finally, the government and investment sectors use g as a fixed input to production.

A.2.3 Labor Markets

The total time endowment for each household is split between labor supply to production markets, and leisure supply in final consumption.

$$\sum_h \bar{L}_{\ell h} = \sum_h C_h \frac{\partial c_h^C}{\partial \tilde{w}_{\ell h}} + \sum_s Y_s \frac{\partial c_s}{\partial \tilde{w}_{\ell s}}$$

Both components of the demand for time depend upon the after-tax wage, $\tilde{w}_{\ell s}$.

A.2.4 Capital Market

There is a fixed supply of capital available from each household, $\bar{K}_h$, which must satisfy factor demands by domestic producers.

$$\kappa \sum_h \bar{K}_h = \sum_s Y_s \frac{\partial c_s}{\partial r^K}$$

κ is a scale-factor which adjusts when we consider steady-state scenarios. In the steady-state, κ adjusts until the rental price of capital, r^K, equals the price of investment.

A.2.5 Household Demand

The level of consumption equals total household income, M_h, divided by the household expenditure function, c_h^C, for each of ten households.

$$C_h = \frac{M_h}{c_h^C}$$

A.2.6 Investment-Savings

Household and government savings are assumed to be constant and the relationship between total savings and investment demand determines the price of investment.

$$I = \sum_h S_h + S_G$$

A.2.7 Current Account

The price of foreign exchange is determined by the current account condition. Capital account for the government and households, B_G, B_h, plus the total value of exports from Colombia must equal the total value of imports into Colombia.

$$B_G + \sum_h \bar{B}_h + \sum_{s,g} Y_s a^M_{gs} \frac{\partial r^Y_{gs}}{\partial \tilde{p}^X_g} = \sum_g A_g \frac{\partial c^A_g}{\partial \tilde{p}^M_g}$$

A.3 Income Balance

A.3.1 Household Income

Each household's income comes from factor endowments, $\bar{L}_{\ell h}, \bar{K}$, capital account flows, $\bar{B}_h$, transfers $\bar{T}_h$. Each household is assumed to save a fixed amount of income, $\bar{S}_h$.

$$M_h = \sum_\ell \bar{L}_{\ell h} \tilde{w}_{\ell h} + \kappa \tilde{r}^K \bar{K}_h + e\bar{B}_h - \bar{T}_h - p^I \bar{S}_h$$

A.3.2 Government

Government income comes from several tax streams, income transfers, and capital account flows. Most of the tax revenues are computed using the compensated demand for factors or commodities and the tax rate.

$$\begin{aligned} M_G \;=\; & \sum_g A_g \frac{\partial c^A_g}{\partial \tilde{p}^M_g} (\tilde{p}^M_g - p^M_g) + \\ & + \sum_g A_g \frac{\partial R^A_g}{\partial \tilde{p}^X_g} (\tilde{p}^X_g - p^X_g) \\ & + \sum_s Y_s \frac{\partial c_s}{\partial \tilde{w}_{\ell s}} (\tilde{w}_{\ell s} - w_{\ell s}) \\ & + \sum_{\ell h} \left(L_{\ell h} - \frac{\partial c^C_h}{\partial \tilde{w}_{\ell h}} \right) (w_{\ell s} - \tilde{w}_{\ell h}) \end{aligned}$$

Table A-1: Benchmark Tax Base (Trillions of Pesos)

	VAT	TXS	TM	TP	TCM	PARA
TOTAL	86.0	45.9	22.4	57.9	139.3	23.5
BEV	4.9	6.4	0.3	0.6	3.0	-
RFP	2.3	3.9	0.6	0.6	2.6	-
TRK	4.4	-	2.7	0.2	2.2	-
FIN	7.5	-	-	2.9	12.0	-
OMC	6.4	-	4.6	0.2	0.9	-
MCH	4.2	4.9	2.7	0.2	1.1	-
COM	3.0	-	-	0.9	3.7	-
CHM	6.3	10.2	3.5	0.7	6.0	-
CMC	-	-	0.2	7.2	14.6	-
COF	-	-	-	-	-	2.3
CTH	2.1	-	0.6	0.5	2.1	-
FRN	1.9	-	0.5	0.3	1.2	-
MTL	2.7	-	1.5	0.5	2.8	-
OIL	-	-	-	0.7	-	4.1
PPR	1.7	-	0.5	0.2	1.7	-
PLS	1.8	-	0.5	0.4	2.1	-
GLS	1.7	-	0.3	0.5	2.7	-

Key:

BEV	Beverages
RFP	Refined petroleum products
TRK	Trucks other transportation machinery
FIN	Financial Services
OMC	Other light machinery and electricity products
MCH	Machinery
COM	Post and telecommunications
CHM	Basic chemical products
CMC	Commercial services and products (margins)
COF	Coffee
CTH	Finished clothing
FRN	Furniture
MTL	Basic metal products (except machinery)
OIL	Oil
PPR	Paper products
PLS	Plastics
GLS	Glass products

Table A-2: Benchmark Tax Revenue (Billions of Pesos),

	VAT	TXS	TM	TP	TCM	PARA	TOTAL
TOTAL	5601	2089	1392	972	813	766	-
BEV	504	808	31	31	15	-	1406
RFP	200	1051	37	35	12	-	1351
TRK	721	-	195	11	11	-	952
FIN	599	-	-	127	88	-	849
OMC	471	-	246	9	4	-	734
MCH	453	2	203	13	6	-	681
COM	573	-	-	50	9	-	647
CHM	249	0	193	41	30	-	543
CMC	-	-	3	1	326	-	466
COF	-	-	0	-	-	447	421
CTH	315	-	8	22	10	-	365
FRN	290	-	31	11	6	-	346
MTL	179	-	81	20	14	-	311
OIL	-	-	0	40	-	223	277
PPR	182	-	24	11	9	-	235
PLS	122	-	64	17	10	-	224
GLS	127	-	24	20	14	-	201

Key:

BEV	Beverages
RFP	Refined petroleum products
TRK	Trucks other transportation machinery
FIN	Financial Services
OMC	Other light machinery and electricity products
MCH	Machinery
COM	Post and telecommunications
CHM	Basic chemical products
CMC	Commercial services and products (margins)
COF	Coffee
CTH	Finished clothing
FRN	Furniture
MTL	Basic metal products (except machinery)
OIL	Oil
PPR	Paper products
PLS	Plastics
GLS	Glass products

Table A-3: Benchmark Average Tax Rates (%),

	VAT	TXS	TM	TP	TCM	PARA
AVERAGE	7	5	6	2	1	3
BEV	10	13	10	6	1	-
RFP	9	27	6	6	-	-
TRK	17	-	7	5	-	-
FIN	8	-	-	4	1	-
OMC	7	-	5	4	-	-
MCH	11	-	8	5	1	-
COM	19	-	-	6	-	-
CHM	4	-	6	6	-	-
CMC	-	-	2	-	2	-
COF	-	-	6	-	-	20
CTH	15	-	1	5	-	-
FRN	15	-	6	3	1	-
MTL	7	-	5	4	-	-
OIL	-	-	3	6	-	5
PPR	10	-	4	5	1	-
PLS	7	-	12	5	-	-
GLS	7	-	7	4	-	-

Key:

BEV	Beverages
RFP	Refined petroleum products
TRK	Trucks other transportation machinery
FIN	Financial Services
OMC	Other light machinery and electricity products
MCH	Machinery
COM	Post and telecommunications
CHM	Basic chemical products
CMC	Commercial services and products (margins)
COF	Coffee
CTH	Finished clothing
FRN	Furniture
MTL	Basic metal products (except machinery)
OIL	Oil
PPR	Paper products
PLS	Plastics
GLS	Glass products

Table A-4: Shares of Economic Activity (%),

	GDP	UFS	UFN	UTC	UMC	RSW	RNW	K
PAD	9.4	18.9	-	-	36.5	9.3	-	5.0
RLS	9.3	6.8	7.1	5.1	5.1	3.1	1.3	17.9
CMC	8.2	6.3	21.4	27.8	0.7	2.6	9.5	4.2
FIN	6.5	5.7	4.2	3.4	15.7	0.6	0.7	11.6
CRO	6.0	-	-	-	-	27.2	31.2	0.4
LVS	4.9	-	-	-	-	21.4	24.5	1.0
GND	3.6	4.5	10.4	13.8	0.2	1.5	2.7	0.3
PBE	3.5	7.2	-	-	13.8	3.5	-	1.6
CON	3.2	3.2	8.2	6.2	2.8	1.1	1.4	2.5
CVL	3.1	1.1	2.8	2.1	1.1	0.6	0.7	6.9
PVS	2.7	3.2	3.4	2.4	2.2	1.0	0.2	3.4
CRP	2.6	4.1	4.3	3.1	2.9	1.5	0.5	1.8
ELE	2.5	2.1	0.0	0.1	0.2	0.6	-	6.8
HTL	2.3	1.9	6.3	8.3	0.3	1.0	3.1	1.2
COM	2.3	1.1	2.3	3.1	0.1	0.5	0.8	4.5
PBH	2.2	3.9	-	-	7.5	1.9	-	1.8
COF	2.2	-	-	-	-	9.6	11.0	0.3

Key:

PAD	Public administration
RLS	Real Estate (including the rental market)
CMC	Commercial services and products (margins)
FIN	Financial Services
CRO	Other crops
LVS	Livestock
GND	Ground transportation services
PBE	Public education
CON	Building Construction (non-civil)
CVL	Civil construction (bridges and streets)
PVS	Private education (all levels)
CRP	Corporate services (except financial services)
ELE	Electricity and gas
HTL	Hotels and restaurants
COM	Post and telecommunications
PBH	Public health and services
COF	Coffee

Table A-5: Shares of Economy-Wide Demand (%),

	H	G	I	E	M	MARGIN
CMC	-	-	0.1	0.2	0.7	91.9
PAD	-	62.7	-	-	-	-
RLS	13.8	-	0.9	-	-	-
CRO	5.5	-	1.7	15.1	4.5	-
CON	0.1	-	27.7	-	-	-
CVL	-	-	26.5	-	-	-
GND	5.3	-	-	0.3	-	8.1
PBH	1.0	18.7	-	-	-	-
HTL	6.2	-	-	-	-	-
PBE	0.2	17.3	-	-	-	-
PVS	4.2	-	-	-	-	-
COF	-	-	-1.2	15.4	0.0	-
FIN	2.0	-	-	0.8	2.0	-
COM	2.2	-	-	1.6	0.6	-
ELE	1.7	-	-	0.0	0.0	-
CRP	0.7	-	0.4	0.4	1.9	-
LVS	1.2	-	0.7	0.1	0.1	-

Key:

CMC	Commercial services and products (margins)
PAD	Public administration
RLS	Real Estate (including the rental market)
OMC	Other light machinery and electricity products
CHM	Basic chemical products
CRO	Other crops
TRK	Trucks other transportation machinery
CON	Building Construction (non-civil)
CVL	Civil construction (bridges and streets)
MTF	Processed Meat and Fish
MCH	Machinery
BEV	Beverages
GND	Ground transportation services
PBH	Public health and services
HTL	Hotels and restaurants
CTH	Finished clothing
PBE	Public education

Table A-6: Expenditure Shares (%)

	TOTAL	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10
RLS	14	7	7	9	8	10	10	11	12	13	20
MTF	7	9	9	10	9	9	9	9	8	7	5
BEV	7	8	8	8	8	8	8	7	7	6	6
HTL	6	3	5	5	6	6	7	7	7	7	6
CRO	6	10	9	10	9	8	8	7	6	5	2
GND	5	5	5	5	5	6	6	6	6	6	4
CHM	4	5	6	5	6	5	5	5	5	4	3
PVS	4	2	2	2	3	3	3	3	4	4	6
CTH	4	4	5	5	5	5	5	5	5	4	4
GRN	3	6	6	5	4	4	4	4	3	3	2
DAR	3	4	3	3	3	3	3	3	3	3	3
FRN	3	1	1	2	2	2	2	2	3	3	3
TRK	2	0	0	0	0	0	0	1	1	2	5
COM	2	1	1	1	1	2	2	2	2	2	3
FIN	2	1	1	1	1	1	1	1	1	2	3
TNF	2	1	1	1	1	1	1	1	2	2	3
ELE	2	2	2	2	2	2	2	2	2	2	1

Key:

RLS	Real Estate (including the rental market)
MTF	Processed Meat and Fish
BEV	Beverages
HTL	Hotels and restaurants
CRO	Other crops
GND	Ground transportation services
CHM	Basic chemical products
PVS	Private education (all levels)
CTH	Finished clothing
GRN	Grain products
DAR	Dairy Products
FRN	Furniture
TRK	Trucks other transportation machinery
COM	Post and telecommunications
FIN	Financial Services
TNF	Tourist infrastructure (stadiums, parks and special hotels)
ELE	Electricity and gas

Table A-7: Shares of Economy-Wide Earnings (%)

	TOTAL	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10
UFS	30359	1	2	3	4	5	6	8	11	18	42
UFN	10461	3	6	6	8	8	11	12	13	12	20
UTC	7002	4	5	6	7	8	9	10	11	14	26
UMC	2768	0	1	1	1	2	3	3	9	11	67
RSW	17436	1	2	3	4	5	6	8	11	18	42
RNW	5493	3	6	6	8	8	11	12	13	12	20
K	7564	1	1	2	2	3	5	7	11	15	53
TRN	7148	13	27	21	16	10	9	2	-3	1	-78
TAX	8864	6	18	15	11	8	6	4	3	2	26
SAV	5396	2	3	4	4	5	9	12	15	21	25

Key:

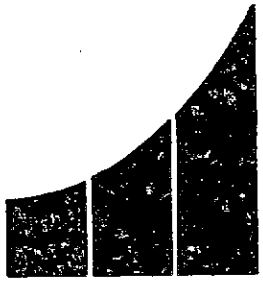
H1-H10	Representative households.
UFS	Urban formal salaried work
UFN	Urban formal non-salaried work
UTC	Urban traditional contract work
UMC	Urban modern contract work (consulting)
RSW	Rural salaried work (organized farming work)
RNW	Rural non-salaried work (farming)
K	Capital income
TRN	Transfers
TAX	Household income taxes
SAV	Household saving

Table A-8: Sources of Household Income (%)

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10
UFS	12	15	18	17	20	18	20	21	25	27
UFN	12	13	12	12	11	12	11	9	6	4
UTC	10	8	7	7	7	6	6	5	4	4
UMC	0	1	1	0	1	1	1	2	1	4
RSW	7	8	10	10	11	11	12	12	14	15
RNW	6	7	6	7	6	6	6	5	3	2
K	2	2	3	3	3	4	4	5	5	8
TRN	35	43	27	17	9	7	1	-2	0	-12
TAX	18	36	24	15	9	5	3	2	1	5
SAV	5	4	4	3	3	5	5	5	5	3

Key:

H1-H10	Representative households.
UFS	Urban formal salaried work
UFN	Urban formal non-salaried work
UTC	Urban traditional contract work
UMC	Urban modern contract work (consulting)
RSW	Rural salaried work (organized farming work)
RNW	Rural non-salaried work (farming)
K	Capital income
TRN	Transfers
TAX	Household income taxes
SAV	Household saving



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FUNDACION PARA LA EDUCACION SUPERIOR Y EL DESARROLLO

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Para el cumplimiento de sus objetivos, adelantará directamente o con la colaboración de universidades y centros académicos, proyectos de investigación sobre problemas de interés nacional.

Entre los temas de investigación que han sido considerados de alta prioridad están la planeación económica y social, el diseño de una política industrial para Colombia, las implicaciones del crecimiento demográfico, el proceso de integración latinoamericana, el desarrollo urbano y la formulación de una política petrolera para el país.

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