

# DECENTRALISED PROVISION OF QUASI-PRIVATE GOODS: THE CASE OF COLOMBIA

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## Abstract

This paper quantifies the welfare effects of decentralisation in Colombia, using a multiregional CGE model. We investigate to what extent will the Colombian population be better off when goods such as health and education, are delivered locally as against centrally. A provision scheme based on the median voter is considered. According to the results, the provision of health and education by regional governments improves the welfare of the Colombian population as a whole, since regional governments provide goods and services in a way that better caters to local preferences. More importantly, these welfare gains vary from 1.3% to 2.3% of GDP, a substantial magnitude especially when compared with the efficiency gains associated to the tax reforms of the early nineties.

Keywords: Decentralisation, applied CGE modelling, quasi-private goods.

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## 1. INTRODUCTION

This paper investigates to what extent will the Colombian population be better off when goods such as health and education, are delivered locally as against centrally. Health and education are quasi-private goods<sup>1</sup>, that is goods that have the characteristics of private goods, such as excludability and positive marginal costs of supply to an additional consumer, but are publicly provided. In this case, public intervention could be justified on the grounds of market failure, merit wants, externalities, or distributional arguments (Hare, 1988).

Toward this end, we build a multiregional computable general equilibrium (CGE) model for Colombia in order to compare two provision scenarios: one in which the provision of the quasi-private goods is carried out centrally, against one in which provision is carried out regionally. The literature on the provision of private goods by the public sector is mainly normative, since it focuses on the characteristics of possible provision rules. In this modelling exercise, a provision rule based on the median voter is considered. In this framework, the median voter (either national or regional) determines the quantity of the publicly provided private good to be allocated to each consumer.

During the last two decades the assignment of tax and spending powers between different levels of government has been receiving increasing attention from economists and policymakers alike. The main economic argument in favour of decentralisation is that it enhances economic efficiency, since regional governments tend to be better informed about local preferences than national governments.<sup>2</sup>

Many developing countries, including the transition economies of Eastern Europe, are turning to decentralisation as a way to escape from inefficient central governments, macroeconomic instability and inadequate economic growth (Bird, 1993). Decentralisation can also be justified on political grounds, especially if a country's population is not homogeneous in terms of ethnic, racial, cultural, linguistic, or other relevant characteristics are regionally distributed. In Canada, for example, the move

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<sup>1</sup> The term quasi-private was taken from Boadway et al (1994).

<sup>2</sup> See Boadway et al (1994) for a presentation of the pros and cons of decentralisation. For recent theoretical models of the costs and benefits of decentralisation see Lockwood (1998a, 1998b), and the references therein.

towards greater decentralisation has been mainly the result of political considerations, as some provinces are demanding more independence. In China, greater decentralisation has been driven by the need to regain some control over national public revenue. And in Ethiopia, ethnic diversity together with the belief that decentralisation would help hold national unity have been behind the decentralisation effort (Tanzi, 1995).

In Colombia the centralist organisation of the government has been evident since the Political Constitution of 1886. Political, administrative and fiscal powers as well as the provision of public services w

ere concentrated in the central government, leading to a growing dissatisfaction among the regions because of the lack of autonomy and deficiencies in the provision of public services. In the early 1980s, a Commission on Intergovernmental Finances recommended an increase in the use of local resources for local purposes, which in turn resulted in a new legislative framework for decentralising functions and finances (Departamento Nacional de Planeación, 1981). The Political Constitution of 1991 introduced some modifications to the prevailing territorial order of the country and redefined the functions of territorial entities, establishing new parameters to assign and determine transfers from the central government to lower levels of government. In 1993, each level of government was assigned functions in areas such as health, education, housing, drinking water and other public service.<sup>3</sup>

Contemporaneously with the decentralisation effort, poverty reduction became an important issue in Colombia. Poverty alleviation programs have been typically planned, executed and controlled by the central government. They are conceived as a multi-sectoral effort touching health, education, water, sanitation, utilities, family welfare, rural development and housing (World Bank, 1994). Given the observed decline in rural incomes and the prevailing level of violence in the country, the new strategy to improve the standard of living of the population was primarily based on the provision of essential

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<sup>3</sup> At the same time, a major change regarding the way transfers were allocated was introduced. Under the new regulations central government transfers were no longer allocated according to the population of each territorial entity, but based on unsatisfied basic needs, fiscal effort, administrative efficiency and, in some cases, in proportion to the potential population to be covered by health and education services. Also, the new regulations unified the source of the transfers so that they are now a growing percentage of the nation's current income.

social services (such as health, education, housing and drinking water), and the generation of employment opportunities by shifting public expenditures towards social sectors. Decentralisation and poverty reduction were then brought closer together with the introduction of the Law on local government functions and financing in 1993, which gave regional governments the responsibility of delivering social programmes and services to the poor.<sup>4</sup>

The main contribution of this paper relies on the fact that neither multiregional CGE models nor a scheme for public provision of private goods based on the median voter, have been previously applied to quantify the magnitude of the efficiency gains associated with decentralisation. This paper develops an equilibrium structure in which the quantities of the quasi-private goods to be provided by the government, together with the taxes levied to finance their provision are endogenously determined. In addition, the provision of the quasi-private goods affects the production structure of the economy, since in some regions more (less) of the good is produced, so that factors of production reallocate both within and between regions. Hence, the multiregional CGE modelling approach constitutes an appropriate tool for this analysis, since it allows us to model the interrelationships between different regions.

According to the results which follow, the Colombian population as a whole is likely to be better off when the provision of health and education is carried out regionally as opposed to centrally, since with regional provision each consumer group is allocated an amount of the goods that is closer to its preferences. More importantly, these welfare gains vary between 1.3% and 2.3% of GDP approximately, a substantial magnitude especially when compared with the efficiency gains associated to the tax reforms of the early nineties.

The paper is organised as follows. Section 2 presents a brief literature review regarding the public provision of quasi-private goods, and the provision rule used in the paper. Section 3 describes the structure of the multiregional CGE model. Section 4 presents the quantification of the efficiency gains from decentralised provision of health and education in Colombia. Section 5 offers some concluding remarks.

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<sup>4</sup> See Garay (1994) and Fainboim et al (1994) for a description of the decentralisation process in Colombia.

## 2. PUBLIC PROVISION OF QUASI-PRIVATE GOODS: A BRIEF LITERATURE REVIEW

The literature concerning the provision of private goods by the public sector is scant. Since Arrows'(1971) public expenditure model, this literature has mainly concentrated on the characteristics of possible allocation rules, that is how a private good "should be" publicly provided (Blomquist and Christensen, 1994; Hare, 1988; Munro, 1991). This literature has also analysed issues such as the introduction of user charges (Besley, 1991; Balestrino, 1995), the possibility of private market supplementation of the publicly provided private good (Epple and Romano, 1996; Blomquist and Christiansen, 1998), and the cost efficiency of in-kind transfers with repeated interaction (Thum and Thum, 2001).

Atkinson and Stiglitz (1980, Lecture 16) develop three models of public provision of private goods, where government intervention is justified on distributional grounds. In particular, they consider private goods that are freely provided to all consumers in a specified quantity, and cannot be traded by the individuals. These three models produce an optimal allocation which coincides with that obtained under free market conditions: that is, in the absence of government intervention, the level of provision of private goods for each individual is determined by the market, at the point where the marginal rate of substitution over consumption goods equals the marginal rate of transformation between these goods.

Besley and Coate (1991) develop a two-good general equilibrium model which shows that universal public provision<sup>5</sup> of private goods, such as health, housing and education, can redistribute income from the rich to the poor, even if the provision is financed through a head tax. Besley and Coate's model is a discrete choice model where individuals demand at most one unit of the good, and their decision as to whether to consume the good in the public or private sectors is based on quality considerations. These authors assume that the government provides a fixed quality level of the good (at zero price), which is typically not too high, and that the public provision is financed

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<sup>5</sup> Universal provision means that everybody is eligible and provision is free.

through a head tax. Under these circumstances, individuals with higher incomes may decide to pay for the good supplied by the private sector which offers a better quality level, rather than consuming the good provided by the government. The benefits from public provision will be mainly enjoyed by individuals with lower incomes. Nonetheless, the authors also find that universal provision schemes of private goods involve a dead-weight loss for the society as a whole. Besley and Coate's provision rule does not state how the fixed quality level and the head tax are determined.

The literature surveyed tells us the general features of possible provision rules in a normative sense. In practice, however, the government has to rely on surveys or other sources of information to infer the preferences of the population. The provision rule could be the result of a voting process. Since all consumers can benefit from the provision of the goods and services, the evident rule would be unanimous consent; however, it will take a long time to achieve unanimous consent and it encourages strategic behaviour (Mueller, 1989). In democratic societies, the majority rule is commonly chosen to make collective decisions. This rule introduces some redistribution, since some individuals are going to be worse off than they would be if the other outcome had been chosen. The possibility of distributional gains also creates an incentive to form coalitions. Under the majority rule an equilibrium outcome is obtained when voter's preferences are single-peaked. If these preferences can be depicted along a single dimension, as with an expenditure issue, the equilibrium lies at the peak-preference for the median voter (Mueller, 1989). It then follows that the median voter rule can be an alternative provision rule, where the demand for the good being provided by the government is determined by the median voter income. In order to apply the model empirically it is necessary to assume that the quantity of the good being provided is that demanded by the consumer with the median income (see Inman, 1978).

In the modelling approach used in this paper, the quantity of the quasi-private good provided by the government is determined by the median voter provision rule. As Oates (1993) puts it, in the median voter framework the equilibrium level of local services is faithfully mirrored by the median of the preferred levels of outputs of local residents. That is, under decentralised provision, each regional government will determine the provision level of the quasi-private good according to the corresponding

demand of the median voter. As one would expect, some individuals will be consuming more (or less) than they would have done being the good privately supplied. The public provision of the quasi-private good is financed by taxes, which results in transfers from consumers with high incomes to consumers with low incomes. Finally, the provision rule and the tax regime used to finance the provision of the good must be considered jointly, because of the distributional effects they have on the population.

In what follows, we describe the structure of the multiregional CGE model used to assess the welfare effects of the decentralised provision of quasi-private goods by the government.

### **3. THE MODEL**

We use a CGE model to capture the welfare gains associated with the regional public provision of quasi-private goods, as compared to central provision. In this model the national economy is disaggregated into regions, since we are interested in the distributional effects among them. In addition, more than one consumer group is considered, since there are also distributional effects among consumers.

The model is for a closed economy consisting of  $R$  regions, each one with demand and production structures. Each region produces two types of goods: those that are provided by the public sector, and are thus referred to as the publicly provided quasi-private goods (henceforth PPQP); and those that are allocated by the market according to supply and demand conditions, and are thus referred to as the private goods (henceforth PRI). In the model, the PPQP goods are considered to be non-tradable across regions, whereas the PRI goods are considered to be qualitatively the same as those PRI goods produced by other regions. There are two factors of production, namely labour and capital; for simplicity, intermediate production is not considered. Each region has three groups of consumers and its own local government. There is also a national government. The formal equations and notation used in the model are presented in Appendix 1.

In the model, a standard production structure is used, where each region produces two PPQP goods and three PRI goods. Constant elasticity of substitution (CES) production functions describe the substitutability between labour (L) and capital (K) in

the production of value added for each PRI good in each region. Each industry in each region selects an optimal level of inputs that minimises the cost of producing the goods. Regarding the PPQP goods, their production involves only labour.

Factors of production are non-produced commodities in fixed supply in each region. It is assumed that both factors are mobile across industries within each region. Regarding interregional factor mobility, labour is assumed to be inter-regionally immobile since the analysis focuses on the interregional distributional effects of policy changes. The analysis excludes all the efficiency issues associated with regional labour movements. Capital is assumed to be inter-regionally mobile.

Turning to the demand side of the model, each region has three groups of consumers. These can be thought of as low, medium, and high-income groups, since we are interested in the distributional effects of the decentralised provision of the PPQP goods within each region. Consumers differ in their preferences for both PPQP and PRI goods, and this is the key element to obtain gains from decentralisation.

As mentioned earlier, in this modelling exercise the quantity of the PPQP goods to be publicly provided (either nationally or regionally) is determined by the median voter. Thus, the median voter (in the country or in each region, depending on which provision scenario is being considered) determines his/her optimal consumption bundle by maximising his utility function subject to his budget constraint. In particular, the median voter's behaviour is summarised by means of a CES utility function defined over PRI and PPQP goods, more formally,

$$U_M^r = \left( \sum_i (\alpha_{M,i}^r)^{1/\mu_M^r} (X_{M,i}^r)^{(\mu_M^r-1)/\mu_M^r} + (\alpha_{M,j}^r)^{1/\mu_M^r} (Q_{M,j}^r)^{(\mu_M^r-1)/\mu_M^r} \right)^{\mu_M^r/(\mu_M^r-1)} \quad [1]$$

where  $U_M^r$  is the utility function of the median voter,  $\alpha_{M,i}^r$  and  $\alpha_{M,j}^r$  are share parameters,  $X_{M,i}^r$  is the demand of the median voter for the PRI good  $i$ ,  $Q_{M,j}^r$  is the demand of the median voter for the PPQP good  $j$ , and  $\mu_M^r$  is the elasticity of substitution in consumption between PRI and PPQP goods.

The median voter's budget constraint is in turn given by income equal expenditure ( $I_M^r = E_M^r$ ). Consumer's income is derived from factor ownership, whereas

consumer's expenditure includes the amount spent on both PRI and PPQP goods as well as the taxes paid to finance the provision of the PPQP goods.

$$I_h^r = \sum_i P_{PRI_i} X_{h,i}^r + \sum_j \tilde{P}_{PPQP_j}^r Q_{h,j}^r + T_h^r \quad [2]$$

where the price paid by consumers for the PPQP goods ( $\tilde{P}_{PPQP_j}^r$ ) corresponds to a fraction ( $\phi^r$ ) of the real cost of the good ( $P_{PPQP_j}^r$ ). All consumers pay the same percentage, this means that all consumers in each region pay the same price.  $T_M^r$  denotes taxes paid by the median voter, which correspond to either  $T_M^r = I_M^r t$  or  $T_M^r = I_M^r t^r$ , depending on whether the provision is financed by national or regional taxes, respectively; in either case the tax rates  $t$  and  $t^r$  are endogenously determined. The median voter will take into account the cost to him of the provision as well as the taxes levied to finance such provision. Hence, both the quantity demanded of the PPQP goods and the tax rate(s) will be determined simultaneously.

The government takes the optimal quantities of the PPQP goods that result from the utility maximisation problem of the median voter to allocate to the other consumers. Other consumer groups (in the country or in the region) will in turn determine their optimal consumption bundle by maximising their utility functions subject to i) their budget constraints and ii) the exogenously determined quantities of the publicly provided quasi-private goods.

Regarding the public sector, it is assumed that neither the central government nor the regional governments are optimising agents. The government, either national or local, provides the PPQP goods at a provision price ( $\tilde{P}_{PPQP_j}^r$ ), which could be zero. This provision price is a percentage ( $\phi^r$ ) of the cost covering price ( $P_{PPQP_j}^r$ ), which implies that the government in charge of the provision, has to cover the difference between these prices. In order to do this, a uniform income tax (either national or regional) is introduced, which is endogenously determined and must be such that the zero government surplus condition is satisfied (that is income equals expenditure,  $I_G = E_G$ ). In addition, a third financing alternative is considered which involves a combination of

national and regional taxes: the former is exogenously determined at a level of 0.05%<sup>6</sup> whereas the latter are endogenously determined. In this case, the revenues generated by the national tax are transferred to regional governments.

Central government income is given by the revenues generated by the provision of the PPQP goods and tax revenues. On the other hand, government expenditure is given by the cost of provision of the PPQP goods and transfers to regional governments ( $TR^r$ ). Since government income must equal government expenditure, the national tax rate can be calculated as:

$$t = \frac{\sum_{h,r,j} (P_{PPQP_j}^r - \tilde{P}_{PPQP_j}^r) \bar{Q}_{h,j}^r + \sum TR^r}{\sum_{h,r} (P_L^r \bar{L}_h^r + P_K^r \bar{K}_h^r)} \quad [3]$$

If the provision of the PPQP goods is financed by regional taxes, the regional tax rate can be determined by equalising government income (i.e. the revenues generated by the provision of the PPQP goods, tax revenues and central government transfers) and expenditure (i.e. the cost of provision of the PPQP goods) in each region, that is:

$$t^r = \frac{\sum_{h,j} (P_{PPQP_j}^r - \tilde{P}_{PPQP_j}^r) \bar{Q}_{h,j}^r - TR^r}{\sum_h (P_L^r \bar{L}_h^r + P_K^r \bar{K}_h^r)} \quad [4]$$

Once the model has been specified, it can be solved for an equilibrium solution. A general equilibrium in the model can be interpreted in the usual Walrasian sense as a set of prices for which all markets clear. In equilibrium, demand-supply equalities hold in each goods and factors markets; zero profit conditions hold for each industry, in each region; and, budget balance conditions must be satisfied for the central government and regional governments alike, and also for consumers in each region.

#### 4. QUANTIFYING THE WELFARE EFFECTS OF DECENTRALISATION IN COLOMBIA

Colombia, like many other countries, has engaged in a rather ambitious process of state decentralisation.<sup>7</sup> This process has followed the reforms carried out between 1988 and

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<sup>6</sup> This value was arbitrarily chosen so as to avoid numerical problems when solving the model.

1992 by the Colombian government in order to modernise the economy, which included areas such as foreign trade, foreign exchange regime, fiscal legislation, the financial sector and the labour market.<sup>8</sup>

Using data for 1992<sup>9</sup>, in this section a multiregional CGE model for the Colombian economy is built in order to quantify the welfare effects of the decentralised provision of quasi-private goods by the government. We will be dealing with a simplified version of the Colombian economy, in the sense that aspects such as foreign trade are not considered.

#### **4.1 BENCHMARK DATA SET, CALIBRATION AND ELASTICITIES**

Colombia comprises 33 provinces (or administrative regions). The complexities of a model with 33 regions are of secondary relevance to the problem being studied, so that these provinces were grouped according to the geographical classification of the country. Colombia is divided in five so-called “natural” or geographic regions: Pacific, Atlantic, Andean, Amazonia, and Orinoquia. Due to data constraints, Amazonia and Orinoquia are considered as one region. Hence, there are four regions of different size. The Andean region accounts for 63% of the country’s GDP, the Pacific and Atlantic regions each accounts for 15% of GDP, and the Amazonia and Orinoquia (henceforth A&O) region accounts for the remaining 7% of GDP.<sup>10</sup>

Turning to the commodities in the model, each region is assumed to produce three PRI goods and two PPQP goods. The former includes primary commodities (including fuels), manufactured goods, and services, whereas the latter corresponds to health and education. It is assumed that each region’s PRI goods are qualitatively the

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<sup>7</sup> In the country there have been two national commissions to study decentralisation: Departamento Nacional de Planeación (1981) and Wiesner (1992).

<sup>8</sup> See Urrutia(1994) for a presentation of these reforms.

<sup>9</sup> This year was chosen because the decentralisation process in Colombia was just beginning.

<sup>10</sup> To assess the sensitivity of the results to the regional classification, the country was also divided into three regions according to the GDP of each province. Administrative regions with the lowest GDP were grouped in region one, those with medium GDP were grouped in region two, and those with the highest GDP are in region three. In addition to the geographic and GDP classifications, provinces were classified in five regions according to agricultural GDP, with the provinces with the lowest agricultural GDP grouped in region one, and those with the highest in region five. The results under these alternative regional classifications are qualitatively the same, and so are not reported.

same. It should be mentioned that in Colombia the majority of education and health services are provided by the private sector. However, from the available data it is only possible to determine the value of the education and health services provided by the government (i.e. 0.4% and 2.3% of GDP, respectively), but not by the private sector. For this reason, the existence of pure private provision of education and health is not considered in the analysis.

The benchmark data set involves information on value added by component by industry, and domestic consumption. It was constructed using data from Regional Accounts, as compiled by DANE (1995b), and following the methodology presented by St-Hilaire and Whalley (1987). In this methodology, each region is treated as a separate economy, in which production and demand transactions by commodity at the regional level are presented. The data set also includes transactions between regions (e.g. commodity trade), payments of taxes by region as well as government expenditure. The equilibrium conditions that characterise the model are present in the data set, that is the value of final demands for each good in each region must equal the value of net supply (i.e., excluding intermediate supply), each consumer group satisfies its budget constraint, and budget balance conditions must be satisfied for the central government and regional governments alike.<sup>11</sup>

At this point, it is important to mention that in the Colombian data set, the PPQP goods are provided according to the preferences of each consumer group, with each one of them demanding different quantities of the goods. This seems inconsistent with the fact that the observed data is based on a period in which the PPQP goods were delivered by the central government. It would be ideal to allow the benchmark data set to represent the scenario in which the PPQP are delivered by the central government. However, there are problems with this approximation, since there is not information available to explain the differences between the levels of provision between consumer groups and between regions. The benchmark data set (Table A2.1 in Appendix 2) is therefore used as a starting point to calculate the quantities of the PPQP goods provided by central and regional governments.

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<sup>11</sup> An appendix with the sources and the procedure followed to assemble the data set is available from the author upon request.

Once the data set has been assembled, some parameter values, such as share parameters and scale parameters, can be directly calculated from the equilibrium conditions of the model, following the procedure described in Mansur and Whalley (1984). This procedure is known as calibration, and can be understood as the ability of the model to reproduce base year data as a model solution. The benchmark data set provides information on equilibrium transactions in value terms. The first step of the calibration procedure involves the separation of these transactions into price and quantity observations. In order to do this, a unit convention is widely used, in which it is assumed that a physical unit of each good and factor is the amount that sells for one currency unit (in this case, one Colombian peso). That is, both goods and factors have a price of unity in the benchmark equilibrium.

The next step in the calibration procedure is to calculate parameters for production functions from the benchmark equilibrium observations, given the required values of pre-specified elasticities. As CES functional forms are used, substitution elasticities must be exogenously determined. On the demand side, the model involves elasticities of substitution in consumption between PRI and PPQP goods. In this case, it was not possible to find econometric estimates, then this elasticity was set equal to one in all regions; these elasticities imply Cobb-Douglas demand functions. Regarding the supply side, the elasticity of substitution between labour and capital is the key parameter of the value-added functions of the PRI goods. These elasticities were calculated as weighted averages of the elasticities presented in Whalley (1985, p. 100). This elasticity is not required in the production of the PPQP goods, since their production only involves labour.

Once these parameters have been specified, share parameters can be obtained from demand functions. On the supply side, share and scale parameters can be obtained from cost functions. These parameters allow us to reproduce the data set as an equilibrium solution of the model. Then, we compare counterfactual equilibria with the benchmark equilibrium generated by the data. The model was solved using a routine we wrote in the General Algebraic Modelling System (GAMS) software.

## 4.2 MODEL RESULTS

In this section, counterfactual experiments are performed in order to analyse the welfare effects of the decentralised provision of PPQP goods, as measured by the equivalent variation (EV)<sup>12</sup>. In the applied general equilibrium literature, welfare measures focus on comparisons between equilibria.

In the analysis that follows, two provision scenarios are compared: national versus regional. In other words, we move from the scenario in which the provision is carried out by the central government to that in which PPQP goods are delivered by regional governments.

In the national provision scenario, uniform quantities of the PPQP goods are provided to all consumer groups across the country. These quantities correspond to the optimal demands derived from the utility maximisation problem of the median voter of the country. In the regional provision scenario, uniform quantities of the PPQP goods are provided to all consumers in each region, and these quantities correspond to the optimal demands obtained from the utility maximisation problems of the median voters in each region. It is important to bear in mind that since secondary data are used, it is likely that the share parameters in the utility functions are not the best. Then, it is assumed that the information contained in the benchmark data set reflect consumers preferences.

Since it is assumed that consumers pay a fraction of the cost of the PPQP goods, the government finances the remaining part for which three financing alternatives are considered: a) a national income tax; b) two regional income taxes; and c) a combination of a national tax and two regional taxes. Counterfactual experiments were carried out for the cases where the government finances 20%, 50%, 70%, and 100% of the cost of provision of the goods, although for brevity we shall focus on the case where consumers pay 50%. The new tax rate(s) is(are) endogenously determined and must be such that the zero government budget surplus condition is satisfied. Tax rates are calculated using equation [3] when provision is financed by a national tax, or [4] when using regional taxation.

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<sup>12</sup> The EV is the minimum amount that someone who gains from a particular change would be willing to accept to forego the change. In the case of an individual who loses from the change, the EV is the maximum he would be willing to pay to prevent that change.

Tax rates are expected to be larger as the percentage of the cost of provision of the PPQP goods paid by consumers gets smaller, because the government has to cover larger subsidies. In addition, the fact that consumers pay only a fraction of the cost of provision of the PPQP goods and that the government finances the remaining part, means that some consumer groups pay less than they should pay, whereas other groups pay more.

When uniform quantities of the PPQP goods are provided to all consumer groups across the country, consumers are allocated the optimal quantities demanded by consumer group two in the Atlantic region (the median voter of the country).<sup>13</sup> When the provision takes into account regional differences, uniform quantities of the PPQP goods are allocated to all consumers in each region corresponding to the optimal quantities demanded by the median voter of each region, in this case consumer group two (Appendix 3 presents the quantities allocated to each consumer group in both provision scenarios).

It is important to mention that when the provision, either national or regional, is financed by a national tax, the quantity demanded by the median voter increases as the percentage of the cost of provision paid by the consumer reduces, since the cost of the provision is covered by all consumers in the country. By contrast, when the provision is financed by regional taxes or a combination of regional and national taxes, the quantity demanded by the median voter reduces as the percentage of the cost of provision paid by the consumer increases, since the cost of the provision is now covered only by the consumers in the region.

Table 1 presents the subsidies received by consumers when they pay 50% of the cost of provision, under the three financing alternatives<sup>14</sup>. This table shows that when provision is carried out nationally, consumers in the Andean region are subsidising the provision of health and education for the rest of the country (i.e. there is redistribution

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<sup>13</sup> In strict sense, the median quantity would correspond to the average of the resulting quantities of the utility maximisation problem of consumer groups two in the Atlantic and Pacific regions because there is an even number of consumers in the country. To simplify the solution of the model, it was decided to consider only the results of consumer group two in the Atlantic region.

<sup>14</sup> The results when consumers pay 80%, 30%, and 0% of the cost of provision are not reported here, but are available from the author upon request.

among regions). The Andean region is the most densely populated region (around 60% of the population lives there) and is also the most industrialised one. If, on the other hand, provision follows regional preferences, consumer groups two and three in the Andean and A&O regions contribute to finance not only the provision of consumer group one in their respective region, but also the provision of the poorest consumer group in the Pacific and Atlantic regions. In this case there is redistribution within regions and among them.

When the provision is financed by regional taxes and carried out centrally, taxes are higher in the Pacific, Atlantic, and A&O regions than in the Andean region because the cost of provision represents a higher proportion of these region's income. When the provision is carried out regionally, tax rates are lower in all regions (compared to regional provision financed by a national tax) because smaller quantities of the PPQP goods, more in line with consumers' preferences, need to be financed.

Regarding subsidies, consumer groups two and three in each region subsidise consumer group one in both provision scenarios. In this case there is redistribution within the regions. As the percentage paid by consumers for the provision of the good falls, subsidies increase since higher taxes are required to balance the budget of the government. For example, when consumers pay 50% of the cost of provision, and the provision is carried out by the central government, consumer group one in the Pacific region receives Col\$7.7 billion (see Table 1); when consumers pay 30% and 0%, the subsidy increases to Col\$10.5 billion and Col\$14.3 billion, respectively.

When the government finances the provision of the PPQP good with a 0.05% national tax and regional taxes, tax rates are lower than when only regional taxes are used, because the revenues generated by the national tax are transferred back to regional governments. It was assumed that 25% of the tax revenues raised by the national tax were transferred to each regional government. This percentage can be used as a policy instrument in order to redistribute income from the richest to the poorest regions. With the transfers the central government helps to cover part of the cost of provision of the PPQP goods, so that less regional taxes are needed. In the other financing alternatives there are no transfers from the central to regional governments. In this financing alternative, under both provision scenarios the two richest consumer groups in the

Andean region are not only subsidising consumer group one in that region but also helping to finance the provision of consumer group one in the other three regions. In this case there is redistribution from the richest region to the poorest, and from the richest consumer group to the poorest consumer groups.

Now, let us consider the welfare effects of the decentralised provision of the PPQP goods. Both provision scenarios are compared (i.e., central versus regional) and the resulting efficiency gains (losses) are presented in Table 2 for each region and for the economy as a whole.<sup>15</sup> As can be seen from the table, whether the provision is financed with a national tax, regional taxes, or a combination of a 0.05% national tax and four regional taxes, the society as a whole gains from decentralised provision (except when the provision is financed by a national tax and the goods are provided free of charge). This is the case since under regional provision the quantity of the PPQP good supplied to consumers is more in line with their preferences. In addition, the welfare gains vary from 1.3% to 2.3% of GDP.<sup>16</sup> Notice that when the provision is financed with a national tax, the Andean region benefits the most from decentralisation, despite the fact that consumers in this region are subsidising the provision of consumers in other regions. As the percentage of the cost of provision reduces, the Andean region gains become losses since higher taxes are required. The Pacific region is worse off because of reduced aggregate consumption. The Atlantic and A&O regions are in some cases worse off; the decentralised provision of the PPQP goods increases considerably the quantity allocated to these two regions (when the percentage of the cost of provision paid by consumers is 30% and 0%), leading to a considerable reduction in the consumption of PRI goods; yet, the increased consumption of the PPQP goods is not enough to compensate the reduction in welfare due to the reduced consumption of the PRI goods.

When the provision of education and health is financed with a national tax, welfare losses in the Pacific region increase as the percentage of the cost of provision paid by consumers reduces. Welfare gains in the A&O region become welfare losses as

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<sup>15</sup> Regional equivalent variations were calculated as the arithmetic sum of individual equivalent variations summed across consumer groups. The aggregate welfare change was calculated using an arithmetic sum of regional equivalent variations. Problems associated to this procedure are discussed in Boadway (1974) and Boadway and Bruce (1984).

<sup>16</sup> Welfare gains are similar when 25% of the revenues raised by the national tax are transferred to the Pacific region, 25% to the Atlantic region, 10% to the Andean region, and 40% to the A&O region.

the percentage paid by consumers reduces; these losses are generated by a reduction in disposable income, because of higher taxes, since they are contributing to finance the poorest consumer in the Pacific and Atlantic regions. In the Andean region, welfare gains increase as the percentage paid by consumers increase; this is the result of increased aggregate consumption caused by the increase in disposable income resulting from lower taxes.

It is interesting to notice that when the provision is financed with either regional taxes or a combination of national and regional taxes, all regions are better off as a result of the decentralised provision of health and education. Further, welfare gains are larger than when the provision is financed with a national tax alone.

The magnitude of the welfare gains from decentralised provision is substantial, especially when compared to those resulting from the tax reforms carried out between 1990 and 1992, which have been estimated to account for only 0.2% of GDP (see Lora and Herrera, 1994). These results suggest that regional differences are very important, not only the number of regions, but also the preferences for the goods to be publicly provided. The more different the preferences among regions, the better chance for considerable welfare gains.

The results of the model are dependent on the values selected for the elasticities of substitution. Sensitivity analysis is performed around the values chosen (although these results are not reported here). In particular, the elasticity of substitution in consumption between PRI and PPQP goods was varied from 0.5 to 1.5. This elasticity is very important in our model since consumption effects, determine the welfare effects of any policy change. We conclude that the results are robust to the elasticity choice, in the sense that the main predictions of the model do not change. Independently of the financing alternative the decentralised provision of PPQP goods generates welfare gains, except when the provision is financed by a national tax and consumers pay 0% of the cost of provision of the goods. However, the magnitude of the welfare gains is sensitive to the value of the elasticity chosen; in particular, the larger the elasticity of substitution the smaller the welfare gains. This means that as the goods become more substitutes in

consumption there is less room for welfare gains as a result of increased consumption of the goods.

In a second set of simulations, the elasticity of factor substitution in value added of the PRI goods was varied from 0.5 to 1.5. The results of the model are robust to the value of the elasticities chosen with aggregate welfare gains accounting for approximately 2.3% of GDP, as in the central case specification when the provision is financed by either regional taxes or a combination of national and regional taxes.

## **5. CONCLUDING REMARKS**

This paper has presented numerical results on the welfare effects of the decentralised provision of health and education using a multiregional CGE model for Colombia. Two provision scenarios were compared: one in which goods and services are supplied according to national preferences, as opposed to one where goods and services are delivered following regional preferences. When the provision is carried out nationally, consumers groups across the country are provided with uniform quantities of the goods, and these are determined by the median voter of the country. When the provision is carried out regionally, uniform quantities of the goods are provided for all consumer groups in each region, and these quantities are determined by the corresponding regional median voter. In the model, consumers pay a fraction of the cost of the PPQP goods, and the government finances the remaining part using a national income tax, regional income taxes, or a combination of the two.

The results show that the decentralised provision of education and health improves the welfare of the Colombian population as a whole (except in the case when the provision is free of charge). It is worth pointing out that not all regions benefit when the provision is financed by a national tax; the Andean and the A&O regions subsidise the provision of the Pacific and Atlantic regions. When the provision is financed by regional taxes or a combination of national and regional taxes, all regions benefit from decentralised provision.

The main conclusion that arises from this modelling exercise, is that the society as a whole is better off when the provision of health and education is carried out

regionally as opposed to centrally: with regional provision, each consumer group is allocated amounts of the goods that are closer to its preferences. More importantly, these welfare gains vary between 1.3% and 2.3% of GDP, a substantial magnitude especially when compared with the estimated efficiency gains associated to the tax reforms of the early nineties. When the country was divided into three and five regions, the welfare gains of decentralisation vary between 1.4% and 2.3% of GDP and between 0.5% and 1.4% of GDP, respectively. This result suggests that regional differences are very important, not only the number of regions, but also the preferences for the goods to be publicly provided. The more different the preferences among regions, the better chance for considerable welfare gains.

Finally, it is worth mentioning that from the policy point of view, decentralisation properly implemented can provide important economic and political benefits to regions, as local governments deliver services more efficiently and are accountable for public spending. Decentralisation not only involves the allocation of expenditure responsibility and/or more fiscal powers to sub-national levels of government. It also requires the provision of the necessary resources and the development of adequate institutional support and public expenditure management structures, if the results are to be socially and economically beneficial. The question is then, as McLure (1995) puts it, how to do it well, since decentralisation badly done can reduce welfare, increase income disparities among regions, and aggravate fiscal problems and corruption, among others.

**Table 1: Subsidies when consumers pay 50% of the cost of provision  
(Col \$ billions)**

Regions/consumers.	National provision financed by:			Regional provision financed by:		
	National tax	Regional taxes	Regional taxes and national tax of 0.05%	National tax	Regional taxes	Regional taxes and national tax of 0.05%
<b>Pacific</b>						
Consumer 1	14.3	7.7	7.9	18.4	8.8	9.1
Consumer 2	7.2	-2.1	-1.5	0.8	-2.4	-1.9
Consumer 3	4.6	-5.6	-4.9	-5.5	-6.4	-5.7
<b>Atlantic</b>						
Consumer 1	12.8	7.3	7.5	13.2	7.3	7.5
Consumer 2	5.8	-2.5	-1.9	-4.4	-2.5	-1.9
Consumer 3	4.2	-4.8	-4.1	-8.5	-4.8	-4.1
<b>Andean</b>						
Consumer 1	-5.0	7.9	6.9	56.9	46.9	45.9
Consumer 2	-35.4	-2.0	-4.1	-17.4	-11.7	-13.9
Consumer 3	-47.4	-5.9	-8.5	-47.1	-35.2	-37.8
<b>A&amp;O</b>						
Consumer 1	15.1	6.5	7.0	3.2	2.2	2.8
Consumer 2	11.9	-3.3	-2.2	-4.8	-1.1	-0.0
Consumer 3	11.9	-3.2	-2.1	-4.8	-1.1	-0.0

Note: The subsidy is calculated as the cost of provision of the PPQP goods, minus the value paid by the consumer and the income tax.

**Table 2: Welfare effects of decentralisation**  
(Col\$ billion)

	Percentage of the cost of provision paid by consumers							
	80%		50%		30%		0%	
	EV	%GDP	EV	%GDP	EV	%GDP	EV	%GDP
1. National tax								
Pacific	-33.5	-0.1%	-50.6	-0.2%	-61.9	-0.2%	-292.0	-1.0%
Atlantic	78.9	0.3%	38.8	0.1%	-2.5	-0.0%	317.7	1.0%
Andean	540.6	1.8%	529.0	1.7%	466.9	1.5%	-884.6	-2.9%
A&O	49.1	0.2%	15.8	0.1%	-12.5	-0.0%	135.1	0.4%
Total	635.1	2.1%	533.0	1.8%	390.0	1.3%	-723.8	-2.4%
2. Regional taxes								
Pacific	1.4	0.0%	2.1	0.0%	2.6	0.0%	3.3	0.0%
Atlantic	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%
Andean	612.4	2.0%	633.9	2.1%	647.3	2.1%	666.3	2.2%
A&O	28.4	0.1%	24.9	0.1%	22.8	0.1%	19.9	0.1%
Total	642.2	2.1%	660.9	2.2%	672.7	2.2%	689.5	2.3%
3. Regional taxes and a 0.05% national tax								
Pacific	1.5	0.0%	2.2	0.0%	2.6	0.0%	3.3	0.0%
Atlantic	195.6	0.6%	199.3	0.7%	400.7	1.3%	593.0	2.0%
Andean	441.9	1.5%	444.9	1.5%	249.9	0.8%	87.3	0.3%
A&O	3.2	0.0%	14.5	0.0%	19.2	0.1%	5.6	0.0%
Total	642.2	2.1%	660.9	2.2%	672.4	2.2%	689.2	2.3%

Notes: Totals may not add up because of rounding. EV denotes equivalent variation. GDP corresponds to national GDP.

## References

- Arrow, K. (1971). A Utilitarian Approach to the Concept of Equality in Public Expenditure. *Quarterly Journal of Economics*, Vol. 85, 409-415.
- Atkinson, A. and Stiglitz, J. (1980). *Lectures on Public Economics*. McGraw-Hill, London.
- Balestrino, A. (1995). Public Provision of Private Goods and User Charges. *Recherches Economiques de Louvain*, Vol. 61, No. 4, 461-477.
- Besley, T. (1991). Welfare Improving User Charges for Publicly Provided Private Goods. *Scandinavian Journal of Economics*, Vol. 93, No. 4, 495-510.
- Besley, T. and Coate, S. (1991). Public Provision of Private Goods and the Redistribution of Income. *American Economic Review*, Vol. 81, No. 4, 979-984.
- Bird, R. (1993). Threading the fiscal labyrinth: Some issues in fiscal federalism. *National Tax Journal*, Vol. 46, No. 2, 207-227.
- Blomquist, S. and Christiansen, V. (1994). *Public Provision of Private Goods as a Redistributive Device in an Optimum Income Tax Model*. Working Paper 1994:26, Department of Economics, Uppsala University, Sweden.
- Blomquist, S. and Christiansen, V. (1998). Topping up or opting out? The optimal design of public provision schemes. *International Economic Review*, Vol. 39, No. 2, 390-411.
- Boadway, R. (1974). The welfare foundations of cost-benefit analysis. *Economic Journal*, Vol. 84, 926-39.
- Boadway, R., and Bruce, N. (1984). *Welfare Economics*, Basil Blackwell, Oxford.
- Boadway, R., Roberts, S., and Shah, A. (1994). *The reform of fiscal systems in developing and emerging market economies: A federalism perspective*. Policy Research Working Paper 1259. Policy Research Department, Public Economics Division. The World Bank, Washington.
- DANE (1995a). Cuentas Nacionales de Colombia: Definitivas 1987-1992. *Boletín de Estadística* 505, April.
- DANE (1995b). *Cuentas Departamentales de Colombia*.

- Departamento Nacional de Planeación (1981). *Finanzas intergubernamentales en Colombia*, Informe final de la misión de finanzas intergubernamentales, Bogotá.
- Epple, D. and Romano, R. (1996). Public provision of private goods. *Journal of Political Economy*, Vol. 104, No. 1, 57-84.
- Fainboim, I., Acosta, O., and Cadena, H. (1994). *El proceso reciente de descentralización fiscal en Colombia y sus perspectivas*. Mimeo, April.
- Garay, L. (1994). *Descentralización, bonanza petrolera y estabilización. La economía Colombiana en los años noventa*. FESCOL, CEREC, Bogotá.
- GAMS386 (1989). Washington: IBRD/World Bank.
- Hare, P. (1988). Economics of the Publicly Provided Private Goods and Services. In Paul G. Hare (ed.) *Surveys in Public Sector Economics*. Basil Blackwell, Oxford, 68-101.
- Inman, R. (1978). Testing Political Economy's "as if" proposition: is the median income voter really decisive?. *Public Choice*, Vol. 33, 45-65.
- Lockwood, B. (1998a). The assignment of powers in federal and unitary states. *Warwick Economics Research Papers* 511, February.
- Lockwood, B. (1998b). Distributive politics and the benefits of decentralisation. *Warwick Economics Research Papers* 513, August.
- Lora, E. and Herrera, A. (1994). *Tax incidence in Colombia: A general equilibrium analysis*. Fedesarrollo. Mimeo, April.
- Mansur, A. and Whalley, J. (1984). Numerical Specification of Applied General Equilibrium Models: Estimation, Calibration and Data, 69-127. In H.E. Scarf and J.B. Shoven (eds.) *Applied General Equilibrium Analysis*, Cambridge University Press, Cambridge.
- McLure, C., Jr. (1995). Comment on "Fiscal federalism and decentralisation: A review of some efficiency and macroeconomic aspects". In *Annual World Bank Conference on Development Economics 1995*, 317-322. M. Bruno and B. Pleskovic (eds.), World Bank, Washington.
- Mueller, D. (1989). *Public Choice II. A Revised Edition of Public Choice*. Cambridge University Press.

- Munro, A. (1991). The Optimal Public Provision of Private Goods. *Journal of Public Economics*, Vol. 44, 239-261.
- Oates, W.E. (1993). Fiscal decentralisation and economic development. *National Tax Journal*, Vol. 46, No. 2, 237-243.
- St-Hilaire, F. and Whalley, J. (1987). A microconsistent data set for Canada for use in regional general equilibrium analysis, *Review of Income and Wealth*, Vol. 33, 327-343.
- Tanzi, V. (1995). Fiscal federalism and decentralisation: A review of some efficiency and macroeconomic aspects, 295-315. In *Annual World Bank Conference on Development Economics 1995*. M. Bruno and B. Pleskovic (eds.), World Bank, Washington.
- Thum, C. and Thum, M. (2001). Repeated interaction and the public provision of private goods, *Scandinavian Journal of Economics*, Vol. 103, No. 4, 625-643.
- Urrutia, M. (1994). Colombia. In J. Williamson (ed.), *The Political Economy of Policy Reform*. Institute for International Economics, Washington.
- Valderrama, F. and Gutetiérrez, J. (1996). Matriz de contabilidad social SAM 1992 y multiplicadores de contabilidad. *Revista de Planeación y Desarrollo*, Vol. 27, No.1, 251-304, January-March.
- Whalley, J. (1985). *Trade Liberalisation among major world trading areas*. MIT press. Cambridge, Massachusetts.
- Wiesner, E. (1992). *Colombia: Descentralización y federalismo fiscal*. Presidencia de la República y Departamento Nacional de Planeación, Bogotá.
- World Bank (1994). *Colombia: Poverty Assessment Report*.

## Appendix 1: Model equations and notation

### *Production side of the model*

- Value-added functions

$$VA_{PRI_i}^r = \gamma_i^r \left( \delta_i^r (L_{PRI_i}^r)^{(\sigma_i^r-1)/\sigma_i^r} + (1-\delta_i^r) (K_{PRI_i}^r)^{(\sigma_i^r-1)/\sigma_i^r} \right)^{\sigma_i^r/(\sigma_i^r-1)} \quad [A.1]$$

$$VA_{PPQP_j}^r = L_{PPQP_j}^r \quad [A.2]$$

### *Demand side of the model*

- Utility function

1. Median voter

$$U_M^r = \left( \sum_i (\alpha_{M,i}^r)^{1/\mu_M^r} (X_{M,i}^r)^{(\mu_M^r-1)/\mu_M^r} + (\alpha_{M,j}^r)^{1/\mu_M^r} (Q_{M,i}^r)^{(\mu_M^r-1)/\mu_M^r} \right)^{\mu_M^r/(\mu_M^r-1)} \quad [A.3]$$

2. Other consumers

$$U_h^r = \left( \sum_i (\alpha_{h,i}^r)^{1/\mu_h^r} (X_{h,i}^r)^{(\mu_h^r-1)/\mu_h^r} + (\alpha_{h,j}^r)^{1/\mu_h^r} (\bar{Q}_{h,i}^r)^{(\mu_h^r-1)/\mu_h^r} \right)^{\mu_h^r/(\mu_h^r-1)}, \quad h \neq M \quad [A.4]$$

### *Constraints*

- Consumer budget constraint ( $I_h^r = E_h^r$ )

1. Median voter

$$P_L^r \bar{L}_M^r + P_K^r \bar{K}_M^r = \sum_i P_{PRI_i}^r X_{M,i}^r + \sum_j \tilde{P}_{PPQP_j}^r Q_{M,j}^r + T_M^r \quad [A.5]$$

where  $T_M^r = I_M^r t$  if a national tax is used to finance the provision, where

$$t = \frac{\sum_{j,h,r} (P_{PPQP_j}^r - \tilde{P}_{PPQP_j}^r) Q_{M,j}^r + \sum_r TR^r}{\sum_{h,r} I_h^r}.$$

If regional taxes are used to finance the provision then  $T_M^r = I_M^r t^r$ , where

$$t^r = \frac{\sum_{j,h} (P_{PPQP_j}^r - \tilde{P}_{PPQP_j}^r) Q_{h,j}^r - TR^r}{\sum_h I_h^r}.$$

Notice that in the expressions for  $t$  and  $t^r$  the summations are over all consumer groups including the median voter.

## 2. Other consumers

$$P_L^r \bar{L}_h + P_K^r \bar{K}_h = \sum_i P_{PRI_i} X_{h,i}^r + \sum_j \tilde{P}_{PPQP_j}^r \bar{Q}_{h,j}^r + T_h^r, h \neq M \quad [A.6]$$

where,

$T_h^r = I_h^r t$  or  $T_h^r = I_h^r t^r$  depending on the financing alternative.

- Provision PPQP goods

$$\bar{Q}_{h,j}^r = Q_{M,j}^r \quad [A.7]$$

- Central government budget constraint ( $I_G = E_G$ )

$$\sum_{h,r,j} \tilde{P}_{PPQP_j}^r \bar{Q}_{h,j}^r + \sum_{h,r} (P_L^r \bar{L}_h + P_K^r \bar{K}_h) t = \sum_{h,r,j} P_{PPQP_j}^r \bar{Q}_{h,j}^r + \sum_r TR^r \quad [A.8]$$

- Regional governments budget constraints ( $I_G^r = E_G^r$ )

$$\sum_{h,j} \tilde{P}_{PPQP_j}^r \bar{Q}_{h,j}^r + \sum_h (P_L^r \bar{L}_h + P_K^r \bar{K}_h) t_r + TR^r = \sum_{h,j} P_{PPQP_j}^r \bar{Q}_{h,j}^r \quad [A.9]$$

### *Zero profit conditions*

- In each region the value of sales must equal the industries' costs

$$P_{PRI_i} VA_{PRI_i}^r = P_L^r L_{PRI_i}^r + P_K^r K_{PRI_i}^r \quad [A.10]$$

and

$$P_{PPQP_j}^r VA_{PPQP_j}^r = P_L^r L_{PPQP_j}^r + P_K^r K_{PPQP_j}^r \quad [A.11]$$

### *Market clearing conditions*

- Goods markets: gross output must equal final demand:

$$\sum_r VA_{PRI_i}^r = \sum_{h,r} X_{h,i}^r \quad [A.12]$$

$$VA_{PPQP_j}^r = \sum_h Q_{h,j}^r \quad [A.13]$$

- Labour market

$$\sum_h \bar{L}_h^r = \sum_i L_{PRI_i}^r + \sum_j L_{PPQP_j}^r \quad [A.14]$$

- Capital market

$$\sum_{h,r} \bar{K}_h^r = \sum_{i,r} K_{PRI_i}^r + \sum_{j,r} K_{PPQP_j}^r \quad [A.15]$$

*Equations for price relationships*

- Provision price PPQP goods

$$\tilde{P}_{PPQP_j}^r = \phi^r \left( \frac{P_L^r L_{PPQP_j}^r}{P_L^0 L_{PPQP_j}^r} \right), \quad [A.16]$$

*List of variables*

$VA_{PRI_i}^r$  Value added PRI good i region r.

$VA_{PPQP_j}^r$  Value added PPQP good j region r.

$L_{PRI_i}^r$  Labour input PRI good i region r.

$L_{PPQP_j}^r$  Labour input PPQP good j region r.

$K_{PRI_i}^r$  Capital input PRI good i region r.

$K_{PPQP_j}^r$  Capital input PPQP good j region r.

$U_h^r$  Utility consumer group h region r.

$X_{h,i}^r$  Demand PRI good i consumer group h region r.

$Q_{h,j}^r$  Demand PPQP good j consumer group h region r.

$I_h^r$  Income consumer group h region r.

$E_h^r$  Expenditure consumer group h region r

$P_L^r$  Selling price labour input region r.

$P_K$  Selling price of capital.

$P_{PRI_i}$  Price paid by consumers for PRI good i.

$P_{PPQP_j}^r$  Cost covering price PPQP good j region r.

- $\tilde{P}_{PPQP_j}^r$  Price paid by consumers for PPQP good j region r.
- $T_h^r$  Income tax paid by consumer group h in region r.
- t National income tax rate.
- $t^r$  Regional income tax rates.
- $TR^r$  Central government transfers regional government r.

*List of parameters*

- $\gamma_i^r$  Scale parameter value added function, PRI good i region r.
- $\delta_i^r$  Share parameter value added function, PRI good i region r.
- $\sigma_i^r$  Elasticity of substitution between labour and capital, PRI good i region r.
- $\nu_j^r$  Elasticity of substitution between labour and capital, PPQP good j region r.
- $\alpha_{h,i}^r$  Share parameters utility function, PRI good i region r.
- $\alpha_{h,j}^r$  Share parameters utility function, PPQP good j region r.
- $\mu_h^r$  Elasticity of substitution in consumption consumer group h region r.
- $\bar{L}_h^r$  Endowment of labour consumer group h region r.
- $\bar{K}_h^r$  Endowment of capital consumer group h region r.
- $\overline{Q_{h,j}^r}$  Government provision of PPQP good j to consumer group h region r.
- $\phi^r$  Percentage of the cost of provision of the PPQP goods paid by consumers.

## **Appendix 2: Colombian regional data set**

The resulting four-region data set is presented in the following table. It presents production and demands by commodity along with consumers and government(s) income and expenditure accounts. On the production side, labour and capital are used to produce the PRI goods in each region; as to the PPQP goods, labour is the only factor that enters in their production.

On the demand side, consumers demand both types of goods, and it is initially assumed that consumers pay the full cost of the goods provided by the government. The consumers income and expenditure accounts show that income generates from factor ownership, that is consumers own both factors of production, while expenditure corresponds to final demand. Lastly, government income is given by the revenues generated by the provision of the PPQP goods and tax collections (although initially it is assumed that there are no taxes); government expenditure is in turn given by the cost of provision of the PPQP goods.

**Table A2.1:** Colombian regional data set  
(Col\$ billion)

Production side: Primary inputs

	Pacific region			Atlantic region			Andean region			A & O region			Total VA
	L	K	VA	L	K	VA	L	K	VA	L	K	VA	
Primary goods	390	587	977	508	1,030	1,537	1,252	2,290	3,542	289	971	1,260	7,316
Manufactures	398	451	850	319	361	679	1,589	1,800	3,388	20	23	43	4,960
Services	1,170	1,426	2,596	1,014	1,243	2,257	5,314	6,204	11,519	344	411	755	17,126
<u>Education</u>													
Pacific region	17	0	17	0	0	0	0	0	0	0	0	0	17
Atlantic region	0	0	0	15	0	15	0	0	0	0	0	0	15
Andean region	0	0	0	0	0	0	89	0	89	0	0	0	89
A & O region	0	0	0	0	0	0	0	0	0	5	0	5	5
<u>Health</u>													
Pacific region	102	0	102	0	0	0	0	0	0	0	0	0	102
Atlantic region	0	0	0	90	0	90	0	0	0	0	0	0	90
Andean region	0	0	0	0	0	0	527	0	527	0	0	0	527
A & O region	0	0	0	0	0	0	0	0	0	32	0	32	32
Total	2,077	2,464	4,542	1,945	2,633	4,578	8,772	10,294	19,065	690	1,405	2,095	30,280

Notes: L denotes labour input; K denotes capital input; and VA denotes value added.

**Table A2.1 (Continued):** Colombian regional data set  
(Col\$ billion)

Demand side: Final demands

	Pacific region			Atlantic region			Andean region			A & O region			Total
	Cons.1	Cons.2	Cons.3	Cons.1	Cons.2	Cons.3	Cons.1	Cons.2	Cons.3	Cons.1	Cons.2	Cons.3	
Primary goods	234	420	323	368	661	508	849	1,523	1,170	303	555	402	7,316
Manufactures	201	340	309	161	271	247	801	1,354	1,234	10	18	15	4,960
Services	346	911	1,339	300	792	1,164	1,533	4,044	5,941	102	253	400	17,126
<u>Education</u>													
Pacific region	2	6	9	0	0	0	0	0	0	0	0	0	17
Atlantic region	0	0	0	2	5	8	0	0	0	0	0	0	15
Andean region	0	0	0	0	0	0	12	30	47	0	0	0	89
A & O region	0	0	0	0	0	0	0	0	0	1	2	3	5
<u>Health</u>													
Pacific region	14	34	54	0	0	0	0	0	0	0	0	0	102
Atlantic region	0	0	0	12	30	48	0	0	0	0	0	0	90
Andean region	0	0	0	0	0	0	72	175	280	0	0	0	527
A & O region	0	0	0	0	0	0	0	0	0	5	11	16	32
Total	797	1,711	2,034	844	1,760	1,975	3,266	7,126	8,672	420	840	836	30,280

**Table A2.1 (Continued):** Colombian regional data set  
(Col\$ billion)

Consumers income and expenditure accounts

	Pacific region			Atlantic region			Andean region			A & O region			Total
	Cons.1	Cons.2	Cons.3	Cons.1	Cons.2	Cons.3	Cons.1	Cons.2	Cons.3	Cons.1	Cons.2	Cons.3	
Labour income	364	782	931	358	748	839	1,503	3,279	3,990	138	276	275	13,483
Capital income	432	928	1,104	485	1,012	1,136	1,764	3,848	4,682	282	563	561	16,796
Total income	797	1,711	2,034	844	1,760	1,975	3,266	7,126	8,672	420	840	836	30,280
Final demand	797	1,711	2,034	844	1,760	1,975	3,266	7,126	8,672	420	840	836	30,280
Taxes	0	0	0	0	0	0	0	0	0	0	0	0	0
Total expenditure	797	1,711	2,034	844	1,760	1,975	3,266	7,126	8,672	420	840	836	30,280

Government income and expenditure accounts

Provision Education	127
Provision Health	751
Tax collections	0
Total income	878
Cost provision Education	127
Cost provision Health	751
Total expenditure	878

Source: Totals may not add up due to rounding. DANE (1995b) and author's calculations.

### Appendix 3

Quantities of education and health provided by  
the central and regional governments as determined by the median voter

**Table A.3.1:** National provision  
(billion units)

Percentage of The cost of Provision paid by consumers (PP):	Education	Health
<i>1. Financed with a national tax</i>		
PP = 80%	5.4	31.8
PP = 50%	5.9	35.2
PP = 30%	6.4	37.9
PP = 0%	7.2	42.8
<i>2. Financed with regional taxes</i>		
PP = 80%	4.9	29.0
PP = 50%	4.7	27.7
PP = 30%	4.6	27.0
PP = 0%	4.4	25.9
<i>3. Financed with regional taxes and a 0.05% national tax</i>		
PP = 80%	4.9	29.0
PP = 50%	4.7	27.7
PP = 30%	4.5	27.0
PP = 0%	4.4	25.9

**Table A.3.1 (Continued): Regional provision**  
(billion units)

Percentage of the cost of provision paid by consumers:	Region 1		Region 2		Region 3		Region 4	
	Educ.	Health	Educ.	Health	Educ.	Health	Educ.	Health
<i>1. Financed with a national tax</i>								
PP = 80%	6.9	40.6	6.0	35.6	31.4	186.0	2.2	12.9
PP = 50%	9.8	57.6	8.6	50.4	34.6	204.9	3.3	19.3
PP = 30%	13.7	80.1	11.9	69.8	37.2	219.8	5.0	29.1
PP = 0%	33.8	196.5	28.8	168.0	41.8	246.8	21.4	124.6
<i>2. Financed with regional taxes</i>								
PP = 80%	5.6	33.2	4.9	29.0	28.9	171.1	1.7	10.2
PP = 50%	5.4	32.0	4.7	27.7	27.9	165.2	1.6	9.6
PP = 30%	5.3	31.2	4.6	27.0	27.3	161.5	1.6	9.3
PP = 0%	5.1	30.1	4.4	25.9	26.4	156.3	1.5	8.8
<i>3. Financed with regional taxes and a 0.05% national tax</i>								
PP = 80%	5.6	33.2	4.9	29.0	28.9	171.0	1.7	10.2
PP = 50%	5.4	31.9	4.7	27.7	27.9	165.1	1.6	9.6
PP = 30%	5.3	31.2	4.5	27.0	27.2	161.5	1.6	9.3
PP = 0%	5.1	30.1	4.4	25.9	26.4	156.2	1.5	8.8

Note: In some cases the provision levels seem identical, but this is due to rounding.