Poverty Impacts of Agricultural Policy Adjustments in an Opening Economy: the Case of Colombia*

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Abstract

We aim to contribute to the assessment of sectoral and poverty impacts on the rural sector arising from agricultural policy adjustments in Colombia. For this we use an agriculture specialized static CGE model, jointly (sequentially) with a microsimulation model that allows for effective job relocation. Results indicate that the sectoral impact of the program implemented tends to be small and has considerable variability across crops. Also, although it reduces poverty, poverty impacts are small and tend to concentrate in rural households toward the middle of the income distribution ladder.

Keywords: Agricultural policy, Rural poverty, Computable General Equilibrium, Microsimulation, Colombia

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1. Introduction

On occasion of the negotiations for the establishment of a Free Trade Agreement between Colombia and the United States, the government agreed with representatives of agricultural producers to design and operate a program for compensating the losers from the agreement and for enhancing sectoral competiveness. A program for these purposes was launched in April 2007 and was given significant resources to operate. This policy package seems to reinforce a policy trend in Colombia toward increasing transfers to agricultural producers. In fact, a World Bank's (2008) study shows that Colombia is the Latin American economy (among eight economies studied) that higher transfers makes per person engaged in agriculture in the region.

With the resources deployed, it can be expected that the policy will have non-negligible effects on agricultural production and rural poverty reduction. As in other countries, Colombia shows high and persistent poverty rates in the rural sector and rural poverty, historically, has been higher than urban poverty.

The aim of this research is to estimate the likely short run effects of this program at both the sectoral and micro levels. At the macro level we want to appraise the impact of this new agricultural policy on goods' relative prices, production quantum, employment by sector, and real factor returns. At the micro level we want to assess induced changes in rural households' income and on poverty incidence.

For this, we use an integrated macro-micro approach in a top down fashion. First, we estimate macro changes using an agriculture specialized static computable general equilibrium model. Then, we use some results from the macro model to run a non-standard behavioral microsimulation model that allows for computing changes in rural households income and to measure their poverty status.

The structure of the report is as follows. Section 2 provides a policy background for understanding the context in which policy changes take place. Then, in section 3, a general description of the way the policy package has been designed and is being implemented is provided. Section 4 presents the research objective and the methodology, including a technical description of the main characteristics of the CGE model, as well as a general description of the microsimulation model. In section 5 a general description of the relevant characteristics of Colombian agriculture and rural poverty is presented for aiding in the interpretation of results. Section 6 presents and discusses the main results and section 7 concludes.

2. Policy Background

According to the World Bank (2008) Colombia has transitioned from taxing agriculture to support it. During the 1960s and up to the end of the 1970s, the nominal rate of assistance to agriculture was negative. Then, during the 1980s it became positive with values around 5% during the first part of the decade and 0.2% during the second part. The 1990s marked the beginning of a period of rising assistance: 8.2% for the first half of the 1990s, 13.2% for the second half, and 25.9% for the first half of the 2000s. Most of this support was provided through border measures, while assistance through domestic market measures was almost nonexistent. This pattern is salient when contrasted to the behavior of other Latin American countries included in the World Bank study. Although some countries (Brazil, Dominican Republic and Ecuador) have also moved from taxing to protecting the agricultural sector, in no case this change started as early and has reached the levels it has in Colombia. Even countries that have traditionally protected the agricultural sector, like Chile, have tended to decrease the level of assistance.

Within this context, and in the wake of negotiations for establishing a Free Trade Agreement (FTA) with the United States, the Colombian government agreed with farmers' organizations that a policy package would be designed and put in place for smoothing the impact of the implementation period of the FTA and for boosting sectoral competitiveness. As the agricultural sector was deemed to be one of the losers from the agreement, farmers' organizations tend to either oppose its implementation or seek special treatment in terms of longer implementation periods or limited market access provisions. According to official statements for the press at the time negotiations were held between the government and sectoral representatives, the policy package was agreed as a way to compensate the losers from the agreement. Announced in March 2006, the program was put in place in April 2007 with the signing of a law that layed out its general principles and allocated a budget to it.[1] The program was assigned a budget of around US$217 million for 2007, which represented 35% of that year's total public sectoral budget (excluding debt servicing). By law, the budget assigned to the project has to keep its real value and hence it was indexed to the Consumer Price Index. Although in relative terms the size of the program is modest (around 2.3% of sectoral GDP) it is by far the largest policy instrument in sectoral policy in Colombia.

AIS has a relatively complex structure. Its two main components target different objectives. One of them is devoted to provide direct support for farmers in order to protect their income during the implementation period of the FTA with the US (Sectoral Direct Support Component -SDSC). The other is aimed at enhancing sectoral competitiveness, increasing its productivity and helping launch restructuring processes (Competitiveness Enhancement Component -CEC). Each component addresses a specific objective assigned to the program at its inception. Direct support is provided unconditionally to farmers and is set to be selective and temporary. The government reserves for itself the role of defining “in an objective manner” the subsectors eligible for this type of support, the amount of support to be given to each sub sector, and the conditions that beneficiaries must fulfill. It was also established that after six years of program operation, all direct support measures should have been phased out. On the other hand, competitiveness enhancement measures should be allocated no less than 40% of the program's total budget, and the governments assumes the commitment to give priority to Departments (States) that lag behind in terms of productivity and competitiveness indexes, while assuring there is an equitable regional distribution of resources from the program.

Each component has its own internal structure. CEC has three main policy instruments: productivity incentives, subsidized credit, and marketing support. Productivity incentives are aimed at enhancing technical assistance, technology development and transfer, implementing good agricultural practices, fostering associativeness, and land conversion, irrigation and drainage cofinancing. Subsidized credit is devoted to support productive restructuring, land conversion, productivity enhancement, and new investment for promoting agricultural modernization. Marketing support is targeted to the implementation of traceability systems, domestic absorption mechanisms, and other supplementary activities.

This set of instruments is basically channeled through nine subprograms, of which the most important for our purposes are: the Special Credit Line (SCL), the Incentive for Rural Capitalization (IRC), and the

[1] Law 1133 of 2007.

Call for Irrigation and Drainage Projects (CID).[2] The SCL is a subsidized credit scheme aimed at supporting productivity improvements and restructuring (shift between agricultural activities) that is provided through the financial system. Credit conditions have varied through time, but on average imply significantly lower interest rates as compared to normal credit (between 12 and 5 percentage points, according to the type of farmer and the year). Small farmers tend to use it for planting and maintenance of crops, while large farmers for acquisition of machinery for primary transformation of products. Medium size farmers tend to be the main beneficiaries from this scheme (in terms of their share in the total amount disbursed by the program) and devote its resources to planting and maintenance of crops and to land preparation.

The IRC is intended to foster agricultural investment by means of a credit line that operates at market interest rates but that entails limited credit forgiveness. As a program, IRC existed before the implementation of AIS but the latter uses it to allocate part of its resources. It also extends the set of activities that are eligible, beyond the boundaries of the original IRC. Under its provisions, small producers are given 40% forgiveness on the value of credit devoted to activities included in an eligibility list. Medium size and large farmers are given 20% forgiveness subject to some exceptions (related to the activities carried on). In the case of construction, enlargement or rehabilitation of large irrigation projects, forgiveness is at the level of 40%, regardless of farmer size, and there are no limits in the amount of the incentive.[3] The list of eligible activities includes land preparation and water management; productive infrastructure; biotechnology development and application; machinery and equipment for agricultural production; livestock and aquaculture equipment; low technology fishing; primary transformation of agricultural goods; planting, maintenance, and renewal of perennial crops; acquisition of pure breed bovine livestock; implementation of integrated livestock and forestry projects; and investment in generic agricultural inputs.

The CID is a subprogram aimed at cofinancing irrigation and drainage projects that are tied to existing or prospective production. The amount of subsidy granted by the government varies according to the type of project (individual, cooperative, regional) and may reach up to 80% of direct costs. The rest of the costs have to be either covered by regional institutions or directly by the farmers or both. Funds for this program are allocated on a competitive basis. Proponents have to prepare a proposal, including an economic evaluation, and enter in a contest through which it is determined who gains access to the funds.[4] Furthermore, large farmers fragmented their projects in order to violate the ceilings imposed on the amount of the subsidy, managing to illegally get access to a big proportion of resources.

Lastly, the SDSC uses some of the same subprograms that the CEC uses, specially the SCL and the IRC. As mentioned, a difference here is that funds from this component target specific sectors according to an evaluation performed by the government. The other difference is that the level of subsidization is higher in this case. Credit forgiveness for medium size and large farmers benefiting from IRC are higher, for instance (30% as compared to 20% under the CEC). In 2007, all resources of the component were directed to cereals and rice and disbursed in close proportions under the SCL and IRC (44% and 56% on average). In 2009, it was given priority to the cut flowers sector (for social and environmental purposes), to planting of corn for feedstock purposes, and to planting of beans in coffee growing areas.

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[2] The other subprograms are: Incentive for Technical Assistance, Livestock Sanitation, Coffee Extension Service, Forestry Incentive Certificate, Science and Technology, and a fertilizer program (Fertifuturo).

[3] Some of these conditions changed from time to time.

[4] This is the program that have mainly gave rise to criticism of AIS, since large farmers were better positioned to present good proposals than small farmers.

In spite of the fact that negotiations for the FTA with the US ended in November 2006 and that only in October 2011 the treaty was approved by the US Congress (which implies that implementation could only begin in 2012), AIS entered into force in 2007 and has been in place since then.[5] To accommodate the fact that the trade pact was not in place and therefore there was a weak basis for implementing the SDSC, the government determined that 72% of the budget should be allocated to the CEC, 26% to the SDSC, and the remaining 2% to the administration of the program. This allocation rule, in the sense of giving priority to the CEC, has been in place during the following years.[6]

3. Implementation of AIS

Between 2007 and 2009, the program executed an accumulated budget of around US$704 million, 91% of which devoted to the CEC. As mentioned in the evaluation of the program that was contracted by the Ministry of Agriculture (Econometria, 2011), the majority of resources were used by four subprograms (irrespective of the component to which they were used for): the Special Credit Line (SCL), the Incentive for Rural Capitalization (IRC), the Incentive for Technical Assistance (ITA), and the Call for Irrigation and Drainage Projects (CID). The base line and the Econometria evaluation itself were limited to these four subprograms.[7]

All subprograms but the SCL, the IRC, and the CID, are expected to yield results that are difficult to pin down in an evaluation and more so by means of a CGE model. For instance, technical assistance (as enhanced through the ITA and the Coffee Extension Service) is expected to raise yields as better production techniques are supposed to be put in place, pest and insect control is fostered, and better use of inputs can be made. However, the extent to which yields may increase is uncertain and a priory estimates may be lacking. Therefore, use of the CGE model we employ here is restricted to an estimation of the expected impacts arising from the three subprograms mentioned above.

In spite of the institutional complexity of AIS (two components, eleven subprograms, different access rules and subsidization levels for each subprogram-component-beneficiary type combination), when it comes down to the economic incentives that it creates for farmers, the situation is relatively simple. Table 1 lists (in a simplified way) the main activities that were financed in 2008 through the three subprograms we consider here and groups them according to the type of incentive that they create.[8]

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[5] In 2009 the program came under fire when missallocation of resources was made public by the press. With a new government in power, the program was rebranded as Equitable Rural Development (DRE for its acronym in Spanish) in 2011, big farmers where denied access and marginal changes were introduced in its operation. Its basic structure, organization, and policy instruments in use, continue being the same.

[6] Budget allocation for 2008 was as follows: 93.6% to CEC, 5.2% to SDSC, and 1.2% for administrative costs.

[7] The methodology used in this evaluation follows the general guidelines of an econometric program evaluation perspective.

[8] Items and activities change from year to year, but the way incentives work is similar in spite of this. We illustrate the situation for 2008 since this is the year we use as the basis for the simulation.

Table 1 Incentives Created by the Program

Subprogram	Item	Activity	Effect	Incentive
SCL	Working Capital	N.A.	Subsidy on working capital	Lower unit cost
	Investment	Productive infrastructure	Capital subsidy	Lower capital cost
		Primary processing and marketing	Capital subsidy	Lower capital cost
		Machinery and equipment	Capital subsidy	Lower capital cost
		Land adaptation	Capital subsidy	Lower capital cost
		Planting and crop maintenance	Subsidy on working capital	Lower unit cost
		Agricultural production	Subsidy on working capital	Lower unit cost
		Crop maintenance	Subsidy on working capital	Lower unit cost
		Livestock acquisition	Excluded from the study	N.A.
		Support services infrastructure	Excluded from the study	N.A.
		Livestock maintenance	Excluded from the study	N.A.
	Credit Refinancing		Excluded from the study	N.A.
IRC	N.A.	Agricultural machinery	Capital subsidy	Lower capital cost
		Production infrastructure	Capital subsidy	Lower capital cost
		Planting of late yield perennials	Capital subsidy	Lower capital cost
		Land adaptation	Land subsidy	Lower land cost
		Primary processing	Capital subsidy	Lower capital cost
		Pure breed livestock acquisition	Excluded from the study	N.A.
CID	N.A.	Irrigation and drainage projects	Land subsidy Productivity enhancement	Lower land cost Higher productivity

Source: authors' schematization

A couple of comments are in order with respect to the classification provided in the table. First, since items that are eligible for a working capital subsidy are broad and tend to cover a wide range of productive activities (ranging from inputs purchases, to outsourcing of different activities) it is convenient to represent the effects of this subsidy as spreading across the whole financing of the production process and, hence, as having the effect of lowering unit costs. Second, both investments financed through the SCL or through the IRC, are almost entirely devoted to support and enhance capital use and its effects are better represented as a subsidy on capital. There are, however, some exceptions to this. Investment subsidies allocated for planting and crop maintenance or for agricultural production, tend to be general in terms of items that are eligible and therefore behave in a manner similar to that of working capital subsidies, so their effects are also viewed as lowering unit costs. On the other hand, although subsidies for land adaptation may include in some cases irrigation related activities, most of the times it only involves activities that do not comprise irrigation or water management. As we want to have a clear divide between irrigation related subsidies granted through the SCL or the IRC from those granted through the CID, we treat land adaptation subsidies as capital subsidies.[9]

As there is no distinction in the model we use between farmers types, subsidies conveyed through the program are relevant only as aggregates. That is, for the modeling it is not important if a certain amount of subsidy corresponds to the 40% subsidy that is granted to small farmers benefiting from the IRC or to the 20% granted to large farmers. Instead, what matters is the whole subsidy amount granted to each agricultural activity in the model. The subsidy amounts disbursed by the program in 2008, as well as the actual subsidy rates implied, for each type of incentive, are reported in Table 2.[10] From there it follows that slightly more than half of the resources considered here were granted as productive capital subsidies (US$74.7 million representing 51.9% of the total), followed by irrigation subsidies (US$64.5 million, or 44.8% of the total), and by working capital subsidies (US$4.7 million, or 3.3% of the total). Therefore, the program actually devoted the majority of resources for uses that potentially entail some form of technological change, assuming that capital investments embody a particular technology choice.[11] While working capital subsidies can be expected to be neutral, productive capital subsidies clearly imply a capital intensification bias and its implication on labor use depends on whether capital and labor are complements or substitutes.

It can also be appreciated from the table, that the activity that received the highest amount of resources is agricultural investment, an activity that comprises new planted areas of perennials crops. US$55.9 million (38.8% of total subsidies) were allocated to this activity, followed by fruits and oil palm (with 10.4% and 10.2%, respectively).[12] In total, 79.4% of resources were assigned to perennial crops. The activities with the lowest allocations of resources were plantain, cereals, and other crops (0.03%, 0.04%, and 0.24%, correspondingly). If only productive capital subsidies are considered, agricultural investment is by far the largest recipient of subsidies (74.8%), followed by coffee (6.1%), rice (6%), and sugar cane (6%). In terms of irrigation subsidies, the largest beneficiaries are oil palm (22%), fruits (21.9%), sugar cane (10.6%), and cocoa (8.8%). Lastly, with respect to working capital subsidies, the largest subsidy amounts were allocated to rice (25.4%), cotton (22.8%), potatoes (12.5%), vegetables (10.2%), and corn (9.9%). Therefore, the program not only favors capital intensification but also tends to more heavily support perennial crops.[13]

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[9] Admittedly, this implies a distortion in the way we evaluate the expected impacts of the program. However, the effect of this assumption is negligible as irrigation financing through the SCL and the IRC is quite small (in relative terms) and it has an unpredictable effect on productivity, which as will be mentioned ahead is an important consideration in simulating the effects of the CID. In principle, the main implication of the assumption is that it understates the level of subsidization for land use and overstates that of capital use, a feature that has a negligible effect given that composite land and composite capital-labor are, as will be seen, in fixed proportions in the model.

[10] Subsidy rates are calculated as the ratio of governmental contributions to total project values, expressed in percentage terms. Therefore do not represent the subsidization level granted for the whole of an agricultural activity, but rather the corresponding to the average project presented to the program.

[11] Clearly, this is not necessarily the case, as capital investment may be directed to replace same vintage capital.

[12] Fruit and oil palm, among other activities, are perennial crops. The distinction here points to the fact that agricultural investment is an activity that encompasses newly planted areas that, by definition, do not yield production yet. In contrast, subsidies granted to activities producing particular perennial goods are expected to have an impact on current production levels.

[13] Whether this bias in support for perennials is intended or not could be debatable, as there is an important demand component at play.

Table 2. Government Expenditures in Subsidies and Implied Subsidy Rates (2008, US$ million)

	Working capital subsidy:		Productive capital subsidy:		Irrigation subsidy:	
Crop	Amount	Actual rate	Amount	Actual rate	Amount	Actual rate
Coffee	0.00	6.4	4.56	22.9	3.69	75.7
Cereals	0.04	2.1	0.02	12.4		
Corn	0.46	1.4	1.35	16.6	2.54	79.1
Rice	1.19	1.8	4.48	12.1	3.25	75.0
Potatoes	0.58	3.9	0.31	12.3	3.95	79.3
Legumes	0.21	5.4	0.12	13.2	2.75	79.2
Vegetables	0.48	11.2	0.83	12.9	4.00	78.2
Tubers	0.18	2.8	0.08	2.4	0.34	77.7
Bananas			0.37	11.0	2.59	67.2
Plantain			0.04	17.2		
Fruits	0.00	2.8	0.75	15.9	14.15	77.4
Oil palm			0.52	13.5	14.19	77.5
Oil seeds	0.04	1.4	0.41	19.9		
Other crops	0.00	3.1	0.30	18.1	0.05	40.1
Cocoa	0.00	0.0	0.17	23.6	5.70	74.9
Tobacco	0.44	4.4	0.03	20.4	0.32	72.7
Sugar cane			4.49	14.8	6.82	69.6
Cotton	1.07	1.6	0.01	21.4	0.17	77.0
Ag. investment			55.85	17.0		
Total	4.70		74.69		64.51	

Source: authors' calculations based on Ministry of Agriculture's data

4. Research Objective and Methodology

Our main research objectives are to estimate the likely short run sectoral impact of the newly introduced agricultural policies, as well as its likely effect on rural poverty. In particular, to assess the potential impact of the main components of AIS on agricultural goods' relative prices, production quantum, and real factor returns and the way they impinge upon rural households' income generation. Given the strong targeting of AIS we also aim at identifying the main winners and losers, in terms of goods and households, which the program will generate within the rural sector.

In spite of the policy package being one of the largest in its kind in Colombian agricultural policy, its size relative to the sector is small. Although sizable, the program's annual budget represents a small share of sectoral value added (around 2.3%). Therefore, it is expected that its impact mainly concentrate within the agricultural sector and that changes induced at the aggregate level be relatively small in the short term. More important macro effects from the policy may be generated over a longer run, since the rural sector may attract a higher relative allocation of capital due to the type of incentives the policy creates and new perennial plantings grow to productive age. Our focus here is on the short run (as defined ahead), so relatively small macro impacts are expected from the simulations; however, retaining a general equilibrium focus is important as backward and forward linkages differ from crop to crop and they should affect the policy outcomes.

For reaching our objectives, we integrate an agriculture specialized static CGE model and a microsimulation model that allows effective labor relocation within occupational groups for the agricultural sector. The CGE is used for simulating the impact on relative prices and macro variables of sectoral policies. Changes in macro variables (wages, employment by agricultural sub-sector, etc.) are fed into the microsimulation model. The latter allows for a rich simulation of changes in rural households income, providing a sound basis for assessing the poverty effects induced by sectoral policies.

The approach we follow here is top-down, so there are no interactions between the two models in a loop. There are a number of advantages in using microsimulation models linked to macro models (Savard, 2003). First, we can accommodate a large number of households without the difficulties inherent to incorporating them directly into the CGE model. Second, discrete-choice or integer behavior can be incorporated much more easily into the household model than into the CGE model, and they may be important for modeling the rural sector. While there is no need to assure consistency between household data used in the microsimulation model and SAM data when there is looping, we do need to assure it from the beginning.

The reason is that without looping there is no guarantee that results from the two models will converge. Using a top-down approach without feedback, as we do here, there is no convergence in any strict sense. Therefore, having consistency between the macro and the micro data assures us that changes in "macro" variables (prices and quantities mainly), in the aggregate, have the "right" impact on households. As agricultural activities have the same relative size in both models, the same labor composition usage, and the same structure of households' labor factor income, changes in macro variables reflect in an appropriate way at the micro level. This is a case example of the degree of consistency between macro and micro datasets that is required for properly undertaking macro-micro modeling as summarized in Bourguignon, Bussolo, and Cockburn (2010).

Simulation of sectoral policy changes uses the 2008's allocation of AIS' resources to the different policy instruments, as illustrated in Table 2 above.

4.1 The CGE Model

The CGE model is based upon one of PEP Standard CGE models (in this case the single country, static version: PEP-1-1). It has a neoclassical structure with equations that describe producers' production and input decisions, households' behavior, government demands, import demands, market clearing conditions for commodities and factor markets, and numerous macroeconomic variables and price indexes. Demand and supply equations for private-sector agents are derived from the solutions to optimization problems, in which it is assumed that agents are price-takers and markets competitive. The external sector is modeled as a single region and a "mild" version of the small country assumption is used. [14] A thorough documentation of the model is found in Decaluwé et al (2009).

The model is adjusted in two major senses. First, a new production structure is included for the agricultural sector, allowing for a convenient representation of agricultural production. Second, a structure for the supply of land services is added so as to have a more realistic behavior of land allocation between agricultural activities. However, our definition of agriculture here excludes livestock, dairy production, meat production, forestry and fisheries.[15] The reasons for this are that we have no

[14] In the sense that local producers can increase their share in international markets as long as they can offer a price that is advantageous with respect to the world price (and subject to a price elasticity of export demand).
[15] However, these sectors are included in the model either independently or as part of other activities.

dependable information for land use in this type of activities (especially for livestock) and the dominant nature of livestock production in Colombia, which impinges upon the way land is allocated between rural land-based activities.[16]

With respect to the structure of agricultural production, we have at the top that value added and a composite intermediate good are used in fixed proportions (Leontief). Then, in a second nest, value added is defined as a Leontief function of composite land and a composite of capital and labor. On the composite intermediate good side, the structure is described, again, by fixed proportions. This specification reflects the marked degree of complementarity that agricultural production tends to exhibit. Moving on to the value added nest, the composite of capital and labor is modeled as a Constant Elasticity of Substitution (CES) combination of composite labor and composite capital (third nest). Composite labor is in turn a CES combination of skilled and unskilled labor (fourth nest). While the model allows for a composite of several capital types, currently only one type of capital is used. On the other hand, composite land (third nest) is a CES combination of land and fertilizer, allowing for the latter to play a role in determining value added. The structure of agricultural production is represented in Figure 1.

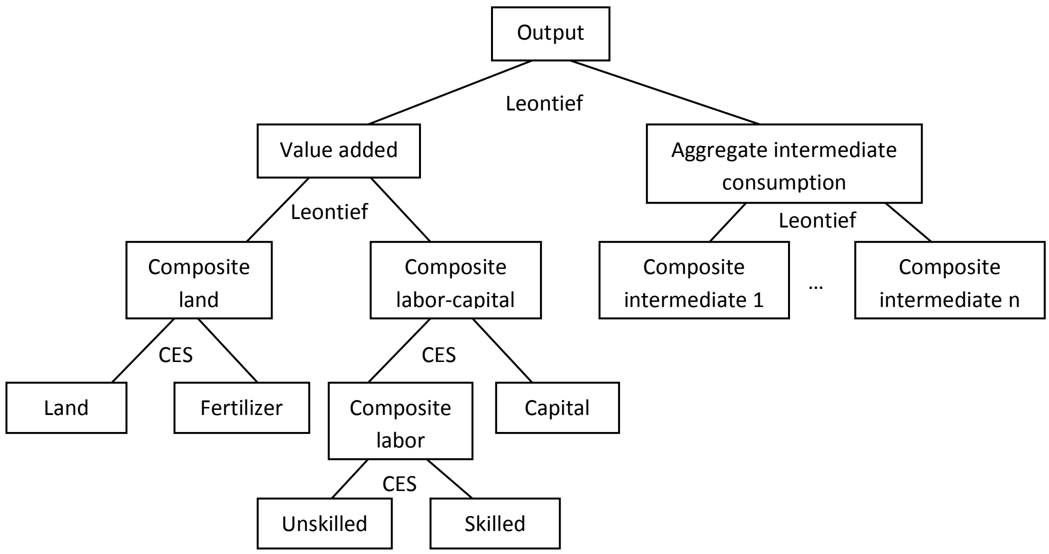

Figure 1 Structure of Agricultural Production

As regards land services, agricultural land is assumed heterogeneous in the model and only land for agricultural use is considered (no land services for livestock, forestry, and industrial use are taken into account). However, crops compete for land services with no regard for the agroecological conditions that they require and land services are rendered to each crop type with certain restrictions. This feature responds to two considerations. First, it approximates the fact that land is heterogeneous: land availability is tied to climate and other characteristics that suite some crops but not others and, as a consequence, it cannot be freely "mobile" across crops. Second, agricultural land use is conditioned upon certain economic constraints. In particular, land use may depend on the easiness with which land

[16] Livestock activities in Colombia are predominantly of the extensive type (based on natural and cultivated pastures and itinerant grazing) and are known to be used not only as an economic activity but also as a way to claim land use in a relatively low cost and non labor intensive way.

can be allocated to different crop types, according to characteristics such as the way cash flows produced or required by the activity behave, or to the size of initial investments. Therefore, land allocation is “sluggish” in the model and a Constant Elasticity of Transformation (CET) function is used to represent it.

In particular, land allocation is done according to the degree of “easiness of entry” into a particular activity. Activities for which it is required to make sizable investments in land preparation or for which the maturing period is large, are deemed to experience lower propensities to be switched to from other uses. Hence, supply of land services at the top is divided among perennial and seasonal crops (first nest with an elasticity given by σ_1). This is a decision usually associated to the need for relatively lumpy investments and cash flow constraints, given that perennials take some time to begin producing. Then, in the second nest land is allocated to particular crops (both perennial and seasonal with elasticities given by σ_2 and σ_3, respectively). At this level, land allocation decisions differ according to the type of crop. Land allocation within seasonal crops is the most flexible given that investments required to switch from one crop to the other are relatively low. In contrast, land allocation between perennials is less easy as switching from one crop to the other entails incurring in higher costs. The following relationship holds for the three elasticities: $\sigma_1 < \sigma_2 < \sigma_3$. The structure of the supply of land services is shown in Figure 2.[17]

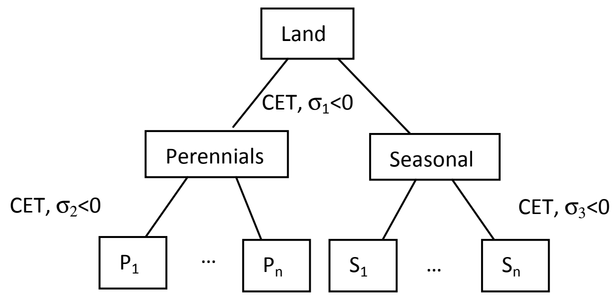

Figure 2 Supply of Land Services

The model uses a 2007 SAM with 31 activities and 31 commodities. 23 activities and commodities belong or are directly related to the agricultural sector: nine are seasonal crops, nine are perennial crops, and the remaining five are perennials that are not productive yet (agricultural investment), livestock and poultry, forestry, agricultural services, and agroindustry. Among the non-agricultural sectors, there are two services sectors (services in general and financial services) and two sectors that produce agricultural inputs (fertilizers and other agrochemicals). There are three production factors: land, labor, and capital. Land is used only by crops, so livestock and poultry, forestry, and agricultural services, only use labor and capital. Labor is split into four categories, rural unskilled, rural skilled, urban unskilled, and urban skilled, and there is only one type of capital. Households are disaggregated into rural and urban and each type is, in turn, split in income quintiles, for a total of 10 household types. We consider no self-consumption of agricultural goods produced by rural households.[18]

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[17] A detailed description of the implementation of agricultural production and supply of land services is omitted here for brevity.

[18] Consumption shares consistent with the LES system for each household type were estimated from household survey data, following Bibi et al (2009). A list of model parameter and elasticities is provided in the Appendix.

A key point of the SAM used with the model is that, for rural households, it explicitly considers rural non-agricultural activities and income. Therefore, for all relevant activities in the model there is a distinction between its sourcing of urban and rural labor. Regarding the labor market, the model allows either for full factor mobility or for factor specificity. In the simulations it is assumed that labor is perfectly mobile between sectors while capital is sector specific. However, it must be kept in mind that there are two features in the model that result in labor mobility within the agricultural sector being limited. As land allocation between agricultural activities is "sluggish", labor mobility in the agricultural sector is impaired. Also, as production in the agricultural sector uses a capital-labor composite and capital is sector specific, labor mobility tends to be limited. For these reasons, even though it is generally considered that labor mobility between agriculture and other activities should be modeled in a way that it is less than perfect, in this case closing the labor market through salaries, while having a perfectly inelastic supply of labor, is deemed appropriate for our objectives. Also, having capital use as sector specific is convenient as we aim to appraise the short run effects of the policy package under consideration.

4.2 Modeling Strategy

In light of our discussion in section 3, we basically need to model three types of incentives created by the policy: subsidies lowering unit costs, subsidies lowering productive capital costs, and subsidies lowering land use costs (including a productivity effect).

We model all subsidies having an effect akin to a lowering of unit costs as creating a (negative) wedge between an activity's unit cost and its basic price:

$$PT_j = (1 + ttip_j - SWK_j)PP_j$$

where:

$PP_j = activity\ j\ unit\ cost$
$PT_j = basic\ price\ of\ industry\ j's\ output$
$SWK_j = rate\ of\ subsidy\ for\ working\ capital\ for\ activity\ j\ (endogenous)$
$ttip_j = tax\ rate\ on\ the\ production\ of\ activity\ j$

On the other hand, productive capital subsidies lower the cost of capital for beneficiary activities so the price of this factor decreases according to the implied subsidy rate (for the whole activity):

$$RTI_j = R_j\left(1 + ttik_j - SKD_j\right)$$

where:

$R_j = rental\ rate\ of\ capital\ in\ activiy\ j$
$SKD_j = rate\ of\ subsidy\ for\ capital\ used\ in\ activity\ j\ (endogenous)$
$ttik_j = tax\ rate\ on\ capital\ used\ in\ industry\ j$

Irrigation subsidies entail two effects. On one side, they lower the cost of using land and therefore act in the same way as the subsidy for productive capital. On the other, they are expected to have an effect on productivity since enhanced water availability and management is expected to increase yields. These effects are modeled as follows:

$$RTT_j = RTS_j(1 + ttit_j - STI_j)$$

$$CT_j = CTPF_j * B_j^{CT}\left[\beta_j^{CT} TD_j^{-\rho_j^{CT}} + (1 - \beta_j^{CT}) FD_j^{-\rho_j^{CT}}\right]^{\frac{-1}{\rho_j^{CT}}}$$

where:

$RTT_j = Rental\ rate\ of\ land\ payed\ by\ activity\ j$
$RTS_j = Rental\ rate\ of\ land\ supplied\ to\ activity\ j$
$STI_j = Subsidy\ rate\ on\ land\ rent\ for\ activity\ j\ (endogenous)$
$CT_k = Composite\ land\ used\ in\ activity\ j$
$CTPF_j = Productivity\ parameter\ from\ irrigated\ land\ for\ activity\ j\ (endogenous)$
$TD_j = Land\ used\ by\ activity\ j$
$FD_j = Fertilizer\ used\ by\ activity\ j$
$ttit_j = Tax\ rate\ on\ land\ used\ by\ activity\ j$
$B_j^{CT} = Scale\ parameter\ for\ activity\ j\ (CES\ composite\ land)$
$\beta_j^{CT} = Share\ parameter\ for\ activity\ j\ (CES\ composite\ land)$
$\rho_j^{ct} = Elasticity\ parameter\ for\ activity\ j\ (CES\ composite\ land)$

The productivity effect arising from irrigation should ideally be calibrated on a crop by crop basis. Unfortunately there is no enough and reliable information for doing this and in the simulations it is assumed a single value for all crops. Furthermore, the parameter is estimated on the basis of the (average) yield gap that is deemed to exist between irrigated and non-irrigated land for several crops. Data on yield gaps come from information available for some crops and from experts' judgment.[19]

Lastly, it is worth mentioning the general characteristics of the simulation. First, it is given consideration to the financing of the program. For this, it is assumed that governmental expenses incurred in for subsidizing agricultural activities are financed through direct taxes designed to raise the exact amount needed (therefore, the corresponding tax rates for households and firms adjust endogenously). Second, the simulation uses the following closure rules. The nominal exchange rate is the numeraire, labor is in fixed supply, fully utilized, and freely mobile between all sectors, government expending is fixed, investment is saving-driven, the current account balance is fixed, and total land demand is fixed.[20] We define our time horizon as short term, so capital is assumed sector specific. This feature is not only consistent with the idea that most capital used in agricultural activities relates to trees and plants and less so to machinery and equipment,[21] but also with the fact that, even in the case of capital that is not strictly specific to an activity (like machinery), the time span considered in the simulation makes it unlikely that there could be any significant capital reallocation between activities.

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[19] Given the nature of this information, sensitivity analysis is conducted to appraise the effect of changes in this parameter (see subsection 3.5).

[20] Since we have land demand governed by a CES aggregate (of composite land) and land supply by a CET aggregate, supply of land services has to be endogenous.

[21] At least for the Colombian case.

Given the above depiction of the type of policy instruments that are modeled and the time frame some of them require for being fully operational, it is convenient to clarify the scope of the short term nature of the simulation. We understand short term in this context as a time period of up to two years, allowing enough time for new capital investments to be built and operational (in particular productive capital and land improvements and irrigation), but not for new areas planted with perennials to enter their productive stage. In this way we reconcile the static nature of the model with the main features of the policy package, so the simulation is meaningful. In particular we do not deal with the fact that part of the policy instruments are aimed at fostering new planted areas of perennial crops or with the entrance of already planted areas into production, both of which would require use of a dynamic model.

4.3 The Microsimulation Model

We use a non standard behavioral approach for the microsimulation model. It is non standard in that we do not seek to mimic household behavior in terms of labor participation or labor choice for household members. Instead, we combine parametric and nonparametric approaches in and ad hoc fashion that suits well the structure of data on which we construct the microsimulation model, as explained below.

Based on the Colombian 2008 LSMS we construct a household database that is consistent with macro data (the SAM on which the CGE runs) in terms of the aggregate wage bill, capital income, land income, and transfers. Consistency is achieved as follows: macro data referring to aggregate activities' payments to factors (capital, land, and labor) are used for adjusting the corresponding (aggregate) survey data. Then, household (total) income quintiles are constructed for both urban and rural households and income types' shares[22] are calculated for each household bracket. Shares are used to split the macro account in the SAM among household types. Following, we use the micro data for calculating labor types' shares for each activity and use these shares for splitting activities' payments to labor in the SAM. Lastly, we calculate labor types' income shares for each household type and use these shares for splitting each household type labor income.[23] In this way we have consistency at the macro level (SAM and aggregates in the microdata) and the same household and functional income structures in both datasets.

The micro database keeps all relevant household and individual´s information such as number of adult equivalents, occupational status, gender, relationship to household head, employment status, age, type of activity, land holdings, income (from different sources), and sample weights.

Wage equations are estimated through a two-stage Heckman procedure for economically active (and employed) people belonging to the four labor types considered in the macro model. Estimated parameters are kept in the database and residuals from each individual's estimation are also stored. The stored parameters and residuals are used to update wages for each individual, using percentage changes coming from the CGE model simulation. Individuals' mean income, as estimated through the wage equation, is increased as indicated by the CGE results and then residuals are added so as to (approximately) preserve unexplained income and income variation among individuals.

The specification of the labor market in the CGE model uses wages as the market clearing mechanism and, therefore, there is no unemployment. In spite of this, and considering that our main interest is in

[22] For each factor: labor, land, and capital.
[23] That is, income from rural unskilled labor, rural skilled labor, urban unskilled labor, and urban skilled labor.

income changes at the rural household level, as they relate to changes in agricultural activities, we exploit a feature of agricultural production to mimic changes in employment. Being Colombia a tropical country, crops can be classified according to regions where they can be cultivated. This gives us a partition in three regions defined according to their altitude above sea level: hot weather, mild weather, and cold weather areas. Changes in employment for each agricultural sector can then be assigned to each of these regions. For crops that are suitable for more than one region, employment changes are split between regions according to the shares of each region in that crop's planted area.

In general, for a worker moving from one region to another is tantamount of having to migrate. We assume that workers (and households) remain in their locations and that it is employment that "moves" from one region to another, as crops belonging to a region increase or decrease their demand for labor types. We have, therefore, labor markets for each labor type in each region and it is within these "segmented" markets that we can mimic employment level changes.

We use information from the household survey to assign households to the three regions, so we also have this characteristic in the database. Given the above, we can draw unemployed workers to get into the labor market when their labor type has an increase in employment level in a (weather) region, or expel workers when there is a decrease. For this we build a queue based on the probability that an individual, whether employed or unemployed, gets fired or get a job. We obtain these probabilities by means of a probit model.

To get around the problem that arises when changes in employment yield non-integer values, we borrow from Ferreira-Filho and Horridge (2004). They use a procedure they call the "quantum weights method". The basic idea is simple. A variable, JobScore, is created for each person in the database and is set to 1 if she is employed. Then, when there are changes in employment, this variable is used to split the record and with it the sample weight in such a way that the non-integer figure can be accommodated. The procedure entails splitting the household into two households in such a way so as to replicate the change in the simulated JobScore. This is accommodated by dividing the sample household weight to yield the desired result (the simulated value for JobScore). The two households share the same characteristics, but one has, say, one working adult with a given sample weight (resulting from the division above) and the other an unemployed adult with another sample weight (the complement of the former). In general, a new record is created for each worker with JobScore < 1 and for each unemployed within a labor type and region, for which demand increases. The procedure is followed only for the (infra) marginal worker.

Individuals that move from unemployment into employment, get a wage level determined according to the parameters of the wage equation, taking into account the wage change coming from the CGE model. To this income we add an unexplained income calculated from a random draw based on the residuals from the wage equation (as applied to employed workers). As employment changes apply only to agriculture related jobs,[24] it is assumed that changes in employment arising from the rest of the economy are allocated to individuals based on their probability of being fired, irrespective of whether the household they belong to has members working in agricultural activities and irrespective of the region they belong to.

[24] Recall that there is no employment level change in the macro model and that we are just mimicking changes in employment based on reallocations of labor demand by agricultural activities.

Other household income, in particular income from land holdings and capital is updated on the basis of rent changes for these two factors. For poverty calculations, the poverty line is also updated according to changes in the consumer price index (we prefer this to other alternatives since there are sizable changes in consumption shares across household types).

4.3 Linking the Two Models

Consistency between the macro (SAM) and micro (LSMS) data is assured at the beginning, by appropriately adjusting individuals and households' income, taking sample weights into consideration, to the corresponding macro aggregates.

The main features for linking the two models have been presented above. The micro model is fed with percentage changes in employment by labor type and region (weather-based, as described above), providing the basis for the job reallocation process performed with it. Also, as changes in labor demand in the agricultural sector have its counterpart in changes in employment in the rest of the economy, employment changes for the latter are also transmitted from the macro model.

On the other hand, percentage price changes are fed into the microsimulation model. These refer to wages for each labor type, capital rent, land rent, and the consumer price index, to be used as explained above.

5. Stylized Facts About Colombian Agriculture and Rural Poverty, and Size of Shocks

Before discussing the results from the simulation, it is useful to have an idea of the structure of the Colombian agricultural sector and rural poverty, so that the former can be put in the right perspective. Also, it is convenient to take a look at the relative size of the shocks that are implemented, that is, at the subsidization levels that arise on a subsectoral (activity) base given the amount of resources disbursed by the government. We provide these three pieces of information in the same order.

Table 3 shows some of the basic macro statistics at the sectoral level. From there it can appreciated that the services sector is by far the largest contributor to total value added (first column), followed by machinery and construction, and beverages and manufactures. The agricultural sector, including animals and forestry, accounts for slightly more than nine percent of total value added and for 5.7% if only crops are considered. The share of value added in total sectoral value (second column) is higher for the agricultural sector as compared to other sectors in the economy. As an average, value added accounts for around 80% of total sectoral value in the agricultural sector, while it only reaches 49% for the rest of the economy. The largest value added shares are found in the oil palm, fruits, coffee, and legumes sectors.

Machinery and construction, as should be expected, make up for the bulk of investment, followed distantly by beverages and manufactures, and services. With respect to international trade, the majority of export value (almost 70%) is concentrated in three sectors: oil and minerals, beverages and manufacturing, and agroindustry (mainly green coffee). If exports of chemicals and nonmetals and machinery and construction are added, the five sectors account for almost 85% of total exports. On the import side, beverages and manufactures, machinery and construction, and chemicals and nonmetals, account for around 80% of total imports. As follows from the data, the share of the agricultural sector in international trade is low, 6.2% of total exports and 4.1% of total imports. The highest participation of an agricultural sector is found for exports of other crops (3.2%), a result due to fresh cut flower exports.[25]

Table 3. Sectoral Composition of Value Added, Investment, and Trade in Colombia 2007

Sector	Share in value added	Value added share	Investment share	Exports share	Imports share
Coffee	0.9	92.2	0.4	0.0	0.0
Cereals	0.0	79.3	0.0	0.0	1.0
Corn	0.1	66.6	0.0	0.0	1.6
Rice	0.2	60.7	0.0	0.0	0.0
Potatoes	0.2	65.0	0.0	0.1	0.0
Beans	0.1	90.6	0.0	0.2	0.1
Vegetables	0.3	88.7	0.0	0.1	0.1
Tubers	0.5	83.6	0.0	0.1	0.1
Banana	0.2	70.2	0.0	1.5	0.0
Plantain	0.4	89.3	0.0	0.2	0.1
Fruits	0.8	92.2	0.0	0.3	0.5
Oil palm	0.3	94.4	0.0	0.5	0.0
Oil seeds	0.0	73.1	0.0	0.0	0.3
Other crops	0.4	67.1	0.0	3.2	0.2
Cocoa	0.0	88.3	0.0	0.0	0.1
Tobacco	0.0	88.5	0.0	0.0	0.0
Sugar cane	0.7	89.9	0.0	0.0	0.0
Cotton	0.0	76.2	0.0	0.0	0.1
Ag. Services	0.1	79.4	0.0	0.0	0.0
Ag. investment	0.2	66.9	1.5	0.0	0.0
Animal production	3.4	74.8	0.5	0.9	0.1
Forestry	0.2	76.0	0.0	0.0	0.1
Agroindustry	3.5	27.7	0.0	11.1	4.8
Oil and minerals	7.1	74.4	0.0	30.8	0.9
Beverages and manufacts.	9.1	43.9	9.3	26.4	35.4
Fertilizer	0.2	42.4	0.0	0.9	1.2
Agrochemicals	0.1	46.3	0.0	0.0	1.1
Chemicals and nonmetals	2.6	37.3	0.0	8.2	14.7
Machinery and construct.	9.7	46.4	84.9	8.0	30.0
Services	54.2	62.5	3.3	6.8	4.4
Financial services	4.2	58.9	0.0	0.6	3.1

Source: Colombian 2007 SAM

In terms of factor usage proportions, the agricultural sector tends to show a lower capital-labor ratio than the rest of the economy. However, this variable exhibits high variability across sectors. The average capital-labor ratio for agriculture is 2.37 while it is 3.87 for the non-agricultural sector. The highest ratios for non-agricultural activities are found in the oil and minerals sector (16.13, the highest for the economy) and the animal production sector (11.04, the third largest). Within agriculture there is considerable variation: the highest ratio belongs to the sugar cane sector (14.64, the second largest in the economy) and the lowest to the corn sector (0.12, the lowest in the economy); the standard

[25] This follows from the fact that in the SAM coffee exports (a traditionally important Colombian export) are made by a non-agricultural sector, since coffee processing belongs to agroindustry.

deviation of this variable within agriculture is 3.13. Table 4 shows the relevant figures for these and other factor related variables for the agricultural sector.

Table 4. Relative Factor Intensity Use in Agricultural Activities in Colombia, 2007

Sector	K/L ratio	T/L ratio	K/T ratio
Coffee	0.74	0.09	7.93
Cereals	1.90	0.44	4.36
Corn	0.12	0.36	0.33
Rice	3.16	1.12	2.82
Potatoes	0.99	0.18	5.54
Beans	4.07	0.19	21.98
Vegetables	3.36	0.21	16.03
Tubers	2.78	0.32	8.64
Banana	1.37	0.09	16.03
Plantain	1.19	0.34	3.45
Fruits	2.76	0.15	19.00
Oil palm	2.88	0.30	9.73
Oil seeds	3.06	2.03	1.51
Other crops	0.20	0.04	5.50
Cocoa	0.58	0.28	2.11
Tobacco	1.26	0.11	11.39
Sugar cane	14.64	4.63	3.16
Cotton	0.46	0.18	2.62
Ag. investment	0.29	0.03	9.44

Source: Colombian 2007 SAM

Land-labor ratios (second column in Table 4), tend to be low in Colombian agriculture. The highest ratio is found in the case of the sugar cane sector, while the lowest pertain to the agricultural investment sector. The average land-labor ratio is 0.58 and its standard deviation is 1.09. Lastly, capital-land ratios (third column) also show high variability within agriculture. The largest ratio shows up for the legumes sector, followed by the fruits, and banana sectors. The lowest ratio belongs to the corn sector, followed by the oil seeds sector, and the cocoa sector. The average ratio for agriculture is 8 and its standard deviation is 6.34.[26]

The agricultural sector's share in total factor use is relatively low, as can be inferred from its participation in value added. Agriculture accounts for 5.3% of total labor use and 4.5% of total capital use. Coffee has the highest share in labor demand, while several sectors have shares less than 0.1%. The highest shares in capital use belong to the fruits, sugar cane, tubers, and coffee sectors, while, as in the case of labor use, several sectors exhibit shares below 0.1%. With respect to land use, the sugar cane sector accounts for almost 34% of the total, while the coffee, rice, tubers, and plantain sectors have shares between 8 and 10 percent, accounting for around 36%.

With respect to sectoral demand by labor type, the agricultural sector employs almost 50% of rural unskilled workers, near 18% of rural skilled workers, 2.6% of urban unskilled workers, and 0.8% of urban skilled workers. The largest agricultural user of rural unskilled workers is the coffee sector (15.8%) followed by the fruits (5.3%), and the plantain (4%) and agricultural investment (3.9%) sectors. In turn, the largest employer of rural skilled workers is the fruits sector (10.2%), followed by the coffee (1.7%)

[26] It must be remembered that these are value (and not quantum) ratios.

and other crops (1.6%) sectors. As can be expected from the above figures, the shares of agricultural subsectors in urban labor demand are quite modest.

Table 5 shows the share composition of labor demand by labor type and sector. From there, it can be appreciated that although the share of the agricultural sector in urban employment is low, there are several sectors within which the share of urban labor is high. Such is the case of tobacco, agricultural services, other crops, banana, and oil palm. Also most sectors show a high dependency on rural unskilled labor. This is notably the case of potatoes, oil seeds, beans, cocoa, and coffee. Skilled labor, whether rural or urban, is relatively important in sectors such as banana, sugar cane, cotton, fruits, rice, and other crops. In most of these cases it is urban skilled labor that is significant.

Table 5. Share Composition of Labor Demand by Sector in the Colombian Economy, 2007

Sector	Rural labor		Urban labor	
	Unskilled	Skilled	Unskilled	Skilled
Coffee	92.1	1.2	6.2	0.4
Cereals	84.4		15.6	
Corn	84.9		14.7	0.4
Rice	67.6		14.8	17.6
Potatoes	100.0			
Beans	95.2		4.8	
Vegetables	82.4	3.2	14.4	
Tubers	73.3		26.7	
Banana	31.2		33.5	35.2
Plantain	77.2		9.3	13.5
Fruits	69.1	16.7	13.3	0.9
Oil palm	45.8	6.2	33.4	14.6
Oil seeds	100.0			
Other crops	30.7	1.9	52.1	15.3
Cocoa	93.3		6.7	
Tobacco	21.0		79.0	
Sugar cane	54.7	0.8	22.3	22.2
Cotton	62.7	22.9	14.4	
Ag. investment	70.8	3.0	19.7	6.6
Ag. services	37.3		62.7	
Rest of the economy	4.1	0.8	45.3	49.8

Source: Colombian 2007 SAM

Measured on the basis of the national poverty line, poverty is high in Colombia. It has also been persistent, especially in the rural sector (CRECE, 2005). According to our own measurement, based on the Colombian 2008 LSMS, poverty incidence at the national level was 42.3% and extreme poverty reached 15.7%.[27] In terms of households, poverty affected 36.4% of them and extreme poverty 15.5%. As shown in Table 6, rural poverty and extreme poverty are the highest: measured on the basis of individuals, the first reached almost 59% and the second 27%, while the corresponding figures for the

[27] Our figures are slightly lower than the official ones, a fact due to the use of different methodologies for making survey data compatible with national accounts data (in particular we use land income which is not usually well measured). The official rate of poverty incidence at the national level for 2008 is 46% and for extreme poverty is 17.8%. The same applies to the urban- rural disaggregations.

urban sector are 37% and 12%. When measured on the basis of households, rural poverty is more than 20 percentage points higher than the urban and extreme poverty is almost 13 percentage points higher. The poverty gap (row FGT1 in Table 6) is also highest in the rural sector, both when measured on the basis of individuals and households, meaning that the poor in the rural sector are further below the poverty line and therefore are in need of a larger effort to bring them out of poverty. Lastly, the severity of poverty index (row FGT2) is also highest in the rural sector.

Table 6. Poverty Measures in Colombia, 2008

Measure		Individuals			Households		
		Urban	Rural	Total	Urban	Rural	Total
Poverty	FGT0	37.1	58.7	42.3	32.0	52.2	36.4
	FGT1	16.4	28.6	19.3	15.7	26.7	18.1
	FGT2	10.1	18.1	12.0	10.8	17.9	12.4
Extreme poverty	FGT0	12.2	26.9	15.7	12.7	25.4	15.5
	FGT1	5.9	11.9	7.4	7.7	12.7	8.8
	FGT2	4.1	7.5	4.9	6.0	8.9	6.7

Source: authors' calculations based on 2008 LSMS

It is useful to have a glimpse at the structure of poverty as it helps in understanding the way the policy simulated works its way to have an impact (or lack of) on rural poverty. Table 7 shows the relevant information. Several figures are presented there on the incidence of poverty and of extreme poverty for different categories of individuals. As can be seen, among the population in working age, individuals that are employed show an incidence of poverty of a bit more than 31% and an incidence of extreme poverty of 9.4%. As could be expected, poverty and extreme poverty is higher among unemployed and inactive individuals, being particularly high among unemployed (54.3% poverty and 24.4% extreme poverty). If employed individuals are classified according to the economic sector to which they belong to, it can be appreciated that the incidence of poverty and extreme poverty is considerable higher in the agricultural sector as compared to the mining, industry, and services sectors. As a matter of fact, poverty is about 1.5 times higher among agricultural sector employees than among mining and industry employees, and more than double with respect to services sector employees.

Further classifying employed individuals according to their labor type, allows us to observe that poverty and extreme poverty incidence are the highest among rural unskilled workers. Poverty incidence for this type of worker is 1.6 times higher than for urban unskilled workers, 7.1 times that of urban skilled workers, and 4 times that of rural skilled workers. Differences for extreme poverty are even higher.

Rural and urban households are split in income quintiles in the SAM. The lower part of Table 7 provides figures on poverty and extreme poverty incidence for each of these household types. From there it follows that poverty spreads along the whole spectrum of households, including some extreme cases in urban households belonging to the highest quintile.[28] However, as it should be, the incidence of poverty is quite high among the lower quintiles, urban and rural, and declines as household income increases. Nonetheless, the decline among urban households is more rapid than among rural ones. As a consequence, poverty seems to be wide spread in rural areas and less so in urban areas.

[28] A fact due to the way household quintiles and poverty are calculated: quintiles are construed based on total household income irrespective of its composition, while poverty is calculated on a per capita basis.

Table 7. Behavior of Poverty and Extreme Poverty Incidence across Different Classification Categories

Criteria	Category	Poverty incidence	Extreme poverty incidence
Working age	Employed	31.1	9.4
	Unemployed	54.3	24.4
	Inactive	45.8	18.4
Sectoral activity	Agriculture	53.9	21.2
	Mining	28.1	13
	Industry	28.0	6.2
	Services	25.9	7.0
Labor type	Urban unskilled	31.3	13.5
	Urban skilled	7.2	2.7
	Rural unskilled	50.1	27.2
	Rural skilled	12.6	5.0
Household income quintile	Rural quintile 1	95.5	92.1
	Rural quintile 2	79.0	53.8
	Rural quintile 3	59.4	15.3
	Rural quintile 4	26.4	2.4
	Rural quintile 5	5.2	0.0
	Urban quintile 1	83.7	67.6
	Urban quintile 2	56.5	11.8
	Urban quintile 3	22.4	0.1
	Urban quintile 4	2.8	0.0
	Urban quintile 5	0.2	0.0

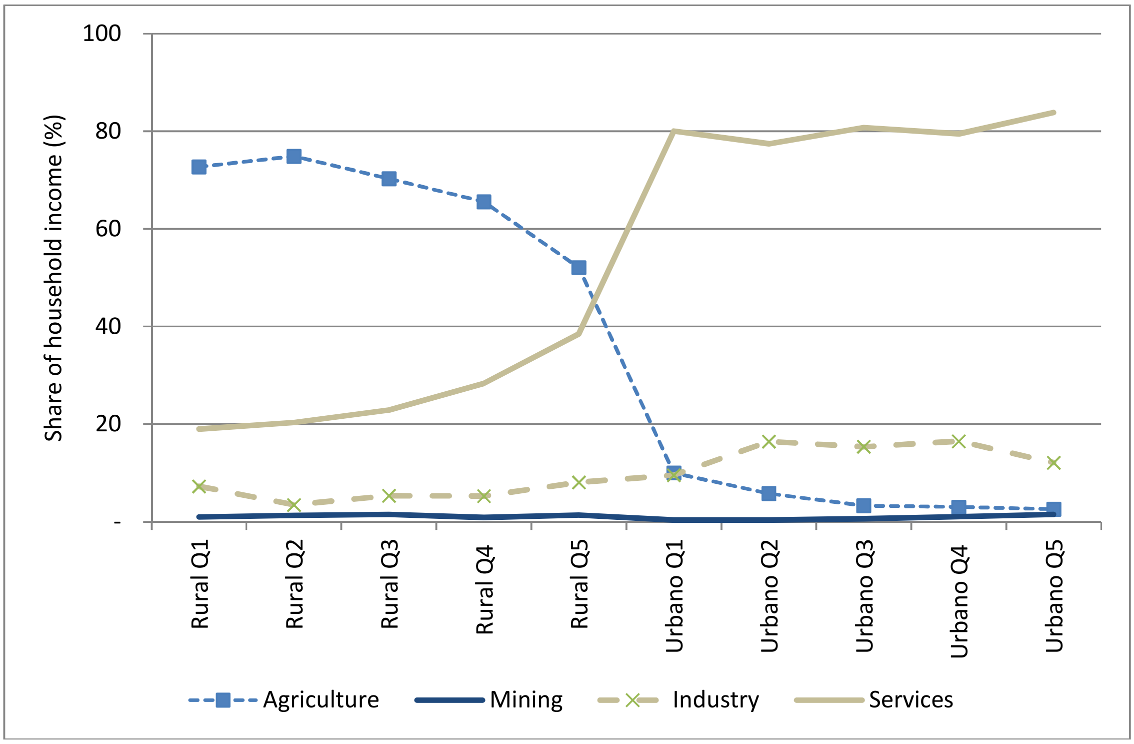
Source: authors' calculations based on 2008 LSMS

For completeness, Figure 3 shows the sectoral composition of households' income.[29] It illustrates the large dependence that rural households have on agriculture and especially so low income rural households (even though the richest rural households derive more than 50% of their income from agriculture). The most noticeable feature of rural households' income is the decline in agriculture-based income and the increase in services-based income, as households' income increases. This situation is compatible with (and the reflection of) the fact that poverty decreases for individuals employed in the services sector.

As expected, urban households' income basically depends upon services-based income, which remains at shares around 80% of total income for all household types. The share of income based on agriculture declines with households' income, going systematically down from 10% in quintile 1 households to 2.6% for quintile 5 households. In turn, industry-based income is higher among households toward the middle of the distribution, being the highest for households in quintiles 2 and 4, with 16.4% and 16.5% shares, respectively.

As the bulk of rural poverty concentrates in the lowest rural households quintiles and their income depends to a large extent on agriculture-based income, it is expected that positive impacts on agricultural activity be functional for reducing rural poverty as a whole.

[29] Based on factor income from labor and capital, excluding land income.



Source: authors' calculations based on 2008 LSMS

Figure 3. Sectoral Composition of Households' Income by Household Type (%)

Against this background, subsidies granted by the government yield,[30] in general, relatively small subsidy rates at the activity level. Since the latter are the rates that matter for the simulation, they are shown in Table 8. Among the features arising from these figures, it is worth mentioning three. First, given the size of the program relative to sectoral GDP, there is a large gap between the subsidy rate that is given to the beneficiary from the program (presented in Table 2) and the ensuing subsidy rate for the activity as a whole. For instance, while the subsidy rate granted to the average coffee producer that benefits from subsidies for productive capital is 22.9%, the corresponding subsidy rate for the coffee sector amounts to just 0.72%. The size of this gap depends upon the total amount of subsidies allocated to a sector as a proportion of sectoral GDP. What is relevant, however, is that beneficiaries from the program gain a significant advantage against non-beneficiaries and this effect is not captured in our evaluation, since we do not differentiate among different producers within an activity or between beneficiaries and non-beneficiaries.

The second feature is that the most significant subsidies are those that reduce the cost of productive capital or of irrigated land use (as opposed to subsidies that tend to be neutral in terms of generating factor usage biases), being the latter the most important in relative terms. Lastly, productive capital subsidies are the most important for agricultural investment (that is, new plantings of perennials), followed by corn and rice, while irrigation subsidies are more widespread across activities in terms of their importance (eight activities receive land subsidies above 12%).

[30] As presented in Table 2

Table 8. Subsidy Rates at the Activity Level Granted through the AIS Program (%)

Activity	Working capital	Productive capital	Land use	Productivity
Coffee	0.00	0.72	4.52	0.88
Cereals	0.09	0.09		
Corn	0.18	11.80	8.28	2.49
Rice	0.15	1.92	4.08	1.15
Potatoes	0.07	0.18	12.53	2.04
Legumes	0.07	0.06	31.32	10.29
Vegetables	0.07	0.19	15.91	6.33
Tubers	0.01	0.01	0.42	0.20
Bananas		0.17	18.08	3.64
Plantain		0.01		
Fruits	0.00	0.07	23.97	6.06
Oil palm		0.15	36.61	10.54
Oil seeds	0.03	0.92		
Other crops	0.00	0.26	0.22	0.02
Cocoa		0.87	51.91	16.98
Tobacco	1.10	0.18	20.77	4.71
Sugar cane		0.45	2.13	0.98
Cotton	1.51	0.12	3.61	0.92
Ag. investment		41.09		

Source: CGE simulation

6. Results

For easiness of exposition results from the two models are presented independently. We first look at the results from the CGE model, and then to the ones from the micro model.

6.1 Results from the CGE model

We first refer to results relating to quantum. Table 9 shows changes in value added, demand for composite labor, demand for land, and demand for fertilizer, for each agricultural activity. It must be remembered that value added is a fixed proportions combination of composite capital-labor and composite land, therefore percentage changes for these three variables are the same. As all activities receive subsidies it could be expected that value added would increase in all cases. However, as follows from the table, this is not true: the quantum of value added decreases for plantain, other crops, and agricultural investment, although in very low proportions (between 0.08% and 0.14%). From the supply side, the feature limiting output expansion is capital fixity and it largely determines the outcome presented in the table. Given the structure of agricultural production, any change in value added must be accommodated in the composite capital-labor nest as a change in demand for composite labor (LDC). As Table 9 shows, changes in labor demand exceed the change in value added, the difference being driven by the share of labor in the composite capital-labor (the larger the labor share, the closer these two changes are) and by the elasticity of substitution between composite labor and capital.[31]

Prices accommodate to ensure optimality at all stages of production and to keep with the fixed proportions assumption between composite capital-labor and composite land. For this reason, changes

[31] As the same elasticity value is assumed for all activities, there are no differences across sectoral behavior in this regard. We use an elasticity value of 1.5.

in demand for land and fertilizer (composite land) need to move in the same direction as changes in composite capital-labor. However, as irrigation subsidies have a positive effect on productivity, there are cases in which changes in demand for land and fertilizer do not necessarily have the same sign as changes in demand for composite labor (as greater productivity amounts to an increase in composite land). In fact, a comparison between the expected effects on productivity arising from irrigation subsidies, as presented in Table 5, and changes in land and fertilizer demand shows that the higher the expected productivity effect, the lower the increase (or the higher the decrease) in demand for composite land (specially as reflected in lower fertilizer use).

Table 9. Changes in Value Added and Input Usage in Agriculture (percentage changes in quantities)

Activity	Value added	Composite labor	Land	Fertilizer
Coffee	0,06	0,10	-0,4	-1,0
Cereals	0,18	0,51	0,7	-0,5
Corn	2,42	2,70	2,6	-2,4
Rice	0,16	0,66	0,8	-2,4
Potatoes	0,28	0,55	3,8	-3,3
Legumes	0,37	1,79	0,3	-17,9
Vegetables	0,22	0,94	-2,7	-12,6
Tubers	0,01	0,05	0,0	-1,5
Bananas	0,41	0,95	1,4	-4,8
Plantain	-0,12	-0,25	-0,6	1,0
Fruits	0,24	0,88	1,1	-8,8
Oil palm	0,89	3,43	2,3	-14,9
Oil seeds	0,24	0,95	0,4	-0,9
Other crops	-0,14	-0,17	-1,1	0,0
Cocoa	3,13	4,88	5,2	-21,5
Tobacco	1,09	2,51	4,7	-7,1
Sugar cane	0,01	0,22	-1,0	-0,8
Cotton	1,80	2,58	2,5	-0,2
Ag. investment	-0,08	-0,11	-1,1	0,0

Source: CGE simulation

The behavior of changes in demand for land and fertilizer is explained by two main factors. First, the degree of complementarity or substitutability between them. In this particular case, we assume that land and fertilizer are weak substitutes,[32] so these changes tend to roughly move in the same direction. However, as we have relatively sizable subsidization levels for land use (as illustrated in Table 5), relative prices within composite land show high variations and substitutability between land and fertilizer is enhanced, yielding several cases in which land and fertilizer demand move in opposite directions. The average change in relative prices between land and fertilizer arising from the shock is 11.3%, with extreme cases as high as 30% to 40% and as low as 0.3%, basically depending on the size of the subsidy to land use.

[32] We assume the same elasticity of substitution for all activities, at the level of 0.5. This is in line with the view that fertilizer and land infrastructure can be regarded as complements while fertilizer and land as substitutes (Ruttan, 2001). As we do not have the means to distinguish between land and land infrastructure, we adopt a midway substitutability/complementarity relationship.

The second factor impinging upon land and fertilizer substitutability comes from the side of supply of land services. As allocation of land services is more “sluggish” between perennials and seasonal crops, and more “sluggish” within perennials than within seasonal, competition for land services is more intense among perennials. As land is not easily reallocated from seasonal to perennial crops, there are cases in which even though a perennial crop benefits from a relatively high subsidy to land use, its demand for land decreases as other perennials have higher subsidies and can expand land use at its expense. This is the case of coffee that shows a 4.52% subsidy for land use but its demand for land decreases by 0.4%.

The case of agricultural investment is worth a short comment, as this activity secures the highest subsidy rate for productive capital use but its output shrinks. This result is driven by several factors. First, as capital is sector specific, the subsidy on capital has no impact on demand for this factor. Instead, the behavior of demand for composite capital-labor depends on the change in the relative price between capital and composite labor. In this particular case (as is also true in the cases of plantain and other crops), this relative price decreases leading to a reduction in composite labor use and to a decline in output. On the demand side, agricultural investment enters, in fixed proportions (in value), into the economy's investment account so its expansion is limited on that side too as the model is saving-driven.

In summary, agricultural activities tend to increase their output (measured as quantity of value added) and do so in a way consistent with the relative level of subsidies each of them receives and the competition for resources that the particular mix of subsidies and resource allocation restrictions impose. Overall, the average percentage increase in output is low (0.6%) and it is also low at the aggregate level of the agricultural sector (0.2%).

For completeness, we now describe a few results in value terms. First, it is useful to observe the behavior of unit costs for all agricultural activities. Table 10 shows both activities unit costs and their basic prices. As mentioned before, the working capital subsidy creates a wedge between these two prices, lowering the basic price, making agricultural output cheaper for other agents in the economy. As can be verified from the figures in the table, the difference between these two prices corresponds to the working capital subsidy level granted to each activity. It can also be observed that unit costs decline on average (by 0.7%, unweighted average) as a consequence of the other two types of subsidies granted through the program. The size of declines in unit costs not only depends on the subsidy levels that each activity enjoys and on the shares that both capital and land have in the production structure, but also on factor price changes. In general, activities benefiting from the highest subsidy levels show the highest declines in unit costs. For instance, cocoa registers a 7.2% decline in unit costs that is basically driven by a high subsidization level for land (almost 52% as shown in Table 5), since the level of the productive capital subsidy the activity receives is relatively low (much lower than that of the activities getting the highest productive capital subsidies, but well above the average with respect to the rest of activities). Divergences between price wedges as can be calculated from Table 10 (that is, the differences between the capital rental rate and the rental rate paid by each activity, and between the rental rate of land and the rental rate paid by each activity) and subsidization levels (as presented in Table 5) are due to price changes for these two factors as activities compete for their use.

The behavior of changes in the price of value added is determined by factor price changes and factor shares. On the composite capital-labor side, the rental rate of capital paid by the activities increases in spite of the subsidy as capital is sector specific. On the other hand, wages for all labor types increase marginally, the highest increases being those of unskilled rural labor (0.5%) and skilled rural labor (0.2%). Therefore, on this side there is an upward pressure on the price of value added. On the composite land side, the rental rate of land paid by the activities decreases as a consequence of the subsidy and the price of fertilizer decreases too as its demand drops. Hence, on this side we have a downward pressure on the price of value added. The result is, as Table 10 shows, that in general the second effect dominates and the price of value added tends to fall, in most cases marginally.

Table 10. Percentage Changes in Prices and the Value of Value Added

Activity	Unit cost	Basic price	Capital rent	Paid capital rent	Land rent	Paid land rent	Value added price
Coffee	0.16	0.16	1.26	0.53	3.25	-1.42	0.17
Cereals	0.02	-0.07	0.87	0.77	-2.70	-2.70	0.16
Corn	-1.67	-1.85	15.90	2.23	-1.79	-9.92	-2.51
Rice	-0.82	-0.96	2.76	0.79	-2.65	-6.62	-1.20
Potatoes	-0.67	-0.74	1.05	0.87	-1.20	-13.58	-1.00
Legumes	-0.32	-0.39	1.73	1.67	-2.89	-33.31	-0.35
Vegetables	-0.32	-0.39	1.25	1.05	-4.36	-19.58	-0.38
Tubers	0.08	0.06	0.42	0.41	-3.03	-3.44	0.07
Bananas	-0.19	-0.19	0.98	0.81	7.19	-12.20	-0.35
Plantain	0.51	0.51	0.23	0.22	2.88	2.88	0.59
Fruits	-0.44	-0.44	1.04	0.97	6.54	-19.00	-0.49
Oil palm	-1.71	-1.71	2.69	2.53	8.93	-30.95	-1.84
Oil seeds	-0.18	-0.21	2.07	1.13	-2.87	-2.87	-0.31
Other crops	0.10	0.10	0.33	0.07	1.97	1.75	0.12
Cocoa	-7.19	-7.19	4.63	3.71	15.32	-44.54	-8.04
Tobacco	-0.33	-1.40	1.99	1.81	-0.82	-21.42	-0.59
Sugar cane	0.01	0.01	0.88	0.43	2.10	-0.08	-0.01
Cotton	-0.12	-1.62	2.20	2.09	-1.86	-5.40	-0.06
Ag. investment	0.19	0.19	70.24	0.30	1.88	1.88	0.24

Source: CGE simulation

As domestic prices tend to fall, the ratio of FOB prices to international prices (exogenously given) also falls and exports tend to increase in quantity. This is true for all activities but plantain and other crops. Nonetheless, the extent to which exports increase is relatively low with the exception of cocoa, corn, cotton, and oil palm, as shown in Table 11. Furthermore, the ratio of prices received by export crops to local prices determines the relative size of changes in the market of destination. If local prices increase more than export prices, the proportional change in supply to the domestic market is higher than that to the export market and vice versa. In general, the increase in exports tends to be higher than the increase in supply to the domestic market, with a few exceptions. Lastly, the ratio of the domestic price to the import price, determines the behavior of imports. In most cases this ratio decreases, leading to a decline in imports that, with some exceptions, tends to be small (the relevant figures are presented in Table 11).

Percentage changes in employment levels and wages, as transmitted from the CGE simulation to the microsimulation model are presented in Table 12. Employment changes for agricultural activities are reported on a regional basis and derived from sectoral changes. As an aggregate, agricultural labor demand increases as follows: for rural unskilled workers 0.4%, for rural skilled workers 1.03%, for urban unskilled workers 0.6%, and for urban skilled workers 0.6%. These increases imply decreases in labor demand in the rest of the economy as follows: for rural unskilled workers 0.4%, for rural skilled workers 0.2%, for urban unskilled workers 0.02%, and for urban skilled workers 0.005%. Hence, in relative terms, the highest increase in labor demand by the agricultural sector is for rural skilled workers; however, in absolute terms it is for rural unskilled workers. As shown in the table, labor demand in agriculture relatively increases the most for hot weather crops (the region to which a significant portion of perennials belong to). It is also important to mention that land rents received by land owners increase 1.7%, while the capital rent received by capital owners do so by 0.13%.

Table 11. Changes in Quantities Traded (percentages)

Activity	Exports	Domestic demand	Imports
Coffee		0.06	
Cereals	0.14	0.18	0.06
Corn	2.75	2.41	-0.58
Rice	1.05	0.10	-1.79
Potatoes	0.66	0.22	-0.91
Legumes	0.54	0.30	-0.45
Vegetables	0.39	0.22	-0.31
Tubers	0.02	0.02	0.11
Bananas	0.39	0.35	-0.09
Plantain	-0.48	-0.10	0.63
Fruits	0.43	0.24	-0.33
Oil palm	2.19	0.08	-4.09
Oil seeds	0.30	0.23	-0.16
Other crops	-0.16	-0.06	0.19
Cocoa	9.12	2.96	-9.03
Tobacco	1.82	0.77	-1.93
Sugar cane	0.00	0.07	
Cotton	2.47	1.79	-1.30

Source: CGE simulation

Finally, it should be mentioned that, as expected, the impact of the program at the macro level is nil. Nominal GDP increases 0.021% while the GDP deflator increases 0.019%. The size of the direct tax needed for financing the program is negligible.

Table 12. Percentage Changes in Labor Demand by Labor Type and Region and Percentage Changes in Nominal Wages

			Labor type			
			Rural unskilled	Rural skilled	Urban unskilled	Urban skilled
Employment	Agriculture	Hot weather	0.58	1.59	1,29	1,22
		Mild weather	0.29	0.90	0,76	0,70
		Cold weather	0.45	0.46	0,10	-0,02
	Rest of the economy		-0,37	-0.22	-0.01	-0,01
Wages			0,49	0,20	0.04	0.01

Source: CGE simulation

One of the appealing features of the AIS program, as designed, is its potential for enhancing productivity. There are several mechanisms through which it is expected that AIS can have an impact on productivity, the two most important being the CID and the ITA. As mentioned, only the former is taken into account in the simulation and its impact is parameterized in the model based upon an assumed average yield gap between irrigated and non-irrigated land for all agricultural activities. The results shown above are based on an average yield gap of 20% that generates the productivity impacts already shown in Table 5. Given the importance of this parameter in determining the results, we now report estimates arising from two somehow extreme alternative assumptions for the yield gap, a 10% and a 30% value, equivalent to halving the base estimate and increasing it by 50%. The basic results are presented in Table 13, where the figures correspond to the difference between the percentage change attained under the new yield gap and the 20% gap. Therefore, a negative number means that the new estimate is lower than that corresponding to the 20% gap, and vice versa.

Table 13. Results from Alternative Values of the Yield Gap between Irrigated and Non-irrigated Land

Activity	Difference in value added		Difference in demand for composite labor		Difference in demand for land	
	10%-20%	30%-20%	10%-20%	30%-20%	10%-20%	30%-20%
Coffee	-0.01	0.01	-0.01	0.01	-0.36	0.35
Cereals	0.09	-0.09	0.25	-0.25	0.38	-0.37
Corn	0.11	-0.10	0.12	-0.11	0.64	-0.63
Rice	0.01	-0.01	0.04	-0.04	0.46	-0.45
Potatoes	0.01	-0.01	0.02	-0.01	0.67	-0.65
Legumes	0.00	0.00	0.01	0.00	1.02	-1.00
Vegetables	0.01	-0.01	0.03	-0.03	0.67	-0.66
Tubers	0.02	-0.02	0.08	-0.07	0.14	-0.14
Bananas	-0.04	0.04	-0.10	0.10	-0.30	0.29
Plantain	-0.03	0.03	-0.07	0.07	-0.24	0.24
Fruits	-0.02	0.02	-0.08	0.08	-0.18	0.18
Oil palm	-0.06	0.06	-0.22	0.22	-0.10	0.09
Oil seeds	0.17	-0.17	0.65	-0.64	0.23	-0.23
Other crops	-0.02	0.02	-0.02	0.02	-0.43	0.42
Cocoa	-0.16	0.16	-0.26	0.25	-0.08	0.08
Tobacco	0.00	0.00	0.00	0.00	0.81	-0.79
Sugar cane	-0.05	0.05	-0.73	0.71	-0.15	0.15
Cotton	0.07	-0.07	0.10	-0.09	0.53	-0.51
Ag. investment	-0.01	0.01	-0.02	0.02	-0.44	0.44

Source: CGE simulation

As the new values for yield gaps spread symmetrically from the 20% value (10 percentage points below or above), the change in productivity attained at the activity level also spreads symmetrically around the values reported in Table 5. As a consequence, changes in value added, demand for composite labor, and demand for land, as reported, tend to be symmetrical too. The important fact arising from the figures is that there are no cases in which we obtain estimates that depart in a significant manner from those attained under the 20% benchmark. The higher differences amount to less than 0.2% in absolute value for value added, around 0.7% for the demand for composite labor, and slightly more than 1% for the demand for land. Hence, even though at the individual level and in relative terms there are cases in which estimated values may greatly differ, these differences have very low leverage for modifying the aggregate results on which we concentrate here. In summary, the assumption of different values for the yield gap, although not innocuous, does not affect the direction of our estimates and change their level in a negligible way.

6.2 Microsimulation model results

In light of the above results, there follow several intuitions on the likely outcome from the microsimulation model. First, as the wage rate for rural unskilled workers raises and poverty incidence is the highest among this type of workers, one can expects that poverty ameliorates. However, considering the size of the poverty gap it is unlikely that the attained wage rise will cause the incidence of poverty to fall. Instead, it is more likely that the effect will reflect in a decrease in the poverty gap and, perhaps, in the severity of poverty.

Changes in employment seem to point in the same direction. Employment in agriculture increases in basically all regions and the incidence of poverty tends to be lower among employed individuals. Therefore, as there are more individuals getting into employment, rural households' income tends to rise (as the dependence of rural households on agricultural income is high). However, there is a fact acting in the opposite direction. Jobs in agriculture are linked to higher poverty incidence that other jobs, so the net result should be the mixed outcome of changes in the employment status of households' members. If new workers get employed in the agricultural sector and the household does not loose other member's employment, then there is the possibility that poverty declines. If the opposite is true and other households' members lose their (non-agricultural) jobs, then the household is likely to be worse off (as poverty incidence among non agricultural workers is lower).

Therefore, the two extreme outcomes for rural households can be summarized as follows. The best outcome arises when no worker in the household gets fired and a member in the household gets hired in the agricultural sector (recall that non-agriculture based jobs decrease). The worst outcome arises when non-agricultural workers get fired and no worker in the household gets hired in agriculture. As the firing/hiring process depends upon each individual's probability of being so, there is no way to ascertain beforehand an expected outcome. What is reasonable is to guess that, given the size of estimated variations in employment and wages, expected changes in poverty incidence are bound to be small, while expected changes in the poverty gap may be higher.

Table 14 shows the poverty and extreme poverty incidence results arising from the microsimulation. Results indicate very limited impacts on poverty. Measured on the basis of individuals, the incidence of poverty decreases 0.03 percentage points in urban areas, 0.06 in rural areas, and 0.04 at the national level. Measured on the basis of households, the incidence of poverty practically does not change, while in rural areas decreases 0.01 percentage points. The poverty gap increases 0.04 and 0.05 percentage points at the urban and national levels, respectively, while increases 0.06 percentage points in rural areas, when measured on the basis of individuals. The same qualitative results are attained when it is measured on the basis of households. The severity of poverty increases meagerly in all cases when measured on both the basis of individuals and households. Extreme poverty increases in all counts (incidence, poverty gap, and severity) when measured on the basis of individuals and the same does when measured on the basis of households, with the only exceptions of the poverty gap and the severity of poverty in rural areas.

These results deserve some comments. That rural poverty incidence decreases when measured at the individuals level and do not do so when measured at the household level (except for rural households) is a feature associated with the composition of households. While wages for all labor types increase, wages for the rural categories of work increase the most. However, households' income, including that of those in the rural sector, is dependent upon income originated in agricultural and non-agricultural activities. While the employment in the former increases, it decreases in the rest of the economy, so as households have members whose income comes from non-agricultural activities, they face the possibility of losing their jobs, a situation that is less likely in the case of rural households given the composition of their employment.

Table 14. Poverty and Extreme Poverty Results from the Microsimulation

Measure		Individuals			Households		
		Urban	Rural	Total	Urban	Rural	Total
Poverty	FGT0	37.08	58.64	42.22	31.96	52.19	36.36
	Difference	-0.03	-0.06	-0.04	0.00	-0.01	0.00
	FGT1	16.41	28.65	19.33	15.72	26.68	18.10
	Difference	0.04	0.06	0.05	0.02	0.02	0.01
	FGT2	10.14	18.18	12.06	10.84	17.86	12.36
	Difference	0.05	0.07	0.05	0.02	0.01	0.01
Extreme poverty	FGT0	12.26	26.97	15.76	12.71	25.44	15.48
	Difference	0.07	0.06	0.06	0.02	0.07	0.03
	FGT1	5.99	11.98	7.42	7.68	12.72	8.78
	Difference	0.05	0.07	0.06	0.02	-0.01	0.02
	FGT2	4.14	7.61	4.97	6.05	8.85	6.66
	Difference	0.05	0.09	0.06	0.02	-0.01	0.01

Source: microsimulation model

To see this, recall that low income rural households derive most of their income from agricultural activities (recall Figure 3) –either in the form of wages, or other factors' income. Given this, with the general increase in agricultural activity we can expect these households' income to rise. However, this is not necessarily the case as figures shown in Table 15 indicate. There, households have been ordered from highest to lowest poverty incidence in the base data. As can be appreciated, poverty incidence either does not vary or slightly increases among the poorest households. It is only in the case of households toward the middle of the distribution that poverty actually decreases, in particular from rural quintile 3 to urban quintile 4.

As wages have small variations, their ability to move households out of poverty is limited and it is entry and exit from employment what may help make a difference. It turns out that members of households with the lowest income levels have also the lowest probabilities of being hired and the highest probabilities of being fired; therefore, they cannot take advantage of the changes arising from the shock. As sown in the table, poverty incidence only decreases for rural households in quintiles 3, 4 and 5, and for urban households in quintiles 3 and 4.

Another way to qualify the results is through observation of the behavior of poverty incidence according to individuals' sector of activity and labor type. Table 16 presents the relevant data. Poverty incidence varies only in the cases of agricultural and services activities, decreasing in the first case and increasing in the second (a feature consistent with employment reallocation from the rest of the economy to agriculture). On the other hand, it decreases for rural unskilled workers, while increasing for the rest of labor types. In these cases, poverty incidence is calculated on a per capita basis for individuals employed in a particular sector or belonging to a labor type, taking into account the whole income level of the household to which they belong. That is, the poverty status reported in each case not only considers the individual's income, but also the income coming from other household's members.

Table 15. Poverty incidence by household type -pre and post-simulation

Household type	Base	Simulation	Change
Rural quintile 1	95.54	95.54	0.0
Urban quintile 1	83.69	83.69	0.0
Rural quintile 2	78.95	79.07	0.12
Rural quintile 3	59.4	59.26	-0.14
Urban quintile 2	56.54	56.54	0.0
Rural quintile 4	26.41	26.21	-0.2
Urban quintile 3	22.36	22.34	-0.02
Rural quintile 5	5.23	5.16	-0.07
Urban quintile 4	2.81	2.67	-0.14
Urban quintile 5	0.22	0.22	0.0

Source: microsimulation model

Therefore, for example, when poverty incidence decreases for individuals employed in agriculture, there are two sources for this decline: changes in wages and net changes in employment within the household. Figures in Table 16, illustrate the way these components interact to yield the results presented in Table 15.

Table 16. Poverty incidence according to individuals' sector of activity and labor type -pre and post-simulation

Sector	Base	Simulation	Labor type	Base	Simulation
Agriculture	53.94	53.87	Urban unskilled	31.29	31.31
Mining	28.06	28.06	Urban skilled	7.15	7.18
Industry	27.96	27.96	Rural unskilled	50.14	50.09
Services	25.87	25.90	Rural skilled	12.59	13.08

Source: microsimulation model

As mentioned, in the CGE simulation it was assumed that the yield gap between irrigated and non-irrigated land was the same across agricultural activities and equivalent to a 20% wedge. A sensitivity analysis was performed for this parameter leading to the conclusion that changes in the parameter result in very small changes from the base scenario, as reported in Table 13. Runs of the microsimulation model (not reported here for brevity) show negligible differences with respect to the results reported above.

7. Conclusions

We attempt to provide an estimate of the sectoral and rural poverty impacts of newly implemented reforms to Colombian agricultural policy, in particular the introduction of the Agriculture, Secured Income Program (AIS). For this we use a computable general equilibrium model specialized in the agricultural sector, sequentially with a microsimulation model.

Although sizable for Colombian agricultural policy standards, in terms of public sector budget allocation, the program is relatively small as compared to the size of the agricultural sector. While the first feature results in relatively high subsidization levels at the project (farmer) level, the second reflects in relatively low subsidy rates at the sectoral level, leading to a potentially low ability to generate significant aggregate (sectoral) impacts but, simultaneously, to potentially high impacts at the individual level.

Therefore, access to the program is key in determining its distributive implications. It is known that resources allocated to medium size and large farmers are exhausted at a rapid pace, once funds are allocated to the program by the government, while demand for funds by small farmers is sluggish. It is also known that disbursements for projects submitted by medium size and large farmers make up for the largest share of funds. In view of these, it is likely that the program may be enhancing the degree of concentration of agricultural activity. While outside the scope of this work, the issue is an important research area for Colombia.

Results from the CGE simulation show that expected impacts in terms of percentage changes in value added at the activity level are small, most of them in the range bellow 1%. Higher changes could be expected in terms of factor and input usage, with demand for composite labor ranging from 4.9% to -0.25%, demand for land use oscillating between 5.2% and -2.7%, and demand for fertilizer changing in between 1% and -21.5%. However, in spite of these wider changes, resulting unit costs decrease 0.68% on average and only in three cases yield decreases above 1%. If the effect of subsidies on working capital is taken into account, the number of activities for which basic prices decline by more than 1% increases from three to five (out of 19). Estimated changes in productivity, arising from increases in land under irrigation an drainage projects and parameterized outside of the CGE, lead to yield average gains around 4.5% with cases as high as 17% and as low as 0.2%.

The macro model yields small wage and capital rent increases, a relatively larger increase in land rents, and limited labor reallocation, leading to small poverty impacts as calculated through the microsimulation model. Rural poverty incidence decrease less than 1 per cent while the poverty gap increases in a similar magnitude. Additionally, poverty reduction concentrates in households located toward the middle of the income distribution, in particular in rural households belonging to income quintiles 3 and 4 (and in urban households in quintile 4).

The above relates to the ability of individuals to get into employment and to their vulnerability to get fired. Seemingly, individuals pertaining to low income households are both, less likely to land employments and more prone to be fired, so they benefit the least from changes induced by the implementation of the program.

In sum, as implemented, AIS seems to have a limited capability for reaching the objectives for which it was designed. As an instrument for smoothing the adverse impact of increased foreign competition it appears to fall short as its estimated impacts on production are low. On the other hand, as an instrument to boost agricultural productivity and competitiveness it shows more promise but lacks reach and may induce greater concentration of agricultural activity at the expense of small farmers. Lastly, although it is not one of its stated objectives, its impact on rural poverty reduction seems to be very limited.

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APPENDIX

Main elasticities and parameters used in the model

Elasticity	Value	Comment
CES - composite labor-capital -ag activities	1.5	There are no recent available estimates for this elasticity for Colombia. Thirks (1974) estimation yields 1.42 across a set of seven crops. Boys et al (2007) finds an average international elasticity of substitution of 4.08.
CES - composite land -ag activities	0.5	There are no estimates for this elasticity in Colombia. According to Townsend (2010) it is 0.58 for the US and should be lower for a country as South Africa.
CES - composite labor	0.5	Recent estimates for Colombia report elasticities in the order of 1.16 to 1.47 (Medina and Posso, 2010). Unel (2007) uses a 1.5 elasticity for the US. Das (2003) reports elasticity values between 0.67 and 0.83 over a cross section of countries. We use a lower value than the one reported by Medina and Posso, to account for our short term horizon.
CET - land supply	0.5	There are no estimates for this elasticity in Colombia. We assume a low value reflecting scant land use substitutability between seasonal and perennial crops. Brooks et al (2010) use a 0.1 value (between permanent crops and rice in the DEVPEM model).
CES - composite commodity	1	According to Hernandez (1998) elasticities range from 0.85 to 0.13, while according to Lozano (2004) they range from 0.26 to 0.89. We use a value of 1 for allowing some latitude due to our time frame.
CET - land supply for perennials	0.5	There are no estimates for this elasticity in Colombia. Following the above (see land supply elasticity) we assign a low value given the significance of sunk costs in perennials production.
CET - land supply for seasonal	2	There are no estimates for this elasticity in Colombia. Following the above (see land supply elasticity) we assign a relatively high value given the easiness of switching from one to another seasonal crop.
CES - value added -nonag activities	1	The elasticity of factoral substitution in Colombia, according to Arango and Rojas (2004) is 0.7. We use a slightly larger elasticity considering our time horizon and based on Zuleta et al (2009), that finds evidence in favor of a larger than unity elasticity of substitution between capital and labor for the manufacturing sector.

Elasticity	Value	Comment
Income elasticity of consumption: Cereals	0.7	Income elasticities were calibrated from survey data (National Income and Expenditures Household Survey 2006-7)
Corn	0.7	
Potatoes	0.7	
Beans	0.7	
Vegetables	1.5	
Tubers	0.7	
Bananas	1	
Plantain	0.7	
Fruits	1.5	
Oil seeds	0.5	
Other	1	
Animals	1.2	
Forestry	1	
Agroindutry	2	
Basic products	1	
Beverages, tobacco, manufactures	1.5	
Fertilizers	0.7	
Agrochemicals	0.7	
Chemicals and minerals	1.2	
Machinery and construction	1.1	
Services	1.2	
Financial services	2.6	
Frisch parameter	-1.5	Calibrated from survey data (National Income and Expenditures Household Survey 2006-7)
Average yield gap between irrigated and non-irrigated land	1.2	Based on available information for some sectors and experts judgment.
Subsidy rate on irrigation projects	0.755	Calibrated from AIS’ expenditures.