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Trade and Sustainable Development: Spatial Distribution of Trade Policies Impacts on Agriculture

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Abstract

As the use of global and national computable general equilibrium (CGE) models has become more widespread, most policies still remain at the regional or sub-national level. This level of disparity requires an approach that bridges the gap between national results and sub-national policies. In this study we combine a general equilibrium model with geographical information to spatially map the effects of trade liberalization on the agricultural sector. This study tries to bridge this gap by merging the results of a CGE analysis with spatial geo-referenced data at the municipal level by means of GIS techniques.

This paper provides a methodology that combines micro-level information with the results of a CGE model and presents them in a spatial way. We apply this methodology to a simultaneous free trade agreement (FTA) between Andean countries and the United States, and its impacts on Ecuador's agricultural sector.

The methodology developed in this paper uses three sources of information. First, trade liberalization results obtained using a general equilibrium model called GTAP-AGR. Second, micro data on producers and crops from the agricultural census of Ecuador. This census allows us to model price transmission mechanisms at the farm level based on farmer's characteristics. This captures farmer's imperfect market integration structure and imperfect transmission of price changes at the border. Third, geographically referenced data for Ecuador from databases of ECLAC.

Using these data sources, we are able to match the economic results from a CGE model with the census micro-data from the agricultural census of Ecuador and present them through the spatial lens. We are able to distribute changes in value of production for each production unit according to the importance of a specific crop in the political

administrative unit. These results show the geographic effects of the FTA on Ecuador's agriculture, and how various types of producers would be affected from trade liberalization.

This kind of results would enable policy makers to formulate policies in a geographic or territorial way. This would also allow policy makers to implement differentiated policies to help different types of farmers groups cope with potential negative impacts from free trade.

Introduction

Computable general equilibrium (CGE) models have been used to assess many economic policy issues for more than 30 years. Ranging from applications on trade policy to environmental strategy, the strength of CGE modeling lies in its integrated ability to explore economic-wide policy impacts at different levels. CGE modeling is usually applied to understand the deep relationship among economic sectors and their interaction. It provides detailed information on policy impacts on prices and quantities and is capable to deliver detailed information for different sectors and for the economy as a whole.

However, it is difficult to draw conclusions about the different policy impacts at the regional (sub-national) level because CGE models are not usually disaggregated at this scale. Most general equilibrium studies and their impacts at the sectoral level are usually at the macroeconomic level, focused on changes of a representative household. Some of the models that do bridge the gap between national and regional levels are usually for large countries such as the United States or Brazil. For example, Dixon et al. (2004) shows a model of the United States at the state level, and Ferreira-Filho and Horridge (2005) analyze for Brazil the impacts of trade liberalization, using input-output matrices at the regional country level.

However, these country models are data intensive, which for smaller economies, usually is not feasible to implement due to data limitations. Those models also lack a geographic representation of what happens at a spatial level, which is also due to the large amount of data needed. Macro-micro simulation studies have studied more in detail the impacts of policy shocks on different levels of income. However, these studies also lack the spatial dimension of the analysis.

At the sectoral level, macro studies also lack detail at a micro level. In agriculture, Morales et al. (2005), using partial equilibrium analysis, make a spatial localization of farms at the second-level of political division and study how tariff reduction affects them. Such disaggregation at the farm level is important, given that the effects of trade liberalization or technological change are influenced by price transmission at the regional level. Nicita (2005) shows that in Mexico, the impacts of the North American Free Trade Agreement (NAFTA) were higher in the northern states closer to the border with the United States, while these impacts in the southern most states of Mexico were negligible.

This spatial distribution of economic impacts on agriculture is important, because they determine the implementation of regional compensation policies. Salcedo (2007) mentions that the majority of subsidies in the farmers' compensation program in Mexico (PROCAMPO), were captured by large farmers. Targeted subsidies to farmers is important because impacts of trade liberalization are different for each farmer, given their own characteristic such as market integration, access to technology, access to credit, etc.

Therefore, there is need for studies that would spatially map impacts of policy shocks. Spatial geo-referenced consequences of a national wide applied policy are usually of great interest to policy makers, especially when they have to implement national programs based on local patterns. If results at a sub-national level are required, a national CGE model should be complemented with additional information at the regional level to disaggregate outcomes by region.

The objectives of this paper are three. First, to map crop distribution at the spatial level by type of producer according to a harmonized product classification. Second, to spatially distribute the economic impacts of a trade liberalization using a general equilibrium model, taking into consideration incomplete international price transmission into domestic markets (rural and urban). Third, to identify at the sub-national level a subsidy strategy tailored for each producer type and crop, that could mitigate possible negative impacts from trade liberalization.

The ability to answer these questions and incorporate, manage and analyze spatial data, is the distinctive characteristic of the Geographical Information Systems (GIS). Applications of GIS are becoming an integrated part of many disciplines, as mapping and geographic analysis using GIS has become more widely used. This study takes advantage of GIS and merges the results of a CGE model with spatial data at the municipal level using a methodology based on micro data. We explore a methodology to integrate the relationship between GIS, which explores the geo-referenced characteristics of the economic system, and CGE, which is a used powerful analytical tool.

Our aim is to join together GIS and economic modeling to develop a better decision support system for policy makers. This tool would enable us to merge CGE models to data that can be spatially referenced such as household surveys, agricultural census data, weather, transportation and population data. In this study, we focus on the farm level data from the agricultural census of Ecuador.

This paper is divided in the following sections. First, we review the general equilibrium studies where there is a spatial analysis of results. Second, we present our methodology to spatially distribute the effects of a general equilibrium model on the agricultural sector. The third section describes the data and the model used. Fourth, we analyze the results in terms of the spatial distribution of crops in Ecuador, the impacts of a FTA on producers, and the distribution of subsidies by size and type of producers. Finally, we draw some conclusions and future research.

I. Economic Models and Spatial Analysis of Model Output

Most spatial information includes data related to weather, slope and elevations, land use, population density, urban-rural interactions, etc. Given this type of information and the nature of spatial data, use of spatial information in economic studies has been mostly focused on modeling the environment, climate change, land use, population, etc.

For example, some models use satellite imagery to map changes on the environment due to climate change. Schuschny and Gallopin (2004) use information from population census and agro-ecological information to map the correlation among poverty and environmental systems in Latin America countries. Asadoorian (2005) simulates the geographical distribution of population at a global level until the year 2100. Lee et al., (2005) developed a CGE model called GTAP-AEZ, which contains detailed data on land use by agro-ecological zones based in part on satellite data at a global scale. Other applications of spatial analysis are on the subject of poverty and trade, such as Haddad and Perobelli (2005) who modeled the spatial effects of trade liberalization and their impacts on poverty in Brazil.

However, the majority of these studies are at a global level, without a microeconomic level focus. National or regional policies would benefit by a more narrow approach that takes into account some of the micro level details needed to formulate policies. This is why CGE models that allow a tailored regional approach to formulate these kind of policies are needed.

The extension of national CGE models to the regional level is the first step in the design of these more specific policies. The spatial distribution of impacts of CGE models at sub-national level such as in

Ferreira-Filho and Horridge (2005) may be used in this case. Dixon et al. (2004) describe the USAGE-ITC model, which is a dynamic general equilibrium model for all 50 states of the United States. However, these studies are at a macro and sectoral level, and do not account for impacts at the microeconomic level.

To distribute the national level impacts at the regional level we need to account for several factors. Distributing impacts at the national or sectoral level at the same rate in all regions or all producers ignores regional differences and differences among producers. Thus, we need to account for regional differences and producer characteristics. These include the level of regional market integration given infrastructure such as roads, whether producers sell their production, and if so, whether it is to local or regional markets, the proximity to urban centers, etc.

Kjöllerström (2004) shows that for small producers transaction costs are a barrier for market integration with export markets. Fixed transactions costs affect farmers' decision making process to integrate themselves into product markets and land markets. Therefore, the decision to produce subsistence products is a rational decision that results from high transaction costs that farmers have. High transportation costs are also a significant barrier that may explain the predominance of production of subsistence products by small farmers.

The structure of market channels also influence how prices are transmitted. Some empirical studies show that downstream imperfect competition is a key factor in the asymmetric transmission of changes in commodity prices. Sheldon (2006) shows that incidence of tariff reductions is affected by such downstream imperfect competition. McMillan et al. (2002) argue that higher prices gains of cashew nuts in Mozambique due to export tax removal were captured mostly by export traders rather than cashew farmers. The reason was that downstream buyers had monopsony power in the purchase of cashew nuts from farmers.

For regional price transmission, Nicita (2004) finds that for Mexico international prices are transmitted differentially within regions, depending on the type of product and distance to the border. The price transmission or "pass-through" of international prices to domestic prices at the border was 66 % for manufactured products but only 25 % for agricultural products. At the same time, that price transmission decreases as distance to the border increases. Nicita also finds that urban areas in Mexico are more sensible to changes in prices at the border than rural areas. For rural regions only a small fraction of international prices are felt, especially in the case of agricultural products. Thus, international price changes due to the Doha Round of trade negotiations would be almost zero in rural areas of Mexico, except for areas to the north that are closer to the border to the United States, where farmers might obtain small gains.

Nicita (2005) also explores the impacts of domestic reforms on rural farmers. These domestic reforms would allow rural producers to better respond to changes in world markets without incurring in additional costs, such as increases in productivity or employment of surplus labor. These changes would allow an increase in rural household welfare in Mexico, except in the south. In the south, there are gains from Doha only when reforms come with an improvement of price transmission, such as better transport and market infrastructure.

In this study we propose a methodology that accounts for these features of imperfect price transmission. This methodology would allow to distribute price changes from trade liberalization to farmers, according to their regional location and characteristics, such as the degree of market integration, their access to credit, technology and other features that make farmers more or less exposed to external price shocks. The next section outlines this methodology more in detail.

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II. Spatial Distribution of General Equilibrium Effects

To account for imperfect price transmission from international prices to domestic prices, we propose a methodology that merges a CGE model results with micro economic data. We set up a model of local price variation which accounts for variations in international prices. This module should to take advantage of micro-data information about farmers' characteristics, which allows accounting for their degree of market integration to local and international markets.

This study assumes that geographic location and producer characteristics determine the degree of price transmission, considering that some geographical areas might be more connected to markets than others. We expect that for more integrated areas, price transmission should be higher than more isolated areas. We base this assumption on Nicita (2005), where he finds that as distance increases from the border, there is less international price transmission. We also assume that the level of market integration is determined by whether the farmer sells or not his or her production, and if it sells for final consumption or to other destination (exporters, industries or other). Based on these producer characteristics we propose a model that reflects the level of market integration and price transmission to markets.

Various authors have shown that geographic location and producer characteristics influence the returns that farmers might receive. Leon and Shady (2003), using agricultural census data for Ecuador, find that as distance increases to the closest road, the amount of gross value of production decreases. The value of production for farmers on the road is more than two times the value for those farmers who are more than 5 Km.

from the road (US$485 vs. US$231). This may denote lower productivity or lower prices received by these farmers. Leon and Shady also find that if farmers produce for their own consumption, value of production is less than half compared to those producers who produce to sell (US$434 vs. US$202).

On the other hand, Escobal (2001) shows the importance of roads on market access for poor farmers in rural Peru. Roads in particular lower transaction costs and substantially improve the incomes of the rural poor in Peru. He shows that transaction costs are appreciably higher for producers who are connected to markets via non-motorized tracks. Some key variables that explain decision of when and where to sell include: a) distance to market, b) travel time to market, c) stability of relations with trading agents, d) market research, e) monitoring of contracts and payments. Finally, Escobal shows that transaction costs are much higher for small-scale farmers than for large-scale ones (67 % versus 32 % of the sales value).

Vakis et al. (2003) find that in Peru, as a region becomes less accessible, both buyers and farmers may find it more favorable to buy (sell) at the farm gate as opposed to local markets. That is, for regions with little accessibility, local markets may be serving as markets of last (or only) resort for farmers who are otherwise constrained to sell at the farm gate because they are inaccessible to local merchants.

A. Linking General Equilibrium Effects to Micro Data

The proposed methodology is based in two basic stylized facts. First, we assume that the path through mechanism of trade liberalization to farmers is ruled by price transmission. Second, Jevons's law of one price does not apply here because international prices are differentially transmitted within sub-national regions, depending on their market accessibility.

To transmit price changes from a CGE model into micro-census data, we use a vector of commodity prices weighted by a market integration coefficient. By doing this, we account for how international prices differ in the domestic market. Using this adjusted price vector we estimate changes in value of production for each crop and each agricultural production unit in the census data. It is important to note that in the census there are production units with multi crop production, which may face changes in prices for more than one crop.

We assign agricultural census data on production on certain crops, which are directly mapped to agricultural sectors from the CGE model. We distribute changes in value of production according to the importance of a specific crop in the political administrative unit. This methodology enables to match the economic results data of the CGE model to the spatial data.

Formally, we define the change in gross production value (GPV) of a production unit *u* as:

$$\Delta GPV^u = \sum_{j=1}^{n_u} \Delta GPV_j^u \tag{1}$$

where ΔGPV_j^u represents the change in value of product *j* in unit *u* and n_u is the number of products produced by unit *u*. We can decompose equation (1) into changes changes of prices and quantities:

$$\Delta GPV_j^u = P_{j,t+1}^u \cdot \Delta Q_j^u + Q_{j,t}^u \cdot \Delta P_j^u \tag{2}$$

where the first term denotes changes in quantities and the second term denotes changes in prices for product *j* at production unit *u*.

Equation (2) shows that changes in prices and quantities affect value of production. However, it does not account for dynamic effects on production, neither distinguishes between short run and long run impacts. In this study, we focus on short and medium run impacts. Thus, we assume that quantities are not be affected by the tariff shock ($\Delta Q_j^u = 0$). This is to reflect the fact that farmers cannot substitute products in the short run given transactions costs such as technology, access to credit and other obstacles that constraint them to change products. This assumption also accounts for farmers that produce permanent crops (i.e bananas, coffee, cacao), whose ability to substitute products is even lower.

Thus, given a tariff (price) shock from trade liberalization, only price variations at the production unit level explain possible changes on GPV. That is, price is the only signal that a production unit u receives from local markets in the short run.

Price variations at the production unit level u for each product j, ΔP_j^u, are estimated as the product of the local product price P_j^c, and the change in international prices for product j:

$$\Delta P_j^u = P_j^c \cdot \frac{\Delta\psi_j}{\psi_j} \cdot F_u \tag{3}$$

where $\Delta\psi_j/\psi_j$ is the ex-post shock price adjustment for product j from the CGE model and $F_u \in [0,1]$ is a sensitivity factor that captures imperfect price transmission for production unit u.

F_u is the mechanism that will enable us to link the macro CGE simulations results with the micro level information from the agricultural census, as it depends on the geographic location of producers and producer's characteristics. F_u is indexed at the farm unit level u, as it captures the inherent characteristics of each producer. This would enable us to analyze how tariff changes can affect each production unit u.

The variables used to construct F_u and identify the producer characteristics and their level of market integration are: a) distance of the agricultural production unit to the closest road, b) whether the producer sells their production or not, and c) for those producer that sell all or part of their production, to whom they sell it (consumers, middle-man, agribusiness companies or exporters). We define the sensitivity factor F_u based on a chain of condition-action rules as follows:

1) If the production unit u does not sell its production, $F_u = 0$. That is, the unit is not affected on its production by changes in prices from a trade policy shock.
2) If the production unit u sells its production, the value of F_u depends on to whom they sell their products:
   (2.a) If the unit sells its products to final consumers, we assume heuristically that $F_u \in [0, 0.5]$.
   (2.b) If the unit sells its products to intermediaries, exporters, and agrifood manufacturers, we assume heuristically that the value range of $F_u \in [0.5, 1]$.

That is,

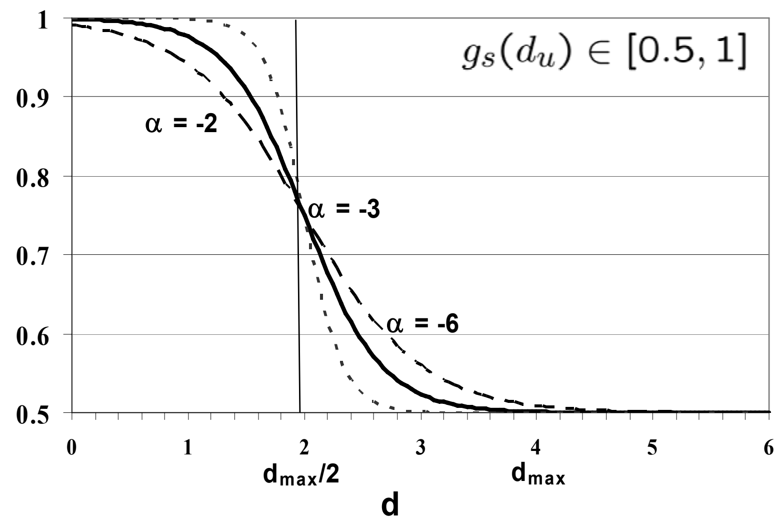
$$F_u = \begin{cases} 0, \text{ if } u \text{ doesn't sell its production} \\ g_s(d_u) \in [0, 0.5], \text{ if } u \text{ sells to final consumers} \\ g_s(d_u) \in [0.5, 1], \text{ if } u \text{ sells to exporters, manufacturers, etc.} \end{cases} \tag{4}$$

In both cases we assume a logistic curve to model F_u as a function of distance of production unit u to the closest road that allows farmers marketplace access, d_u:

$$g_s(d_u) = a + \frac{b-a}{1 + e^{-\alpha\left(d_u - \frac{d_{max}}{2}\right)}} \in [a, b] \tag{5}$$

where $F_u \in [a,b]$, d_{max} is the maximum distant value that makes the sensitivity factor negligible, and α is a sensitivity rate that affects the curvature of the function (see figure 1). For practical purposes a value of $\alpha = -3$ was heuristically chosen for this analysis.

FIGURE 1
SENSITIVITY FACTOR BEHAVIOR AS A FUNCTION OF THE DISTANCE TO THE CLOSEST ROAD



Source: Authors' estimations.

Equation (5) allows to model that as distance to road increases, time to point of sale increases, and if the point of sale is the production unit, price transmission decreases its influence. As the degree of market integration increases, denoted by farmers selling their production, the higher the level of price transmission. Thus, the impact of trade liberalization depends on how changes in border prices are translated into changes in prices paid to farmers. Price transmission depends on the competitive structure of the distribution channels, and the extent products are traded. These factors would likely affect the impacts on different types of farmers (subsistence, traditional and modern enterprises), as later shown in the results section.

Finally, this methodology to map price changes impacts can be used with both partial equilibrium and CGE models. However, when aggregation of the agricultural sector is needed as a whole, it seems that CGE models are a better suited for this purpose.

III. Economic and Spatial Data

To map the effects of trade liberalization on agriculture, we combine three different data sources: the results of a CGE model that we link with micro-census data using GIS software and data. This section describes these three data sources.

A. General Equilibrium Model

The framework used to analyze trade liberalization on the agricultural sector of Ecuador is a computable general equilibrium model. We use a CGE model with special features for the analysis of agricultural issues, called GTAP-AGR. The Global Trade Analysis Project (GTAP) model of global trade (Hertel, 1997), is a standard, multi-region, multi-sector model which includes explicitly treatment of international trade and transport margins, global savings and investment, and price and income responsiveness across countries. It assumes perfect competition, constant returns to scale, and an Armington specification for bilateral trade flows that differentiates trade by origin.

However, critiques argue that the standard GTAP model does not capture some of the important characteristics of the agricultural economy. To include these special features of agriculture there is a modified version of the GTAP model and database called GTAP-AGR (Keeney and Hertel, 2005). The GTAP-AGR model captures certain structural features of world agricultural markets that are not well reflected in the standard GTAP model. GTAP-AGR provides a more realistic representation of the farm and food system. It explicitly identifies farm households as entities that earn income from both farm and non farm activities, pay taxes, and consume both food and non food products. The model tries to characterize the degree of factor market segmentation between agriculture and other sectors of the economy, as well as to improve the representation of input substitution possibilities in farm production.

In this study we use results from Ludeña and Wong (2006) who analyze the impacts of trade liberalization on Ecuador's agricultural sector. Specifically, we use price change information for different agricultural sectors (see Table 1) in the GTAP-AGR database and link it to micro data, as we explain in the section section.

B. Micro Data: Agricultural Census and Prices

The microeconomic data used is the 2000 Agricultural Census data for Ecuador, which is a representative sample of 150,000 farms. We present the results at the municipal (canton) level, the third geographical political disaggregation level. This is the highest political division level of dissagregation at which we can get meaningful averages based on the sample design and size of the census. The census includes information about land size, production, use of inputs (land, machinery, labor, seed, etc.), access to credit, markets and technology, and other variables.

To link these price changes from the CGE model to micro-data from the agricultural census, we first map sectors in the GTAP-AGR database (see Table 2) to crops in the agricultural census. However, the agricultural census does not contain information on commodity prices. For this reason, we supplemented such information with data from the National Institute of Statistics and Census (INEC in Spanish). INEC possesses information on 43 agricultural products, 17 permanent crops and 26 non-perennial crops. A list of products and their correspondence to general equilibrium sectors is in Tables 3 and 4. Finally, we estimated the gross value of production (GVP) using census production data and the price information from INEC.

We supplement this analysis by classifying producers following the same typology used by Morales et al. (2005). These authors defined three types of Agricultural Production Units (APU or UPA in Spanish): (i) subsistence farming, (ii) traditional enterprises, and (iii) modern enterprises. This classification is based on producer's characteristics, as follows:

(i) Subsistence farmers are those who had the following characteristics: a) They lived in the UPA, b) They did not hire labor, and c) They did not have machinery (tractors).

(ii) Traditional enterprises are defined according to the following attributes: a) They hired labor, b) they had machinery and c) They did not hire specialized technical assistance (agronomists, veterinaries, etc).

(iii) Finally, modern enterprises are those that additionally to those previous characteristics, they a) hired specialized technical assistance (agronomists, veterinaries, etc), b) if it was an individual producer, they had finished basic and medium education and have some degree of higher education, and c) they have access to credit.

Tables 5 through 9 offer some insights about these type of producers and their features.

C. GIS Data and Software

The geographically referenced data (third disaggregating level of political division shapefiles) was provided by the Latin American and Caribbean Demographic Centre (CELADE) at the Economic Commission for Latin America and the Caribbean (ECLAC). In our specific case, we map the agricultural census data from Ecuador into existing polygons that represent each one of the 218 cantons in Ecuador. Geo-referenced data were stored, managed, analyzed, and displayed by means of the ArcView commercial software.

IV. Spatial Representation of the Agricultural Sector in Ecuador

This section is divided in two main subsections. First, the spatial distribution of agricultural production in Ecuador based on census data. Second, the spatial distribution of impacts from trade liberalization on the agricultural sector of Ecuador by region and type of producer. Both sections are interconnected, as the second builds on the primary data from the first section in combination with crop price information and data from a CGE model. We focus our analysis on five crops: rice, soft and hard corn, soybeans and plant based fibers.

A. Agricultural Production in Ecuador: Crop Maps

This section shows the geographic distribution of crops production by type of producer based on geographic and climate suitability for crop production of some of the most important crops in Ecuador. In this paper, the focus is on crops identified by the government of Ecuador as sensible in a possible free trade agreement with the United States. These crops include rice, soft corn, hard corn, soybeans (oilseeds) and plant based fibers (cotton and abaca). Other authors (Larson and Leon, 2006; The World Bank, 2004) also offer crop mapping for Ecuador, but focused on other crops (rice, potatoes, bananas, coffee, and cocoa).

Prior to discussing the spatial crop distribution in Ecuador, we first describe the main agro-ecological zones of Ecuador. This would allow a better understanding of the geographic distribution of crops, as agroecological zones determine the best suitable crop growing conditions.

Ecuador has three main agro-ecological zones: Coastal, Sierra, and Oriental region (FAO, 2006). The Coastal region is formed by hills and plains suited for tropical agriculture. The highest elevations in this region are 800 meters above sea level, with median temperature of 24 ºC. Rainfall diminishes as we move from north to south, where the climate is more semi-arid. The Guayas river basin crosses the Coastal region from north to south and irrigates most cropland area in the central area of this region. This region includes, from north to south, the provinces of Esmeraldas, Santo Domingo de los Tsachilas, Manabi, Los Rios, Guayas, and El Oro.

The Sierra region constitutes a mountainous region crossed from north to south by the Andes mountain range, with elevations of more than 5500 meters above sea level with permanent snow. Suitability for agricultural production depends on elevation. At the highest levels (more than 3200 m), the predominant species are tubers and some cereals, with uncertain harvest due to weather conditions. At medium elevations (2200-3200 m), the weather is template and allows cereal, pulses, fruits, vegetables and livestock production. At lower levels (less than 2200 m) there are export crops, cereals, vegetables, pulses and fruit production (FAO, 2006).. This region includes, from north to south, the provinces of Carchi, Imbabura, Pichincha, Cotopaxi, Tungurahua, Bolivar, Chimborazo, Cañar, Azuay and Loja

The Oriental region constitutes almost half of Ecuador and is a large drained plain by rivers that later merge with the Amazon river, with elevations below 600 m. The areas closest to the Andes have medium temperature of 28 ºC and areas to the east are less humid and rainy, with higher temperatures. Agricultural production systems of slash and burn are prominent, with forestry, extensive livestock production and tropical and subsistence crops as the main agricultural activities. This region includes, from north to south, the provinces of Sucumbios, Napo, Orellana, Pastaza, Morona Santiago and Zamora Chinchipe.

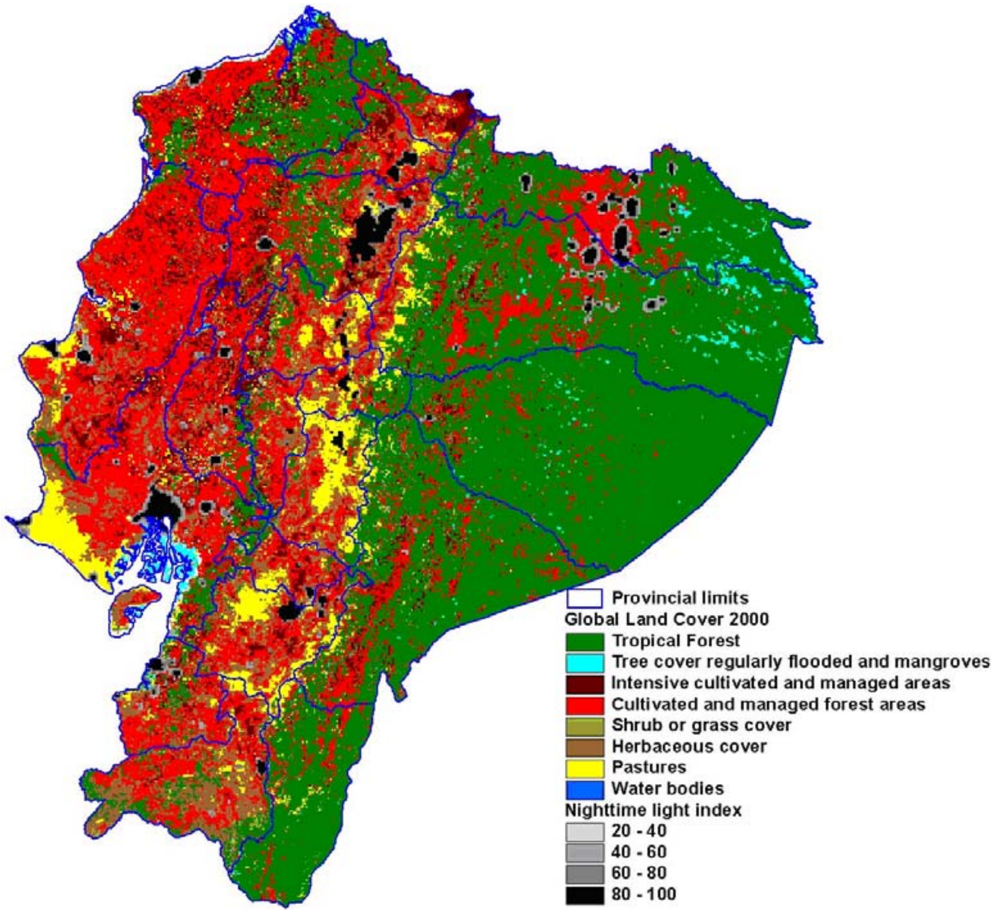
To better illustrate the geographic distribution of ecosystems, figure 2 shows land use by region. The red areas denote cropland and managed forest, mainly distributed around the Guayas river basin and in the Sierra region. Green denotes areas under tropical forest, mainly concentrated in the Oriental region, and north of the Coastal region in the province of Esmeraldas. Large portions of land under pastures (yellow) are concentrated in the Sierra region, where livestock and dairy production is located.

In general terms, the crops discussed here, rice, corn, soybeans and cotton are mainly concentrated in the Coastal region, expect for soft corn production which is located in the Sierra region. That means that impacts and therefore subsidies, would be focused on producers around the Guayas river basin, where most of hard corn, rice and soybeans production is. As we see in the next section, impacts due to the FTA between Ecuador and the United States follow the geographic distribution of crop location, and are differentiated by type of producer

Figures 3 through 12 show the spatial distribution of selected crops in area and number of UPAs. As discussed before, we focus on five crops: rice, soft corn, hard corn, soybeans nad plant based fibers (cotton, abaca). We begin our discussion of the geographic distribution of rice. Rice production in Ecuador occupies the largest area of production than any other cereal grain crop in Ecuador, and within the Andean countries, Ecuador has the largest area of rice under production. Rice production has risen in the last 15 years in Ecuador mainly due to the elimination of price controls and a strong export market in the Andean region (Colombia and Peru).

Almost all area planted (98 %) is concentrated near the Guayas river basin, in the provinces of Guayas (56 %), Los Rios (37 %), and Manabi (5 %) (see figure 3). Most of the area and number of UPAs (50-75 %) in these provinces are traditional enterprises (see figure 4). The rest is planted in other provinces of the coastal region, and also in the Oriental region, where it is principally a subsistence crop (FAO, 2006).

FIGURE 2
VEGETATION COVER AND CROPLAND AREAS IN ECUADOR



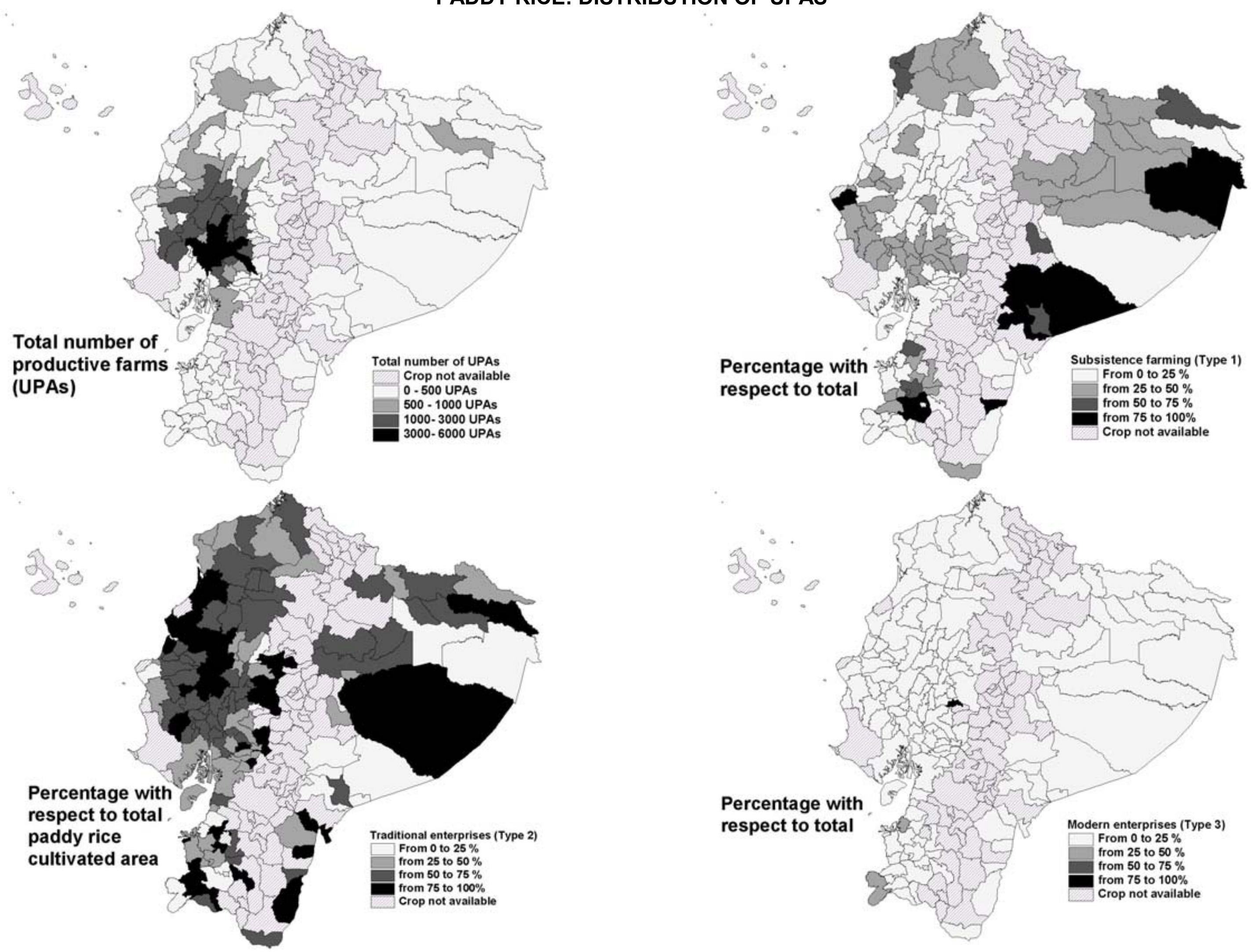
Source: Global Land Cover (http://www-gvm.jrc.it/glc2000/defaultGLC2000.htm).

For corn production, there are four types of corn. Two are hard corn, both in grain and on the cob (see figures 5 and 6), and two are soft corn, also as grain and on the cob. For practical purposes we group these types of corn into hard corn and soft corn (see figures 7 and 8). According to the Ministry of Agriculture (MAG) of Ecuador (2002), corn production accrued for 4 % of agricultural GDP, and the whole value chain (including animal feed and poultry production) 2 % of total GDP. As for labor, corn production uses 8 % of the economic active population (EAP) in agriculture, and if we include the whole chain it represents 3 % of total EAP.

For hard corn production, two thirds is used as animal feed (poultry), 25 % is exported to Colombia and 4 % is used for human consumption and seed (CORPEI, 2007). Due to geographic and climatic differences between production areas in Ecuador and Colombia, Ecuador's hard corn production is complementary to that of Colombia. This is why that a FTA between Colombia and the United States may undermine Ecuador's relative price and geographic advantage in the Colombian market.

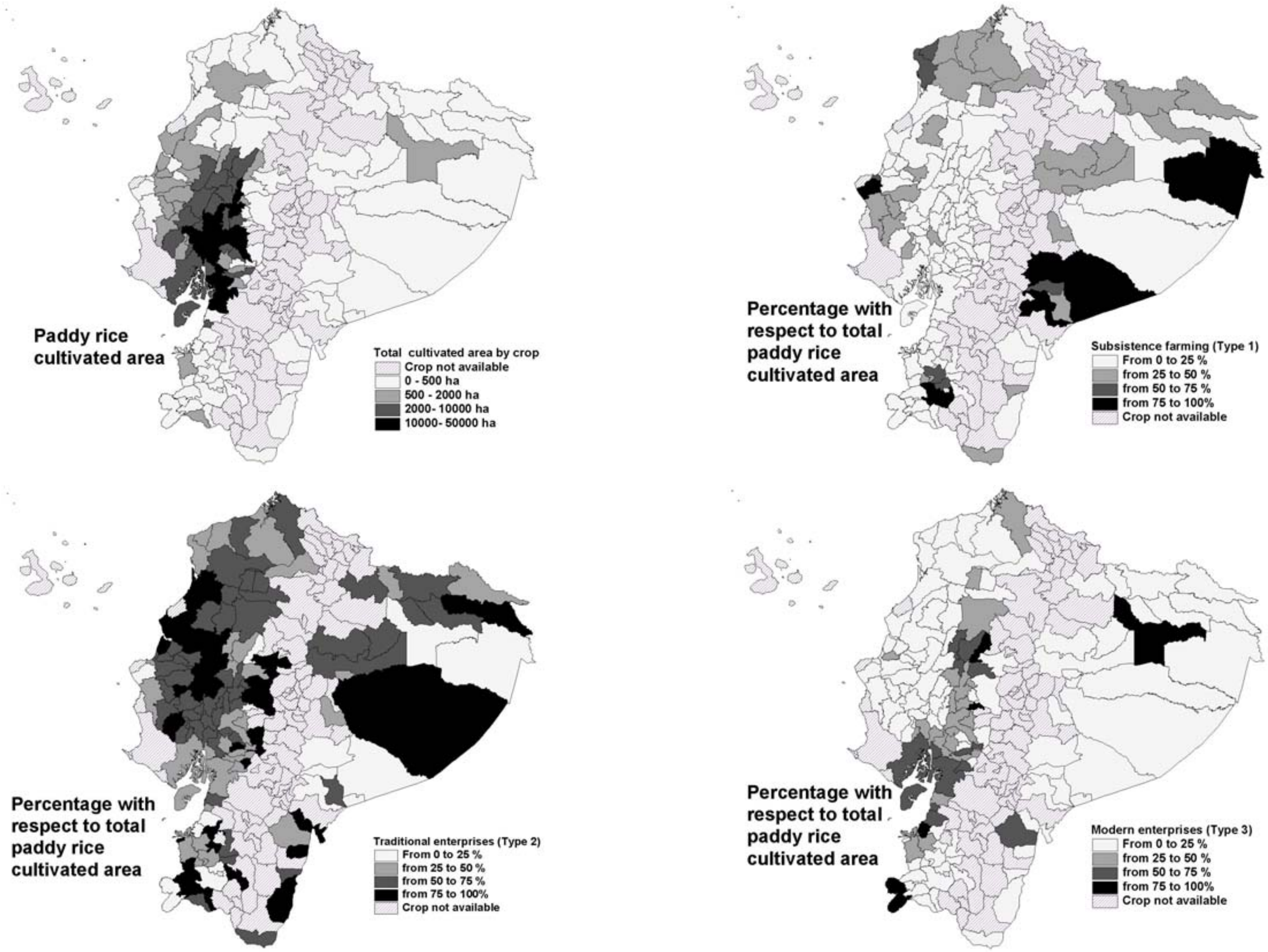
For hard corn both producers and production areas are concentrated in the Coastal region (76 %), in the provinces of Los Rios (31 %), Guayas (21 %) and Manabi (21 %). This region accrues for 88 % of all production, with one province, Los Rios, with almost half of all production (48 %). However, in terms of the number of UPAs, Manabi is the largest. The rest of producers and area are in the south Sierra of Ecuador, in the province of Loja.

FIGURE 3
PADDY RICE: DISTRIBUTION OF UPAS



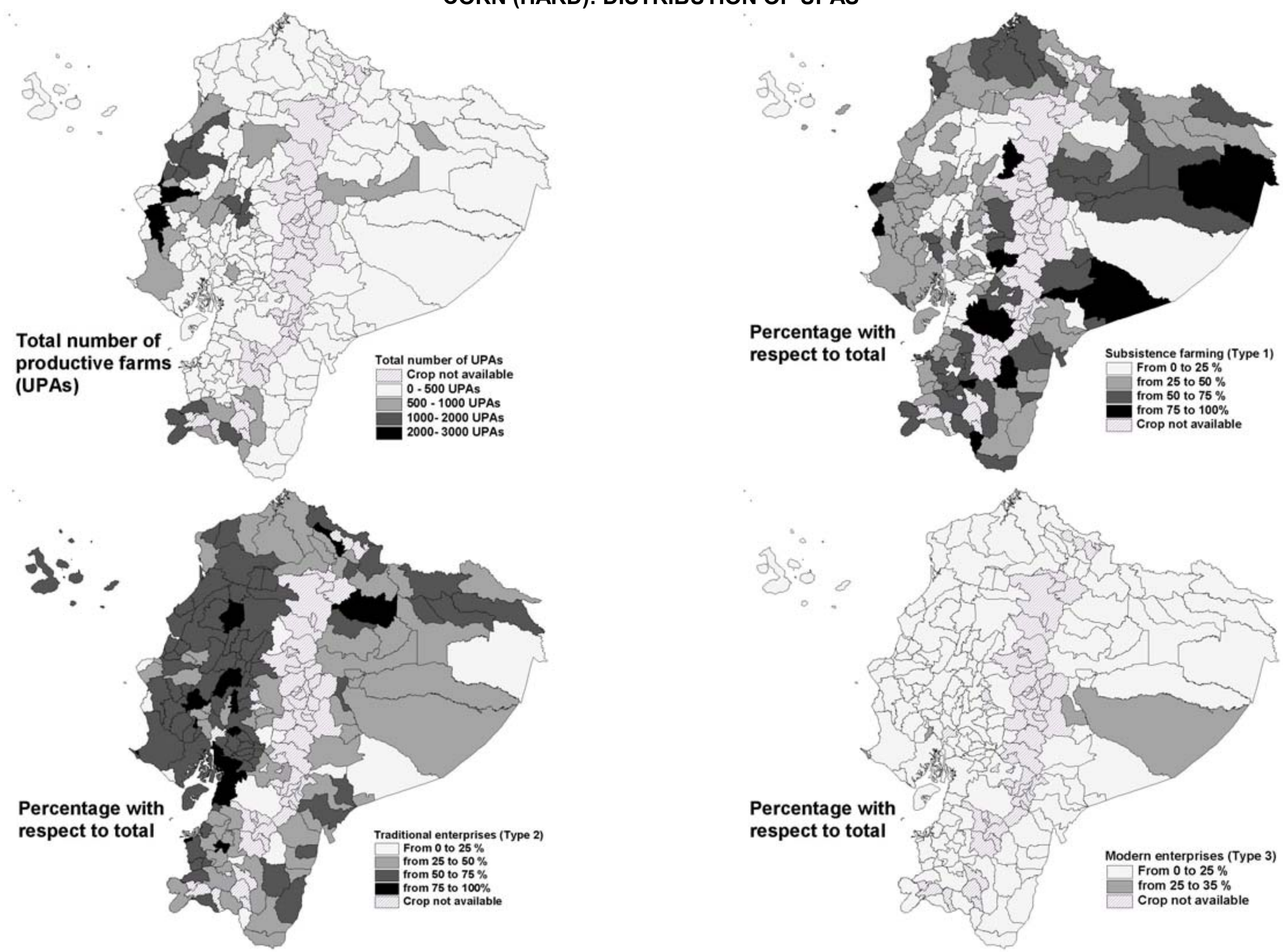
Source: Authors' estimations.

FIGURE 4
PADDY RICE: DISTRIBUTION OF TOTAL CULTIVATED AREA



Source: Authors' estimations.

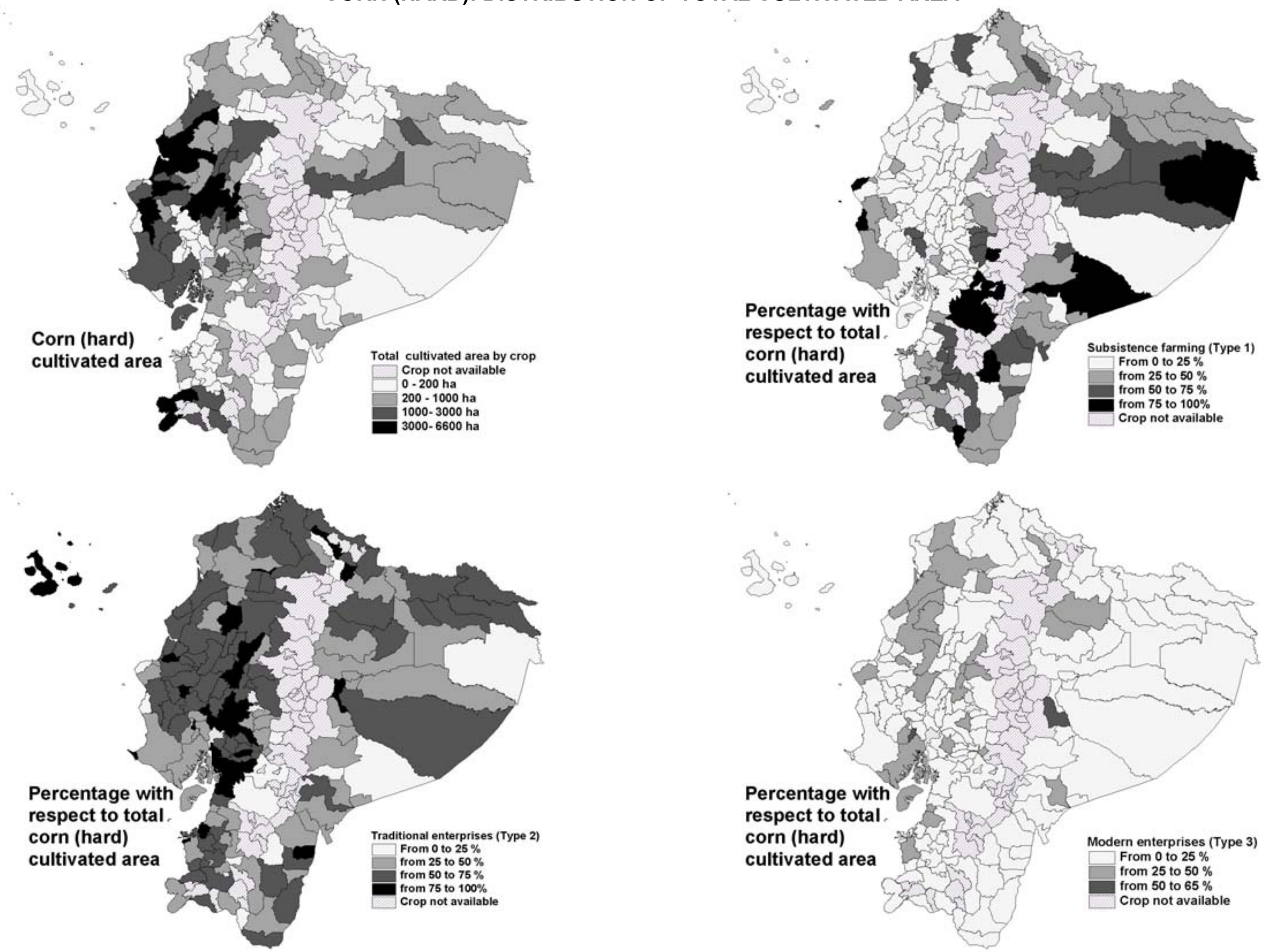
FIGURE 5
CORN (HARD): DISTRIBUTION OF UPAS



Source: Authors' estimations.

FIGURE 6

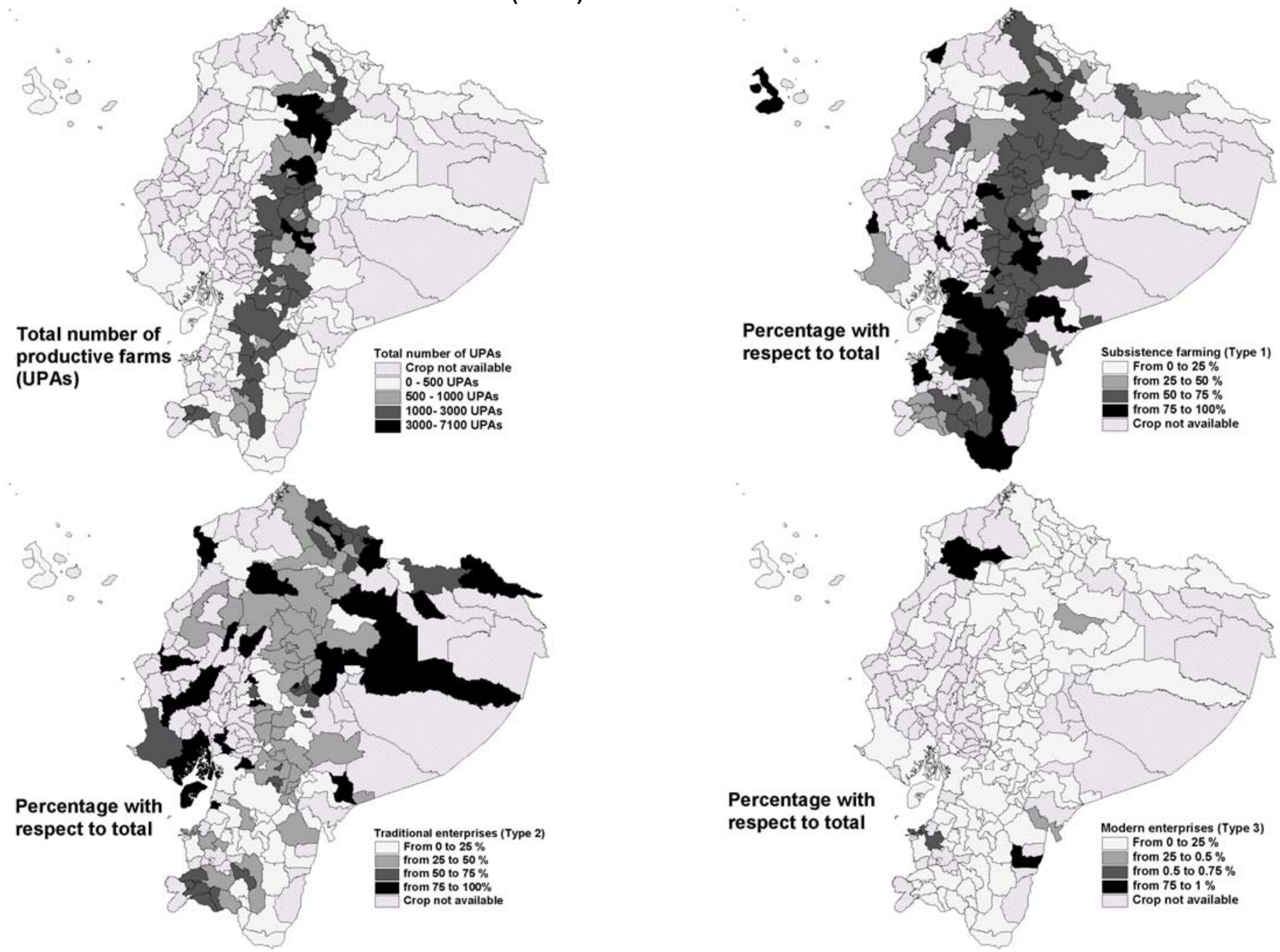
CORN (HARD): DISTRIBUTION OF TOTAL CULTIVATED AREA



Source: Authors' estimations.

FIGURE 7

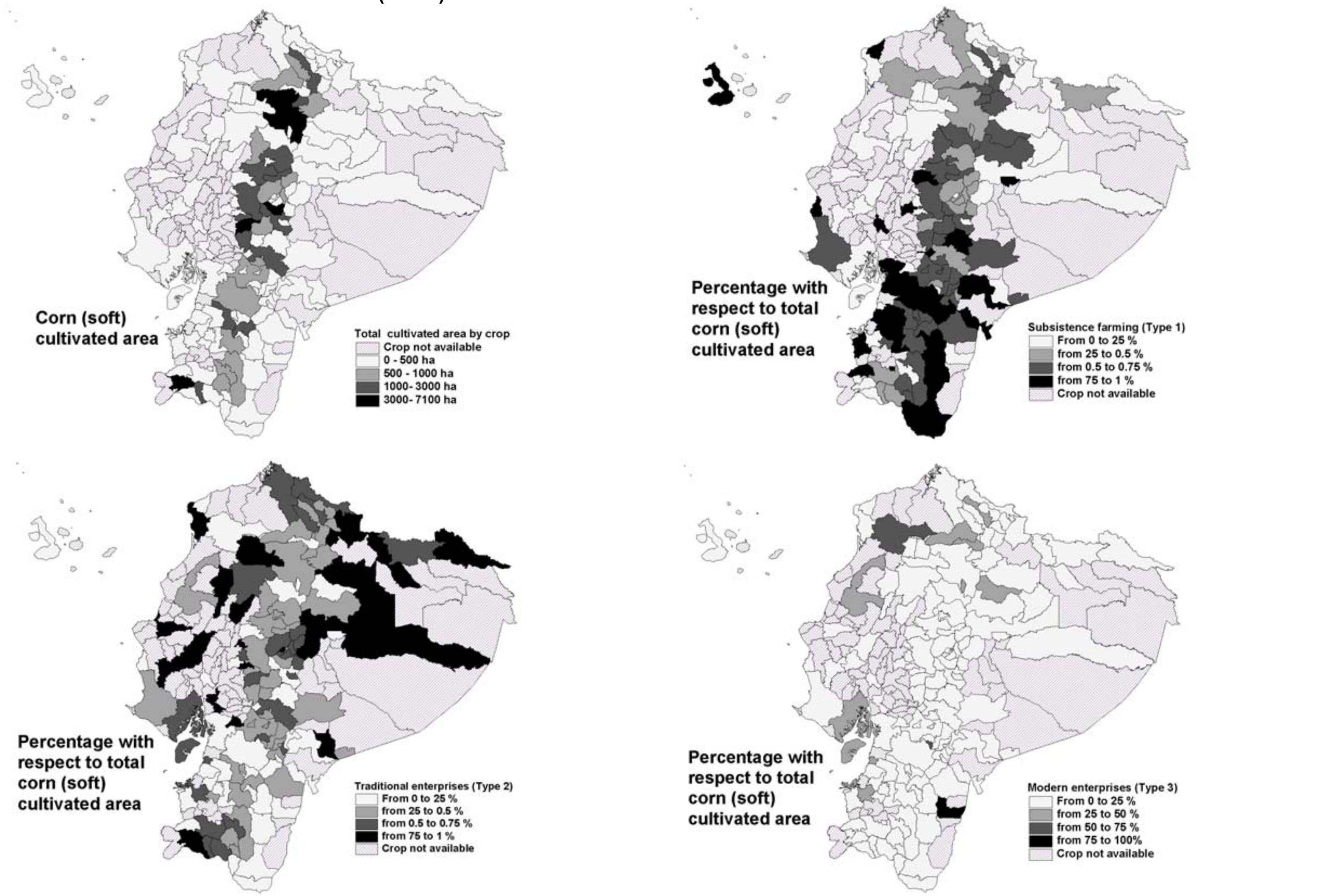
CORN (SOFT): DISTRIBUTION OF UPAS



Source: Authors' estimations.

FIGURE 8

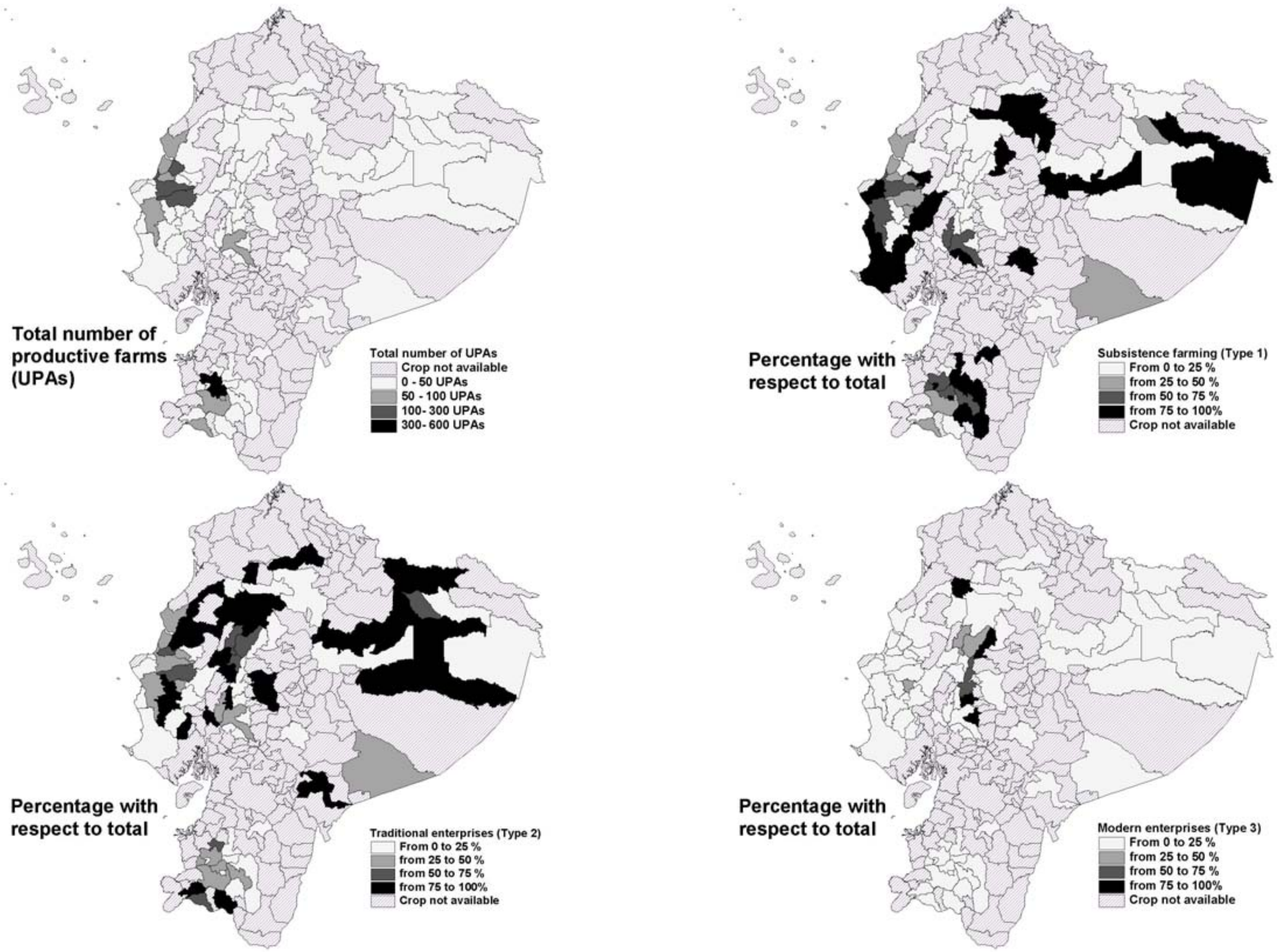
CORN (SOFT): DISTRIBUTION OF TOTAL CULTIVATED AREA



Source: Authors' estimations.

FIGURE 9

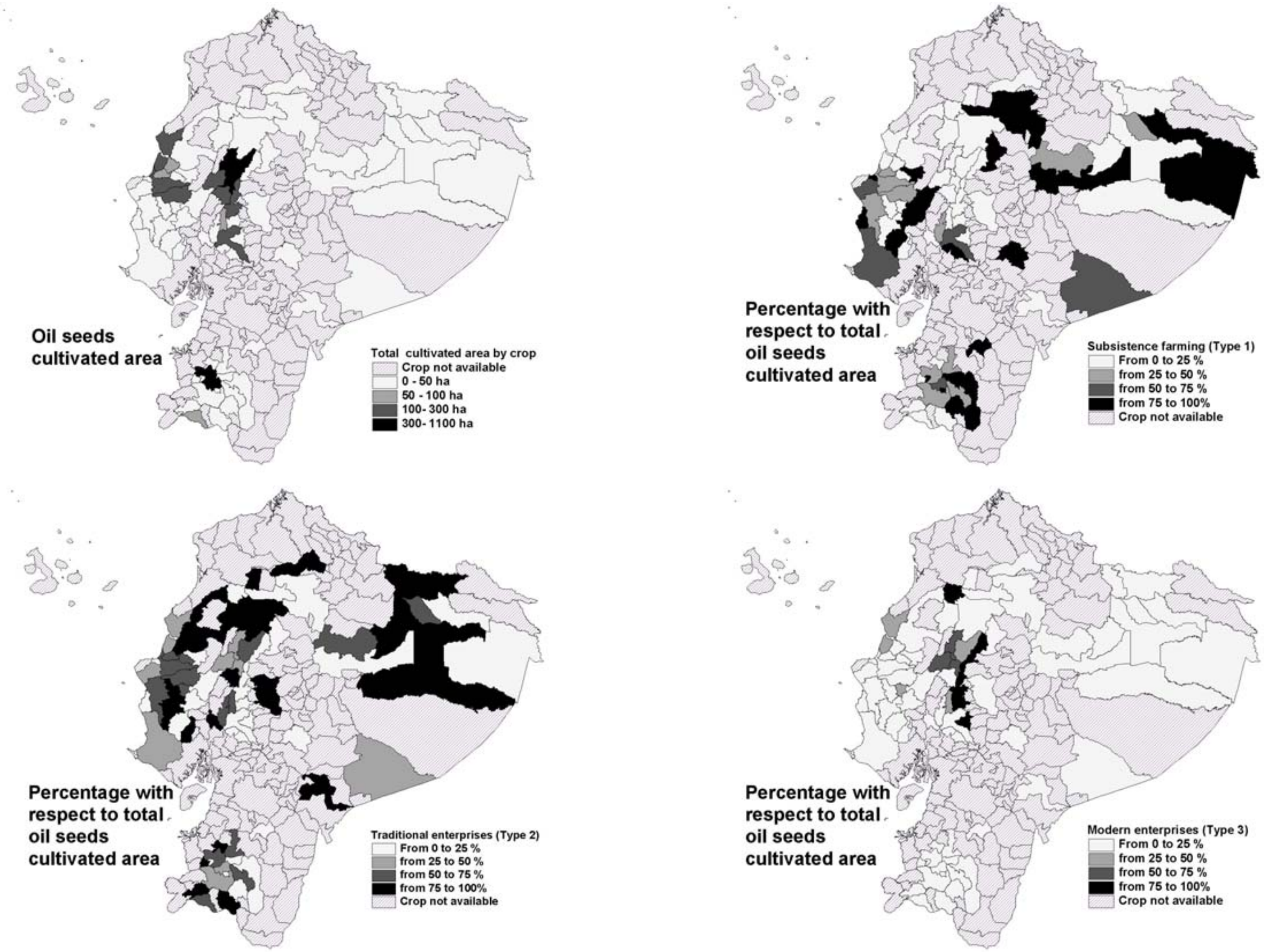
OIL SEEDS: DISTRIBUTION OF UPAS



Source: Authors' estimations.

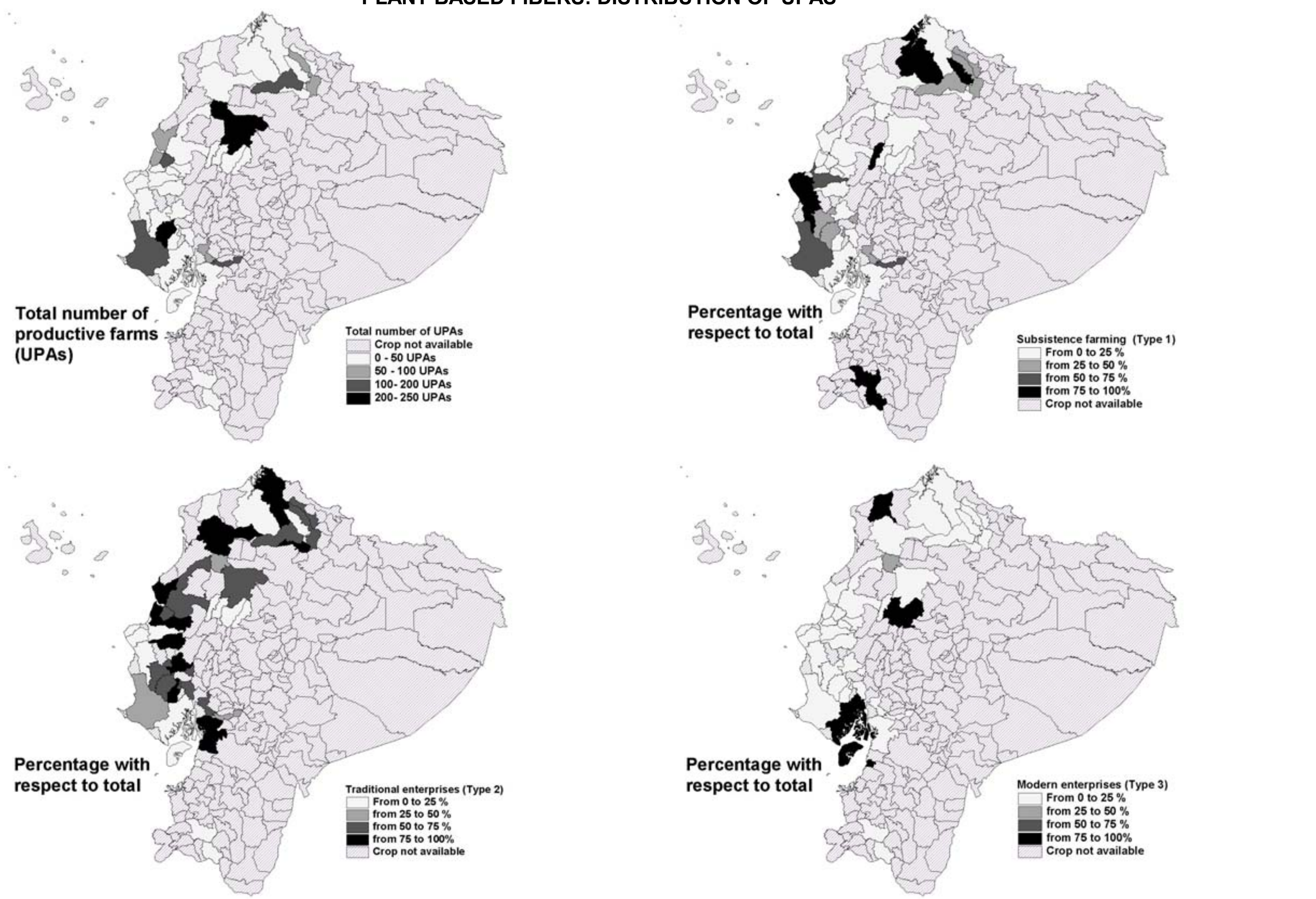
FIGURE 10

OIL SEEDS: DISTRIBUTION OF TOTAL CULTIVATED AREA



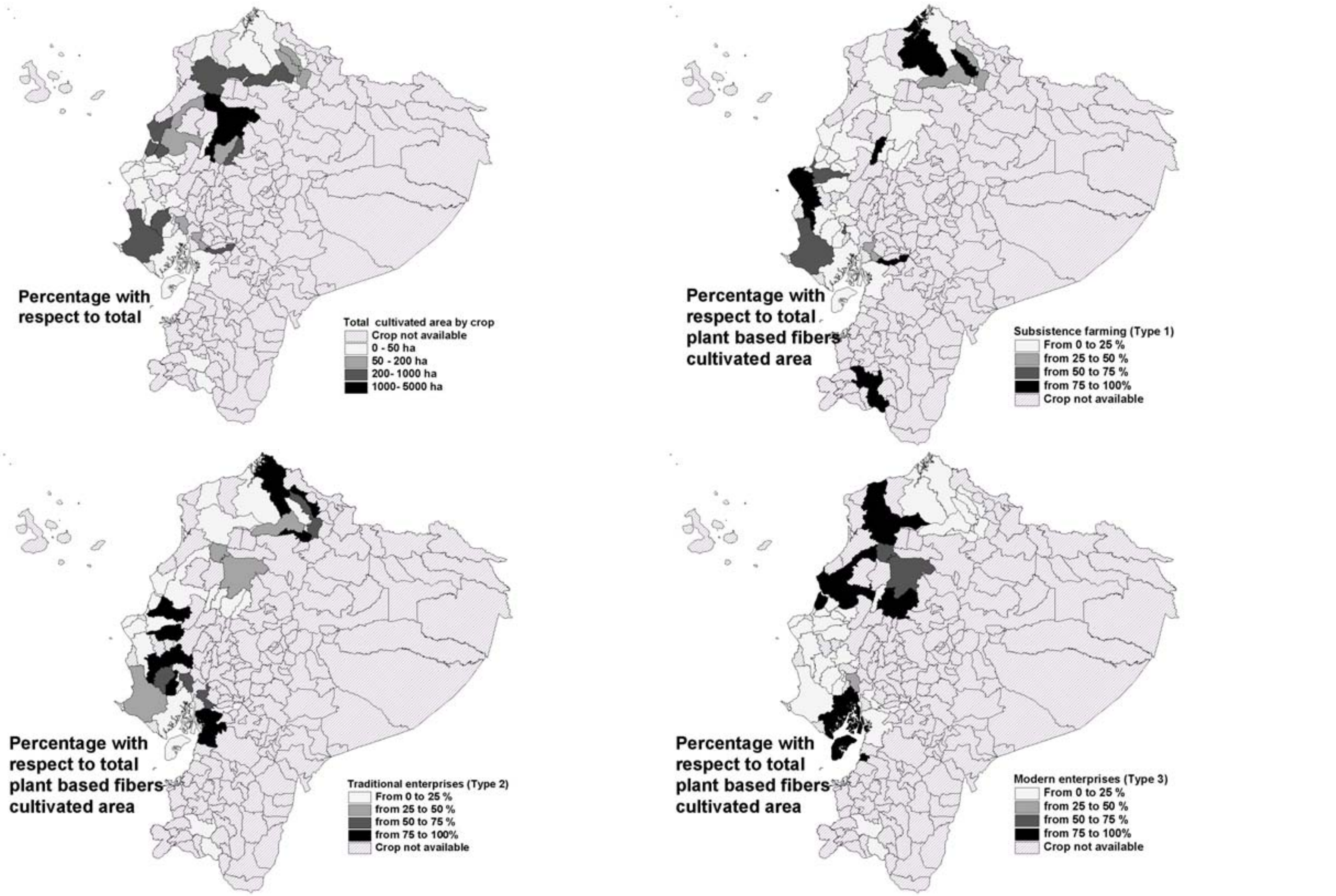
Source: Authors' estimations.

FIGURE 11
PLANT BASED FIBERS: DISTRIBUTION OF UPAS



Source: Authors' estimations.

FIGURE 12
PLANT BASED FIBERS: DISTRIBUTION OF TOTAL CULTIVATED AREA



Source: Authors' estimations.

As for the type of producers, we find that most UPAs in the Sierra and Oriental region are subsistence farmers, while those in the Coastal region most are traditional enterprises. In Manabi, Guayas and Los Rios, the cantons with the highest concentration of UPAs, most of them are traditional enterprises (50-75 %). However, in Loja 50-75 % of all producers are subsistence farmers.

Soft corn production and UPAs are mainly in the Sierra region, with the largest concentrations in the provinces of Pichincha, Cotopaxi and Chimborazo (see figure 7). For those UPAs, the majority (50-75 %) are subsistence farmers. In Azuay and some cantons of Chimborazo, this percentage increases to 75-100 %. As for the distribution of area (see figure 8), Pichincha, Chimborazo, Cotopaxi and Bolivar are the main production areas. Of those, the majority, especially in Central and South Sierra are held by subsistence UPAs. This production structure of soft corn, with the majority of producers both in terms of number of UPAs and area as subsistence farmers would likely affect the type of policies relative to those for hard corn producers, which are mainly traditional enterprises.

As for oilseeds (soybeans, sunflower, peanut, raps, and canola), we will focus our discussion on soybeans, which is the main oilseed crop in Ecuador. Soybean production is inherently linked to feed production, as soybean cake represents 15-20 % of feed composition. According to MAG (2003), in the early 1990's, soybean production represented 2 % of agricultural GDP, using 3.7 % of the economically active population in agriculture. After those years, there was a decline of soybean production, mainly due to pests and weather events (El Niño and La Niña).

The areas of oilseed production are concentrated in Manabi and in areas between Loja and El Oro (see figure 9). Of these UPAs, they are evenly distributed between subsistence farmers and traditional enterprises (see figure 10). The geographic distribution of production areas is somewhat different from the distribution of UPAs. Aside from Manabi, El Oro and Loja, there are production areas at the north of Los Rios. Traditional enterprises make up the majority of area in the provinces of Manabi, El Oro and Loja. In Los Rios, there is an important share of modern enterprises, in some cantons up to 50-75 % of area under production.

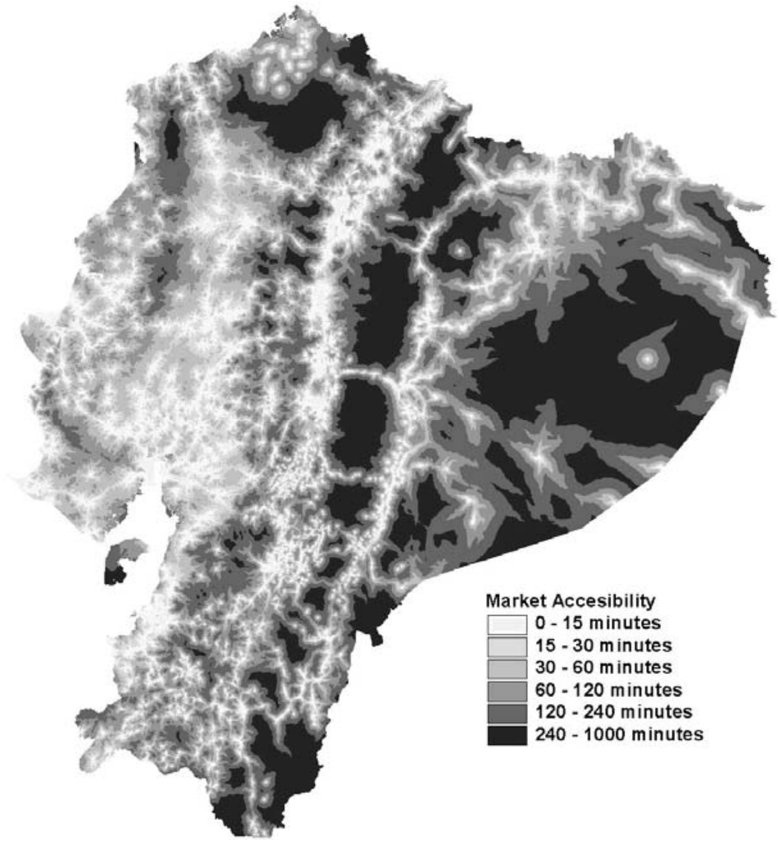
Plant based fibers is composed by cotton, abaca, paja toquilla, and cabuya. Plant based fibers production is scattered in several provinces of the coastal region, mainly in Manabi, Guayas, Esmeraldas and Santo Domingo de los Tsachilas. In terms of the number of UPAs, they are scattered throughout the Coastal region, with no identifiable pattern in the geographic distribution of producers (see figure 11). For cotton, which is the main product within this group, production is concentrated in two provinces, Manabi (52 %) and Guayas (47 %). However, of the total number of UPAs, almost two thirds are in Guayas and one third in Manabi.

B. Spatial Distribution of Trade Liberalization Impacts on Agriculture

After discussing the geographic distribution of agricultural production areas in Ecuador for sensitivity products (rice, corn, soybeans, plant based fibers), this section shows the spatial distribution of impacts of trade liberalization on farmers of these products. This by no means is a complete picture of the total effects in the value of production, since we do not account for the change in production (quantities) that may happen.

Before discussing the results, we present a map of market access to helps us better understand some of the results of impacts, which are determined by farmers' market accessibility (see figure 13). This map denotes in minutes the distance to the closest local market, and account for access to roads, slope, and other factors. The brighter the color, the less time to market, and the darker the color, the longer the time it takes to reach a market. The map shows that most of the Coastal region is well connected to markets, except for the north east region, in the province of Esmeraldas. The Guayas river basin is well connected to markets, specially when is closer to the port of Guayaquil, Ecuador's largest city and main export hub. In the Sierra region, the Pan-American Highway crosses this region at the middle from north to south. Much of the Oriental region has little access, except for that highway that runs from north to south and roads that connect the north part of this region where much of the oilfields are located.

FIGURE 13
ACCESSIBILITY TO LOCAL MARKETS IN ECUADOR



Source: CIAT (2004), available from http://www.ecuamapalimentaria.info.

Figures 14 to 19 show the spatial representation and distribution of results from the general equilibrium model. All figures show changes in gross value of production (GVP), which are all negative mainly because the change in the price vector from the CGE model (Table 1) was negative. As discussed in the methodology, we applied the changes in prices, assuming that in the short run, there would not be any change in quantities as a response on trade liberalization. The results shown in these figures would change if we assume a long term scenario with changes in prices and quantities.

Overall, the largest losses in absolute terms are concentrated in the Coastal region, in the provinces of Los Rios and Guayas (see figure 14). This reflects the agricultural nature of the Guayas river basin, and the high concentration of production of sensitive products (rice, hard corn, soybeans) in those provinces. The cantons more affected are: Babahoyo, El Guabo, Naranjal, Valencia, Ventanas, Machala, Baba, La Troncal, Puebloviejo, Pasaje and Buena Fe.

The most interesting result is that of those mostly affected in those areas and cantons, the majority of producers are modern enterprises. This reflects the nature of the production systems in those areas, and the market linkage that these modern enterprises have relative to subsistence farmers and traditional enterprises. Given that modern enterprises are more linked to exports markets (especially rice producers), any shock in international prices will be transmitted almost entirely to these producers. That is not the case for subsistence farmers, that although may have access to roads, selling to intermediaries reduces the price transmission shocks from international markets. Traditional enterprises make up most of those affected in the provinces of Manabi, Esmeraldas, Loja, central Sierra provinces and the northern provinces of the Oriental region. Subsistence farmers make up most of those losing in the southern Sierra (especially Azuay) and in the Oriental region.

As we look the change in GVP by crop, we observe that rice loses are mainly concentrated in Los Rios and Guayas (see figure 15). The cantons more affected are Babahoyo, Daule, Sanborondon, Santa Lucia, Urbina Jado, Yaguachi and Naranjal. Most of the producers in those cantons with high losses are mainly modern enterprises and traditional enterprises, which as discussed before, are more connected with export markets. These results reflect the concern of the Ecuadorian government of losing the exports markets of Colombia and Peru to imports from the United States. The most affected producers may well be those modern enterprises.

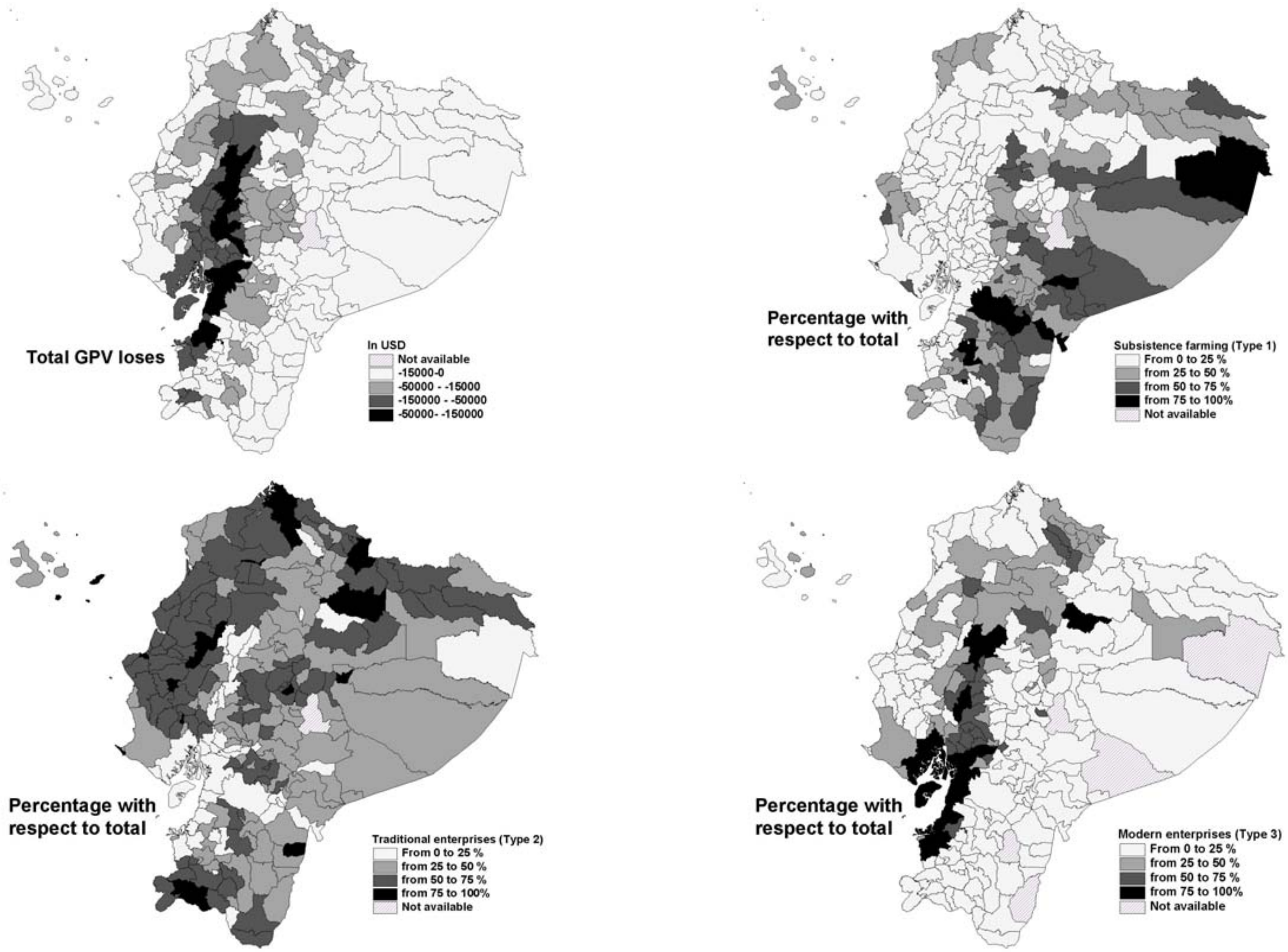
For hard corn (see figure 16), in those areas with the highest losses (Los Rios, Manabi and Guayas), most of the affected are traditional enterprises, and in some cantons, modern enterprises. For soft corn (see figure 17), highest losses in absolute terms are concentrated in Pichincha, Azuay, Loja and some cantons of the central Sierra. Subsistence farmers make up 75-100 % of those losing in Azuay, and 50-75 % of those in some cantons of Loja and the central Sierra. Loosing producers by type are evenly distributed in those cantons in the province of Pichincha.

For oilseeds (see figure 18), highest losses are concentrated in a few cantons in the provinces of Los Rios, which is the main production area of soybean production. The cantons more affected are: Babahoyo, Valencia, Montalvo, Ventanas, Quevedo and Buena Fe. As in rice, the majority of producers affected are traditional and modern enterprises, which reflects the production structure of oilseeds in Ecuador. It is worth noticing that cantons in the province of Los Rios disproportionally loose to those in Manabi, the other main producer province. This result proves the usefulness of the methodology developed for this paper, which identifies loosing farmers by their market integration.

As for plant based fibers (see figure 19), losses are mainly concentrated in the northern area of the coastal region, between the provinces of Esmeraldas and Pichincha. Most loosing producers are mainly modern enterprises, and with a smaller share of traditional enterprises.

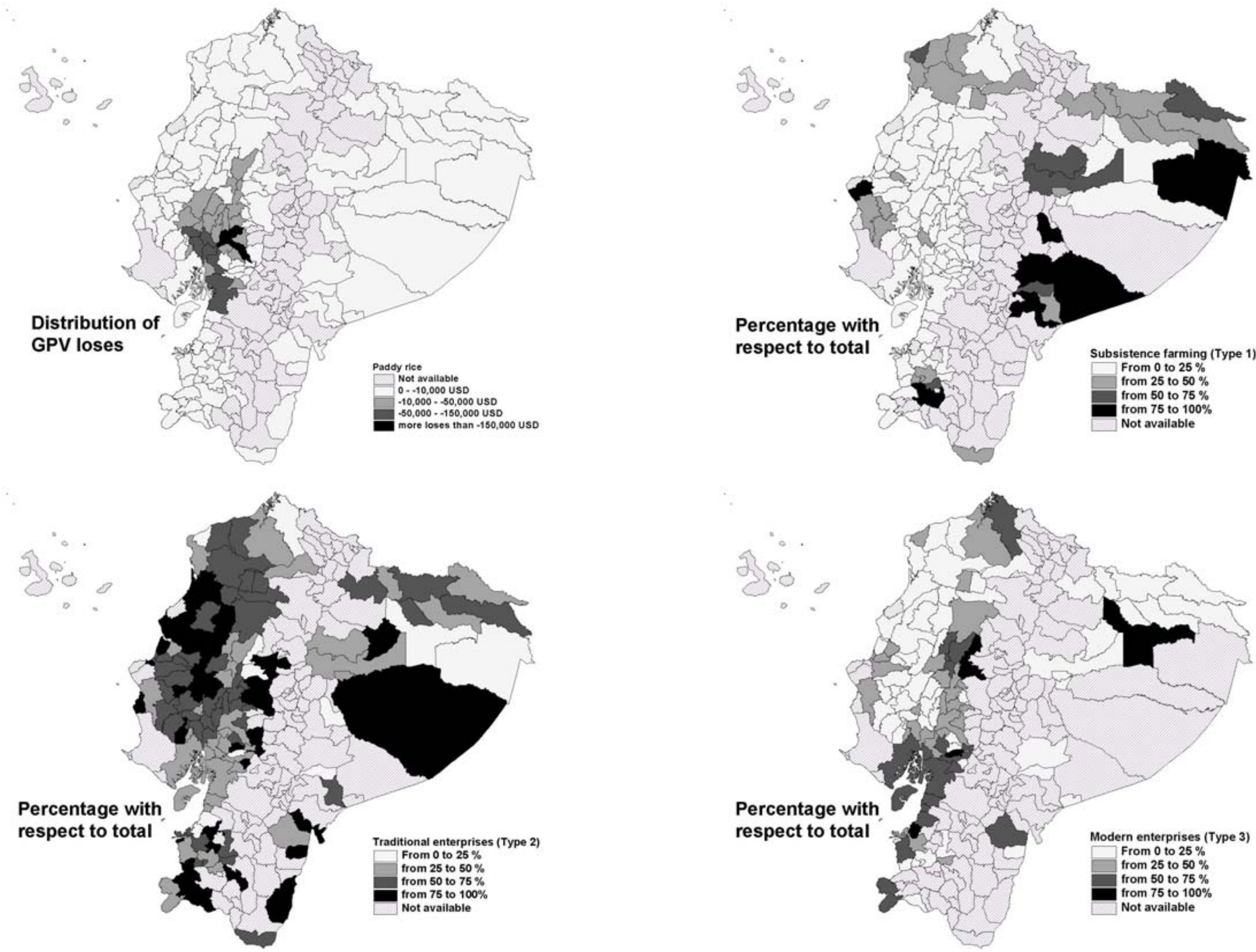
Finally, government's compensation policies should follow the same spatial pattern outlined by the results presented in this section. As the results show, for the majority of crops analyzed, some of the most affected producers are those classified as modern enterprises. This has important implications for policy makers, since in most cases, policies and subsidies are focused on those smaller producers that cannot stand for themselves. Modern enterprises may be able to better change and adapt to the new situations produced by trade liberalization, which may not be true for subsistence farmers. However, and as shown in our results, the focus of policies may as well be modern enterprises, at least during transitional periods.

FIGURE 14
TOTAL DISTRIBUTION OF GPV CHANGES



Source: Authors' estimations.

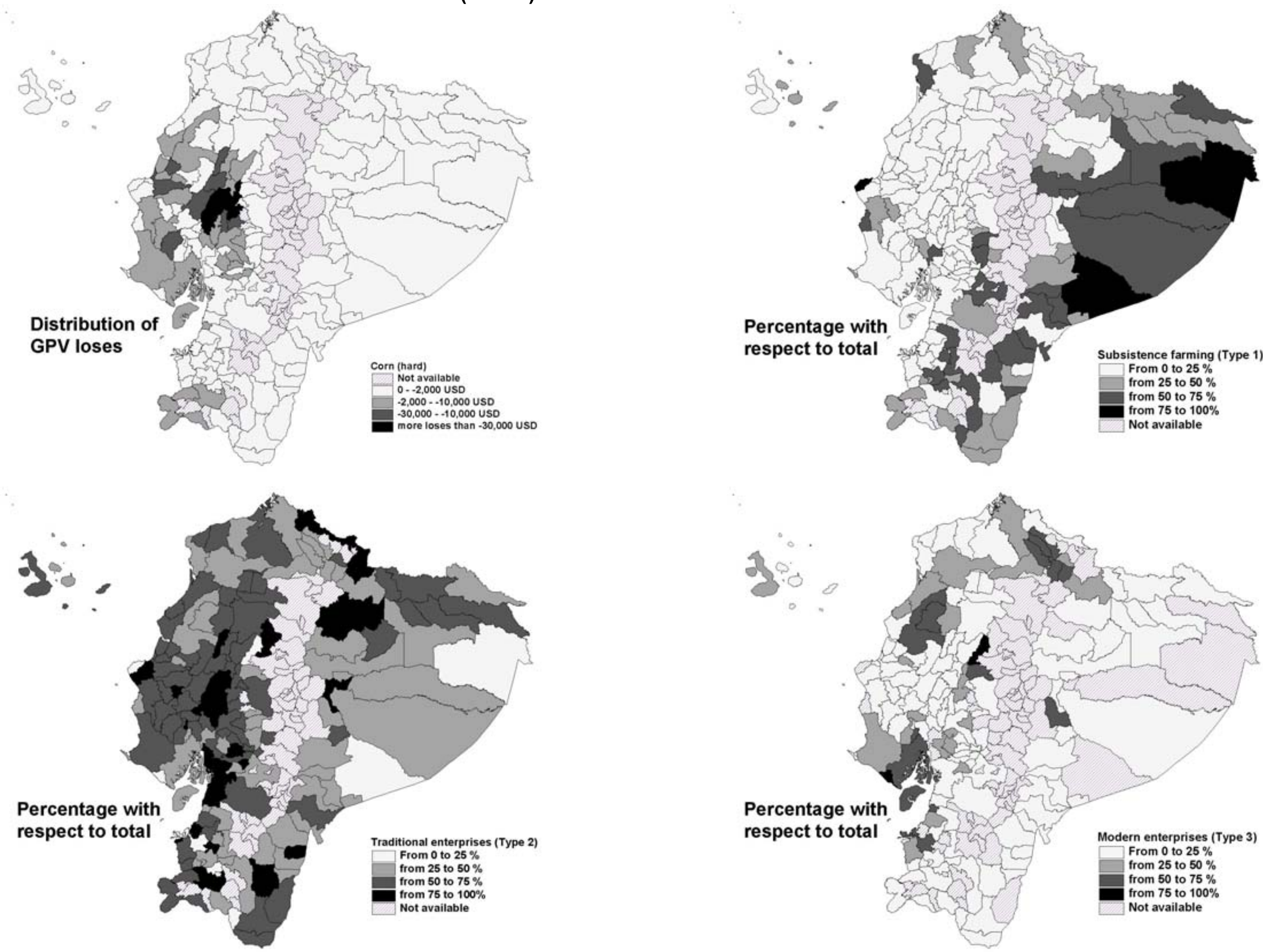
FIGURE 15
PADDY RICE: DISTRIBUTION OF GPV CHANGES



Source: Authors' estimations.

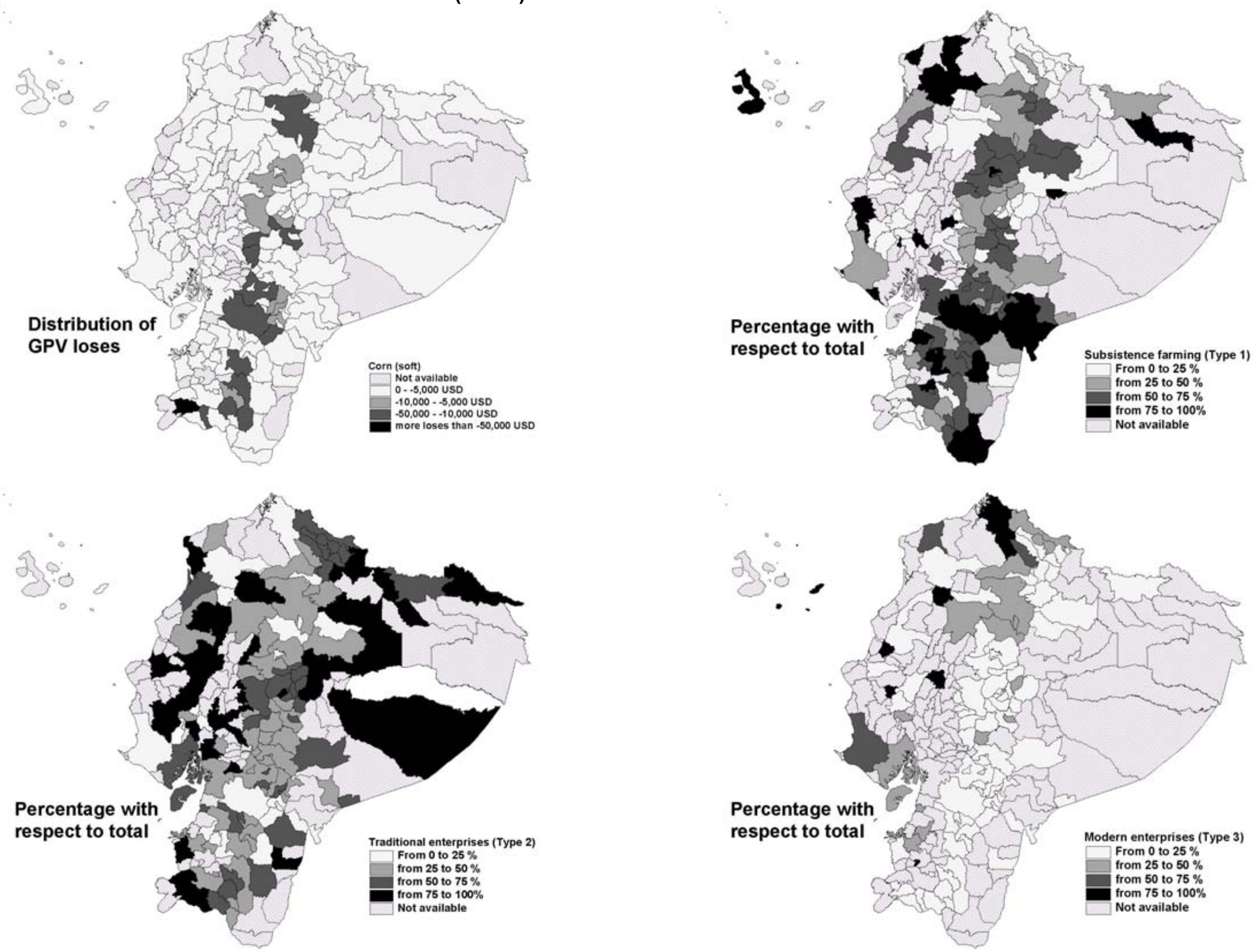
FIGURE 16

CORN (HARD): DISTRIBUTION OF GPV CHANGES



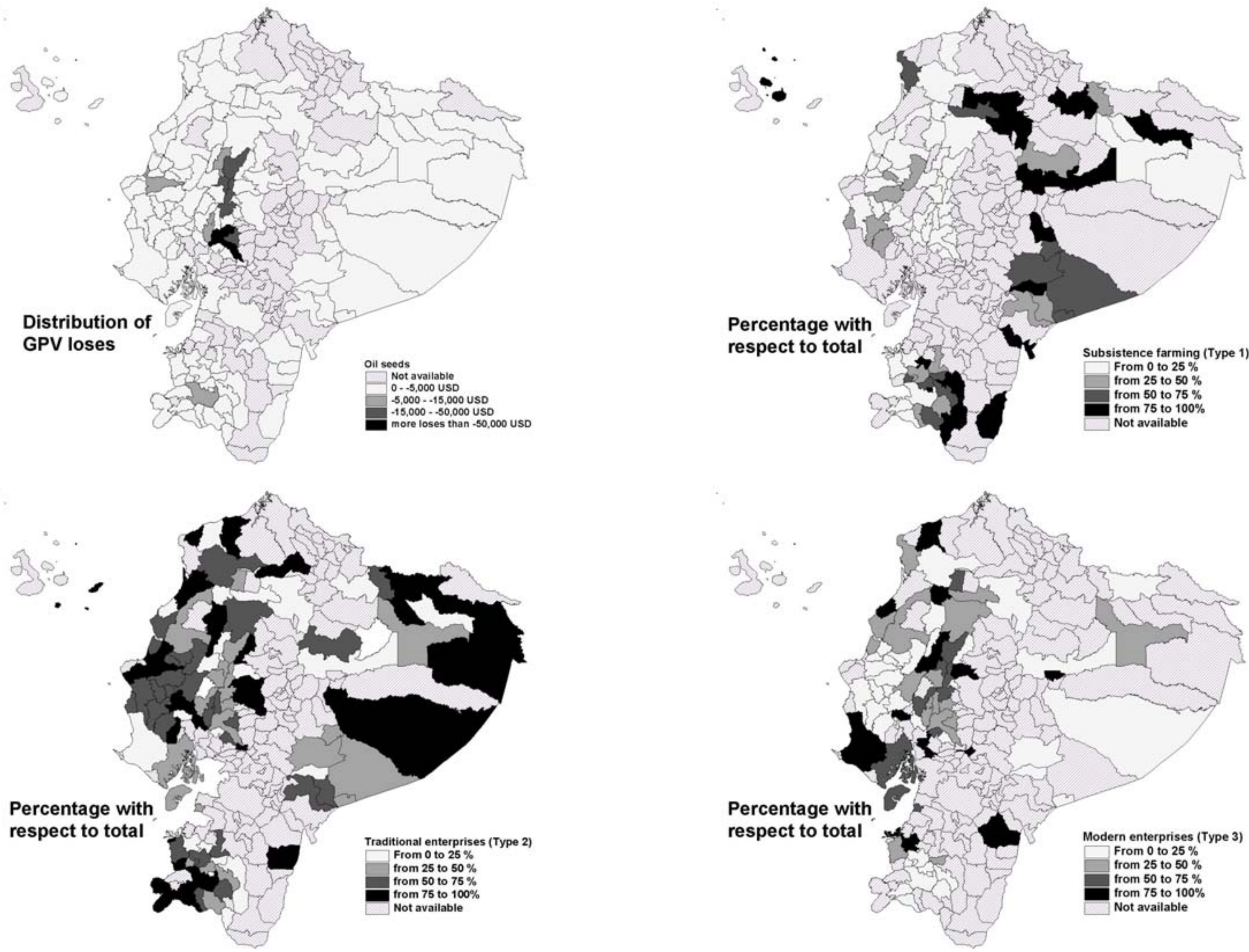
Source: Authors' estimations.

FIGURE 17
CORN (SOFT): DISTRIBUTION OF GPV CHANGES



Source: Authors' estimations.

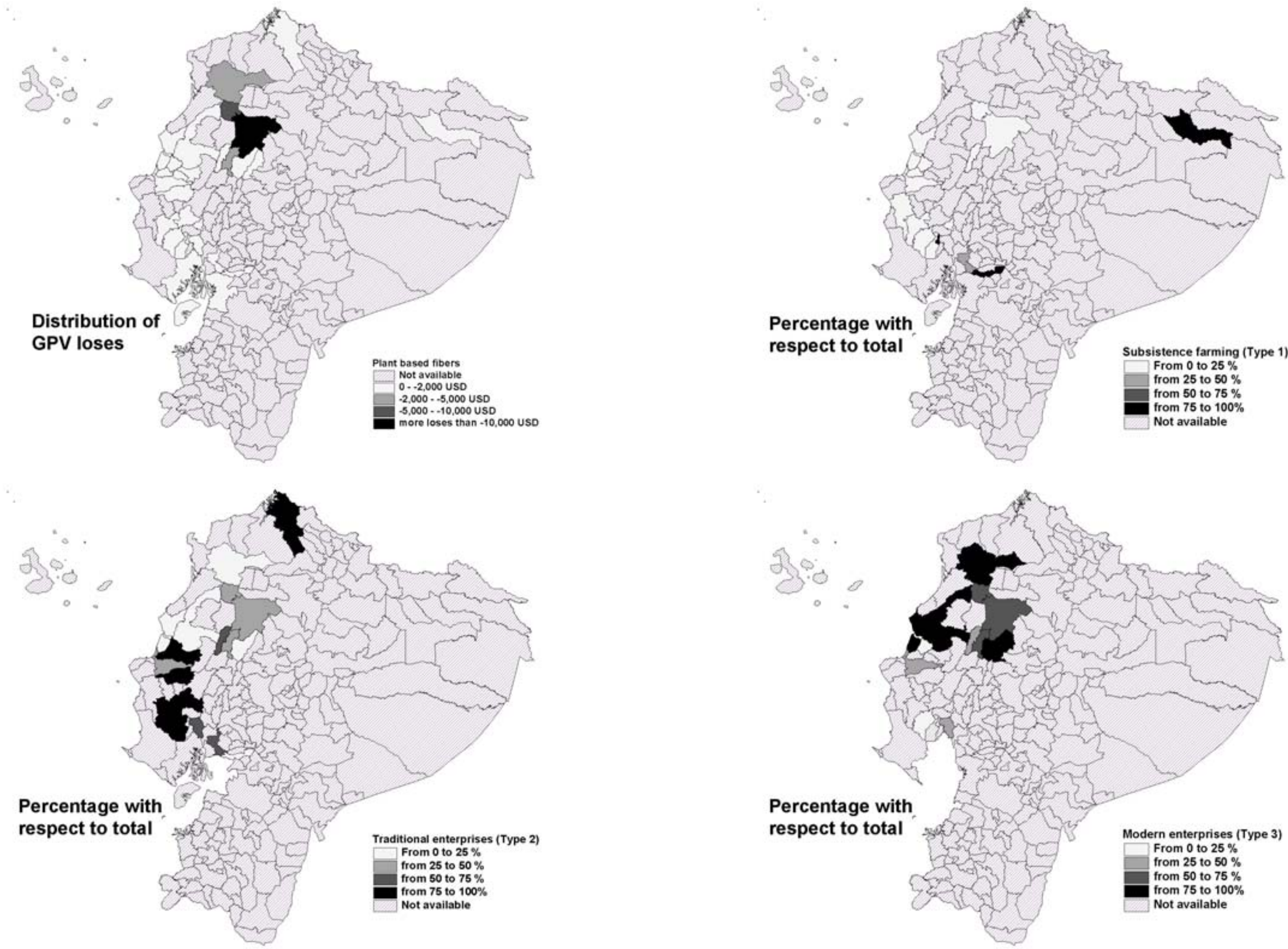
FIGURE 18
OIL SEEDS: DISTRIBUTION OF GPV CHANGES



Source: Authors' estimations.

FIGURE 19

PLANT BASED FIBERS: DISTRIBUTION OF GPV CHANGES



Source: Authors' estimations.

V. Conclusions

In this study we have shown the results of an applied general equilibrium model through the spatial lens. To do this we have developed a methodology that enables us to merge the CGE results with microeconomic information. We have applied this methodology to the effects of a free trade agreement between Ecuador and the United States on Ecuador's agriculture. We show that most producers and area of the crops that would be the focus of compensation policies (rice, corn and soybeans) are mainly around the basin of the Guayas river basin in the provinces of Guayas, Los Rios and Manabi.

The spatial distribution of impacts in Ecuador of the trade agreements studied in this paper could be used to analyze and implement possible compensation policies to mitigate its potential negative impacts. Explicitly, these targeted policies should be mostly focused in the Guayas river basin, where most producers of cereals and oilseeds are. Rice, hard corn and soybeans production areas and producers are concentrated in Guayas, Los Rios and Manabi. Soft corn producers are mainly concentrated in the Sierra region, especially in the central and south areas. Moreover, the government should make a clear distinction between subsistence farmers, traditional and modern enterprises, focusing in subsistence and traditional enterprises because modern enterprises have more capability of adapting to changes from trade liberalization. For subsistence farmers any compensation policy should be complemented with a widespread social policy that enable them improve their access to basic sanitation infrastructure, health services, basic education and capacity building in agricultural issues.

The methodology developed in this study would enable policy makers to focus their policies by means of geo-referenced impact outcomes. The use of this tool with other geographically referenced data (such as income or weather data) would be of great use for policies ranging from poverty reduction to environmental mitigation of global warming in order to spur advances towards the achievement of the Millennium Development Goals and the required sustainable development of the country. For that reason, future improvements of this tool plans to combine other geographically referenced data, such as household surveys with socio-economic information that would enable policy makers to better target specific policies to where they are most needed.

Several areas of future research may improve the methodology developed in this paper. The distribution of impacts should be based more on empirical and econometric work. Market integration and spatial price transmission tests should be a first step in that direction. This is important to estimate the parameters used in the logistic function which has been chosen heuristically. In addition, we need to be able to distinguish between the different channels of commercialization, and determine whether there are sensible differences between the type of market channel and prices. Also, it is important to improve price information and regional price distribution, by means of countrywide prices surveys that cover all the cantons and products. Finally, the methodology could also improve by including a mechanism that accounts for changes in production quantities at the UPA level. Such mechanism could include a microsimulation procedure such as Monte Carlo simulation methods.

Through the use of the Agricultural Census and the GIS geo-referenced process, agricultural sectoral impacts has disaggregated and registered into individual locations, in our case, cantons. The visualization of this disaggregated information by means of GIS techniques would enable decision makers to display the results of the policies to be applied and consequently improve the quality of their choices. This is especially important in the agro-business sector where the productive units reside along the whole country territory. Visualization helps not only in obtaining a systemic view of a subject matter but also to improve the quality of communication among stakeholders. Also, the integration between GIS and CGE analysis makes it possible to capture additional information which is not included in the macro analysis.

We expect that the hybrid combination of macro analysis techniques, such as CGE modeling with micro or geographically disaggregated data will be the next useful step toward the better understanding of transmission mechanisms of economic policies so as to assist the informed policy interventions in issues such as poverty reduction, deforestation, efficient and environmentally friendly use of land and adaptation and mitigation strategies of climate change.

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Annexes

Annex 1

TABLE 1
TRADE LIBERALIZATION IMPACTS ON ECUADORIAN SECTORS
(% change)

Sector	Price	Production	Consumption	Value Added	Imports	Exports	Welfare (millions US $)	Real Farm Income
Paddy rice	-0.8	-0.3	-0.6	-0.3	-0.6	-31.7	-31.7	-0.3
Wheat	-3.5	-0.5	1.3	-0.5	1.3	33.0	33.0	-0.6
Cereal grains	-1.0	-1.3	7.1	-1.3	7.1	-16.7	-16.7	-1.7
Vegetables, fruits and nuts (bananas)	-0.6	0.8	2.1	0.8	2.1	1.3	1.3	1.2
Oil Seeds (soybeans)	-1.2	-3.8	2.9	-3.8	2.9	-11.1	-11.1	-5.2
Sugar Cane	-0.8	-0.6	-2.0	-0.6	-2.0	3.5	3.5	-0.8
Plant-based fibers (cotton)	-1.0	-1.6	4.6	-1.6	4.6	3.2	3.2	-2.1
Crops nec. (coffee, cocoa, roses)	-0.5	0.8	0.4	0.8	0.4	1.6	1.6	1.2
Bovine Cattle, sheep, goat, horses	-0.9	-0.7	-1.6	-0.7	-1.6	-0.4	-0.4	-0.9
Animal Products Nec (Pigs/poultry)	-1.1	-1.8	-0.2	-1.8	-0.2	-1.1	-1.1	-2.4
Raw milk	-0.9	-0.5	-3.8	-0.5	-3.8	5.7	5.7	-0.7
Wool, silk-worm cocoons	-1.1	-1.5	-2.2	-1.5	-2.2	4.0	4.0	-2.0
Forestry	-1.3	-1.3	6.4	-1.3	6.4	4.5	4.5	–
Fish (Shrimp, Tuna)	-0.3	0.3	0.9	0.3	0.9	0.2	0.2	–
Oil and Mining	-0.3	0.3	5.3	0.3	5.3	2.1	2.1	–
Bovine meat products	-0.9	-0.5	23.8	-0.5	23.8	5.4	5.4	–
Meat products nec (pork & poultry)	-1.0	-2.0	36.4	-2.0	36.4	-20.3	-20.3	–
Vegetable oils and fats	-1.1	-0.8	4.5	-0.8	4.5	-2.0	-2.0	–
Dairy products (milk, cheese, etc.)	-0.9	-0.5	8.3	-0.5	8.3	4.5	4.5	–
Processed rice	-1.3	0.0	-2.2	0.0	-2.2	-3.4	-3.4	–
Sugar	-0.9	-1.2	1.5	-1.2	1.5	-10.1	-10.1	–
Food Products Nec	-1.0	1.1	3.6	1.1	3.6	1.8	1.8	–
Beverages and tobacco products	-1.0	-0.3	0.0	-0.3	0.0	1.1	1.1	–
Manufacturing	-1.0	-2.1	2.6	-2.1	2.6	1.0	1.0	–
Real Farm Income in Agriculture								0.36
On farm income								0.40
Off farm income								-0.51

Source: Ludeña and Wong (2006).

TABLE 2
COMMODITY AGGREGATION AND CORRESPONDENCE OF ECUADOR'S AGRICULTURAL SECTORS TO GTAP SECTORS

No.	GTAP Sector	Description	Ecuador Sectors Analyzed
1	pdr	Paddy Rice	Paddy rice
2	wht	Wheat	Wheat
3	gro	Cereal Grains Nec. (corn, rye)	Corn – hard
			Corn – soft
			Other cereals
4	v_f	Vegetables, fruits and nuts (bananas)	Fruits
			Vegetables
5	osd	Oil Seeds (soybeans)	Oil seeds
6	c_b	Sugar Cane	Sugar crops
7	pfb	Plant-based fibers (cotton)	Plant based fibers
8	ocr	Crops nec. (coffee, cacao, roses)	Roses
			Coffee
			Cacao
			Other crops
9	ctl	Bovine Cattle, sheeps, goats horses	
10	oap	Animal Products Nec (Pigs, poultry)	
11	rmk	Raw Milk	
12	wol	Wool, silk-worm cocoons	
13	for	Forestry	
14	fsh	Fishing (Shrimp, Tuna)	
15	Oil and Mining	Oil and Mining	
16	cmt	Bovine meat products	
17	omt	Meat products nec (pork, poultry meat)	
18	vol	Vegetable oils and fats	
19	mil	Dairy products (milk, cheese, etc.)	
20	pcr	Processed rice	
21	sgr	Sugar	
22	ofd	Food Products Nec	
23	b_t	Beverages and tobacco products	
24	Manufacturing	Manufacturing	
25	Services	Services	

Source: Authors' estimations.

TABLE 3
TRANSITIONAL CROPS AND MAPPING TO GTAP SECTORS

Crop (in Spanish)	GTAP Sector	Code	Crop (in Spanish)	GTAP Sector	Code
Acelga	Fruits & Vegetables	v_f	Linaza	Oil seeds	osd
Ají Serrano	Fruits & Vegetables	v_f	Lufa	Fruits & Vegetables	v_f
Ajo	Fruits & Vegetables	v_f	Maíz duro choclo	Other Cereals	gro
Ajonjolí	Fruits & Vegetables	v_f	Maíz duro seco	Other Cereals	gro
Alcachofa	Fruits & Vegetables	v_f	Maíz suave choclo	Other Cereals	gro
Algodón	Plant based fibers	pbf	Maíz suave seco	Other Cereals	gro
Anís	Other crops	otr	Maní	Oil seeds	osd
Apio	Fruits & Vegetables	v_f	Marigold	Fruits & Vegetables	v_f
Arroz	Paddy rice	pdr	Malanga	Fruits & Vegetables	v_f
Arveja seca	Fruits & Vegetables	v_f	Melloco	Fruits & Vegetables	v_f
Arveja tierna	Fruits & Vegetables	v_f	Melón	Fruits & Vegetables	v_f
Avena	Other Cereals	gro	Nabo	Fruits & Vegetables	v_f
Badea	Fruits & Vegetables	v_f	Oca	Fruits & Vegetables	v_f
Berenjena	Fruits & Vegetables	v_f	Papa	Fruits & Vegetables	v_f
Brócoli	Fruits & Vegetables	v_f	Papa china	Fruits & Vegetables	v_f
Brumancia	Fruits & Vegetables	v_f	Papa nabo	Fruits & Vegetables	v_f
Camote	Fruits & Vegetables	v_f	Pepinillo	Fruits & Vegetables	v_f
Cebada	Other Cereals	gro	Perejil	Fruits & Vegetables	v_f
Cebolla blanca	Fruits & Vegetables	v_f	Pimiento	Fruits & Vegetables	v_f
Cebolla colorada	Fruits & Vegetables	v_f	Quínua	Other Cereals	gro
Cebolla perla	Fruits & Vegetables	v_f	Rabano	Fruits & Vegetables	v_f
Centeno	Other Cereals	gro	Remolacha	Fruits & Vegetables	v_f
Chocho	Fruits & Vegetables	v_f	Romanescu	Fruits & Vegetables	v_f
Cilantro	Fruits & Vegetables	v_f	Sandía	Fruits & Vegetables	v_f
Col	Fruits & Vegetables	v_f	Sorgo	Other Cereals	gro
Coliflor	Fruits & Vegetables	v_f	Soya	Oil seeds	osd
Col de bruselas	Fruits & Vegetables	v_f	Suquini	Fruits & Vegetables	v_f
Espinaca	Fruits & Vegetables	v_f	Tabaco	Other crops	otr
Fréjol seco	Fruits & Vegetables	v_f	Tomate riñón	Fruits & Vegetables	v_f
Fréjol tierno	Fruits & Vegetables	v_f	Trigo	Wheat	wht
Garbanzo	Fruits & Vegetables	v_f	Vainita	Fruits & Vegetables	v_f
Girasol	Oil seeds	osd	Yuca	Fruits & Vegetables	v_f
Haba seca	Fruits & Vegetables	v_f	Zambo	Fruits & Vegetables	v_f
Haba tierna	Fruits & Vegetables	v_f	Zanahoria amarilla	Fruits & Vegetables	v_f
Higuerilla	Oil seeds	osd	Zanahoria blanca	Fruits & Vegetables	v_f
Hongos	Fruits & Vegetables	v_f	Zapallo	Fruits & Vegetables	v_f
Jengibre	Other crops	otr	Mashua	Fruits & Vegetables	v_f
Lechuga	Fruits & Vegetables	v_f	Huerto Hortícola	Fruits & Vegetables	v_f
Lenteja	Fruits & Vegetables	v_f	Planta Medicinal Trans.	Other crops	Otr

Source: Authors' estimations.

TABLE 4
PERMANENT CROPS AND MAPPING TO GTAP SECTORS

Crop (in Spanish)	GTAP Sector	Code	Crop (in Spanish)	GTAP Sector	Code
Achiote	Other crops	otr	Manzana	Fruits & Vegetables	v_f
Ají	Fruits & Vegetables	v_f	Maracuyá	Fruits & Vegetables	v_f
Abacá	Plant based fibers	pbf	Marañon	Fruits & Vegetables	v_f
Aguacate	Fruits & Vegetables	v_f	Membrillo	Fruits & Vegetables	v_f
Alcaparra	Fruits & Vegetables	v_f	Mora	Fruits & Vegetables	v_f
Arazá	Fruits & Vegetables	v_f	Naranja	Fruits & Vegetables	v_f
Babaco	Fruits & Vegetables	v_f	Naranjilla	Fruits & Vegetables	v_f
Banano	Fruits & Vegetables	v_f	Níspero	Fruits & Vegetables	v_f
Cabuya	Plant based fibers	pbf	Paja toquilla	Plant based fibers	pbf
Cacao	Other crops	otr	Palma africana	Oil seeds	osd
Café	Other crops	otr	Palmito	Fruits & Vegetables	v_f
Caña de azúcar	Sugar crops	sgr	Papaya	Fruits & Vegetables	v_f
Caña guadua	Other crops	otr	Pepino	Fruits & Vegetables	v_f
Capulí	Fruits & Vegetables	v_f	Pera	Fruits & Vegetables	v_f
Cardamomo	Fruits & Vegetables	v_f	Pimienta dulce	Other crops	otr
Caucho	Forestry	for	Pimienta negra	Other crops	otr
Ceibo	Forestry	for	Piña	Fruits & Vegetables	v_f
Cereza	Fruits & Vegetables	v_f	Pitahaya	Fruits & Vegetables	v_f
Chirimoya	Fruits & Vegetables	v_f	Plátano	Fruits & Vegetables	v_f
Ciruelo	Fruits & Vegetables	v_f	Kiwi	Fruits & Vegetables	v_f
Ciruela costeña	Fruits & Vegetables	v_f	Sábila	Fruits & Vegetables	v_f
Claudia	Fruits & Vegetables	v_f	Tamarindo	Fruits & Vegetables	v_f
Cocotero	Fruits & Vegetables	v_f	Taxo	Fruits & Vegetables	v_f
Durazno	Fruits & Vegetables	v_f	Té	Other crops	otr
Espárrago	Fruits & Vegetables	v_f	Tomate de árbol	Fruits & Vegetables	v_f
Frutilla o fresas	Fruits & Vegetables	v_f	Toronja	Fruits & Vegetables	v_f
Granadilla	Fruits & Vegetables	v_f	Tuna	Fruits & Vegetables	v_f
Guaba	Fruits & Vegetables	v_f	Uva	Fruits & Vegetables	v_f
Guanabana	Fruits & Vegetables	v_f	Uvilla	Fruits & Vegetables	v_f
Guanto	Fruits & Vegetables	v_f	Zapote	Fruits & Vegetables	v_f
Guayaba	Fruits & Vegetables	v_f	Orito	Fruits & Vegetables	v_f
Higo	Fruits & Vegetables	v_f	Chonta	Fruits & Vegetables	v_f
Lima	Fruits & Vegetables	v_f	Tagua	Other crops	otr
Limón	Fruits & Vegetables	v_f	Caimito	Fruits & Vegetables	v_f
Macadamia	Fruits & Vegetables	v_f	Uva de monte	Fruits & Vegetables	v_f
Mamey	Fruits & Vegetables	v_f	Borojó	Fruits & Vegetables	v_f
Mandarina	Fruits & Vegetables	v_f	Huerto frutal	Fruits & Vegetables	v_f
Mango	Fruits & Vegetables	v_f	Planta Medicinal perm.	Other crops	otr

Source: Authors' estimations.

TABLE 5
NUMBER OF PRODUCERS BY REGION

Region	Subsistence	Traditional Enterprises	Modern Enterprises	Total	Share
Coastal	79 558	122 424	17 827	219 809	26.1
Sierra	339 203	210 754	17 665	567 621	67.3
Oriental	24 503	24 279	1 569	50 351	6.0
Galapagos & Others	1 150	3 255	695	5 100	0.6
Total	444 414	360 712	37 755	842 882	100.0
Share	52.7	42.8	4.5	100	

Source: Morales et al. (2005).

TABLE 6
VALUE OF PRODUCTION BY REGION

Region	Subsistence	Traditional Enterprises	Modern Enterprises	Average	Total
Coastal	779	5 219	61 577	22 525	67 575
Sierra	269	1 482	32 865	11 539	34 616
Oriental	1 162	899	2 026	1 362	4 086
Galapagos & Others	845	999	475	773	2 318
Total*	1 048	6 701	94 443		
Average*	524	3 350	47 221		

Source: Morales et al. (2005).
(*) Excludes Oriente and Galapagos & Others.

TABLE 7
AVERAGE SIZE OF UPA BY TYPE OF FARMER AND REGION (HECTARES)

Region	Subsistence	Traditional Enterprises	Modern Enterprises
Coastal	8.7	23.5	116.9
Sierra	4.5	11.4	64.7
Oriental	41.5	51.9	200.8
Total	7.5	18.7	93.8

Source: Morales et al. (2005).

TABLE 8
CROP SHARE OF TOTAL GROSS VALUE OF PRODUCTION BY TYPE OF PRODUCER

Sierra					
Subsistence		Traditional Enterprises		Modern Enterprises	
Dry soft corn	32.6	Potatoes	22.6	Bananas	35.9
Soft corn	2.6	Sugar cane for sugar	21.6	Sugar cane for sugar	17.7
Dry hard corn	3.1	Dry soft corn	12.0	Oil Palm	17.1
Potatoes	18.4	Others	43.8	Potatoes	13.1
Others	43.3			Others	17.1
Total	100.0	Total	100.0	Total	100.0
Coastal					
Subsistence		Traditional Enterprises		Modern Enterprises	
Rice	54.1	Rice	36.7	Bananas	71.3
Cacao	13.6	Bananas	22.6	Sugar cane for sugar	8.5
Dry hard corn	12.1	Dry hard corn	12.7	Rice	7.5
Others	20.2	Cacao	7.6	Oil Palm	7.3
		Others	20.4	Others	5.4
Total	100.0	Total	100.0	Total	100.0

Source: Morales et al. (2005).

TABLE 9
NUMBER OF UPAS BY TYPE OF PRODUCER AND CROP

Crop	Subsistence	Traditional Enterprises	Modern Enterprises
Vegetables	303 506	156 241	9 601
Fruits	75 410	101 263	21 947
Corn hard	202 726	126 318	8 055
Corn soft	45 134	23 900	2 220
Paddy Rice	23 725	50 269	5 229
Wheat	19 938	9 946	0
Other Grains	45 683	22 830	1 063
Oil seeds	0	6 824	1 692
Sugar crops	23 236	15 458	1 404
Other crops	79 877	108 634	8 293

Source: Morales et al. (2005).

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