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Farm Size and Income Distribution of Latin American Agriculture: New Perspectives on an Old Issue

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Abstract

Latin American and Caribbean countries have historically been known for their rates of land inequality, highest in the world. However, these countries also exhibit a high degree of heterogeneity in their patterns of land concentration and average farm sizes. These cross-country differences play a determining role in productivity of farms and the distribution of agricultural income. Constructing a new data-set matching agricultural census and household survey data, we provide suggestive evidence on the positive relationship between farm size and farm income and wages. We identify the prevalence of small farms and the resulting low agricultural incomes as an important mechanism contributing to high income inequality in agricultural regions. Low labor productivity in small farms appears as a key explanatory factor.

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I Introduction

The high and persistent income inequality in Latin America and the Caribbean (LAC) has coexisted with high poverty rates in rural areas, a widening rural-urban income gap, and a shrinking rural population. The rapid urbanization of the region has contributed to improve the condition of millions of people and placed the focus of public policies on cities and urban dynamics. Studies of inequality in LAC mostly ignore the contribution of rural dynamics on income inequality and, in particular, the role of the agricultural sector, implicitly assuming that low agricultural incomes and the large agricultural and non-agricultural income gap have little influence on current income inequality.

The purpose of this chapter is to gauge the contribution of agricultural dynamics on current inequality in LAC, and explore whether the interaction between farm size, agricultural productivity, and agricultural income may partially explain this contribution. Agricultural dynamics may contribute to inequality through two distinct mechanisms: inequality *between* agricultural and non-agricultural sectors, and inequality *within* agricultural areas.

We first measure the contribution of agricultural dynamics on income inequality for nine countries in LAC (Bolivia, Chile, Colombia, Ecuador, El Salvador, México, Paraguay, Perú, and Uruguay). Based on Theil decompositions, we document that agricultural inequality plays a rather important role in explaining total income inequality in the nine countries. The percentage of the contribution of agricultural income inequality in total income inequality ranges from 11 percent in Uruguay to 58 percent in Bolivia. The *between-component* explains around 30 percent of the total agricultural income inequality on average, while the *within agricultural* component explains the rest. Given that the *between-component* is typically small in Theil decompositions, our result documents that it is a significant contributing factor[1] in our sample of countries, pointing to the relative importance of the agricultural and non-agricultural income gap. Nonetheless, the *within-component* plays also an important role to explain income inequality in LAC. The evidence presented by Gomez-Lobo and Oviedo (2023) in this compendium confirm this result, with a substantial contribution of the rural-urban income gap to total inequality in LAC. We present further decompositions to show that high inequality in the agricultural sector, the *within-component*, is not explained by differences *between* agricultural regions, indicating that inequality *within* the agricultural agricultural in a region must be explained by other observables.

Dynamics in the agricultural sector hence largely explain the contribution of rural dynamics on high inequality in the nine countries. The sources of income for the poorest and richest agricultural households confirm this finding. The income of rich agricultural households comes from both own-farm and agricultural wages, yet these households heavily diversify across different sources of non-agricultural income. Across all countries, only households at the top of the distribution diversify into non-agricultural income. The poorest 10 percent, on the contrary, mostly depend on (low) own-farm income. Other than Chile and Uruguay, only a small number of these poor households rely

[1] As measured through ELMO ratios, see Elbers et al. (2008).

on agricultural wages. The income from these wages is quite low for the poorest agricultural households and its share starts picking up for the entire sample around the 40^{th} decile.

Because agricultural income[2] largely determines welfare in the rural sector and income inequality, we explore the influence of farm size and agricultural production on agricultural income. Empirical evidence has documented a robust "inverse relationship" between farm size and land yields.[3] Policies to reduce rural poverty have thus placed a strong priority on small farms as a vehicle to increase agricultural income. However, this emphasis ignores a second empirical regularity: output per worker increases with farm size. Both empirical regularities can originate from frictions in agricultural labor and land markets, such as transaction costs in the labor market that increase the relative costs of hiring workers compared to family workers (Feder, 1985; Lamb, 2003; Barrett et al., 2010; Foster and Rosenzweig, 2022). The high costs from hiring labor pushes small farms to overuse family labor, leading to the negative relation between farm size and land yields, and the positive one between farm size and output per worker. A higher output per worker for large farms can give rise to a positive correlation between average farm size in a region and average agricultural income.

We focus on farm size, the direct input in the agricultural production function, rather than land ownership. Assessing land ownership inequality faces the data limitations documented by Carranza et al. (2023), in this compendium, when measuring wealth inequality. The link between income and land inequality depends on land ownership distribution and the functioning of land markets. Thin land markets in developing countries sustain a strong correlation between land ownership and farm size (Ciamarra, 2004). We provide an analytical framework showing that equalizing farm size reduces aggregate agricultural income and does not eliminate income inequality if farmers are heterogeneous in their productivity levels.

While exhibiting some degree of heterogeneity, LAC is unique among developing regions for its high levels of land inequality and its complex structure in the farm size distribution. With a regional average Gini of 0.84, only a couple countries worldwide exhibit similar levels of land inequality. Some Latin American countries like El Salvador and Ecuador, exhibit a farm size distribution that is skewed towards smaller farms, while in countries like Chile and Uruguay, land is concentrated in large farms, resembling the farm size distribution of high-income countries (Adamopoulos and Restuccia, 2014).

Findings in this chapter confirm the positive correlation between average farm size and average agricultural income in the nine countries except for Chile. Whilst farm size and land yields are inversely correlated for relatively small farms, farm size is positively associated with output per worker. Within countries, regions with higher average farm size also have higher average agricultural household income and average agricultural wages, after controlling for land suitability and weather conditions. Moreover, for some coun-

[2] Agricultural income includes own-farm income and agricultural wages

[3] The evidence on the "inverse relationship" is abundant. Some examples are (Sen, 1962) (Berry et al., 1979), (Feder, 1985), (Heltberg, 1998), (Restuccia et al., 2008), (Barrett et al., 2010) and (Julien et al., 2019).

tries we find a positive correlation between the dispersion of agricultural income and the dispersion of output per worker, while there is no systematic relationship between the dispersion in farm size and income inequality. Based on the predictions of a theoretical framework that we propose to guide our analysis, we interpret these results as evidence that factors deviating farm size from its efficient allocation may be relevant for income inequality both between households in agriculture and households in other sectors and within agricultural households.

This chapter contributes to two strands of the economics literature. First, it adds to the a vast literature on inequality in Latin American countries and the sources driving this inequality. Current research shows that high inequality levels in LAC are related to low intergenerational mobility and inequality of opportunities (Bourguignon et al., 2007; Ferreira et al., 2013; Neidhöfer et al., 2018; de la Torre et al., 2017), labor dynamics and regulations (e.g. changes in skills premiums, minimum wages and wage inequality) (Lustig et al., 2013; Levy and Schady, 2013; Rodríguez-Castelán et al., 2016; Maurizio and Vázquez, 2016; Lustig et al., 2016; Alvarez et al., 2018; Ferreira et al., 2018; Messina and Silva, 2019), inequality in educational attainment (Bouillon et al., 2003; Ferreira et al., 2008; Ferreira and Gignoux, 2014; Cruces et al., 2014; Neidhöfer et al., 2018), the redistributive effect of fiscal policies and social spending (Levy and Schady, 2013; Lustig et al., 2014; Bucheli et al., 2014; Lustig, 2016), regional inequality (Grajales et al., 2018; Chauvin and Messina, 2020), and institutional development (Acemoglu et al., 2007; Gasparini et al., 2008; Acemoglu and Robinson, 2012; Buonanno and Vargas, 2019). Evidence on the contribution of rural dynamics to overall income inequality is scarce. Ferreira et al. (2008) find that the shrinking income gap between urban and rural areas partially explained, among other factors, the fall on inequality in Brazil during the beginning of the 2000s. Bouillon et al. (2003) estimate that one fourth of the increase in México's income Gini between 1984 and 1994 was due to the deteriorating returns of living in rural areas. The findings in this chapter emphasizes rural dynamics, in particular, agricultural ones, play a non-trivial role in explaining income inequality in the nine countries we study, and points to the relation between farm size and agricultural productivity as a potential mechanism to explain low agricultural incomes.

Secondly, we contribute to the literature on the relation between farm size and agricultural productivity. An extensive economic literature has provided ample evidence on the relation between farm size and agricultural productivity, either land yields or output per worker (Sen, 1962; Berry et al., 1979; Feder, 1985; Heltberg, 1998; Restuccia et al., 2008; Barrett et al., 2010; Julien et al., 2019; Rada and Fuglie, 2019; Key, 2019; Sheng and Chancellor, 2019; Foster and Rosenzweig, 2022). Besides the impacts on aggregate agricultural productivity, the relation between farm size and labor productivity also plays a central role in determining the income of agricultural households. This chapter adds to this literature by documenting a strong positive association between average farm size, on the one hand, and average agricultural wages and own farm income for the countries studied. The findings suggest low labor productivity for small farms need to be tackled to reduce rural poverty as well as income inequality within the agricultural sector.

Our findings implicitly bears the question of the persistence of vast amounts of small and very-small farms in Latin America. In Bolivia, Colombia, Ecuador, El Salvador, México, and Perú, the bottom 25 percent of farms are less than or equal to 1 ha. Only Chile and Uruguay have a share of large farms (>50ha) of over 10 percent. Adamopoulos and Restuccia (2020), Adamopoulos and Restuccia (2014) and Chen et al. (2017) show that poorly designed policies and regulations lead to land misallocation and hence to a prevalence of small farm in developing countries. The evidence of this chapter highlights an additional cost of small farm size at the country level: the low income of agricultural households which may contribute to the high income inequality in the nine countries we explore.

The remainder of this chapter proceeds as follows. The next section describes the data we use for the analysis. In section III, we present figures describing our sampled countries' land distribution and income distribution. Sections IV and V present our conceptual framework for analyzing the relationship between farm size and income inequality and our results. We close the chapter with some concluding remarks in section VI.

II Data sources

Our empirical analysis covers nine countries: Bolivia, Chile, Colombia, Ecuador, El Salvador, México, Perú, Paraguay, and Uruguay (See map in Figure 1). We use two main sources of data: Agricultural Censuses and cross-sectional labor surveys. We selected the countries based on the availability of the Agricultural Censuses and the access to its microdata. In this section, we provide a general description of the data and the variables we created. In Appendix Section A.II, we provide further details about the construction of our main variables.

II. A Agricultural Census data

Most data on land distribution, farm size, and agricultural output and inputs come from Agricultural Censuses.[4] To ensure a minimum level of comparability across countries, we first harmonize the data. This process poses several challenges. First, Agricultural Censuses are not updated frequently and thus the year is different in each country (see Appendix Section A.II). Second, the definition of what constitutes a farm and the inclusion criteria for farms and crops are not homogeneous across countries (see Table A1). Third, the wording of questions and time periods for specific questions differ, rendering it difficult to build identically defined measures. Lastly, the censuses do not elicit information on farm gate prices or producer prices. The harmonization of the data is therefore one important contribution of this chapter.

Land variables include the size of private farms (in hectares), the number of hectares allocated to agricultural production, and the number of hectares allocated to livestock production. In our main results, we include only farms that report having agricultural land and we use the number of hectares allocated to agricultural production as a measure of farm size. In the appendix, we present the analysis including all farms and using total farmland as an alternative measure of farm size.

[4] Except for Perú, where the census does not provide output data and we use the Agricultural Survey (2019), which is representative at the national level, to compute output and input variables.

We create measures for agricultural inputs, besides land, which include: (i) number of total agricultural workers, and separated for family and hired workers; (ii) whether the farm has access to an irrigation system; and (iii) number of farms with tractors. We eliminate from the sample farms that do not report the number of workers in Bolivia (1.95%), Chile (26.24%), Ecuador (17.34%), El Salvador (2.16%), México (0.005%), Paraguay (8.34%), Perú (3.85%)[5] and Uruguay (0.28%).[6] To measure labor inputs, we would ideally have the aggregate number of hours dedicated to agricultural activities on the farm, yet time use data is not collected on Agricultural Censuses. Hence, we calculate the yearly number of workers: total, family, and hired. In Appendix Section A.II we describe in detail this calculation.

We use the information on agricultural output to calculate land yields and output per worker. A large percentage of farms produce more than one crop. Hence, for aggregating production at the farm level, we use revenue instead of the quantity produced. We use FAO producer prices at USD constant prices of 2011 to construct measures of farm revenue. This measures cover about, on average, 30% of crops included in all censuses across countries, which constitute 92% of total production (See Appendix Section A.II for details).

Land yield and output per worker are defined as:

$$\text{Land yield}_{ij} = \frac{\sum_{k=1}^{N} p_k \times c_k}{\text{Total hectares}_{ij}} \tag{1}$$

$$\text{Output}_{ij}^{worker} = \frac{\sum_{k=1}^{N} p_k \times c_k}{\text{Total workers}_{ij}} \tag{2}$$

where p_k is the price per ton of crop k produced in farm i located in state j. Total hectares$_{ij}$ is the number of hectares cultivated for the crops with price information. Total workers$_{ij}$ represents the number of hired and family workers allocated to crops with price information, which we calculate as the total number of workers multiplied by the percentage of land cultivated on crops with price information.

Land size and the use of agricultural inputs vary widely across the countries of the sample (See Table 1). Nonetheless, countries can be grouped in three clusters, according to the share of small farms (below five hectares) and large farms (above or equal to 50 hectares) and the area covered by these farms (See Appendix Table A2 for land distribution by land size ranges). Chile, Paraguay, and Uruguay, the first cluster, have the lowest share of small farms (41%, 40%, and 16%, respectively), the highest share of large farms (13%, 7%, and 57%), and thus larger average farm size – 70.7 ha in Paraguay, 87.8 ha in Chile, and 364.2 ha in Uruguay. Land intensity, measured as the number of hectares per worker, is larger

[5]In the Agricultural Survey that we use to compute output measures only 0.03% of farms do not report labor.

[6]We verify that our main results hold if we include farms without workers in the analysis. Results available upon request.

than for most of the other countries: 3.5 for Chile, 6.8 for Paraguay, and 45.3 for Uruguay. In the second cluster of countries, Bolivia, Colombia, Ecuador, México, and Perú, the share of small farms is larger – ranging from 58.6 percent of total farms in Bolivia to 79.2 percent in Perú, whilst the share of farms above 50 hectares is small (1.8% in Perú, 3.8% in México, 4.5% in Colombia, 6.7% in Ecuador, and 8.5% in Bolivia). Subsistence farming is apparently more widespread in these countries, leading to higher labor intensity, albeit with a wide variances across the five countries. The conditions in El Salvador, the third "cluster" are akin to those of a subsistence rural economy. Farms have an average of 2.4 hectares and labor is used intensively (0.4 ha per worker). The percentage of cultivated land, 90 percent of total farm size, suggests over-exploitation, as a only small percentage of land is left for conservation and fallow.

II. B Labor surveys

Data for the analysis of agricultural household income comes from cross-sectional labor surveys in each country. We use Sociométro-BID, IDB's Data Lake for the harmonized household surveys which contains information on wages from the main and secondary occupations, labor and non-labor income, sector of occupation, firm size, rural/urban location, and other individual and household characteristics. We use the household survey of the same year than the Agricultural Census, except for Ecuador, México, and Paraguay, where the earliest household surveys with the representativeness required for the analysis were conducted later.[7]

For studying the link between farm size and agricultural income, we use agricultural wages and household farm income. We rely on two methods to construct own farm income. For Bolivia, Chile, Colombia, Ecuador, and Uruguay the surveys do not include a separate module for agricultural producers. Hence, we construct agricultural income by aggregating wages of all households members that report being employed in the agricultural sector and the income of those self-employed on the agricultural sector, assuming the latter are working on their own farm. We convert income variables to USD constant prices using 2011 as base year and Purchasing Power Parity (PPP) for the same year.

In El Salvador, México, and Perú, which have a separate module to estimate farm income, we calculate net farm income subtracting the costs of farm production from the reported gross farm revenue. We winzorize the highest and lowest one percent of this income for the econometric analysis. Since the surveys for El Salvandor and Perú, also collect information for self-employed, we estimate agricultural income using both methods to gauge the difference in incomes from both modules. The household income calculated with the agricultural module is consistently lower than with the self-employed module: the former is 74 percent, and 72 percent of the latter for El Salvador and Perú.[8] Agricultural household income sums agricultural wages and own farm income for all household members.

The analysis in section III separate households into agricultural and non-agricultural

[7]In particular, 2007, 2016, and 2017, respectively.

[8]The survey for Paraguay also includes an agricultural module. However, 54% of households report agricultural incomes equal to zero, while reporting costs. Given this, we use the self-employment module.

households. We define a household as agricultural when at least one household member works in the agricultural sector.

Merging agricultural variables with household income variables

We combine the information from the Agricultural Censuses with the information from the labor surveys by computing and merging aggregates at the lowest geographical level for which the labor surveys are representative. These correspond to *departamentos* (Bolivia, Colombia, Salvador, Paraguay, Perú and Uruguay), *provincias* (Ecuador), *regiones* (Chile), *entidad federativa* (México). In general, these geographical units are comparable to US states. For some countries, the surveys are not representative for all states, forcing us to drop these states from the analysis.[9] In most of the countries, the surveys are representative at the regional level, yet not at the region-rural level. Thus, agricultural wages and agricultural household income are at the state level, without disaggregating for urban and rural areas, unless noted. Nonetheless, most agricultural workers and agricultural producers in the nine countries live in rural areas.[10] In addition, this allows us to have better comparability as the definition for the rural population differs across country (see Table A3).

Table 2 describes the conditions of the rural sector and its contribution to poverty and GDP. The share of the rural population in LAC is 19 percent, yet this masks high heterogeneity across countries. In our sample, the share of the rural population ranges from 4.6 percent in Uruguay to 38.1 percent in Paraguay. The contribution of agriculture to total GDP and employment is much larger than for OECD countries and varies widely across the sampled countries.[11] The agricultural sector still employs a significant share of the population with wages well below non-agricultural wages. For example, in Ecuador, a country with a large share of employment in agriculture, the agricultural wage is 39 percent of the non-agricultural wage. Rural poverty is much higher than urban poverty in the all countries, except for Chile.

II. C Other controls

We include in the analysis geographical controls to capture land quality and agro-climatic conditions. We construct these variables at the state level. Data for agricultural suitability comes from the FAO - GAEZ Data Portal which measures the agroclimatic potential

[9] In Colombia, we drop Arauca, Casanare, Putumayo, San Andrés, Amazonas, Guainía, Guaviare, Vaupés and Vichada. In Ecuador, we eliminate Galápagos and undelimited zones (Las Golondrinas, La Concordia, Manga del Cura, El Piedrero); for the Amazon region, all states are considered as a single domain (Sucumbíos, Orellana, Napo, Pastaza, Morona Santiago, y Zamora Chinchipe); and we merge Santa Elena and Santo Domingo de los Tsáchilas to their original states, as for the 2000 Agricultural Census these states had not been created yet. In Paraguay, we drop Boquerón, Alto Paraguay and the capital district (Asunción).

[10] The percentage of agricultural workers living in rural areas in Bolivia, Chile, Colombia, Ecuador, El Salvador, México, Paraguay, Perú and Uruguay are, respectively: 91%, 53%, 83%, 86%, 74%, 73%, 90%, 75%, 67%. The percentage of agricultural households living in rural areas in Bolivia, Chile, Colombia, Ecuador, El Salvador, México, Paraguay, Perú and Uruguay are, respectively: 87%, 51%, 80%, 80%, 72%, 69%, 87,3%, 70%, 63%.

[11] In OECD, the contribution of agriculture to total GDP and total employment is 1.4% and 5%, respectively. See https://data.worldbank.org/ accessed on January 10, 2023.

yield for the main staple crops.[12] This variable measures average attainable yield of current cropland at grid levels of 5 x 5 arc minutes (approximately 11 x 11 km) for the period between 1981-2010. We construct the state level agricultural suitability index with a weighted average of the grid values.

We measure weather conditions using accumulated rainfall from ERA5.[13] The data have average monthly rainfall information for 11*11 km grids. To create a state-yearly accumulated rainfall, we calculate a weighted average, using the percentage of the grid located in each state, for the monthly rainfall at the state level and then aggregate it at the year level.

III Description of Agricultural Sector: Distribution of Land and Income

III. A Land Inequality: Context and Estimates

Land inequality and Latin America have a long and well-documented history together. Often highlighted as the pre-eminent example of long-term persistence of land inequality and its effects on modern economic and development outcomes (Easterly, 2007; Engerman et al., 2000; Frankema, 2010; North et al., 2000; Sokoloff and Engerman, 2000), Latin America usually holds a status as *sui-generis* with respect to the magnitude of both historical and present levels of land inequality. The typical story follows that during colonization of Latin America, geographic endowments of some sort (i.e. land suitable for cash crops) and/or a certain set of colonizer-imposed institutions induced an agrarian structure consisting of extremely unequal land ownership, leading to a development path dominated by unequal political, economic and social relationships, in one way or another leading to unequal and depressed modern economic outcomes (Eslava and Valencia, 2023).

Even beyond this well-known institutional story, most of the literature on land inequality focuses principally on its influence as a structuring factor in long-run development. Along these lines, land inequality has been theoretically and empirically linked to delayed industrialization (Adamopoulos, 2008), conflict and social unrest (Brockett, 1992, 2019), political participation and suppression (Baland and Robinson, 2008), and intergenerational mobility (Galán, 2018; Montero, 2022), to name a few. The other major focus of the literature has been to establish the reduced-form effect of *past* land inequality on *present-day* income inequality and growth (Birdsall and Londoño, 1997; Cipollina et al., 2018; Deininger and Squire, 1998; Deininger and Olinto, 1999; Frankema, 2005). There exists a dearth of estimates on present-day land inequality and, more importantly, almost no studies analyze present-day effect of land on income.

To address this gap, we start by providing an updated snapshot of land inequality estimates of Latin America, compared to other major developing regions. We perform

[12] https://gaez.fao.org/accessedonAugust5,2022. Staple crops included are maize, corn, rice, wheat, cassava, soybeans, potatoes, sorghum, sweet potato, yams, and plantain. We selected the main based on https://www.worldatlas.com/articles/most-important-staple-foods-in-the-world.html.

[13] Muñoz-Sabater 2019 and Muñoz-Sabater (2021) accessed on August 5, 2022.

general pareto interpolations[14] (Blanchet et al., 2022) for 54 countries on tabulations of landholding sizes provided by the FAO World Programme for the Census of Agriculture (Nayo et al., 2019). FAO data provides the most country coverage for land inequality estimates. This data only provides distributions of *operational holdings* and not *land ownership*, such that it might be the case that inequality of operational holdings underestimates the true distribution of land ownership. However, recent work has shown that census estimates of operational holding inequality and household survey estimates of land ownership inequality are highly correlated across all regions of the world including Latin America (Bauluz et al., 2020), mitigating concerns that FAO data does not accurately measure land inequality. Thin land rental markets can explain this strong correlation between the distribution of operational holdings and land ownership and, as we discuss in the next section, generate distortions that deviate farm size from the efficient allocation.[15]

This allows us to calculate Gini coefficients for low and middle income countries based on consistent and comparable data. We present the results in Table 3. Latin America and the Caribbean (LAC) stands out with an average Gini of 0.84. The second most unequal region is the Middle Eastern and North-African (MENA) (0.73), followed by Asia (0.56) and Sub-Saharan Africa (0.51). Other than Saint Lucia, all of the LAC countries presented make up 18 of the 23 most land unequal countries. Furthermore, the even more staggering difference between regions is the average farm size in each country. Excluding Caribbean countries, only El Salvador and Guatemala have average farm holdings under 10ha. The rest of Latin American countries represent 12 of the 13 countries with highest average farm size. Theoretically, land inequality does not necessarily imply a large average farm size and vice-versa. This combination is our first empirical observation of the specific nature of Latin American land dynamics. However, a deeper dive into their structure is required.

III. B Land Size Structure in LAC

A common message of the income and wealth inequality literature is to emphasize understanding the entire distribution and not just a simple measure of inequality like a Gini coefficient. In particular, more and more attention is paid to what is happening at the top of the distribution (Alvaredo et al., 2013). In the income and wealth inequality literature, extreme accumulation at the top has mostly induced analysis searching to understand the mechanisms leading to said accumulation. As described in the previous section, research in land inequality has usually focused in understanding the long-run effects of historical land inequality, and little on the actual rates of accumulation today and their consequences. In this paper, we argue that we must also understand the different rates of accumulation at the top and bottom of the distribution as they are essential in understanding the productivity structure of agriculture sectors and hence the very rates of production of agricultural incomes and welfare.

[14]This method allows us to recover an entire distribution with very high accuracy based only tabulated distributional data.

[15]Gáfaro et al. (2012) find that using cadastral data of rural Colombia, *owner* Gini coefficients are very similar to *landholding* Gini coefficients as well.

The importance of going beyond simple inequality measures is evident when looking at Table A2.[16] Having an average farm size of 2.4 ha (El Salvador), or over 350 ha (Uruguay) makes an outsized difference in terms of land size structure and implies prevalence of certain types of structures such as primarily small holding (El Salvador), primarily medium-sized holdings complemented with very-large holdings (Colombia and México), or primarily very-large holdings (Uruguay). This changes in land structure directly imply different inputs, crop choice, and revenues. To better understand the extent of this land size heterogeneity across our sample, we break up the universe of farms into different population shares: bottom 50 percent, Middle 50-90 percent, 90-99 percent, and top one percent. We then analyze each share's portion in total land and average farm size.

Figure 2 plots the share of land per each population share, for each country. We see two main types arise: (i) one set of countries (Bolivia, Chile, Colombia, México, Paraguay, and Perú) can be categorized as *top-heavy* as their top one percent shares are all over 50 percent and their top 10 percent shares being over 70 percent, and; (ii) one set of countries (Ecuador, El Salvador, and Uruguay) can be categorized as *middle-heavy* as their Middle 50-90 percent shares are above 25 percent and most land is not concentrated only among the top one percent but among the whole top 10 percent (as evidenced by the similarity of 90-99% and top 1% shares). This classification, however, is not enough to understand the differences between countries.

Table 4 present average farm sizes per population share. Uruguay stands out as atypical in its structure. The average farm size of the bottom 50 percent is 10 times higher than the next highest country, and this higher order of magnitude is present across all population shares. This is being driven primarily by the reduced amount of total farms in the country, five times less than the next lowest country. We may contrast Uruguay with the other high average farm size countries, Chile and Paraguay. Compared to all countries other than Uruguay, these countries have few farms and high average size, evidenced by the large average size of the bottom 50 percent for both countries and enormous size of the top 10 percent. While we see that average farm size is very large for all three countries, Uruguay exhibits much lower levels of accumulation due to small number of farms and larger sizes at the bottom of the distribution.

Bolivia, Colombia, and México have a combination of many small-sized farms in the bottom 50 percent and very large farms for the top 10 percent. This coincides with the fact while having the same order of magnitude of total land as Chile and Paraguay, they have more than six times the total amount of farms. This implies the presence of a *dual* type of land size structure for Bolivia, Colombia and México with large amount of very small holdings and the presence of very large holdings accumulating the majority of the land. At first glance, Ecuador and Perú demonstrate very similar size patterns throughout the population shares. However, with similar total land sizes, Perú has more than three times the amount of farms, the main driver behind its much higher top 1 percent shares.

[16]Note that FAO tabulation data that we presente above is not always equivalent to the agricultural census micro-data we use in this paper, thus there are sometimes discrepancies between the tabulation ginis/farm sizes and the ginis/farm sizes calculated from our micro-data. See the notes in Table 3 for a discussion of these discrepancies.

Lastly, El Salvador stands alone as the sole *small-holding* example in our sample with high amount of total farms, very small farm size for most of them, with medium-size holdings (5-50 ha) up until the top one percent. Returning to the *top-heavy* and *middle-heavy* categories from above, we see how many differences in structure countries with similar top shares can exhibit.

This typology is not meant to be exhaustive, but it does provide a more precise idea of how different our sample of countries' land size structures are. This heterogeneity could easily be lost if one were to focus solely on land inequality estimates and particularly, on the very high inequality estimates across LAC. We need to remember that even the small-farm El Salvador has a higher Gini than the all but five of non-LAC countries (and a higher Gini than the country with the second-highest average farm size, Uruguay). This exercise thus intends to stress the necessity to move beyond simple measures of land inequality and emphasize the role of differences in land structure across countries.

III. C Income Inequality: Concepts and Estimates

In section IV, we argue that there exists a relationship between farm size and productivity, and thus, a relationship between farm size and income. Before moving to this linkage, we explore how income is distributed in the rural sector, and more importantly, in the agricultural sector of our sample of countries.

Rural employment is composed of farm employment and non-farm employment. Given that we focus on land and agricultural production our primary interest is to understand agricultural income inequality and its contribution on total income inequality. However, given that we know that rural-urban gaps and rural inequality tend to play an important role in developing regions (Lagakos, 2020), we want to disentangle the specific role of the agricultural sector, and so we perform a rough check on the magnitude of the contribution of rural income inequality on total income inequality and compare it to the contribution of agricultural income inequality on total income inequality. We do this by performing a Mean Log Deviation (or Theil's L) decomposition of total household labor income across (i) urban and rural households, and (ii) agricultural and non-agricultural households in all countries in our sample.

The rural-urban results can be found in Table 5 while the agricultural-non-agricultural results can be found in Table 6. We identify a sizeable amount of heterogeneity between sizes and gaps between agricultural and rural sectors.[17] For example, we see that the rural sector is 50 percent bigger than the agricultural sector in Paraguay. An atypical case, Perú's agricultural sector is slightly bigger than its rural sector. An empirical observation mirrored by the World Bank data in Table 2. While relative sizes give us a first idea, we are interested in analyzing how different the decompositions for both sectors are, and later, what the agricultural-non-agricultural decomposition reveals about cross-country differences.

[17] The population sizes from Table 2 use World Bank data, while these estimates come directly from our labor surveys. Proportions are not identical, but the differences between rural and agricultural populations are very similar.

Comparing rural and agricultural decompositions, we first look at the $\text{MLD}_{Between}$ column which calculates the between-component for both decompositions. This number gives us an idea of the magnitude that the difference in average incomes of both groups contributes total inequality in each decomposition. We see that the order of magnitude of both decompositions' between-components is largely equivalent. Furthermore, using ELMO ratios,[18] we see that this relative similarity is robust to the different sizes of agricultural and rural sectors, as we see that the ratios are again of the same scale. For the within-components ($\text{MLD}_{Rural/Agricul}$ and $\text{MLD}_{Urban/Non-Agricul}$), magnitudes are again largely similar. This would seem to imply that agricultural inequality follows roughly the same dynamics as rural nonfarm inequality for these countries, except for Bolivia, Chile, and Paraguay's ($\text{MLD}_{Rural/Agricul}$). Chile exhibits a higher MLD_{Rural}, while Bolivia and Paraguay a higher $\text{MLD}_{Agricul}$. This implies that Chile's agricultural sector displays less inequality than its rural sector and the opposite effect for Bolivia and Paraguay (higher agricultural inequality than rural inequality).

However, the large congruence in all other components of the decompositions implies that agricultural and rural dynamics largely track in our data. This result provides support to the claim that agricultural inequality is an important factor determining non-urban inequality, and furthermore, that agricultural-non-agricultural decompositions tell largely the same story as rural-urban decompositions.

Focusing now on the agricultural-non-agricultural decomposition, we analyze the contribution of agriculture in total income inequality in our sample of countries in Table 6. Between-component ranges from less than 1 percent percent (Uruguay) to 13 percent (Perú). In general it hovers around 10 percent. Theil between-components are naturally small, so the fact they are this big already (corroborated by ELMO ratios being usually >15%) imply that the agricultural-non-agricultural between-component is present and observable in all our countries except Uruguay. Within-component ranges from eleven percent (Uruguay) to 48 percent (Bolivia).[19] Alltogether, between and within-components related to agricultural sector account for a range between 11 percent (Uruguay), Chile (16%), Colombia (27%), México (27%), Ecuador (37%), El Salvador (41%), Paraguay (48%), Perú (54%), and 58 percent (Bolivia). Average across sample is: 35 percent. This indicates that a rough estimate of role of agriculture in total inequality in LAC is 35 percent, with evident heterogeneity across countries.

[18]We complement between-components with ELMO ratios following Elbers et al. (2008). These ratios show the ratio of the between-component and the "maximum between-component" possible from the data. The maximum represents the theoretical biggest between-component. Using the same sized population groups from the original decomposition, you assign the poorest households to the first group, and the next poorest to the next group and so on, such that you end up with a distribution with the same amount and same sized groups as the original decomposition, but the groups all have non-overlapping monotonically increasing incomes, maximizing the between component. These ratios give a normalized and comparable idea of how much a particular between-partition is explaining, beyond the specific size of the between-component. If the ratio is very small, it means that the partition has weak explanatory power to explain differences in averages of groups, while if the ratio is large, it means that that specific partition identifies a clear characteristic along which there are large differences in group averages.

[19]Within-component share of total inequality = $\frac{\text{MLD}_{Agricul} * \text{Pop}_{Agricul}}{\text{MLD}_{Total}}$

This decomposition exercise clearly delineates the two mechanisms through which the agricultural sector contributes to country-wide income inequality, which we discuss in detail in the next section: (i) Gap in incomes *between* the agricultural and non-agricultural sector, and (ii) Unequal distribution of incomes *within* the agricultural sector.

We check if the within-agricultural income inequality is not being driven by regional inequalities in Table 7. Here, we perform the same MLD decomposition as before, but this time only on agricultural households, using regions as the groups across which we decompose income inequality. The analysis shows us that the maximum between-component is 18 percent in Bolivia, concurrently with a maximum ELMO ratio of 21 percent, a significant size. However, the rest of the countries show the opposite magnitude, with Colombia and México barely cracking and all other countries below 10 percent for their ELMO ratios. These results indicate that differences across regions are not driving inequality occurring in the agricultural sector other than in Bolivia. Thus, there are other factors which we are not identifying in the decomposition which are driving within-agricultural inequality and which are likely present in all regions. In the next section, we provide a conceptual framework that might shed light on these potential factors.

In Figure 3 we rank all agricultural households according to their total household agricultural income. For each decile, we calculate the share of income coming from four sources: (i) own-farm income, (ii) agricultural wages, (iii) non-agricultural self-employed income, and (iv) non-agricutural wages. We then plot the percentage of total income that each source represents at each decile. This approach provides information on the potential sources of income heterogeneity across households.[20]

Several patterns arise across our sample of countries. First, the poorest households in all countries (except Chile and Uruguay) rely on own farm income as their main source of income and, as households become richer, they rely less on this source of income. This first result implies the existence of many low-income farm households across our sample of countries.[21] Paraguay buckles the trend in the top 10 percent as own farm income dominates the very top of the distribution, mimicking Chilean and Uruguayan dynamics. This observation follows quite directly from the presence of extremely large farms in all three countries, which are able to accumulate large incomes.

Second, we see varying degrees of importance of waged agricultural work. In Chile and

[20] We perform the same analysis at the individual level in Figure A1 as a robustness check. We see the general trends and patterns in the household and individual level decompositions are very similar. *A priori* this need not be the case. A household on the distribution in Figure 3 is simply a combination of individuals on the distribution Figure A1. It could be the case that individuals from very different parts of the distribution, together, form a household on a different part of the distribution altogether. This sort of reshuffling from the personal-level distribution to the household-level distribution would impact interpretations of household-level decompositions, as the trends seen at a certain location of the household-level distribution would not be driven by the fact that the household's individual members are also in the identical location of the distribution. Given that both distributions are so similar, reshuffling of individuals across households does not seem to be a big factor.

[21] The Chilean and Uruguayan anomaly can partly explain their smallest agricultural-non-agricultural gaps, as these might imply the low prevalence of small, low-income farms. This will be explored more in section V.

Uruguay, this source of income is important for the poorest households and decreases as households become richer. In Colombia, Ecuador, El Salvador, and México, this source is minimal for poorest households, increasing until around the middle of the distribution representing a very significant part of total income, and decreasing at the top of the distribution. Bolivia, Paraguay, and Perú follow a similar trend, but agricultural wages are a significant source of total income only for the top of the distribution.

Lastly, non-agricultural income is almost non-existent for the lowest parts of the distributions across all countries. As a household moves higher along the distribution, non-agricultural income (essentially) monotonically increases and becomes a significant source of income across the sample. The only country whose highest decile does not rely 30 percent or more on non-agricultural income is Uruguay. This implies that poor households do not have the capability to diversify income sources away from agriculture, while rich households do precisely this, and in countries like El Salvador and Peru, rely on non-agricultural income for more than half of their income.

In summary, this section has provided us with several stylized facts for our sample of countries: (i) agricultural income inequality contributes significantly to rural income inequality and explains an average 35 percent of total income inequality, with large heterogeneity across countries; (ii) the mechanisms through which agricultural income inequality affects total income inequality are the *between* agricultural-non-agricultural income gap and *within* agricultural sector inequality, and; (iii) decomposition of sources of household income points to the existence of many low-income farm households and a significant role of agricultural wages in the middle of the distribution, and high reliance on non-agricultural income for the top of the distribution. Rationalizing these empirical observations requires a structured framework, which we move to now.

IV Land size, agricultural productivity, and income inequality

In the previous section, we showed that both income inequality between households in agriculture and households in other sectors, and income inequality within agricultural households contribute to overall inequality in the countries of analysis. In this section, we discuss the potential mechanisms driving these income differences. We focus on agricultural productivity as a key determinant of rural income and argue that low and heterogeneous agricultural productivity within countries can explain these income differences.

The relationship between farm size and income is mediated by numerous factors. In Appendix A.III, we develop a simple theoretical framework to directly track the effect of distribution of farmer productivity on distribution of farm size and consequently, the effect on land yields. The model gives us three main results relating these variables, and hence, gives us intuition regarding the determinants of agricultural income inequality:

Result 1. The distribution of farmers' productivity determines the farm size distribution and more productive farmers operate larger farms. Because farmers' productivity z_i is the only source of variation across individuals in the efficient farm size, its distribution determines the farm size distribution. Moreover, optimal farm size ℓ_i^* increases with farmer's productivity z_i. Thus, farmers with higher values of z_i demand more land and operate larger farms in the efficient allocation.

Result 2. Land yields are constant across farms and output per worker increases with farm size. In the efficient allocation, land yields $\frac{y^*}{\ell^*}$ depend only on aggregate farm productivity $\sum_{j=1}^{N} z_j$ and total land endowment L, and do not vary across farms. Moreover, because labor is fixed across farms and equal to 1, output per worker is equal to total farm output y_i^* which increases with farm size ℓ^*.

Result 3. The distribution of farmers' productivity z_i determines the income distribution and equalizing farm size does not eliminate income inequality. In this simple framework, farm output determines farmers' income. Individual productivity z_i is the only source of variation of output across farms and, therefore, the dispersion in the distribution of z_i determines income inequality. Moreover, if land is evenly distributed across farmers, farm output is $\hat{y}_i = z_i^{1-\gamma}\left(\frac{L}{N}\right)^{\gamma}$, which still depends on individual productivity z_i and, therefore, the dispersion of individual income is still determined by the dispersion on individual productivity z_i.

In the remaining of this section, we present a literature review of the mechanisms highlighted by the model

The reallocation of labor across sectors

Urban-rural income gaps have been widely documented in developing countries. These gaps reflect productivity differences between workers in agriculture and other sectors, which account for most of the differences in aggregate productivity between high and low-income countries (Restuccia et al., 2008; Caselli, 2005; Gollin et al., 2014). Previous studies attribute the persistence of these differences in labor productivity across sectors to frictions that hinder the reallocation of workers across sectors and the technological progress in agriculture (Restuccia et al., 2008; Bryan et al., 2014; Lagakos and Waugh, 2013; Adamopoulos et al., 2022; Adamopoulos and Restuccia, 2014).

Some of these studies introduce models with heterogeneous agents, as in the framework presented above, and explain the persistence of low agricultural productivity with factors shaping the self-selection of low productivity agents in agriculture. These factors include a relatively low skill intensity in agriculture (Young, 2013), subsistence constraints (Lagakos and Waugh, 2013), and frictions in land and capital markets (Adamopoulos et al., 2022; Chen et al., 2022; Adamopoulos and Restuccia, 2014). These frictions to the reallocation of workers from agriculture to other sectors might induce a large heterogeneity in individual farm productivity, which as illustrated in our theoretical framework, might result both in low and heterogeneous agricultural income.

Farm size, agricultural productivity, and income

A large body of work has documented a negative relationship between land yields (the value of agricultural output per unit of land) and farm size in developing countries (see, for example, Sen (1962), Berry et al. (1979), Heltberg (1998), Feder (1985), and Lamb (2003)). This has given rise to the so-called "inverse relationship" between farm size and land productivity. Recent literature has shown that this negative relationship persists even after taking into account potential biases induced by differences in land quality across farms and measurement error (Barrett et al., 2010; Julien et al., 2019).This empirical regularity has motivated the idea of small farms as a vehicle to reduce poverty and increase welfare in rural areas of developing countries. However, the welfare implications of the negative relationship between land yields and farm size are not straightforward and depend on the underlying causes of this relationship.

As illustrated in our theoretical framework, when analyzed within regions, a negative relationship between farm size and land yields suggests deviations from the efficient allocation of land that result in lower aggregate income in agriculture. Some studies attribute these deviations to policy-related distortions in the land market that prevent the most productive farmers from operating at their optimal scale and result in the misallocation of land (Adamopoulos and Restuccia, 2020, 2014; Chen et al., 2022). Other studies argue that the inverse relationship between land productivity and farm size can result from frictions in the labor market (Feder, 1985; Lamb, 2003; Foster and Rosenzweig, 2022). These frictions increase the costs of hired labor relative to family labor (Barrett et al., 2010; Foster and Rosenzweig, 2022). Lower labor costs in smaller farms induce a higher labor intensity, which generates higher yields per unit of land and lower output per worker in small farms (Gollin, 2019; Foster and Rosenzweig, 2022; Fan and Chan-Kang, 2005). In line with this, some studies have documented a negative relationship between farm size and labor intensity and a strong positive relationship between farm size and the value of output per worker in developing countries (Gollin, 2019). To the extent that labor productivity determines the income of agricultural workers, the positive relationship between output per worker and farm size might imply a positive relationship between farm size and household income for landless agricultural households (Foster and Rosenzweig, 2022; Fan and Chan-Kang, 2005).

Once differences in labor use are considered, it is unclear whether small farms have higher overall productivity, and are thus able to generate higher income for farmers (Rada and Fuglie, 2019). Moreover, mechanization and technological progress in agriculture allow farms larger than a particular threshold to offset the increases in labor costs and create economies of scale that might cause a positive relationship between farm size and productivity (Foster and Rosenzweig, 2022). This positive relationship has been documented in developed countries, where average farm size is substantially larger than in developing countries (Foster and Rosenzweig, 2022; Rada and Fuglie, 2019; Key, 2019; Sheng and Chancellor, 2019). Foster and Rosenzweig (2022) propose a theoretical model that combines frictions in the labor market and economies of scale from mechanization to explain the differences in the relationship between farm size and productivity across countries. According to their theoretical framework, in low-income countries where farms are small, the frictions in the labor market drive the negative relationship between farm size and productivity. As farm size increases, economies of scale emerge, and the relationship flips. Results from their counterfactual estimations with Indian data suggest that increases in farm size induce substantial increases in land yields and output per worker and decreases in the number of farms and the share of agricultural workers. They show that the decrease in agricultural workers is less than proportional to the decline in the number of farms, which suggests that in the current land distribution, there is both an excess of labor in agriculture and an underutilization of the existing labor.

Overall, the non-null relationship between land yields and farm size, along with the persistence of small farms, despite the potential gains from land consolidation, might be associated with distortions in land markets (Adamopoulos and Restuccia, 2020, 2014; Chen et al., 2022). Moreover, eliminating these distortions can reduce income inequality. For example, Chen et al. (2022) show that eliminating the restrictions to land rentals in Ethiopia can increase income of rural households, with larger effects in low income households. Restrictions to land rentals in LAC can take various forms. In some countries there are explicit restrictions, in others, the lack of formal titles and and other institutions to resolve land disputes, hinders the development of land rental markets, creating a close link between land property and land use (Assunção and Chiavari, 2014; Alston and Mueller, 2010).

In sum, agricultural productivity determines the income of rural households through agricultural wages and farm profits and by inducing the reallocation of labor in non-agricultural activities. Lower productivity in agriculture, relative to other sectors, can explain income inequality between rural and urban areas. Moreover, the dispersion in agricultural productivity within regions can explain income inequality within rural households, which can be exacerbated by distortions in land and labor markets. In the following sections, we explore the potential role of agricultural productivity and farm size in shaping the patterns we observe in income inequality.

V Rural income, agricultural labor, and farm size

We now explore the relationship between farm size, agricultural labor, and household income in our data. To motivate our analysis, Figure 4 shows that there is positive correlation between average farm size and agricultural value added per worker across LAC countries. Also, countries with a higher agricultural value added per worker have lower rural poverty rates. The figure also shows substantial variation across LAC in average farm size, agricultural productivity, and rural poverty. Our sampled countries cover a wide range of this variation. We now focus on these countries and present patterns underlying these aggregate relationships.

V. A Two facts about farm size and agricultural labor

We document two facts about farm size and agricultural labor that we observe in our sample of countries and, as discussed in the previous section, can have implications on the income of agricultural households. The results we present below use cultivated area as a measure of farm size and we exclude from the sample farms that do not report cultivated area. In the appendix, we present the results including all farms and using total farm size as a measure of farm size.

Fact 1. Small farms employ large shares of workers, but only a small proportion of land. Figure 5a shows that the share of workers in farms with less than one hectare of cultivated area ranges from eight percent in Uruguay and Paraguay to 47 percent in El Salvador. Also, between 28 and 81 percent of farm workers are employed in farms with less than five hectares. Despite this, Figure 5b shows that the land in these small farms ranges between 0.75 percent in Uruguay and 55 percent in El Salvador.[22] This distribution of land and labor across farms implies that labor intensity falls with farm size. As shown in Figure 6, farms with less than one hectare employ on average 7.32 workers per hectare; while farms between 20 and 50 hectares employ on average 0.61 workers per hectare.

Fact 2. Within regions, output per worker increases with farm size and the relationship between land yields and farm size varies across countries and farm size. Figures 7 and 8 present the relationship between farm size, output per worker and land yields, after controlling for region fixed effects.[23] Within regions, larger farms have higher output per worker. In contrast, the relationship between farm size and land yields varies across countries and farm size. In general, for the smallest farms in each country we observe a negative (Bolivia, Chile, Ecuador, México, Perú) or null (El Salvador and Colombia) relationship. For the largest farms, we observe a positive (Chile, Ecuador, El Salvador, Paraguay, Perú) and a null (Bolivia and México) relationship.[24] Appendix figures A3 and A4 present the results using total land holdings as a measure of farm size.

As discussed in our conceptual framework, the heterogeneity in land yields across the farm size distribution suggest the existence of distortions in land and labor markets. The negative relationship between land yields and farm size that we find for small farms in most of the countries is consistent with the empirical regularity in the "inverse relationship" literature. Similarly, the positive relationship that we find for large farms in some countries is consistent with the evidence of Foster and Rosenzweig (2022) for India and suggest the existence of economies of scale from mechanization along with market distortions that prevent the most productive farmers to accumulate land.

The null relationship for small farms in El Salvador might suggest that due to the small scale, transaction costs associated with hired labor are not significant enough to induce a negative relationship. This is also consistent with the fact that international migration has put pressure on agricultural labor supply (AENOR, 2022). Moreover, the few large farms are likely to be very different from the rest in terms of production technologies, and both exhibit economies of scale and face frictions that hinder the scale expansion.

These relationships between farm size, on the one hand, and land and labor yields, on the other, shape the relationship between rural income and farm size. In the next section, we combine information from household surveys with information on farm size to explore

[22] When we compute farm size as total landholdings instead of cultivated area, the differences are more striking. In particular, the share of workers in farms with less than 5 hectares ranges between 4.4% and 72%, and the shares of land in these farms ranges between 0.05% and 34.34% (See appendix A2a and A2b)

[23] Regions are *municipios* (Colombia, El Salvador, México, and Paraguay), *cantones* (Ecuador), and *provincias* (Bolivia, Chile and Perú).

[24] Colombia is the exception with a negative relationship between farm size and land yields for the largest farms. In Chile, we are only able to compute the value of output from cereals, leguminous vegetables, root crops, and industrial crops (see table A1). Appendix figures A5 and A6 present similar patterns when we compare averages across regions. In the case of Chile and Ecuador, these regional aggregates mask the non-linearity in the relationship between farm size and land yields and display a null relationship between average farm size and average land yields across regions. This could be explained by heterogeneity within regions in farm size and land yields.

this relationship.

V. B Heterogeneity across regions and average agricultural income

We estimate linear regressions of the average household income from agriculture and average wages on average farm size across regions. We estimate one regression per country. The unit of observation in each regression is the region, which corresponds to the smallest geographical unit for which household surveys are representative: *departamentos* (Bolivia, Colombia, Salvador, Paraguay, Perú and Uruguay), *provincias* (Ecuador), *regiones* (Chile), *federal entity* (México). We control for average soil quality and rainfall in each region, and therefore, our results are not likely to be driven by differences in agro-climatic conditions across regions.

Figure 9 presents the coefficient estimates from these linear regressions. In all countries except for Chile, there is a positive relationship between regional averages of agricultural income and average farm size. This positive relationship is statistically significant for Ecuador, El Salvador, México, Paraguay, and Perú. In Paraguay, Perú, and Uruguay, we also find a positive and statistically significant relationship between agricultural wages and farm size.[25] Figure 10 shows that in Bolivia, Paraguay, and Perú there is also a positive and statistically significant relationship between the 25^{th} percentiles of income and farm size. This implies that not only the average household, but the poorest households have higher incomes in areas where the smallest farms are larger.

Although the regional aggregates are affected by price differences across regions, the fact that we find a strong positive relationship between farm size and output per worker within regions, suggests that labor productivity differences across farms of different sizes can drive part of the positive relationships that we find between regional averages of income and farm size. The positive correlation between farm size and household income suggests that the prevalence of labor in low output, labor intensive farming can be associated with overall low income in rural areas and might explain part of the income inequalities between households in agriculture and non-agriculture. As discussed in the previous section, the persistence of this gap might result from distortions in land, labor, and capital markets, as well as other factors shaping the selection of agents across sectors (Young, 2013; Restuccia et al., 2008; Bryan et al., 2014; Lagakos and Waugh, 2013; Adamopoulos et al., 2022; Adamopoulos and Restuccia, 2014).

V. C Heterogeneity within regions and the within agricultural income inequality

Heterogeneity in agricultural labor productivity within regions can explain income inequality across agricultural households. Figure 11 shows that in all countries but Chile and El Salvador, there is a positive correlation between the dispersion of output per worker and the dispersion in agricultural income within regions (measured as the interquartile range). This positive relationship is statistically significant in Colombia and Paraguay.

[25] Appendix tables A4 and A5 show the point estimates, and Appendix Figure A7 presents the relationship with total land area as measure of farm size.

When analysing the relationship between the dispersion in farm size and income inequality we find mixed results. Figure 10 and Appendix Table A6 show a positive and statistically significant relationship between the interquartile range of the distribution of agricultural income and farm size in Ecuador, Paraguay, Perú, and Uruguay, while in the rest of the countries the relationship is not statistically significant. Also, Figure A8 documents that in most countries, there is a negative relationship between the land Gini and the income Gini. Only in Paraguay and Perú, this relationship is positive, but it is not statistically significant.

According to our theoretical framework, in the absence of agricultural labor markets, the dispersion of agricultural productivity determines both the dispersion in farm size and agricultural income inequality. The lack of correlation between these variables, along with the heterogeneity that we observe in land yields across farms might suggest that the existence of distortions that deviate farm size from its efficient allocation.

VI Conclusions

The findings in this chapter highlight that the dynamics in the agricultural sector explain one third of total income inequality in the nine countries we study. Income inequality within the agricultural sector, driven by large differences in agricultural productivity, largely explain this effect. Indeed, the poorest agricultural households in the nine countries are mostly small farmers, with little participation in agricultural and non-agricultural labor markets. Earnings of wealthiest households, on the other hand, are more diversified and depend more on agricultural wages.

Our results suggest that the large prevalence of small farms in most of these countries, concomitantly with frictions in labor and land markets, are associated with low agricultural incomes for small producers. Indeed, high labor intensity in small farms and low output per worker, driven by an overuse of family workers, seem to partially explain the low agricultural income of these households and, consequently, income inequality within in the agricultural sector.

Tackling rural poverty and income inequality thus requires understanding the complex relation between land size, agricultural productivity and agricultural income. The widespread idea of high productivity small farms misses an important piece of the puzzle. Output per worker, which largely determines agricultural income, is much lower in these farms. Moreover, this idea could lead to the aim of equalizing farm size within regions, which could lead to lower and more disperse income.

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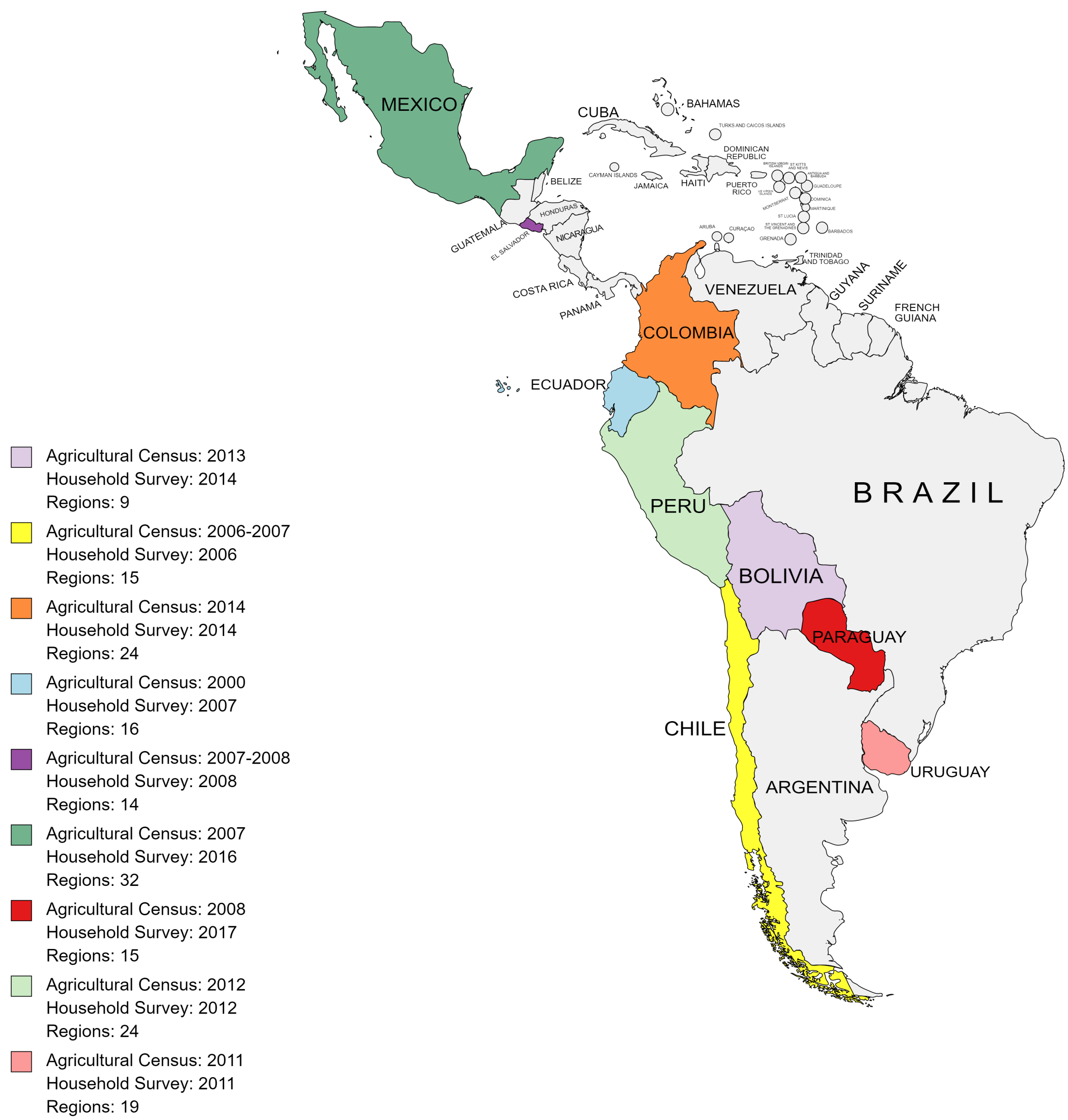
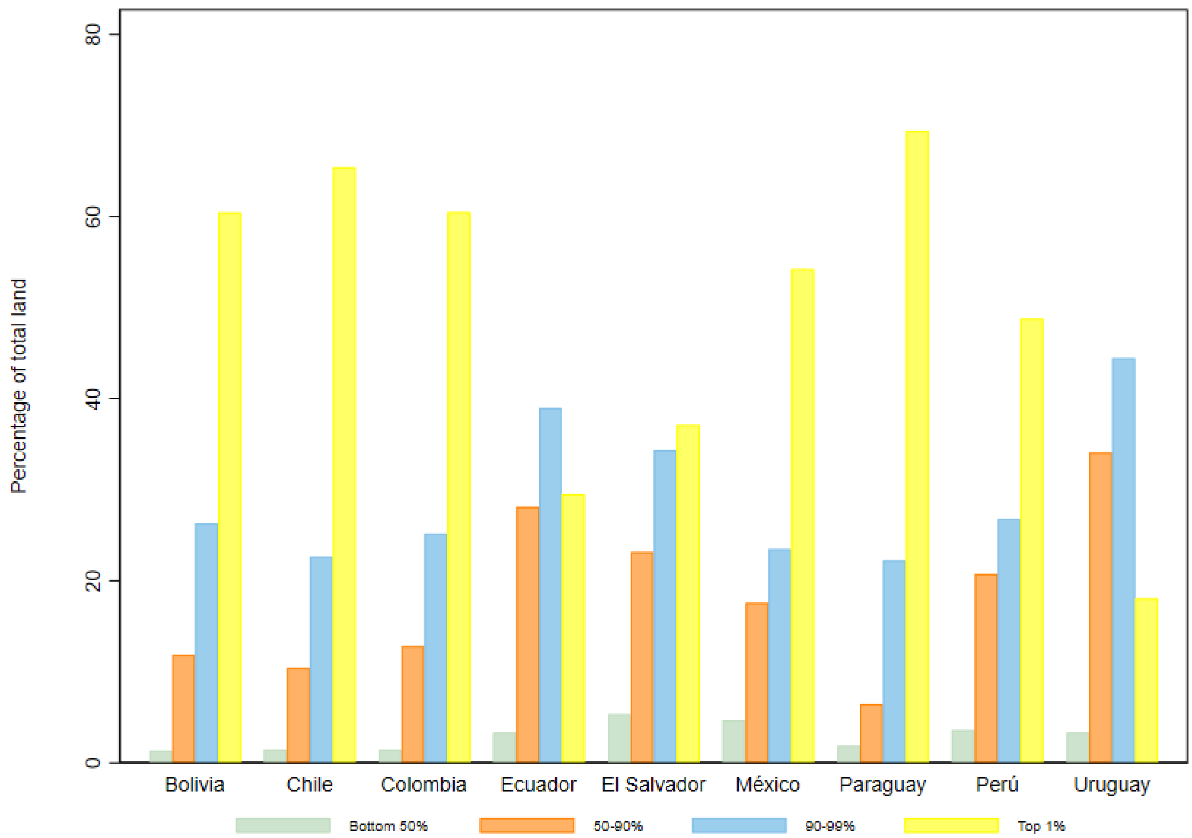
VII Tables and Figures

Figure 1. Countries covered in the chapter



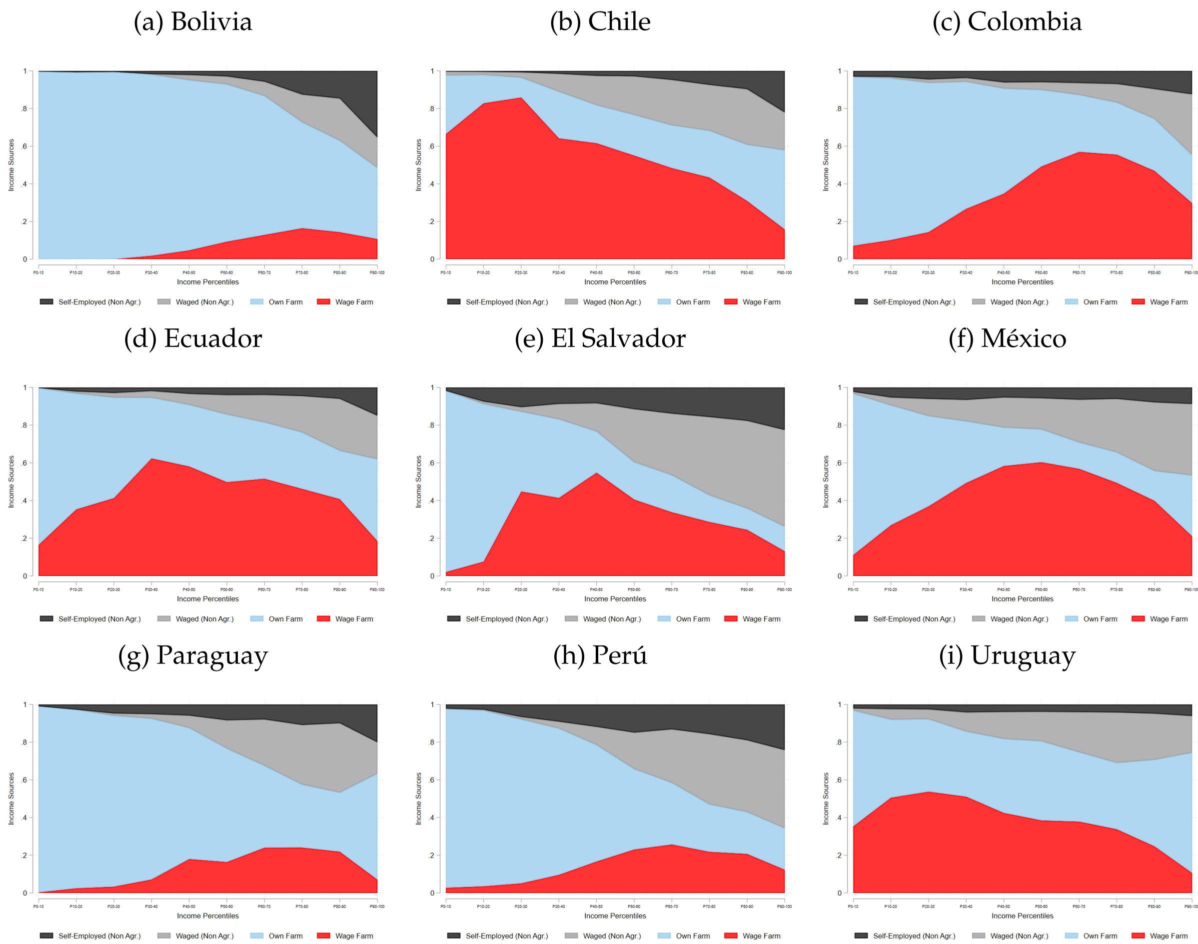
Notes: The map presents in colors the countries included in the analysis. The legend shows the census and surveys years and the number of regions within each country.

Figure 2. Shares of farms by Population Groups



Notes: The sample includes all farms that report at least one worker. Farm size is measured as total farm area.
Sources: Own calculations based on: Bolivia - CAI (2013); Chile - CNVAFVII (2006-2007); Colombia - CNAIII (2014); Ecuador - CNAIII (2000); El Salvador - CAIV (2007-2008); México - CAGFVIII (2007); Paraguay - CAN (2008); Perú - CNAIV (2012) ; Uruguay - CGAXIX (2011).

Figure 3. Household Level Decomposition of Income Sources

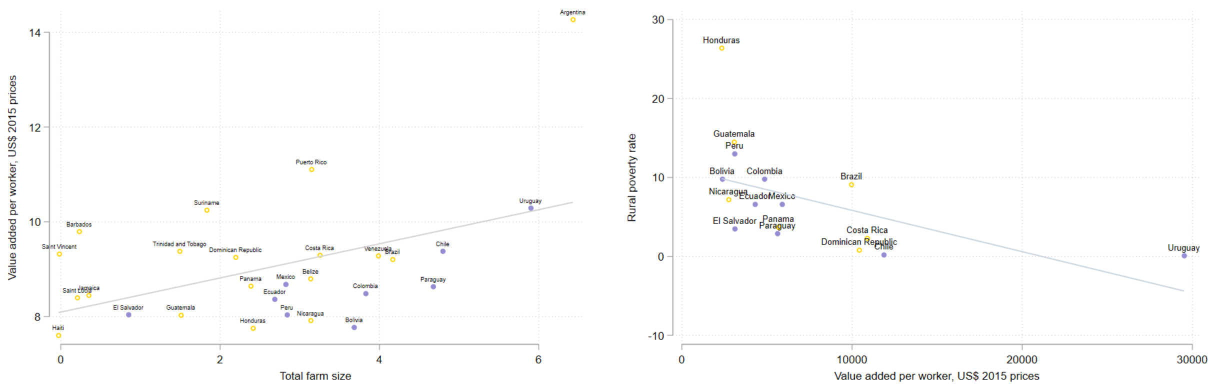


Notes: Includes only agricultural households, whether they are rural or urban. Households are ranked in deciles across income distribution. Total agricultural income of all households in each decile are then plotted according to four different income sources.
Sources: Bolivia - EH (2014); Chile - CASEN (2006); Colombia - GEIH (2014); Ecuador - ENEMDU (2007); El Salvador - EHPM (2008); México - ENIGH (2016); Paraguay - EPH (2017); Perú - ENAHO (2012); Uruguay- ECH (2011).

Figure 4. Aggregate Agricultural Productivity, Farm Size, and Rural Poverty

(a) Value Added per Worker

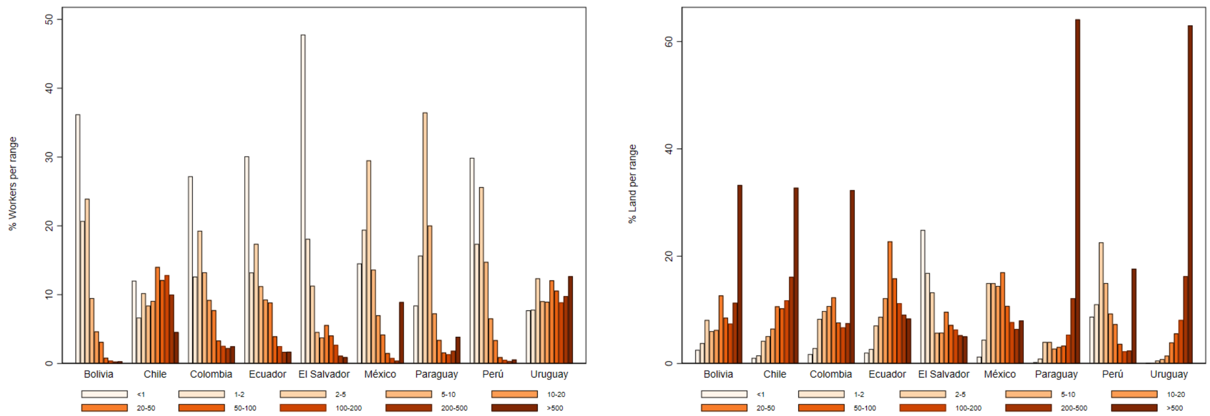
(b) Rural poverty rate and Value Added per Worker



Notes: Panel (a) reports the relationship between log agricultural value added per worker and log average farm size. Panel (b) reports the relationship between rural poverty rate at $2.15/day (2017 PPP) and agricultural value added per worker.
Sources: Agricultural value added and average farm size (FAO), poverty (World Bank Poverty and Inequality platform).

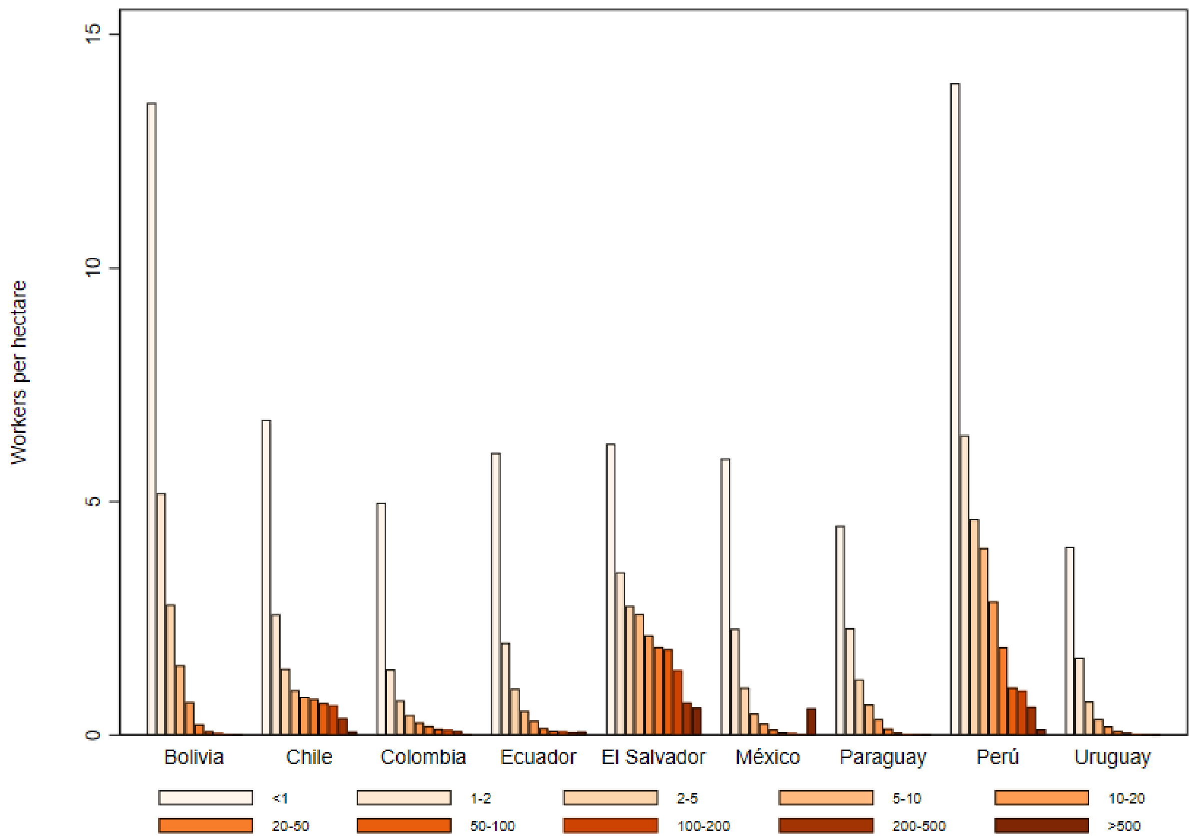
Figure 5. Share of land and labor by farm size

(a) Share of workers (b) Share of land



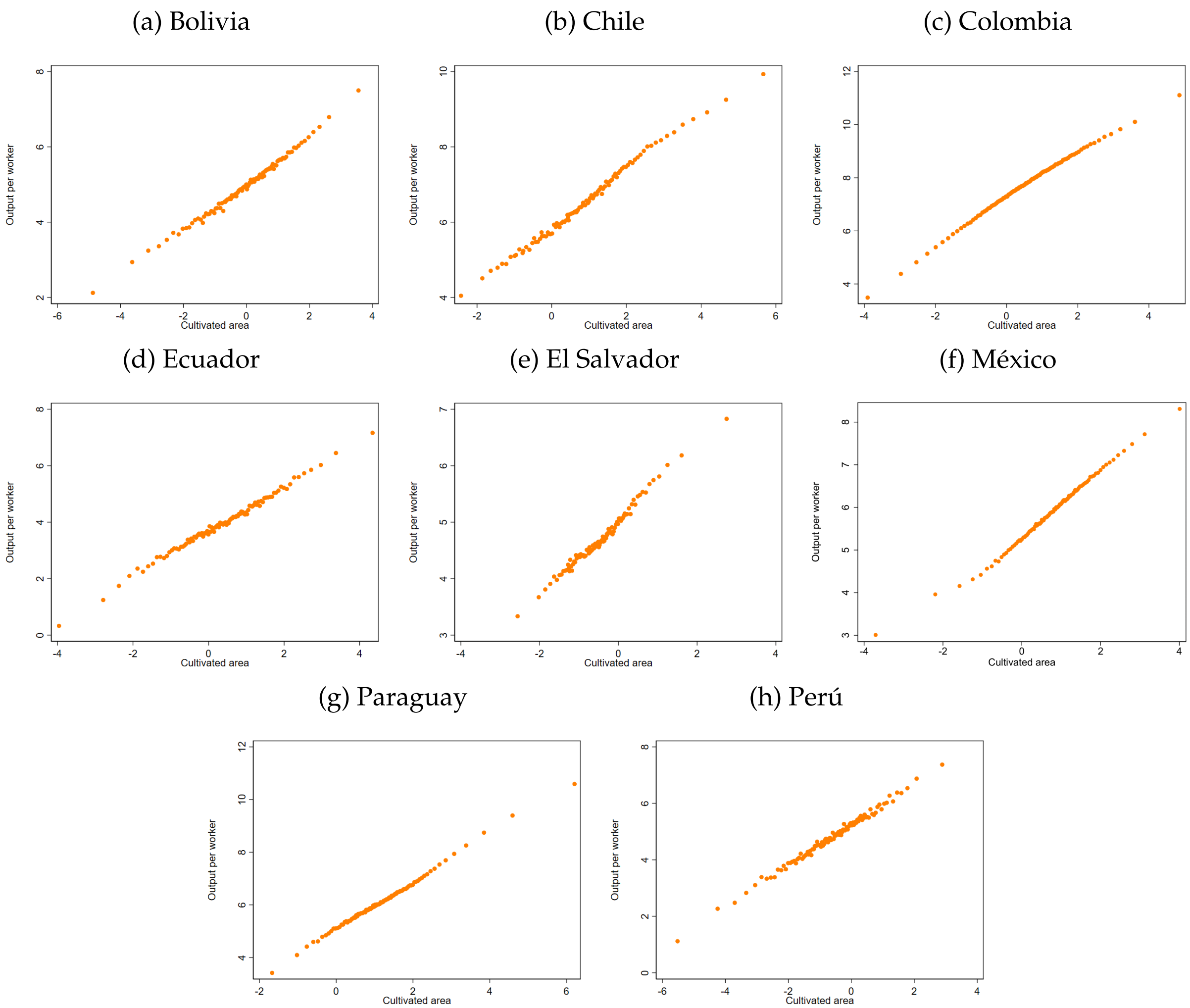
Notes: The sample includes all farms that report at least one worker. Farm workers include family and hired workers (permanent and seasonal). Farm size measured as cultivated area (hectares).
Sources: Own calculations based on: Bolivia - CAI (2013); Chile - CNVAFVII (2006-2007); Colombia - CNAIII (2014); Ecuador - CNAIII (2000); El Salvador - CAIV (2007-2008); México - CAGFVIII (2007); Paraguay - CAN (2008); Perú - CNAIV (2012) ; Uruguay - CGAXIX (2011).

Figure 6. Labor intensity by farm size



Notes: The sample includes all farms that report at least one worker. Farm workers include family and hired workers (permanent and seasonal). Farm size measured as cultivated area (hectares).
Sources: Own calculations based on: Bolivia - CAI (2013); Chile - CNVAFVII (2006-2007); Colombia - CNAIII (2014); Ecuador - CNAIII (2000); El Salvador - CAIV (2007-2008); México - CAGFVIII (2007); Paraguay - CAN (2008); Perú - CNAIV (2012) ; Uruguay - CGAXIX (2011).

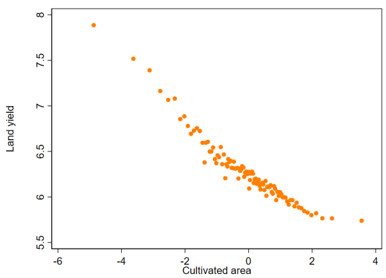
Figure 7. Output per worker and farm size



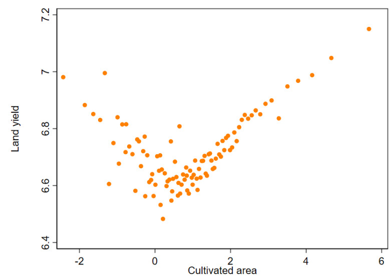
Notes: Binned scatterplots of the relationship between log of output per worker and log of cultivated area controlling for fixed effects of regions within countries.
Sources: Own calculations based on: Bolivia - CAI (2013); Chile - CNVAFVII (2006-2007); Colombia - CNAIII (2014); Ecuador - CNAIII (2000); El Salvador - CAIV (2007-2008); México - CAGFVIII (2007); Paraguay - CAN (2008); Perú - ENA (2019).

Figure 8. Land yields and farm size

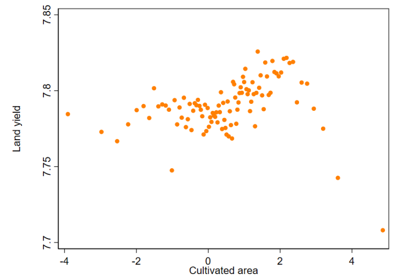
(a) Bolivia



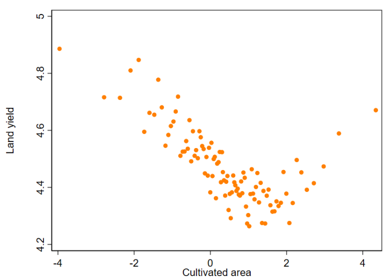
(b) Chile



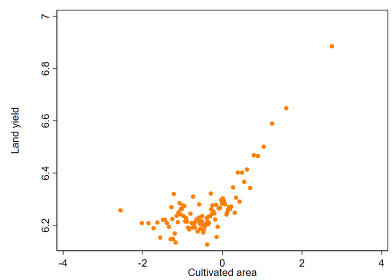
(c) Colombia



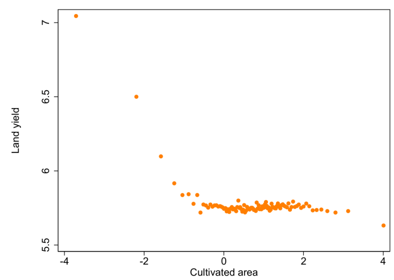
(d) Ecuador



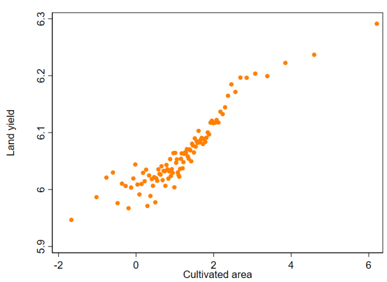
(e) El Salvador



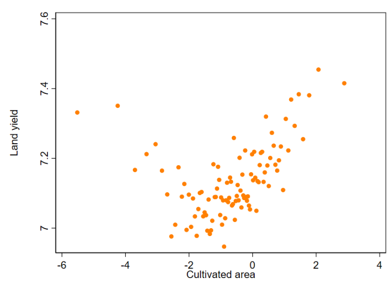
(f) México



(g) Paraguay

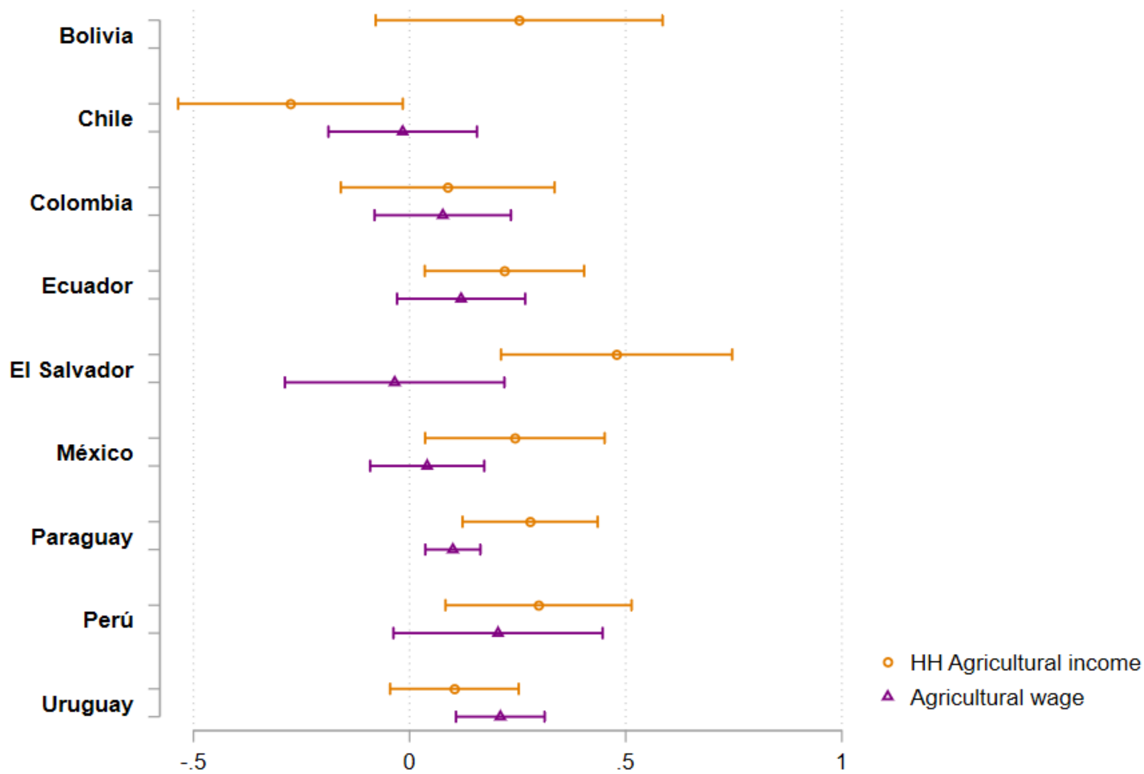


(h) Perú



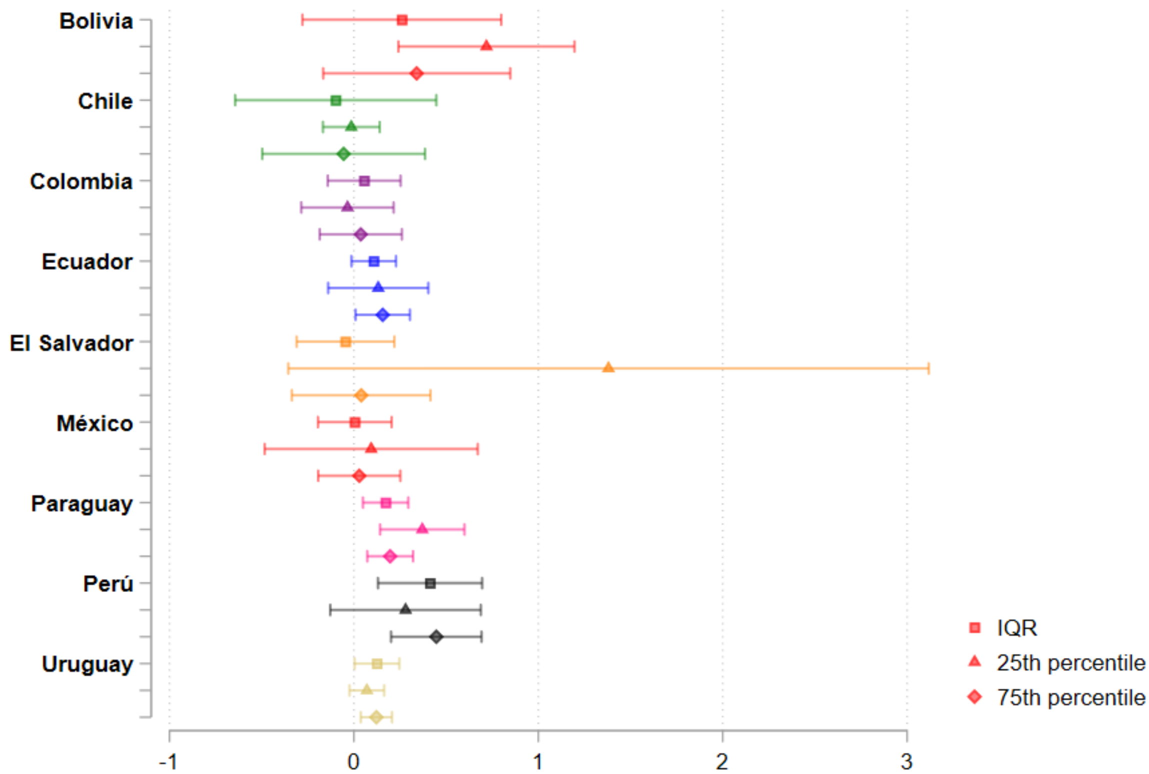
Notes: Binned scatterplots of the relationship between log of land yields and log of cultivated area controlling for fixed effects of regions within countries.
Sources: Own calculations based on: Bolivia - CAI (2013); Chile - CNVAFVII (2006-2007); Colombia - CNAIII (2014); Ecuador - CNAIII (2000); El Salvador - CAIV (2007-2008); México - CAGFVIII (2007); Paraguay - CAN (2008); Perú - ENA (2019).

Figure 9. Relationship between household agricultural income and farm size



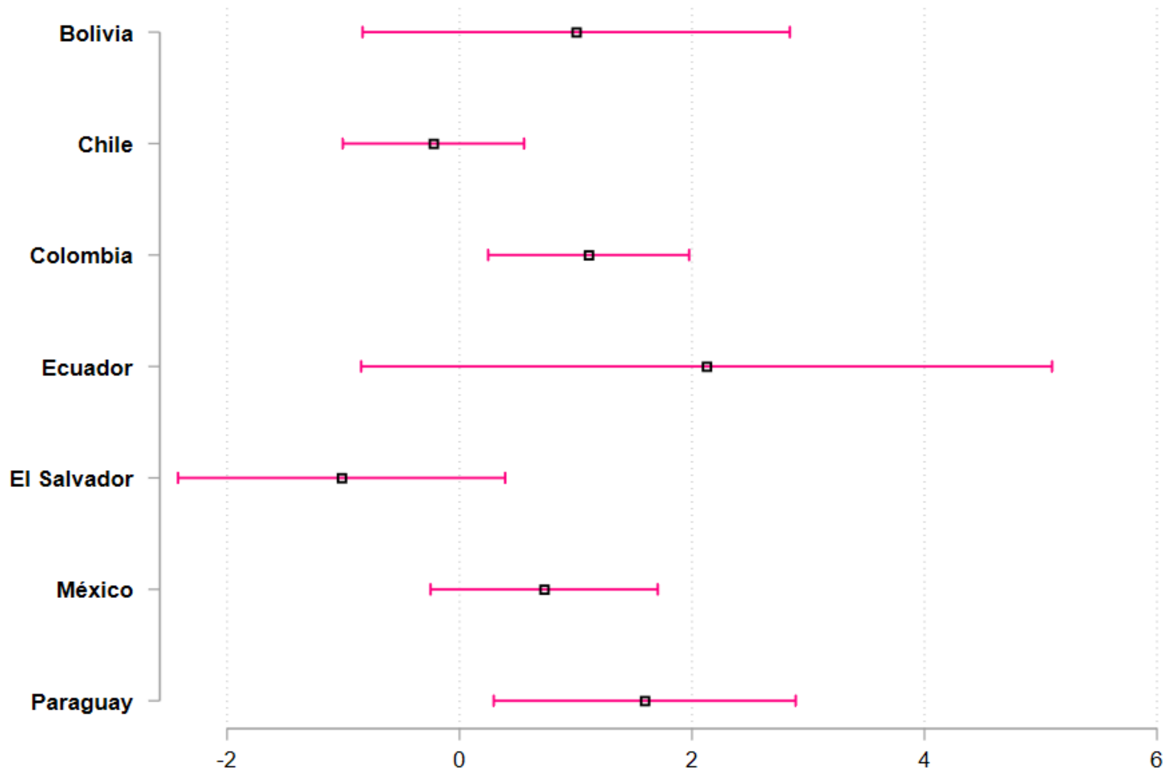
Notes: Coefficient estimates from independent linear regressions with log of average farm size (measured as cultivated area) as independent variable and log of average agricultural income and log of average agricultural wages across regions as dependent variables. Regional averages of soil quality and rainfall are included as control. Bolivia is not included, because the sample that receives agricultural wages is not representative.
Sources: Own calculations based on: Bolivia - EH (2014) and CAI (2013); Chile - CASEN (2006) and CNVAFVII (2006-2007); Colombia - GEIH (2014) and CNAIII (2014); Ecuador - ENEMDU (2007) and CNAIII (2000); El Salvador - EHPM (2008) and CAIV (2007-2008); México - ENIGH (2016) and CAGFVIII (2007); Paraguay - EPH (2017) and CAN (2008); Perú - ENAHO (2012) and CNAIV (2012); Uruguay- ECH (2011) and CGAXIX (2011).

Figure 10. Relationship between interquartile range, 25th, and 75th percentile of agricultural income and farm size



Notes: Coefficient estimates from independent linear regressions with log of IQR, the 25th and 75th percentiles of cultivated area (independent variables) and agricultural income (dependent variables) across regions. Regional averages of soil quality and rainfall included as controls.
Sources: Own calculations based on:Bolivia - EH (2014) and CAI (2013); Chile - CASEN (2006) and CNVAFVII (2006-2007); Colombia - GEIH (2014) and CNAIII (2014); Ecuador - ENEMDU (2007) and CNAIII (2000); El Salvador - EHPM (2008) and CAIV (2007-2008); México - ENIGH (2016) and CAGFVIII (2007); Paraguay - EPH (2017) and CAN (2008); Perú - ENAHO (2012) and CNAIV (2012); Uruguay- ECH (2011) and CGAXIX (2011).

Figure 11. Relationship between interquartile of range of output per worker and interquartile of agricultural income



Notes: Coefficient estimates from independent linear regressions with the log of interquartile range of output per worker as dependent variable and the log of interquartile range of agricultural income as independent variable across regions. Regional averages of soil quality and rainfall included as controls.
Sources: Own calculations based on: Bolivia - EH (2014) and CAI (2013); Chile - CASEN (2006) and CNVAFVII (2006-2007); Colombia - GEIH (2014) and CNAIII (2014); Ecuador - ENEMDU (2007) and CNAIII (2000); El Salvador - EHPM (2008) and CAIV (2007-2008); México - ENIGH (2016) and CAGFVIII (2007); Paraguay - EPH (2017) and CAN (2008).

Table 1. Average land size and input use

Variable	Bolivia	Chile	Colombia	Ecuador	El Salvador	México	Paraguay	Perú	Uruguay
Total farm size (hectares)	38.35	87.83	19.71	14.94	2.37	16.76	70.71	7.54	364.17
	(460,98)	(1,515.97)	(599.85)	(130.14)	(15.23)	(250.08)	(1,065.81)	(159.55)	(872.24)
Total number of workers	6.10	7.67	1.94	3.19	4.62	2.79	3.77	8.56	2.80
	(23.87)	(44.45)	(6.39)	(9.17)	(16.57)	(4.74)	(4.80)	(44.43)	(7.36)
Number of hired workers	2.99	6.06	1.15	0.91	4.30	1.28	1.17	6.60	1.25
	(20.55)	(51.76)	(6.42)	(9.16)	(98.89)	(4.66)	(4.67)	(44.44)	(7.37)
Number of family workers	3.10	2	0.79	2.27	1.41	1.72	2.59	2.04	1.54
	(10.04)	(1.18)	(0.80)	(1.51)	(1.26)	(1.52)	(1.79)	(1.42)	(0.98)
Hectares per worker	2.01	3.50	4.58	2.74	0.29	3.72	6.84	0.79	45.30
	(16.88)	(64.79)	(110.94)	(9.21)	(0.51)	(28.86)	(58)	(23.72)	(288.57)
Cultivated area (% total farm size)	46.33	41.07	74.88	43.40	89.86	84.70	51.87	62.61	24.85
	(0.33)	(0.32)	(0.34)	(0.33)	(0.22)	(0.27)	(0.27)	(0.34)	(0.26)
% Farms with irrigation	31.32	46.25	12.26	29.48	3.26	15.33	1.43	43.89	8.07
% Farms using tractors			0.78		4.09	36.95			
% Farms with own tractors	3.21	12.84		1.16			5.68	0.39	46.96
% Farms with rented tractors	35.91	24.72		0.16			13.71	22.66	

Notes: The sample includes all farms that report at least one worker. Farm size is measured as total farm area. Hectares per workers are calculated using cultivated hectares.
Sources: Own calculations based on: Bolivia - CAI (2013); Chile - CNVAFVII (2006-2007); Colombia - CNAIII (2014); Ecuador - CNAIII (2000); El Salvador - CAIV (2007-2008); México - CAGFVIII (2007); Paraguay - CAN (2008); Perú - CNAIV (2012) ; Uruguay - CGAXIX (2011).

Table 2. Rural population and agricultural sector by country

Variable	Bolivia	Chile	Colombia	Ecuador	El Salvador	México	Paraguay	Perú	Uruguay
Rural population (%)	30.22	12.35	18.89	36.01	27.25	19.55	38.12	21.90	4.57
Employment in agriculture (%)	30.54	8.97	15.77	29.73	16.29	12.47	18.71	27.37	8.4
Agricultural GDP (% GDP)	12.21	3.98	6.41	8.80	5.14	3.39	9.99	6.85	6.45
Rural poverty rate (%)	5.6	0.4	11.8	8.4	2.5	6	1.9	11.1	0.3
Urban poverty rate (%)	0.3	0.8	3.4	1.3	0.7	2.3	0.5	0.8	0.1
Monthly agricultural wage (USD PPP)	666,66	341.02	496.04	114.44	124.05	259.75	660.53	355.22	659.65
	(399.81)	(263.28)	(299.83)	(91.10)	(62.37)	(204)	(420.31)	(301.89)	(644.17)
Yearly hh agricultural income (USD PPP)	5,619.15	6,717	5,467	2,205	1,298	3.111	8,615.53	3,315.97	12,935
	(10,006)	(9,567)	(6,351)	(3,282)	(1,309)	(6,137)	(38,229.10)	(4,620.48)	(16,765)
Agricultural wage ratio (% non-agricultural wage)	68,56	49.10	51.44	39.00	42.53	39,93	70,06	45.13	67,15

Notes: Monetary values are in USD constant prices using 2011. Urban and rural poverty rate at $2.15/day (2017 PPP). Wages and income variables use data for the same years of the household surveys in each country. Other indicators use 2019 data.
Sources: `https://data.worldbank.org` in year 2019 for % of rural population, employment in agriculture, agricultural GDP and rural and urban poverty rates. Own calculations for monthly agricultural wage, yearly household agricultural income and agricultural wage ratio based on: Bolivia - EH (2014); Chile - CASEN (2006); Colombia - GEIH (2014); Ecuador - ENEMDU (2007); El Salvador - EHPM (2008); México - ENIGH (2016); Paraguay - EPH (2017); Perú - ENAHO (2012); Uruguay- ECH (2011).

Table 3. Land Inequality Estimates: LAC, Asia, MENA, SSA

Region	Country	Gini Coefficient	Avg. Farm Size (ha)	Census year
Latin America and Carribean	Bolivia*	0.91	40.22	2013
	Brazil	0.86	67.81	2006
	Chile*	0.94	106.87	2006
	Colombia*	0.95	45.99	2014
	Costa Rica	0.82	26.74	2014
	Ecuador*	0.81	14.66	1999
	El Salvador**	0.82	2.36	2007
	Guatemala	0.85	4.52	2003
	Jamaica	0.81	1.62	2007
	México	0.85	16.85	2007
	Nicaragua	0.78	23.06	2011
	Panama	0.87	10.86	2011
	Paraguay*	0.94	107.61	2008
	Perú*	0.93	17.51	2012
	Puerto Rico	0.74	17.99	2012
	Saint Lucia	0.69	1.29	2007
	Uruguay*	0.77	365.27	2011
	Venezuela	0.87	63.81	2008
	Virgin Islands	0.85	10.85	2007
Average of Region:		**0.84**	**49.7**	
Asia	Bangladesh	0.52	.59	2008
	Cambodia	0.55	1.63	2013
	India	0.61	1.15	2010
	Indonesia	0.65	0.97	2013
	Kazakhstan***	0.90	394.33	2006
	Laos	0.44	2.41	2010
	Myanmar	0.49	2.56	2010
	Nepal	0.51	.66	2011
	Pakistan	0.64	2.59	2010
	Philippines	0.65	1.31	2012
	Thailand	0.51	3.15	2013
	Vietnam	0.63	0.75	2011
Average of Region:		**0.56**	**1.3**	

Region	Country	Gini Coefficient	Avg. Farm Size (ha)	Census year
Middle East - North Africa	Algeria	0.65	8.74	2001
	Egypt	0.67	0.92	2009
	Iran	0.72	4.90	2014
	Jordan	0.82	3.33	2007
	Lebanon	0.69	1.40	2010
	Morocco	0.62	6.10	1996
	Oman	0.83	0.97	2012
	Qatar	0.91	11.91	2000
	Saudi Arabia	0.92	12.00	2015
	Tunisia	0.67	10.66	2004
	Turkey	0.59	6.10	2001
	Yemen	0.75	1.36	2003
Average of Region:		**0.73**	**5.7**	
Sub-Saharan Africa	Burkina Faso	0.45	4.40	2006
	Cabo Verde	0.52	1.07	2015
	Cote d'Ivoire	0.66	3.89	2001
	Ethiopia	0.52	1.03	2001
	Malawi	0.42	0.84	2006
	Namibia	0.38	2.88	1997
	Senegal	0.51	4.29	1999
	Seychelles	0.46	0.88	2011
	Tanzania	0.58	2.70	2007
	Uganda	0.62	2.16	1992
Average of Region:		**0.51**	**2.4**	

Notes: For all countries, micro and tabulations may not represent the same data. This arises from two main reasons: (i) the data trimming process which we perform on the micro data as described in the data sources section; and (ii) the micro-data we receive from statistical offices sometimes does not include the data on which the tabulations were created (for example: For Chile, the tabulations exclude forest and wooded regions while the micro data includes them. The inverse is true for Colombia, that is, micro-data don't include forest and wooded regions while the census tabulations do.).
* **Ginis:** we also calculate the Gini based on agricultural census micro-data for the five countries in our sample which also had FAO tabulations: 0.91 (Bolivia); 0.91 (Chile); 0.90 (Colombia); 0.82 (Ecuador); 0.93 (Paraguay); 0.83 (Perú); 0.76 (Uruguay). Almost all Ginis from generalized pareto interpolations are very close in magnitude to micro-data estimates except for Peru with a decrease in the micro-based gini of 0.1. This is due to the trimming procedure discussed in the data section.
* **Avg. Farm Size:** The sizeable difference in average size farm for both data sources for example in Chile (87 vs 106) and Colombia (19 vs 46) stems again from the same data discrepancies between both sources described above.
** Census Tabulations don't exist for El Salvador so micro-data from this paper was used to calculate this Gini and average farm size directly.
*** Given the obvious status as an outlier, we do not include Kazakhstan in the averages for the region. If we do include it, the average Gini of Asia is 0.59 and the average farm size of Asia inflates up to 32.9 ha.
Sources: Formatted FAO data used for generalized pareto interpolations was graciously provided by authors of (Bauluz et al., 2020). Original data stems of FAO WCA tabulations found in booklets for 2000 and 2010 rounds here: https://www.fao.org/world-census-agriculture/wcarounds/census/en/.

Table 4. Average Farm Size per Population Share (ha)

	Bottom 50%	50-90%	90-99%	Top 1%	# of Farms	Total Land	Avg. Size
Bolivia	1.04	11.31	115.52	2,298.54	844,104	32,373,152	38.35
Chile	2.63	22.85	220.94	5,744.15	218,487	19,190,198	87.83
Colombia	0.58	6.31	55.19	1,192.66	1,893,939	37,334,816	19.71
Ecuador	0.98	10.65	66.48	441.38	692,550	10,348,257	14.94
El Salvador	0.32	1.07	8.99	83.68	388,742	923,202	2.37
México	1.42	8.15	49.70	909.50	3,961,799	66,425,736	16.77
Paraguay	2.65	11.56	174.88	4879.67	261,428	18,486,282	70.71
Perú	0.54	3.83	24.81	348.42	2,123,973	16,016,540	7.54
Uruguay	24.44	310.25	1,799.94	6,548.42	44,653	16,261,345	364.71

Sources: Own calculations based on: Bolivia - CAI (2013); Chile - CNVAFVII (2006-2007); Colombia - CNAIII (2014); Ecuador - CNAIII (2000); El Salvador - CAIV (2007-2008); México - CAGFVIII (2007); Paraguay - CAN (2008); Perú - CNAIV (2012) ; Uruguay - CGAXIX (2011).

Table 5. Rural-Urban Theil Decomposition

	MLD_{Total}	$\text{MLD}_{Between}$	ELMO	MLD_{Rural}	Pop_{Rural}	MLD_{Urban}	Pop_{Urban}
Bolivia	0.56	0.08	0.26	0.74	0.34	0.36	0.66
Chile	0.50	0.01	0.08	0.51	0.13	0.48	0.87
Colombia	0.52	0.07	0.28	0.41	0.24	0.46	0.76
Ecuador	0.57	0.06	0.22	0.53	0.31	0.50	0.69
El Salvador	0.47	0.05	0.22	0.43	0.32	0.41	0.68
México	0.56	0.04	0.18	0.67	0.21	0.48	0.79
Paraguay	0.51	0.03	0.10	0.67	0.42	0.35	0.58
Perú	0.62	0.09	0.29	0.77	0.26	0.44	0.74
Uruguay	0.39	0.00	0.03	0.33	0.14	0.39	0.86

Notes: Includes all households with positive income. Rural definition is defined by each survey.
Sources: Bolivia - EH (2014); Chile - CASEN (2006); Colombia - GEIH (2014); Ecuador - ENEMDU (2007); El Salvador - EHPM (2008); México - ENIGH (2016);Paraguay - EPH (2017); Perú - ENAHO (2012); Uruguay- ECH (2011).

Table 6. Agricultural - Non. Agricultural Theil Decomposition

	MLD_{Total}	$MLD_{Between}$	ELMO	$MLD_{Agricul}$	$Pop_{Agricul}$	$MLD_{Non-Agricul}$	$Pop_{Non-Agricul}$
Bolivia	0.56	0.06	0.20	0.87	0.31	0.34	0.69
Chile	0.50	0.02	0.12	0.38	0.16	0.50	0.84
Colombia	0.52	0.05	0.21	0.42	0.21	0.48	0.79
Ecuador	0.57	0.06	0.21	0.53	0.29	0.50	0.71
El Salvador	0.47	0.05	0.22	0.50	0.29	0.38	0.71
México	0.56	0.04	0.20	0.72	0.16	0.48	0.84
Paraguay	0.51	0.03	0.12	0.81	0.27	0.36	0.73
Perú	0.62	0.08	0.25	0.78	0.33	0.41	0.67
Uruguay	0.39	0.00	0.00	0.36	0.12	0.39	0.88

Notes: Includes all households with positive income. Agricultural definition was described in data sources section.
Sources: Bolivia - EH (2014); Chile - CASEN (2006); Colombia - GEIH (2014); Ecuador - ENEMDU (2007); El Salvador - EHPM (2008); México - ENIGH (2016);Paraguay - EPH (2017); Perú - ENAHO (2012); Uruguay- ECH (2011).

Table 7. Agricultural Sector Regional Theil Decomposition

Country	$\text{MLD}_{Agricull}$	$\text{MLD}_{Between-Regions}$	ELMO	$\text{MLD}_{Within-Regions}$	# of Regions
Bolivia	0.87	0.16	0.21	0.71	9
Chile	0.38	0.02	0.06	0.36	15
Colombia	0.42	0.05	0.11	0.37	24
Ecuador	0.53	0.03	0.07	0.50	16
El Salvador	0.50	0.01	0.03	0.49	14
México	0.72	0.08	0.12	0.64	32
Paraguay	0.81	0.06	0.08	0.75	15
Perú	0.78	0.07	0.08	0.72	25
Uruguay	0.36	0.02	0.07	0.34	19

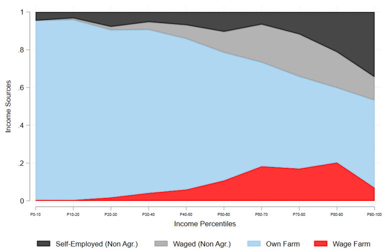
Notes: Includes all agricultural households with positive income. Agricultural definition was described in data sources section.
Sources: Bolivia - EH (2014); Chile - CASEN (2006); Colombia - GEIH (2014); Ecuador - ENEMDU (2007); El Salvador - EHPM (2008); México - ENIGH (2016);Paraguay - EPH (2017); Perú - ENAHO (2012); Uruguay- ECH (2011).

A Online Appendix

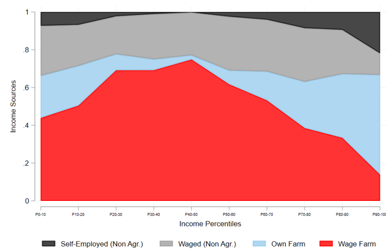
A.I Additional Figures and Tables

Figure A1. Individual Level Decomposition of Income Sources

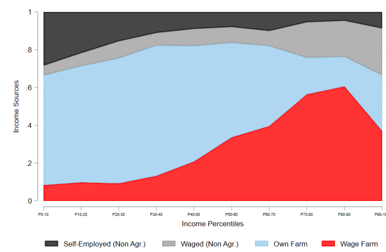
(a) Bolivia



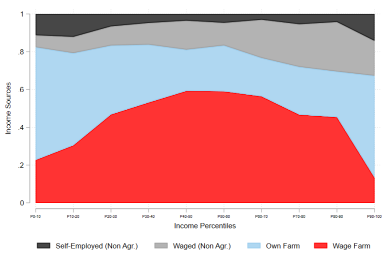
(b) Chile



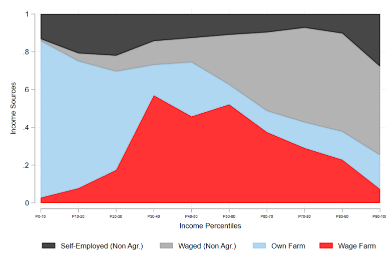
(c) Colombia



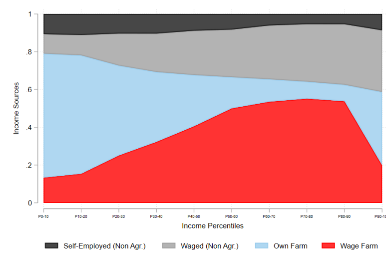
(d) Ecuador



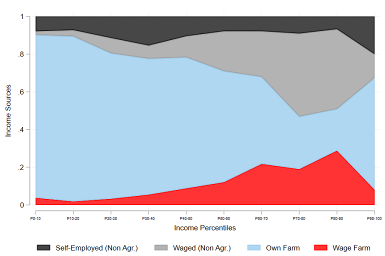
(e) El Salvador



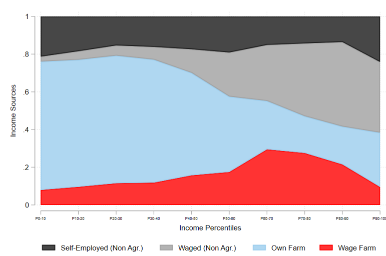
(f) México



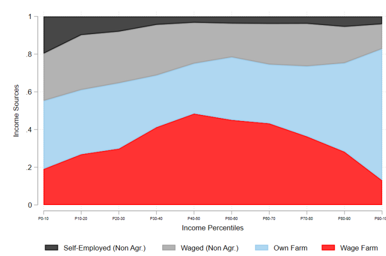
(g) Paraguay



(h) Perú



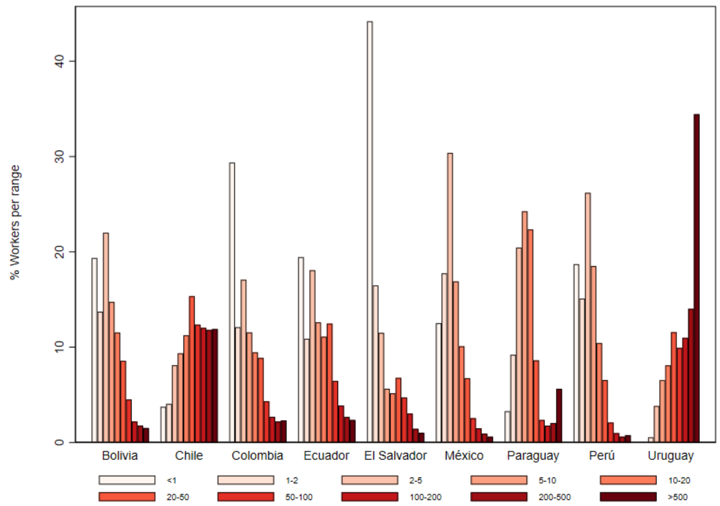
(i) Uruguay



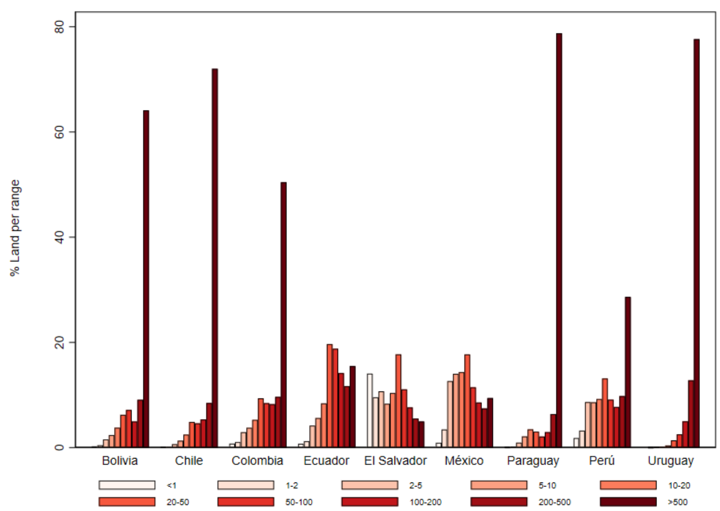
Notes: Includes only individuals in agricultural households, whether they are rural or urban. Individuals are ranked in deciles across income distribution. Total income of all individuals in each decile are then plotted according to four different income sources.
Sources:Bolivia - EH (2014); Chile - CASEN (2006); Colombia - GEIH (2014); Ecuador - ENEMDU (2007); El Salvador - EHPM (2008); México - ENIGH (2016); Paraguay - EPH (2017); Perú - ENAHO (2012); Uruguay- ECH (2011).

Figure A2. Share of land and labor by total farm area

(a) Share of workers

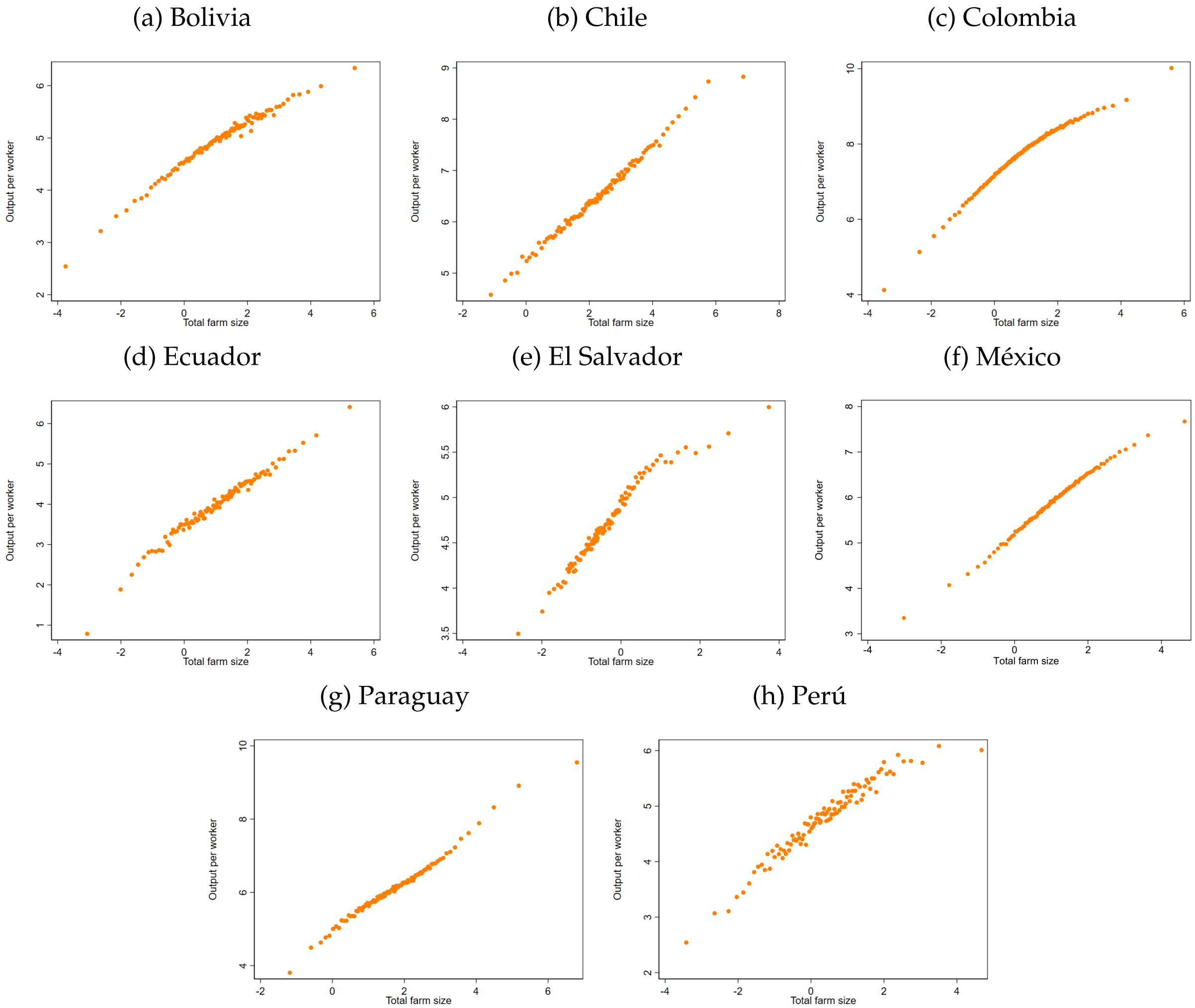


(b) Share of land



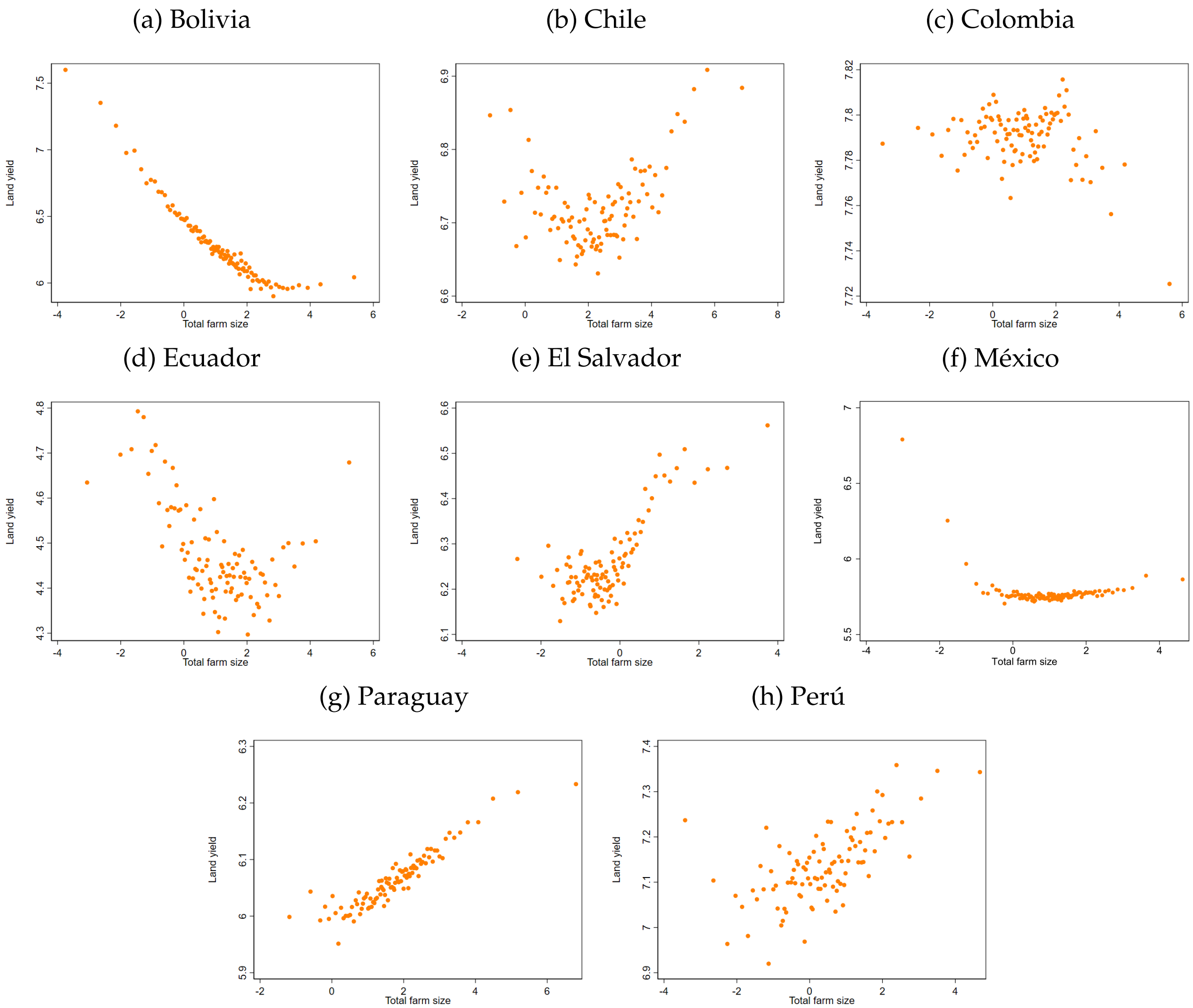
Notes: The sample includes all farms that report at least one worker. Farm size measured as total farm area (hectares). Farm workers include family and hired workers (permanent and seasonal).
Sources: Own calculations based on: Bolivia - CAI (2013); Chile - CNVAFVII (2006-2007); Colombia - CNAIII (2014); Ecuador - CNAIII (2000); El Salvador - CAIV (2007-2008); México - CAGFVIII (2007); Paraguay - CAN (2008); Perú - CNAIV (2012) ; Uruguay - CGAXIX (2011).

Figure A3. Output per worker and total farm area



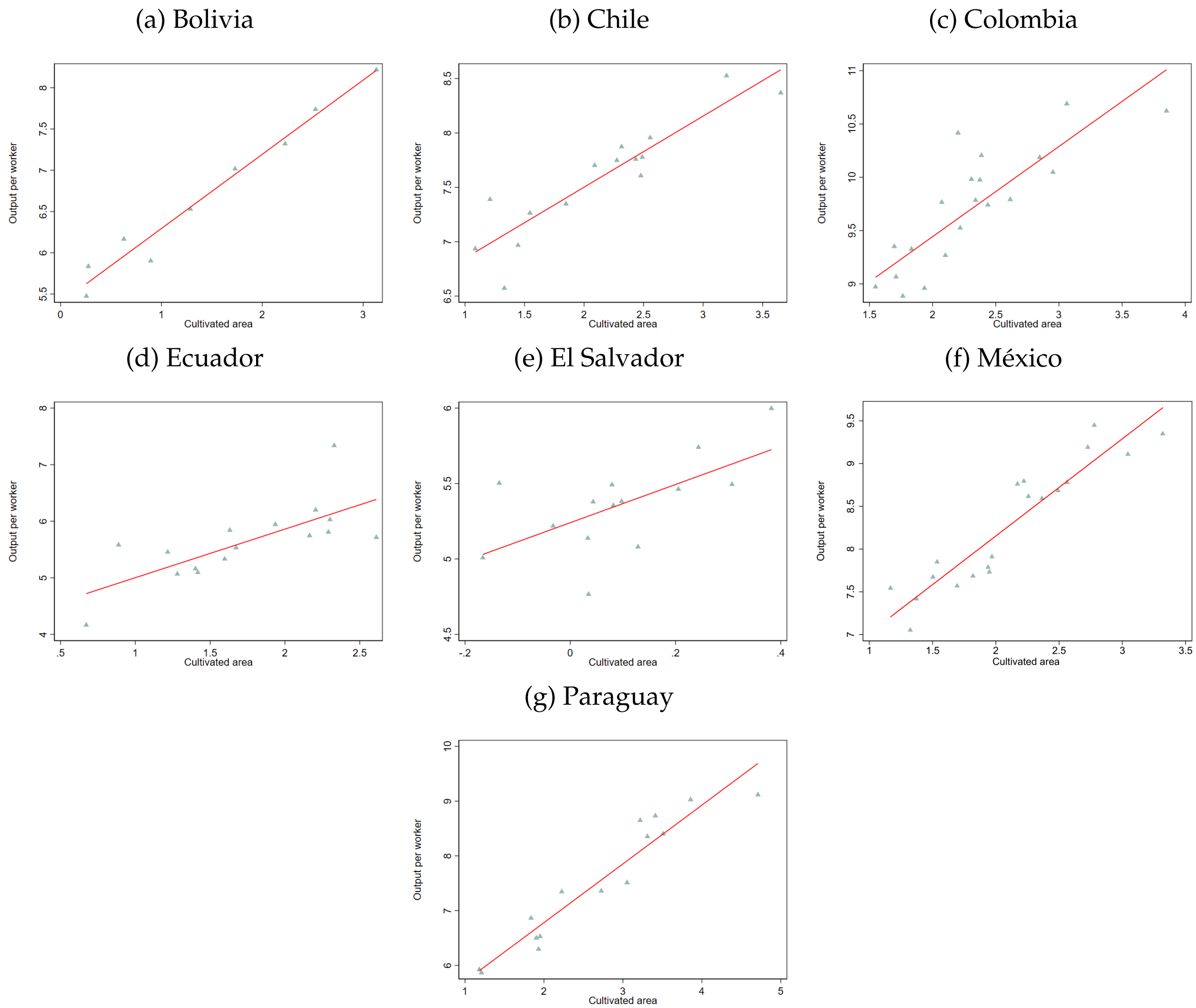
Notes: Binned scatterplots of the relationship between log of output per worker and log of total farm area controlling for fixed effects of regions within countries.
Sources: Own calculations based on: Bolivia - CAI (2013); Chile - CNVAFVII (2006-2007); Colombia - CNAIII (2014); Ecuador - CNAIII (2000); El Salvador - CAIV (2007-2008); México - CAGFVIII (2007); Paraguay - CAN (2008); Perú - ENA (2019).

Figure A4. Land yields and total farm area



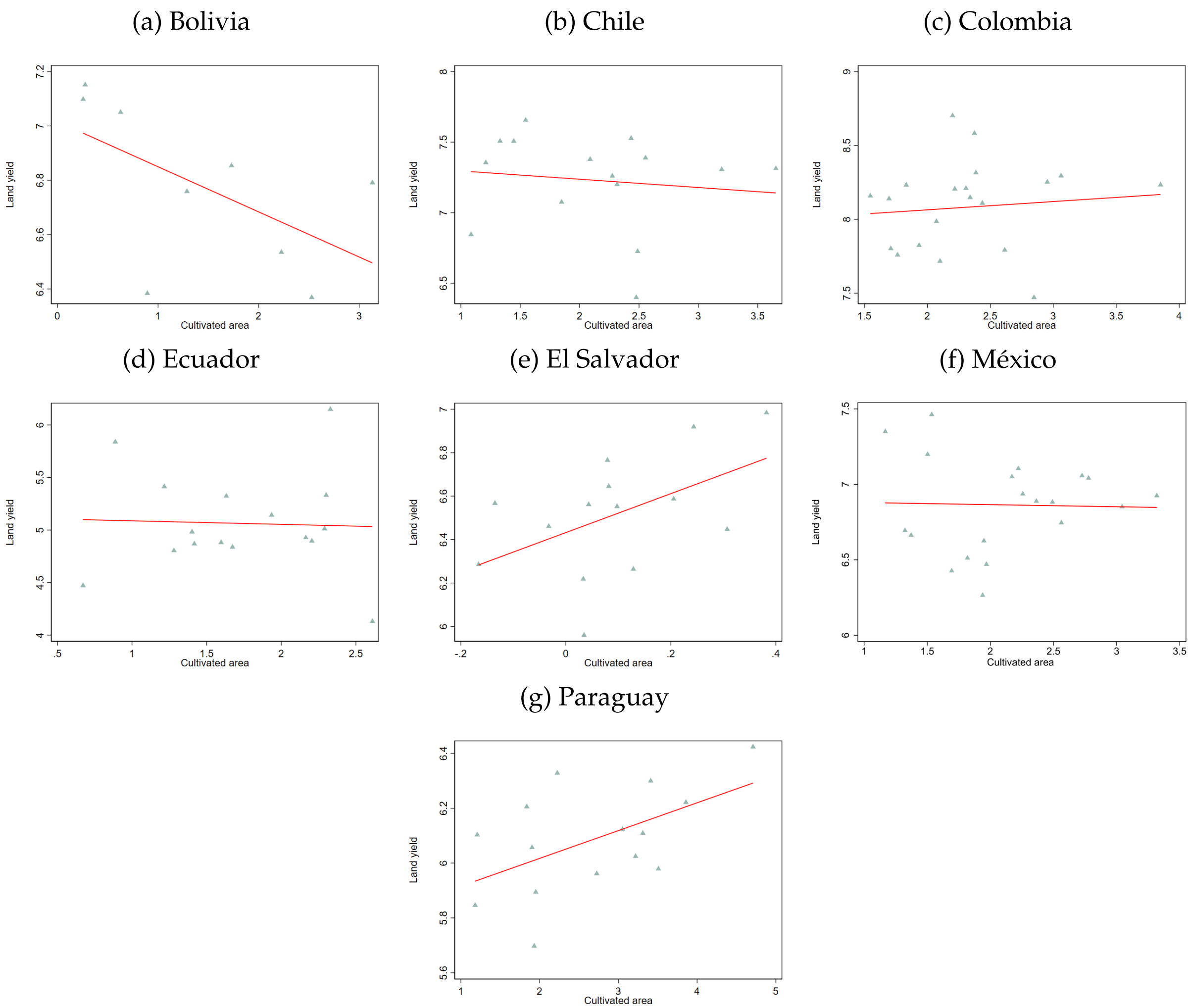
Notes: Binned scatterplots of the relationship between log of land yields and log of total farm area controlling for fixed effects of regions within countries.
Sources: Own calculations based on: Bolivia - CAI (2013); Chile - CNVAFVII (2006-2007); Colombia - CNAIII (2014); Ecuador - CNAIII (2000); El Salvador - CAIV (2007-2008); México - CAGFVIII (2007); Paraguay - CAN (2008); Perú - ENA (2019).

Figure A5. Output per worker and farm size



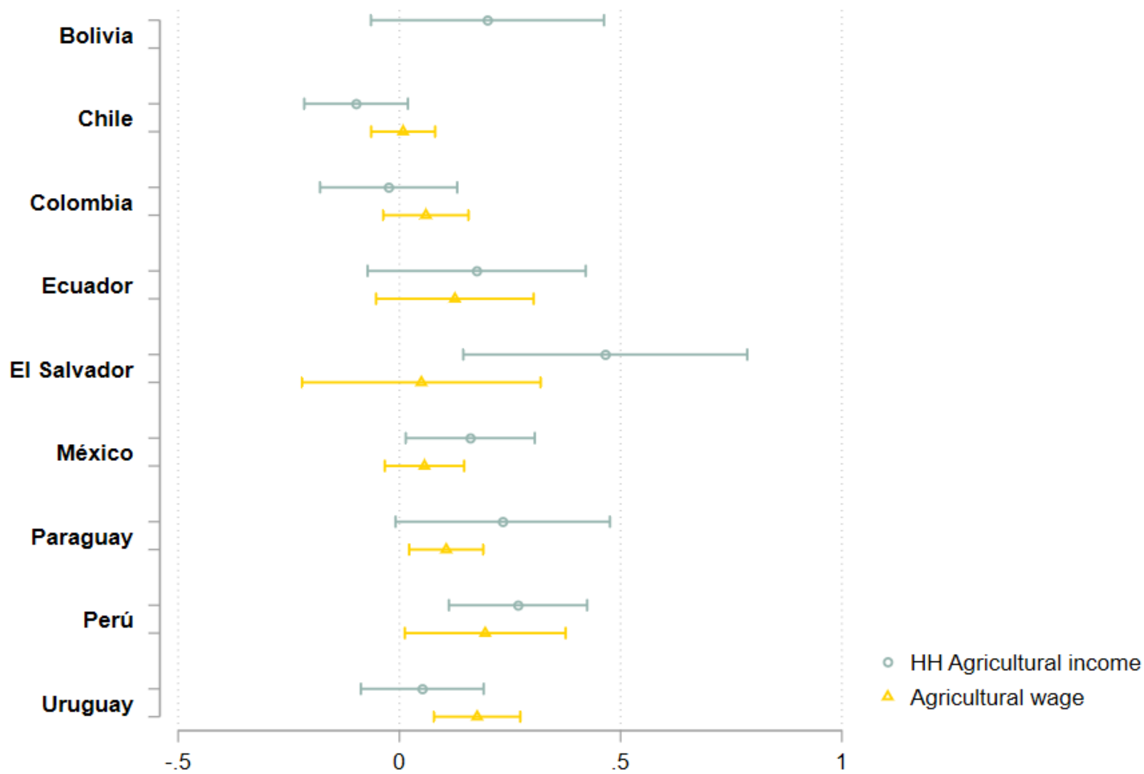
Notes: Binned scatterplots of the relationship between log of average output per worker and log of average cultivated area controlling for agricultural suitability and total rainfall across regions. Farms without production are excluded.
Sources: Own calculations based on: Bolivia - CAI (2013); Chile - CNVAFVII (2006-2007); Colombia - CNAIII (2014); Ecuador - CNAIII (2000); El Salvador - CAIV (2007-2008); México - CAGFVIII (2007); Paraguay - CAN (2008).

Figure A6. Yields per hectare and farm size



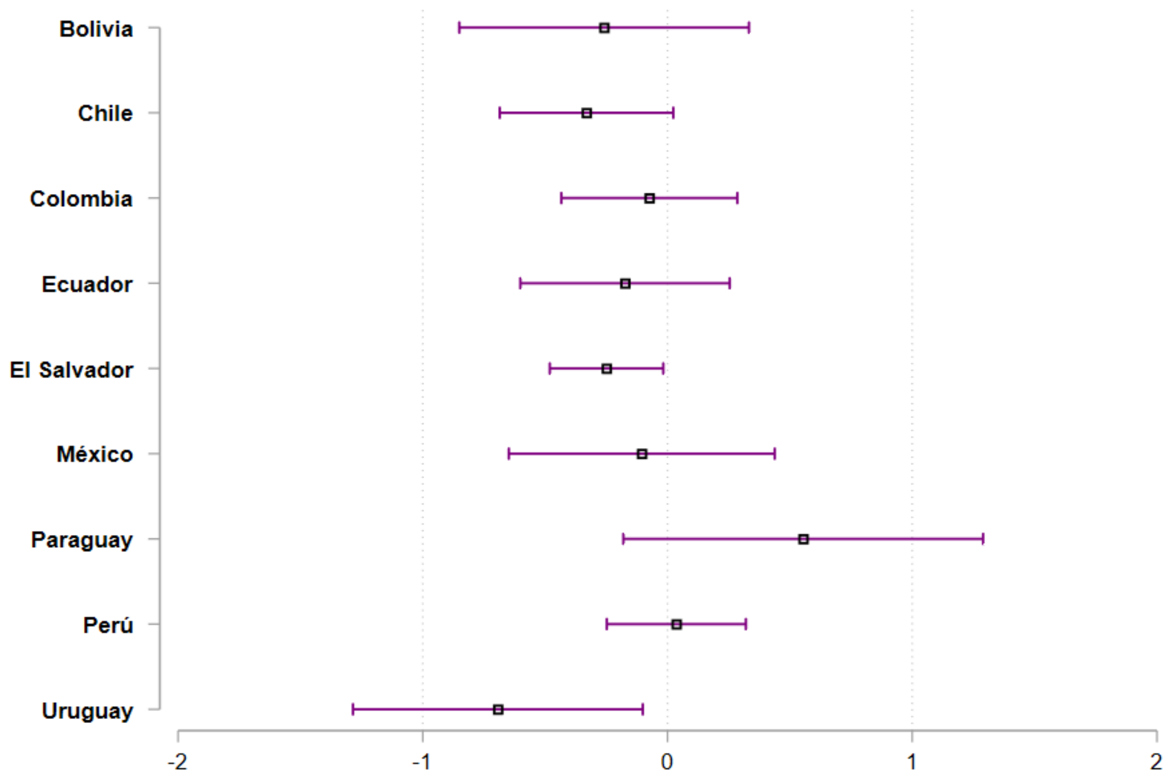
Notes: : Binned scatterplots of the relationship between log of average land yield and log of average cultivated area controlling for agricultural suitability and total rainfall across regions. Farms without production are excluded.
Sources: Own calculations based on: Bolivia - CAI (2013); Chile - CNVAFVII (2006-2007); Colombia - CNAIII (2014); Ecuador - CNAIII (2000); El Salvador - CAIV (2007-2008); México - CAGFVIII (2007); Paraguay - CAN (2008).

Figure A7. Relationship between household agricultural income and total farm area



Notes: Coefficient estimates from independent linear regressions with log of average farm size (measured as total farm area) as independent variable and log of average agricultural income and log of average agricultural wages across regions as dependent variables. Regional averages of soil quality and rainfall are included as control. Bolivia is not included, because the sample that receives agricultural wages is not representative.
Sources: Own calculations based on: Bolivia - EH (2014) and CAI (2013); Chile - CASEN (2006) and CNVAFVII (2006-2007); Colombia - GEIH (2014) and CNAIII (2014); Ecuador - ENEMDU (2007) and CNAIII (2000); El Salvador - EHPM (2008) and CAIV (2007-2008); México - ENIGH (2016) and CAGFVIII (2007);Paraguay - EPH (2017) and CAN (2008); Perú - ENAHO (2012) and CNAIV (2012); Uruguay- ECH (2011) and CGAXIX (2011).

Figure A8. Relationship between agricultural income Gini and farm size Gini



Notes: Coefficient estimates from independent linear regressions with the Gini of agricultural income as dependent variable and the Gini cultivated area across regions as independent variable. Regional averages of soil quality and rainfall included as controls. Sources: Own calculations based on: Bolivia - EH (2014) and CAI (2013); Chile - CASEN (2006) and CNVAFVII (2006-2007); Colombia - GEIH (2014) and CNAIII (2014); Ecuador - ENEMDU (2007) and CNAIII (2000); El Salvador - EHPM (2008) and CAIV (2007-2008); México - ENIGH (2016) and CAGFVIII (2007); Paraguay - EPH (2017) and CAN (2008); Perú - ENAHO (2012) and CNAIV (2012); Uruguay - ECH (2011) and CGAXIX (2011).

Table A1. Description of Agricultural Censuses by Country

Variable	Bolivia	Chile	Colombia	Ecuador	El Salvador	México	Paraguay	Perú	Uruguay
Census and year	1er Censo Agropecuario del Estado Plurinacional de Bolivia - CAI (2013).	VII Censo Nacional Agropecuario y Forestal - CNAFVII (2006-2007).	3er Censo Nacional Agropecuario - CNAIII (2014).	III Censo Nacional Agropecuario - CNAIII (2000).	IV Censo Agropecuario - CAIV (2007-2008).	VIII Censo Agrícola, Ganadera y Forestal - CAGFVIII (2007).	Censo Agropecuario Nacional - CAN (2008).	IV Censo Nacional Agropecuario - CNAIV (2012).	XIX Censo General Agropecuario - CGAXIX (2011)
Inclusion criteria	Agricultural farms settled in rural areas, peri-urban areas, and special cases in urban areas.	All rural plots with agricultural production, livestock and forestry and urban plots with agricultural production, livestock, and forestry.	Rural area registered on the Official Cadaster (IGAC) which covers 99% of the total rural area.	Rural agricultural farms.	Rural and urban agricultural producers. Cover 100% of rural census segments and 16% of urban census segments.	Rural geostatistical areas with and without agricultural and forestry activity, as well as urban geostatistical areas with livestock.	Agricultural farms active during the census. It does not cover all rural land plots.	Agricultural farms.	Agricultural farm greater than or equal to 1 ha.
Definition of farm (Agricultural Production Unit)	Plot, set of land or plots, used totally or partially for agricultural activities, conducted as an economic unit by a producer, regardless of size, tenure regime or legal status.	Plot used in agricultural production, livestock, and forestry by a one decision-making unit (household or firm). A farm may cover a part of a land plot, the total plot, or a sum of land plots (or parts). Plots can be contiguous or separated located in one comuna. Covers landless exploitations dedicated to animal or livestock production located in urban and rural areas.	A farm may cover a part of a land plot, the total plot, or a sum of land plots (or parts). Plots can be contiguous or separated in one or several municipalities. Criteria to consider a land plot as agricultural: (i) active in agricultural production, livestock, forestry, and/or fish farms; (ii) operated by one decision-making unit (household or firm): and (iii) uses at least one production input.	Plot of a size equal or larger than 0.05 hectares, dedicated fully or partially to agricultural production and under one decision - making unit. Plots below 0.05 hectares were included only if, during the year of the census, they produced and sold an agricultural product.	Plot used in agricultural production, livestock, and fish farms. A farm may cover a part of a land plot, the total plot, or a sum of land plots (or parts). Plots can be contiguous or separated in one municipality. Operated by one decision-making unit (household or firm) or a group of decision-making units. It includes landless exploitations.	Set of lands with or without agricultural or forestry activity in the rural area or with agricultural activity in the urban area, located in the same municipality; Animals that are owned regardless of the place where they are, as well as the equipment, machinery and vehicles destined for agricultural, livestock or forestry activities must be managed under the same administration.	Plot used in agricultural production, or livestock. A farm may cover a part of a land plot, the total plot, or a sum of land plots (or parts). Operated by one decision-making unit (household or firm) or with participation of additional decision-making units (household or firm). Inclusion criteria: (i) 0.1 hectares with seasonal crops, commercial vegetable garden, permanent crops, flowers, ornamental plants and/or greenhouses; (ii) three livestock units; (iii) five sheep, goat or porks; (iv) 100 fowls; and/or (v) 10 beehives.	Plot, or group of plots, used in agricultural production, or livestock under one decision-making unit. Exclusion criteria: (i) concession for the exploitation of natural products; (ii) fish farms; or (iii) production of fighting cocks, racing horses; and fighting bulls.	Includes all land dedicated totally or partially to agricultural, livestock and/or forestry purposes under one decision-making unit. Regardless of tenure, the condition legal and that productive activities are carried out or not for commercial purposes.
Crops	Annual and permanent summer crops, forage grass and forestry. No production for forage grass and forestry.	Yearly forage crops, permanent forage, vegetables, flowers, vineyards, fruits, and forestry. Production information for cereals, leguminous vegetables, root crops, and industrial crops.	Seasonal crops, permanent crops, forestry, and forage crops. Production data for all crops.	Seasonal crops, permanent crops, flowers, and forage grass. No production for forage grass.	Grains, vegetables, seasonal and permanent agro-industrial crops, fruits, and coffee. No production for coffee.	Annual spring-summer crops and perennials (Fruit trees, plantations or cultivated grass).	Seasonal crops, permanent crops, vegetables, forage crops, and forestry. No production information for forage crops and forestry.	Permanent crops (agro-industrial crops, fruit trees, forestry and cultivated grass) and seasonal crops (cereals, fruits, vegetables, grains, root crop and forage crops). No data for agricultural production.	Forestry, fruits, vineyards, vegetables, cereals, industrial crops and forage crops. No data for agricultural production.
Prices	Agricultural producer prices FAO (2013).	Agricultural producer prices FAO (2006).	Agricultural producer prices FAO (2013).	Agricultural producer prices FAO (2000).	Agricultural producer prices FAO (2006).	Agricultural producer prices FAO (2007).	Agricultural producer prices FAO (2008).		

Notes: Output data for Perú comes from the Agricultural Survey (2019), which includes agricultural units of small and medium producers and companies and large producers. The survey covers permanent and seasonal crops. Producer prices for each crop are taken from FAO (2019).
Sources: Own elaboration based on census methodological guides.

Table A2. Number and area of farms by farm size range

Country	Variable	All sizes	<1 ha	1-2 ha	2-5 ha	5-10 ha	10-20 ha	20-50 ha	50-100 ha	100-200 ha	200-500 ha	>500 ha
Bolivia	Number of farm	844,104	223,044	108,692	163,538	114,454	93,902	68,305	39,032	12,655	9,593	10,889
	Average farm size (ha)	38.35	0.35	1.33	3.08	6.75	13.07	29.52	59.41	127	306.99	1,906.44
	Share of farm (%)	100	26.42	12.88	19.37	13.56	11.12	8.09	4.62	1.50	1.14	1.29
	Share of farm size (%)	100	0.24	0.45	1.56	2.39	3.79	6.23	7.16	4.96	9.10	64.12
Chile	Number of farm	218,487	26,196	23,691	39,259	35,759	33,936	30,049	12,809	7,397	5,319	4,072
	Average farm size (ha)	87.83	0.51	1.31	3.19	7.07	14	31.12	69.12	138.43	306.12	3,393.94
	Share of farm (%)	100	11.99	10.84	17.97	16.37	15.53	13.75	5.86	3.39	2.43	1.86
	Share of farm size (%)	100	0.07	0.16	0.65	1.32	2.48	4.87	4.61	5.34	8.48	72.02
Colombia	Number of farm	1,893,939	742,698	276,037	338,508	198,848	139,811	112,281	45,268	22,339	12,015	6,134
	Average farm size (ha)	19.71	0.38	1.45	3.23	7.10	14.11	31.19	69.73	137.99	299.76	3,070.11
	Share of farm (%)	100	39.21	14.57	17.87	10.50	7.38	5.93	2.39	1.18	0.63	0.32
	Share of farm size (%)	100	0.76	1.07	2.93	3.78	5.28	9.38	8.45	8.26	9.65	50.44
Ecuador	Number of farm	692,551	194,497	95,889	139,830	85,114	64,613	65,875	29,833	11,323	4,370	1,207
	Average farm size (ha)	14.94	0.4	1.33	3.1	6.83	13.46	30.91	65.19	129.48	276.47	1,328.18
	Share of farm (%)	100	28.08	13.85	20.19	12.29	9.33	9.51	4.31	1.64	0.63	0.17
	Share of farm size (%)	100	0.75	1.24	4.19	5.62	8.41	19.68	18.79	14.17	11.67	15.50
El Salvador	Number of farm	388,742	262,799	67,269	33,224	10,913	6,895	5,357	1,525	531	178	51
	Average farm size (ha)	2.37	0.49	1.31	2.97	7.04	13.91	30.55	67.04	132.88	286.84	908.23
	Share of farm (%)	100	67.69	17.30	8.55	2.81	1.77	1.38	0.39	0.14	0.05	0.01
	Share of farm size (%)	100	14.07	9.56	10.71	8.33	10.39	17.73	11.07	7.64	5.52	4.97
México	Number of farm	3,961,799	582,185	766,063	1,193,665	638,268	380,129	248,771	80,522	37,529	20,863	13,804
	Average farm size (ha)	16.77	0.4	1.15	2.88	6.66	13.21	28.55	67.25	132.27	293.79	2,099.52
	Share of farm (%)	100	24.69	19.34	30.13	16.11	9.59	6.28	2.03	0.95	0.53	0.35
	Share of farm size (%)	100	0.35	1.33	5.18	6.40	7.56	10.69	8.15	7.47	9.23	43.63
Paraguay	Number of farm	261,428	13,175	32,219	59,940	62,497	54,065	20,784	5,826	4,072	3,882	4,968
	Average farm size (ha)	70.71	0.45	1.18	2.90	6.30	11.86	26.99	66.66	133.60	303.63	2,931.17
	Share of farm (%)	100	5.04	12.32	22.93	23.91	20.68	7.95	2.23	1.56	1.48	1.90
	Share of farm size (%)	100	0.03	0.21	0.94	2.13	3.47	3.03	2.10	2.94	6.38	78.77
Perú	Number of farm	2,123,973	790,483	415,543	477,186	212,691	115,051	73,079	22,451	9,521	5,469	2,499
	Average farm size (ha)	7.54	0.37	1.25	2.91	6.49	12.87	28.80	65.01	129.99	286.79	1,836.36
	Share of farm (%)	100	37.22	19.56	22.47	10.01	5.42	3.44	1.06	0.45	0.26	0.12
	Share of farm size (%)	100	1.82	3.23	8.66	8.62	9.25	13.14	9.11	7.73	9.79	28.65
Uruguay	Number of farm	44,653		426	2,635	4,197	4,716	6,899	5,693	5,625	6,405	8,057
	Average farm size (ha)	364.17		1.1	3.27	7.07	14.2	32.71	72.23	144.43	324.5	1,567.31
	Share of farm (%)	100		0.95	5.90	9.40	10.56	15.45	12.75	12.60	14.34	18.04
	Share of farm size (%)	100		0.00	0.05	0.18	0.41	1.39	2.53	5	12.78	77.66

Notes: The sample includes all farms that report at least one worker. Farm size is measured as total farm area.
Sources: Own calculations based on: Bolivia - CAI (2013); Chile - CNVAFVII (2006-2007); Colombia - CNAIII (2014); Ecuador - CNAIII (2000); El Salvador - CAIV (2007-2008); México - CAGFVIII (2007); Paraguay - CAN (2008); Perú - CNAIV (2012) ; Uruguay - CGAXIX (2011).

Table A3. Definition of Rural Population by Country

Country	Definition
Bolivia	The area of population dispersed or grouped in population entities that do not exceed 2,000 inhabitants.
Chile	Human settlement with: (i) a population lower or equal to 1,000 inhabitants; or (ii) between 1,001 and 2000 inhabitants in which more than 50% work on the primary sector.
Colombia	Area with a high dispersion of houses and plots with farming exploitation. The area lacks an official grid street plan, official street name, public services, or other amenities typical of urban areas.
Ecuador	Rural areas are human settlements with: (i) less than 100 adjacent housing unit and it is not a district capital; or (ii) more than 100 housing units that are dispersed.
El Salvador	The rural area is the residual of the urban area in a municipality. An urban area is: (i) the population center that contains the municipal mayorship and is known as urban zone of the municipality; or (ii) conglomerate of housing units located far from the urban zone, has a population density equal or above to 1,000 inhabitants per squared kilometer. If 5% or less of the population is rural, the municipality is defined as urban.
México	Locality that has less than 2500 inhabitants and is not the municipal seat.
Paraguay	The urban area are the district urban area and the rural area the residual of the municipality.
Perú	In the population census, rural areas are human settlements with: (i) less than 100 adjacent housing unit; or (ii) more than 100 housing units that are dispersed. In the ENAHO survey, the rural area of a district is any population center with less than 2,000 inhabitants.
Uruguay	For the National Institute of Statistics, the rural area is the one that is outside the urban area. The urban area is delimited according to Law No. 10,723 on Populated Centers.

Table A4. Agricultural income and farm size

PANEL A	Agricultural income								
	Bolivia	Chile	Colombia	Ecuador	El Salvador	México	Paraguay	Perú	Uruguay
Total farm size	0.20	-0.10*	-0.02	0.17	0.47***	0.16**	0.23*	0.27***	0.05
	(0.10)	(0.05)	(0.07)	(0.11)	(0.14)	(0.07)	(0.11)	(0.07)	(0.07)
R-squared	0.56	0.41	0.01	0.52	0.53	0.52	0.41	0.73	0.16
PANEL B									
Cultivated area	0.25	-0.28**	0.09	0.22**	0.48***	0.24**	0.28***	0.30***	0.10
	(0.13)	(0.12)	(0.12)	(0.08)	(0.12)	(0.10)	(0.07)	(0.10)	(0.07)
R-squared	0.56	0.49	0.03	0.63	0.63	0.53	0.66	0.69	0.23
Observations	9	15	24	16	14	32	15	24	19

Notes: Dependent variable: log average agricultural income at the region level. Panel A uses log average total farm size and Panel B log average total cultivated area. Geographic Controls include: agricultural suitability and total rainfall. Standard errors in parentheses.
*** significance at the 1%, ** significant at the 5%, * significant at the 10%.
Sources: Own calculations based on: Bolivia - EH (2014) and CAI (2013); Chile - CASEN (2006) and CNVAFVII (2006-2007); Colombia - GEIH (2014) and CNAIII (2014); Ecuador - ENEMDU (2007) and CNAIII (2000); El Salvador - EHPM (2008) and CAIV (2007-2008); México - ENIGH (2016) and CAGFVIII (2007); Paraguay - EPH (2017) and CAN (2008); Perú - ENAHO (2012) and CNAIV (2012); Uruguay- ECH (2011) and CGAXIX (2011).

Table A5. Agricutural wage and farm size

PANEL A	Agricultural wage							
	Chile	Colombia	Ecuador	El Salvador	México	Paraguay	Perú	Uruguay
Total farm size	0.01	0.06	0.13	0.05	0.06	0.11**	0.19**	0.18***
	(0.03)	(0.05)	(0.08)	(0.12)	(0.04)	(0.04)	(0.09)	(0.05)
R-squared	0.30	0.11	0.29	0.31	0.48	0.66	0.50	0.58
PANEL B								
Cultivated area	-0.02	0.08	0.12	-0.03	0.04	0.10***	0.20*	0.21***
	(0.08)	(0.08)	(0.07)	(0.11)	(0.06)	(0.03)	(0.12)	(0.05)
R-squared	0.30	0.08	0.33	0.31	0.45	0.72	0.46	0.63
Observations	15	24	16	14	32	15	24	19

Notes: Dependent variable: log average agricultural wage at the region level. Panel A uses log average total farm size and Panel B log average total cultivated area. Geographic Controls include: agricultural suitability and total rainfall. Standard errors in parentheses.
*** significance at the 1%, ** significant at the 5%, * significant at the 10%.
Sources: Own calculations based on: Chile - CASEN (2006) and CNVAFVII (2006-2007); Colombia - GEIH (2014) and CNAIII (2014); Ecuador - ENEMDU (2007) and CNAIII (2000); El Salvador - EHPM (2008) and CAIV (2007-2008); México - ENIGH (2016) and CAGFVIII (2007); Paraguay - EPH (2017) and CAN (2008); Perú - ENAHO (2012) and CNAIV (2012); Uruguay - ECH (2011) and CGAXIX (2011).

Table A6. Interquartile range of agricultural income and farm size

PANEL A	Agricultural income								
	Bolivia	Chile	Colombia	Ecuador	El Salvador	México	Paraguay	Perú	Uruguay
Total farm size	0.15	-0.08	-0.01	0.08	0.02	-0.02	0.14*	0.25**	0.02
	(0.14)	(0.11)	(0.06)	(0.06)	(0.16)	(0.07)	(0.06)	(0.11)	(0.07)
R-squared	0.42	0.30	0.03	0.22	0.12	0.28	0.42	0.61	0.12
PANEL B									
Cultivated area	0.26	-0.10	0.06	0.11*	-0.05	0.00	0.17**	0.41***	0.12**
	(0.21)	(0.25)	(0.09)	(0.06)	(0.12)	(0.10)	(0.06)	(0.14)	(0.06)
R-squared	0.45	0.28	0.05	0.32	0.14	0.28	0.56	0.66	0.33
Observations	9	15	24	16	14	32	15	24	19

Notes: Dependent variable: log IQR of agricultural income at the region level. Panel A uses log IQR of total farm size and Panel B log IQR of total cultivated area. Geographic Controls include: agricultural suitability and total rainfall. Standard errors in parentheses.
*** significance at the 1%, ** significant at the 5%, * significant at the 10%.
Sources: Own calculations based on: Bolivia - EH (2014) and CAI (2013); Chile - CASEN (2006) and CNVAFVII (2006-2007); Colombia - GEIH (2014) and CNAIII (2014); Ecuador - ENEMDU (2007) and CNAIII (2000); El Salvador - EHPM (2008) and CAIV (2007-2008); México - ENIGH (2016) and CAGFVIII (2007); Paraguay - EPH (2017) and CAN (2008); Perú - ENAHO (2012) and CNAIV (2012); Uruguay - ECH (2011) and CGAXIX (2011).

A.II Description of the data

For each country we use data from the most recent agricultural census for which data are available: Ecuador (2000), Chile and Mexico (2007), El Salvador, Paraguay (2008), Uruguay (2011), Perú (2012), Bolivia (2013), Colombia (2014). The Peruvian and Uruguayan censuses do not collect information on agricultural production and Chile only collects output data for cereals, leguminous vegetables, root crops, and industrial crops. See Table A1 for a summary.

Sample

Farms are the unit of observation on the nine agricultural censuses. It is defined as a plot or group of plots, not necessarily contiguous, under the same decision-making unit (firm or household). Our analysis concentrates on private farms. Hence, we eliminate from the sample: (i) indigenous reservations and other type of land access arrangements for indigenous communities (Colombia); (ii) collective territories of afro-descendants or ancestral territories of *raizales* (Colombia); (iii) National Parks (Chile and Colombia); (iv) land with environmental restrictions for agricultural exploitation (Colombia); (v) agricultural communities (Bolivia and Chile); (vi) historical communities (Chile); and native communities (Peru).

All censuses, with the exception of Colombia and Ecuador, cover rural and urban areas, albeit without identifying where the plot is located. In addition, the Paraguayan and Uruguayan censuses exclude farms below 0.1 and 1 hectare, respectively. Our main results include farms in the whole range of areas for which data is available and eliminate non-agricultural farms and those without land, which are usually fish farms, poultry producers or greenhouses in urban areas. Lastly, in Perú we eliminate from the data *El Callao*, a district with only urban population.

Labor Input Variables

To measure labor inputs, we would ideally have the aggregate number of hours dedicated to agricultural activities on the farm, yet time use data is not collected on agricultural censuses. Hence, we calculate the yearly number of workers: total, family and hired. For estimating the number of workers, we define family workers as those household members or persons living in the farm and working permanently or temporarily on the farm.

In Bolivia, the census does not discern between permanent or temporary workers, but makes the distinction between paid and unpaid labor. We assume that all unpaid workers are family workers. If the farm does not register workers in the employment module, the number of workers is assigned according to the household members that report participating in farm activities. For Mexico, once the number of workers from the employment module is calculated, the number of workers is imputed to the farms that do not register this, as follows:

- If the producer reports that she alone is in charge of the farm activities, one worker is assigned to her farm.
- If the producer reports that her family is involved in the farm activities, the number

of workers is assigned according to the average number of family workers per state, according to the 2010 Population Census.

- If the producer reports that she is part of a group or cooperative, the number of workers is assigned according to the total number of members of the group. Note that this provides an upper bound for the total number of workers of farms that belong to cooperatives or groups of producers.

In Colombia, the census includes the number of daily temporary workers (*jornaleros*) employed during the previous month. We transform this variable to an equivalent of permanent workers by assuming that a permanent worker works 6 days a week for 4 weeks a month. This overestimates the number of agricultural workers by 7% when compared to the total number of agricultural workers estimated from the GEIH (3.6 million vs 3.4 million of workers, respectively).

Finally, the Uruguayan census asks for the number of *zafrales* hired in the census year, according to census guidelines, a temporary worker is equivalent to 200 *zafrales*.

Output per worker and land yields

We use the information on agricultural output to calculate land yields and output per worker. The percentage of farm producing more than one crop is 77% in Bolivia, 40% in Chile, 81% in Colombia, 85% in Ecuador, 60% in El Salvador, 52% in Mexico, 94% in Paraguay, and 86% in Peru. Hence, for aggregating production at the farm level, we use revenue instead of the quantity produced. We use FAO producer prices to construct measures of farm revenue. We transform output variables to USD constant prices using 2011 as base year.

In Paraguay, the production of some crops is measured in boxes, bushells, etc. We first calculate the average weight of those units weight and then convert it in ton. In El Salvador, the census registers input information at the producer level and not at the farm level. For producers that have more than one farm (0.82%), we allocate workers across farm using the percentage of land that each farm represents.

Equations 1 and 2 in the text present our definitions of land yields and output per worker. These measures use total farm revenue, the number of hectares cultivated for the crops with price information, and the number of hired and family workers allocated to crops with price information, which we calculate as the total number of workers multiplied by the percentage of land planted with crops that have price information.

The crops without price information represent a small percentage of total production. For Bolivia, 74.65% of crops do not have price information, which amounts to 2.96% of total production. For Chile, these numbers are 45.45% and 4.12%, respectively. For Colombia, 88% and 8.55%. For Ecuador, 73.38% and 12.13%. In El Salvador 69.01% and 1.29%. In Mexico, 39.07% and 20.4%. In Paraguay, 82.73% and 6.71%. In Peru, 57.07% and 4.59%.

A.III Derivations of the theoretical framework[26]

There are N farmers with heterogeneous productivity z_i and a total land endowment L. Farmers use land ℓ_i and a fixed unit of labor to produce a simple homogeneous good y_i with a price normalized to one and production function:

$$y_i = z_i^{1-\gamma} \ell_i^{\gamma}, \tag{3}$$

with $\gamma < 1$.

The efficient land allocation solves the social planner's problem of maximizing aggregate output $\sum_{j=1}^{N} y_j$ subject to the land endowment constraint $\sum_{j=1}^{N} \ell_j = L$. This maximization problem is given by

$$\textbf{max} \sum_{j=1}^{N} z_j^{1-\gamma} \ell_j^{\gamma} + \lambda \left(\sum_{j=1}^{N} L - \ell_j \right), \tag{4}$$

where λ is the Lagrangian multiplier associated to the land endowment constraint. The solution to the maximization problem in 4 is

$$\ell_i^* = \frac{z_i}{\sum_{j=1}^{N} z_j} L \quad \text{for} \quad i = \{1, ..., N\}. \tag{5}$$

Substituting into 3 gives

$$y_i^* = z_i \left(\frac{L}{\sum_{j=1}^{N} z_j} \right)^{\gamma} \quad \text{for} \quad i = \{1, ..., N\}. \tag{6}$$

Proof of Result 1. The distribution of farmers' productivity determines the farm size distribution and more productive farmers operate larger farms. From 5 it can be seen that the share of land allocated to each farmer in the efficient allocation is proportional to her individual productivity. Farmers with a larger z_i hold a larger share of land. Also, the only source of variation in ℓ_i^* across farmers is z_i, therefore, the distribution of z_i determines the distribution of ℓ_i^*.

[26]We thank Diego Restuccia for his generosity in sharing his valuable insights, which we closely follow to develop this section.

Proof of Result 2. Land yields are constant across farms and output per worker increases with farm size. From 5 and 6 we can derive an expression for land yields in the efficient allocation:

$$\frac{y_i^*}{\ell_i^*} = \left(\frac{\sum_{j=1}^{N} z_j}{L} \right)^{1-\gamma} \quad \text{for} \quad i = \{1, ..., N\}. \tag{7}$$

Land yields in expression 7 depend on aggregate productivity $\sum_{j=1}^{N} z_j$ and total land endowment L and do not vary across farmers. Output per worker is equal to farm output in 6, which increases with z_i.

Result 3. The distribution of farmers' productivity z_i determines the income distribution and equalizing farm size does not eliminate income inequality. In this simple framework, farm output determines farmers' income. From equation 6 it can be seen that farm output depends on individual productivity z_i, and therefore the distribution of income is a function of the productivity distribution. If land is evenly distributed across farmers farm size is $\hat{\ell}_i = \frac{L}{N}$ for $i = \{1, .., N\}$ and farm output $\hat{y}_i = z_i^{1-\gamma} \left(\frac{L}{N}\right)^{\gamma}$, which still depends on z_i.