Off-Farm Work and Income Inequality in Rural Brazil[#]

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Resumo: A busca por postos de trabalho *off-farm* é analisada na literatura como uma estratégia de diversificação agrícola para que domicílios rurais, principalmente aqueles e condições de pobreza e extrema pobreza, consigam lidar com suas restrições orçamentárias e se previnam de possíveis choques exógenos. Entretanto, apesar de ser uma receita menos incerta e, portanto, aumentar a renda total domiciliar, pode também acentuar desigualdades rurais visto que o acesso é distinto para indivíduos dependendo das características individuais e capacidade de acesso a trabalhos mais diversificados, por exemplo. Neste sentido, o objetivo do presente trabalho é verificar como rendas *off-farm* alteram a concentração de renda dos domicílios rurais. Para isso, estima-se um modelo de Regressão Quantílica Incondicional e, posteriormente, aplica-se a decomposição de desigualdades proposta por Oaxaca-Blinder para captar efeitos não observáveis. Os resultados confirmam que, de fato, os domicílios mais ricos se beneficiam desproporcionalmente mais que os mais pobres das rendas *off-farm* e este resultado é explicado especialmente por características relacionadas ao *background* domiciliar e a região do trabalho. Isto posto, a regulamentação e garantia de acesso do mercado de trabalho formal para trabalhadores rurais é imperativo para garantia de bem-estar e desenvolvimento equitativo destas áreas.

Palavras-chave: Trabalho off-farm; Renda não agrícola; Concentração de renda; Decomposição de desigualdades

Abstract: *This article analyzes off-farm work as a diversification strategy for rural households, especially the poorest, to deal with budget restrictions and protect themselves from possible exogenous shocks. However, despite providing a more certain revenue stream and, therefore, an increase overall household income, it can also accentuate rural inequality since its access depends on individual characteristics and the capacity to access more diversified jobs. In this sense, our objective is to verify how off-farm income alters income concentration in rural households. To do so, we employ an Unconditional Quantile Regression model and, afterwards, apply the inequalities decomposition proposed by Oaxaca and Blinder in order to capture unobserved effects. Our results confirm that indeed wealthier households benefit disproportionately from non-agricultural income, which is explained especially by educational background and regional characteristics. That said, it is imperative to regulate and guarantee rural workers access to the formal labor market in order to improve the well-being and equitable development of rural areas.*

Keywords: *Off-farm work; Nonagricultural income; Income concentration; Inequality decomposition*

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1. Initial Remarks

Brazilian rural households have been through several social, economic, and demographic transformations in recent years, leading rural residents to seek adaptation strategies. One of the strategies stems from agricultural diversification, which can relate to rural and non-rural activities (Schneider, 2009). The latter mainly encompasses off-farm work, which can play two major roles: to gain scope economies expanding their portfolio in diversified markets (including the labor market) and an adaption strategy to overcome exogenous shocks and random variation in agriculture by guaranteeing an external and less volatile source of income (Piedra-Bonilla et al., 2020).

The choice of non-agricultural jobs is associated with their different individual particularities and the returns of such activities, which depend on the level of human and physical capital invested. According to Start (2001), even though non-agricultural jobs can serve as a determinant for household well-being and a concrete path to overcome poverty, their impact could be positive or negative depending on the activity performed. In this sense, non-agricultural jobs can increase per capita income in rural households or, on the other hand, they could be responsible for increasing inequality since wealthier families can access better markets and, therefore, reinforce a scenario of disparities among families (Lima, 2008; Moreira, 2010; Ney and Hoffmann, 2008).

The study of income concentration in rural areas is especially important in Brazil, where massive inequalities persist in the labor market and not only define the vulnerability of certain groups, but also reinforce the economic mechanisms of access to credit, rural extension, or even access to basic needs like electricity and water supply (Dong and Hao, 2018; Freitas et al., 2018; Neves et al., 2020). For example, even though the total area of agricultural land has increased, the number of people occupied in agricultural activities has decreased. Further, 23% of producers are illiterate and land and income is highly concentrated (IBGE, 2017).

In this paper, we contribute to the literature by discussing income inequality and the access to non-agricultural labor market by rural residents, considering demographic and individual particularities, and how they affect income concentration (or distribution). That said, we seek to answer if off-farm work – here seen as engagement in non-agricultural jobs – can reduce income inequality in rural areas in Brazil. To do so, we use PNAD 2015 microdata and estimate the effects through an Unconditional Quantile Regression approach, as proposed by (Firpo et al., 2009). Additionally, we apply the Oaxaca (1973) and Blinder (1973) decomposition to check how the particularities of labor market explain disparities in overall income.

Following this introductory section, the paper is organized as follows: Section 2 provides the background on rural labor market and rural inequality. Section 3 describes the theoretical model and Section 4 introduces the methodology and data. Section 5 presents the results and Section 6 concludes.

2. Background

The study of inequality in its various dimensions is important, especially for developing countries. Evidence for rural areas, however, tends to be centered on the productivity and efficiency approach, where individual and labor market characteristics are often neglected. In this section, we provide an overview that highlights different findings regarding rural specificities and labor market relations, specifically concerning work diversification and inequality.

For example, Ney and Hoffmann (2008) studied the impact of rural and non-rural income on wealth distribution in Brazil and confirmed that these income are responsible for respectively decreasing and increasing rural inequality. Though non-rural income increases average household income, the relative weight varies according to income level. These levels – in Brazil often classified by classes – in turn, depend on the income source (industrial or autonomous services, for example) and, as the poorest have limited access to education and credit, they tend to obtain the most unskilled and worst-paid jobs Kageyama and Hoffmann (2000).

Even though off-farm work and particularly non-agricultural activities are paths through which individuals in rural areas investigate a new way of life, it is crucial that public policies guarantee well-being

and opportunity in rural areas. According to Christiaensen and Martin (2018), the growth inside agriculture activities is two to three times more effective at reducing poverty in addition to other welfare measures than those external to the agricultural sector. This applies to the poorest members of society and differs depending the activity performed. In this sense, the study of off-farm work and income inequality intersects with who performs this labor and, further, pinpointing the type of activity could lead to policy implications not only about rural areas, but also to a general model of development for the country.

Studies of income concentration have considered the cases of China and Pakistan, for example, and multiple authors have pointed out that different income origins impact wealth distribution differently (Adams, 1994; Wan, 2001). Likewise, Ney and Hoffman (2008) analyzed this theme in Brazil, and found that agricultural occupations contribute to a decrease in income disparities. The authors analyzed how the share of agricultural and non-agricultural income impacts quantiles and the Gini index, but disregarded the particularities of individual workers and available jobs. Lima (2008) and Moreira (2010) similarly studied the effects of off-farm work on poverty and rural inequality but limited their focus to the pluriactive[1] households in Brazilian Northeast and Southeast, respectively.

3. Theoretical Framework: Choosing to Engage in Off-Farm Work

In developing countries, households in rural areas are more exposed to market imperfections, in the sense that a theoretical framework could not treat the market as one in which perfect competition takes place. In their seminal paper, Yutopoulos and Lau (2002) stated that in the presence of market failures, it is possible to find households based on a non-separability model. This means that household decisions regarding production and consumption affect each other because they are made simultaneously. In other words, they have a pure profit maximization, which includes their utility and well-being (consumer theory) and production profits (firm theory) (de Janvry and Sadoulet, 2006).

Similarly, Bardhan and Udry (1999) proposed a theoretical model where households face imperfections in both land access and labor markets. Suppose, therefore, an economy without a market for land and involuntary unemployment in the rural labor market, here interpreted as off-farm work. The household problem is:

$$\begin{aligned} & Max\ U(c,l), c, l, L^H, L^F \geq 0 \\ \text{s.t.} \quad & pc = F(L^f + L^h, E^A) - wL^h + wL^m \\ & l + L^f + L^m = E^L \\ & L^m \leq M, \end{aligned}$$

where L^h is the hired workforce used on the farm, L^f represents the family workforce used on the farm, L^m is the time spent engaged in paid activities, and M represents the maximum time allocated for such paid activities. These main activities can take different formats and be modeled based on distinct particularities. Here, it will be considered a general form, where $L^m \leq M$ is not binding and the general restriction becomes $pc + wl = F(L, E^A) - wL + wE^L$, where L is the total labor time used on the farm. In such cases, the separation property holds.

Because our objective is to illustrate the effects of off-farm work on income concentration, we can consider a model where the family composed by i individuals maximizes its utility subject to agricultural and non-agricultural income, such as (Lee, 1998; Lima, 2008):

$$\begin{aligned} & \max U(T_{d1}, T_{d2}, C; J) && (1) \\ \text{s.t.} \quad & C = f\left(p;\ T_{agr1}, T_{agr2}; H, Z_{agr}\right) + g\left(T_{nag1}, T_{nag2}; H, Z_{nag}\right) + OSI && (2) \\ & T_i = T_{di} + T_{agri} + T_{nagi}, i = 1{,}2 && (3) \\ & T_{agri}, T_{nagi} \geq 0\ i = 1{,}2, && (4) \end{aligned}$$

[1] Pluriactive describes households where the income is drawn from both agricultural and non-agricultural sources, as in individuals perform on and off-farm work.

where T is the time allocated for household tasks and leisure (*d*), agricultural (*agr*) and non-agricultural activities (*nag*) and leisure; C is goods consumption; J represents family characteristics; f and g relate consumption as a function of agricultural and non-agricultural income, respectively; p is a price vector; Z is the input, OSI are other sources of income, such as public transfers, retirement, and other.

This maximization problem shows that the family's utility is defined by the time allocated to household tasks and leisure, consumption, and family characteristics (Eq. 1). Families mainly face two constraints: budgetary (Eq. 2), related to their different sources of income; and temporal (Eq. 3), which depends on the allocation of time. Furthermore, the model assumes that the time allocated on and off the farm could be zero (negativity constraint – Eq. 4). Given the possibility of a corner solution, it is possible to build a *Lagrangian* equation:

$$\begin{aligned} L = U(T_{d1}, T_{d2}, C; J) + \lambda\left[f\left(p;\ T_{agr1}, T_{agr2}; H, Z_{agr}\right) + g\left(T_{nag1}, T_{nag2}; H, Z_{nag}\right) + OSI - C\right] \\ + \gamma_1\left[T_1 - T_{d1} - T_{agr1} - T_{nag1}\right] + +\gamma_2[T_2 - T_{d2} - T_{agr2} - T_{nag2}] \end{aligned} \tag{4}$$

According to the work structure in the household (performance on or off-farm), the optimization can take different forms. Here we consider families where some individuals perform off-farm work and others do not. That said, it can be assumed that $T_{agr}, T_{nag} \geq 0$. In summarizing the main mathematical proceedings, it can be found that $W_1 = \gamma_1/\lambda$ and $W_1 = \gamma_2/\lambda$. Furthermore, for the consumption equation:

$$\begin{aligned} C + W_{1nag}T_{d1} + W_{1agr}T_{d1} + W_{2nag}T_{d2} + W_{2agr}T_{d2} \\ = W_{1nag}T_1 + W_{2nag}T_2 + W_{1agr}T_1 + W_{2agr}T_2 \\ + \left[f\left(p; T_{agr1}, T_{agr2}; Z_{agr}\right) - \left(W_{1agr}T_{agr1} + W_{2agr}T_{agr2}\right)\right. \\ \left. - \left(W_{1nag}T_{agr1} + W_{2nag}T_{agr2}\right)\right] + g\left(T_{nag1}, T_{nag2}; H; Z_{nag}\right) + OSI \end{aligned} \tag{5}$$

Simplified, Equation (5) can be rewritten as $C + L = VT + \pi^* + S + OSI$, which means that consumption and leisure are equal to the sum of the work value measured by on and off-farm work; agricultural profits, represented by the revenues and costs of the trade-off between working on or outside of the farm; and the wage gained from off-farm activities.

Finally, the choice to engage in off-farm work depends first on the ability to leave the farm, which, in turn, depends greatly on income. Further, several unobserved characteristics can explain the individual motivation to participate in such activities. That said, in the next section we explore the empirical strategy to properly estimate the effects of off-farm work on income concentration, considering both observed and omitted particularities.

4. Identification Strategy

Our research investigates how off-farm work contributes to household income and inequality. We show that engagement in such activities depends on individual characteristics and job quality, which varies given the background and motivations of individual workers. In this sense, even though income from off-farm work may be responsible for an overall increase in household income, its effects can be unbalanced in the household and also increase inequality. The estimation must consider two important features in order to obtain proper effects: i) individuals in wealthier households have different incentives to take part in off-farm labor markets than those in the poorest households (Escher et al., 2015); and ii) on and off-farm jobs have particularities that influence intra-household resource allocation influence the allocation of intra-household resources (Start, 2001).

One method that has gained attention in the literature analyzing the effects of inequality is Unconditional Quantile Regressions (UQR).[2] Proposed by Firpo, Fortin, and Lemieux (2009), this technique allows for an estimation of the marginal effects of covariates on quantiles of any functional

[2] This method has been used to analyze the effects of rural extension and credit on income concentration in rural areas (Freitas et al., 2018; Neves et al., 2018), income inequality in Brazilian regions (Madeira, 2017), gender wage gaps (Blau and Kahn, 2017), and labor market and inequality (Maurizio, 2014).

income – similar to what the Ordinary Last Squares (OLS) method does for averages. The UQR allows not only within-group, but also between-group comparisons. That is, we can investigate whether off-farm work is responsible for reducing income dispersion within different quantiles, but also the overall inequality measured by the different income strata in rural areas.

The UQR approach is based on an influence function concept known as the Recentered Influence Function (RIF), with expectations equal to $v(F_Y)$, which is extended to different types of measures beyond quantiles of the outcome variable (here, household income). For the quantiles, the dependent variable in the regression is represented by Equation (6):

$$RIF(Y; q_\tau, F_Y) = \frac{q_\tau + (\tau - 1\{Y \leq q_\tau\})}{f_Y(q_\tau)} \tag{6}$$

where q_τ represents the distribution of the τ-th quantile of income distribution Y. After estimating the sample quantile q_τ through the density $f_Y(q_\tau)$, it forms a dummy variable $1\{Y \leq q_\tau\}$, which indicates whether the income is below q_τ. Then it is possible to run an OLS regression of the new dependent variable on the covariates.

To properly observe the effect of income on different groups, Firpo (2007) proposed an extension of the Oaxaca-Binder approach, which decomposes the mean income difference into observed characteristics and their return considering the quantiles and variance (Neves et al., 2020; Oaxaca, 1973). To do so, two groups of households can be assumed, divided by those whose main income arises from off-farm work (group *A*) and otherwise (group *B*). Such decomposition makes it possible to identify the difference in the income distribution of *i* groups based on income quantiles (Eq. 7):

$$\Delta v = v\left(F_{yA}\right) - v\left(F_{yB}\right), \tag{7}$$

where $v\left(F_{yi}\right)$ is the statistic of income distribution of groups *i* (*A* and *B*). The term Δv is divided in order to check the return effect (difference between groups Δv_R) and the composition effect (difference in observable individual characteristics Δv_X), such as (Eq. 8):

$$\Delta v = \Delta v_R + \Delta v_X. \tag{8}$$

Equation (8) is obtained by re-estimating the RIF regressions for both groups, which leads to $v\left(F_{yA}\right)$ and the counterfactual $v\left(F_{yB}\right)$ (Eq. 9):

$$v\left(F_{yt}\right) = E[RIF(y_t; v_t)|X, T = t] = X_t\beta_t, \tag{9}$$

where *t=A, B* represents the two different groups: one in which the main income arises from off-farm work and one without off-farm work (Group *B*). Here, β is the parameter of interest that represents the impact of the off-farm work in the different income quantiles. To estimate β, a probit model is used to obtain weighting factors that will be used afterward in the RIF regressions through an OLS model.

In sum, such a method allows for the identification of the influence of individual characteristics on the choice to perform off-farm work. Furthermore, we see how on and off-farm work differs in terms of household inequality. Even though the process of choosing a job naturally leads to a biased estimator,[3] there is no need to declare a causal effect to properly answer the research question. That is because this paper is more focused on understanding how certain particularities (individuals and jobs) and public policies could be created to disrupt income disparities. The data considered is from PNAD 2015; the variables and a description are listed in Table 1.

[3] Since it is not possible to observe some characteristics that led the individual to make a particular choice, there will be a correlation between the error term and the parameter of interest that makes it endogenous and, therefore, biased.

Table 1 Variables and Description

Variable	Description
Household Income	Monthly household income
Off-farm Income	Individual income from non-agricultural activities (classified according to CBO)
Female	=1 if the household is headed by a woman; 0 otherwise
White	=1 if the head of household is white; 0 otherwise
Age	Average age of household members
Education	Dummies for the highest educational levels of the household responsible (no instruction, elementary school, high school, university education)
Information	Index of access to mobile phone, tv, and/or internet in the household
Single Mother	=1 if the household is composed exclusively of mother and children; 0 otherwise
Elderly	Number of household members aged at least 60 years old
Children	Number of household members aged 15 years old or less
Region	Dummies for each region (North, South, Northeast, Southeast, Midwest)
Travel Time	Dummies for time spent on work commute.
Occupied	Number of individuals in the household actively employed
Self-Consumption	=1 some goods consumed in the household were self-produced
Formal	Average of individuals in the household with formal employment
CBO	Dummies for job classifications accordingly to CBO (undefined, directors, teachers of art and science, technicians, managers, general services, trade services, agricultural, industrial, army)

Source: Authors' elaboration.

5. Results

5.1 Rural Incomes and Individual Characteristics

In this section we outline the main characteristics of our population of interest: all rural residents who are more than 15 years old. Table 2 shows descriptive statistics of the main variables, considering those who perform agricultural and non-agricultural activities and those who are unemployed.

Table 2 Descriptive Statistics for Rural Residents by Job Type in Brazil, 2015

	Agricultural Jobs		Non-Agricultural Jobs		Unemployed	
Variable	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
Women	0.17	0.38	0.25	0.43	0.27	0.45
White	0.43	0.49	0.47	0.5	0.42	0.49
Age	43.73	15.88	37.11	12.59	44.61	22.04
Info	1.91	1.15	1.91	1.16	1.88	1.16
Occupied	2.3	1.2	2.2	1.1	1.1	1.02
Head of Household Study	4.72	3.64	7.05	4.4	4.72	3.95
No Instruction	0.64	0.48	0.36	0.48	0.5	0.5
Elementary	0.09	0.28	0.12	0.32	0.07	0.26
High School	0.06	0.25	0.2	0.4	0.07	0.25
University	0.01	0.09	0.06	0.23	0.01	0.1
Single Mother	0.06	0.24	0.09	0.29	0.12	0.32
North	0.23	0.42	0.21	0.41	0.21	0.4
Northeast	0.41	0.49	0.38	0.49	0.48	0.5
Southeast	0.15	0.36	0.17	0.37	0.14	0.35
South	0.14	0.34	0.16	0.37	0.12	0.32
Midwest	0.08	0.27	0.08	0.27	0.06	0.24
Travel time 1	0.21	0.4	0.57	0.49	0	0
Travel time 2	0.05	0.22	0.14	0.34	0	0
Travel time 3	0.02	0.13	0.05	0.22	0	0
Formal	0.08	0.27	0.3	0.46	0	0
Observations	**1524**		**9176**		**13822**	

Source: Authors' Elaboration.
Note: SD = Standard deviation.

In Brazil, the agricultural labor market is mainly composed by men and non-white individuals. Women are more proportionally unemployed and more engaged in non-agricultural jobs (25%) than in agriculture (17%). On-farm workers and the unemployed are on average the same age (43 and 44 years old, respectively), while the average age for non-agricultural jobs is 37 years old. We can also see that there are approximately two items for access of information (phone, tv, and/or internet).

Off-farm workers live in households where the heads of household are more educated and where the presence of people with tertiary and secondary education is greater, while in agricultural jobs, 64% of the individuals have not received any formal instruction. The greater number of unemployed individuals live in the North and Northeast, the only regions where rural residents are more engaged in agricultural activities. Additionally, workers tend to spend less than 30 minutes traveling to work.

There are also some particularities concerning the type of work individuals perform, whether off-farm or not. Such particularities reflect the effects of the direction of income and are manifested differently in relation to Brazilian regions, given the process of modernization, and marked by the productive structure of each region. Table 3 presents the distribution of rural workers among the Brazilian regions.

Table 3 Occupational Distribution of Rural Workers in Brazil, 2015

Occupation	North	Northeast	South	Southeast	Midwest
Agricultural	65.01%	64.45%	59.48%	60.94%	61.80%
Directors	0.88%	0.85%	1.35%	1.75%	2.24%
Teachers of Science and Arts	3.35%	2.38%	3.50%	1.91%	2.95%
Technicians	2.68%	2.47%	2.43%	2.11%	1.68%
Managers	1.30%	1.53%	3.14%	3.00%	2.59%
General Services	9.32%	9.79%	8.96%	13.24%	15.92%
Trade Services	4.46%	5.01%	3.06%	2.92%	2.70%
Industrial	12.87%	13.37%	17.89%	14.03%	9.97%
Army	0.14%	0.14%	0.17%	0.10%	0.15%
Other	-	-	0.03%	-	-
Observations	**5,679**	**9,997**	**3,628**	**3,935**	**1,966**

Source: Authors' elaboration.

The data shows that occupations are distributed similarly in different regions of Brazil. The incidence of agricultural work is greater in the North and Northeast regions, where 65% and 64% of the rural population are dedicated exclusively to agricultural activities. In both regions, among off-farm activities, those related to services and industrial activities are the most prevalent. The South, in turn, is the region with the lowest incidence of exclusively agricultural workers and the highest concentration in industrial activity. The Southeast and Midwest regions employ approximately 61% of the population in agricultural activities and, like the other regions, among non-agricultural activities the main concentration of workers is in the service and industrial sectors. Table 4 illustrates the subdivisions of agricultural activities among the regions.

Table 4 Position of Workers Employed in Agricultural Activities in Brazil, 2015

	North	Northeast	South	Southeast	Midwest
Permanent employee in auxiliary services	0.41%	0.82%	0.32%	0.49%	6.16%
Permanent employee in agriculture, forestry, or raising cattle, buffalo, goats, sheep, or pigs	10.32%	9.63%	11.37%	23.97%	32.42%
Permanent employee in other activity	0.54%	0.31%	1.85%	0.70%	1.95%
Temporary employee	6.70%	10.73%	3.05%	6.53%	2.81%
Self-employed in auxiliary services	2.48%	2.50%	1.39%	1.48%	4.99%

Self-employed in agriculture, forestry, or cattle, buffalo, goat, sheep, or pig farming	32.27%	25.46%	38.51%	23.93%	18.94%
Self-employed in other activity	5.37%	4.56%	2.27%	0.33%	2.03%
Employer in auxiliary services	0.08%	-	-	-	0.08%
Employer in agriculture, forestry, or cattle, buffalo, goat, sheep, or pig farming	1.27%	0.62%	1.11%	2.67%	2.03%
Employer in other activity	0.08%	0.02%	0.32%	-	-
Unpaid worker and member of the household	14.26%	10.42%	16.92%	13.01%	8.26%
Other unpaid worker	0.08%	0.19%	0.05%	0.04%	0.08%
Worker producing for self-consumption	26.14%	34.75%	22.84%	26.85%	20.27%
Observations	**3,703**	**6,441**	**2,163**	**2,436**	**1,283**

Source: Authors' elaboration.

According to Table 4, a small portion of rural residents are employers, indicating that the management of rural establishments – especially large ones – is carried out by urban residents.[4] Here, it must be noted that the better-paid (or more profitable) agricultural job positions are not held by rural workers. Most permanent employees are engaged in activities related to agriculture, forestry, or animal husbandry. The concentration is even higher in the Midwest and Southeast. On the other hand, the lowest proportion of permanent employees is in the Northeast region, which has the highest percentage of individuals who have temporary jobs. This is an important indication of vulnerability since jobs and, therefore, incomes are more uncertain. In any case, most rural individuals, in all regions, are farm workers who produce for their own consumption or perform agricultural activities on their own. In this sense, there is still a significant contingent of unpaid workers within households.

Since rural income distribution, as well as participation in on and off-farm work, differs between states and regions, Figure 1 illustrates the distribution of agricultural and non-agricultural income in Brazil, as well as the ratio between them.

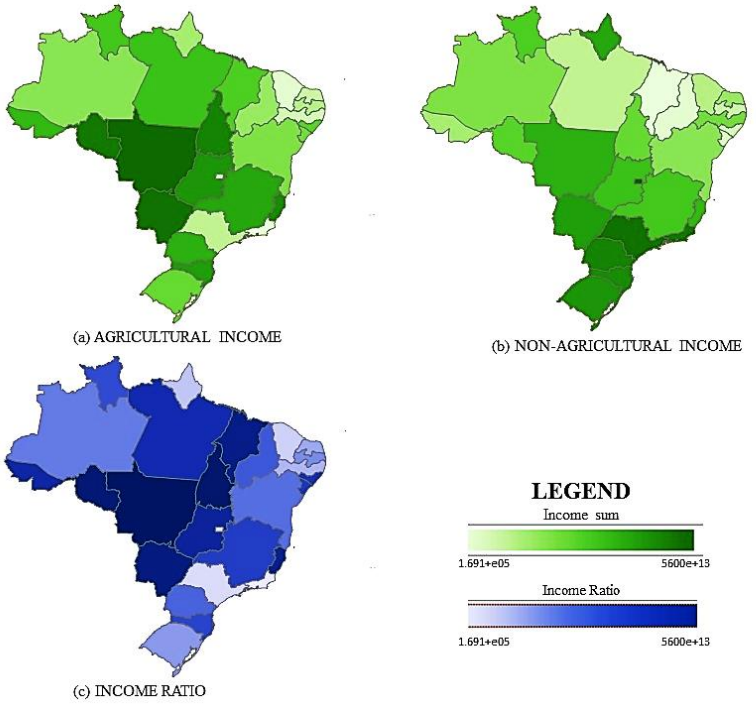

Figure 1 Distribution of Agricultural and Non-Agricultural Incomes of Rural Workers in Brazilian States, 2015
Source: Research results based on PNAD 2015.

[4] 13% of the workers engaged in agricultural activities who reside in urban areas are employers.

Figure 1 shows that Midwest states contain the highest concentration of agricultural incomes (Fig. a). This is also the region that has the least number of people working on their own or for self-consumption and, at the same time, the highest incidence of permanent employees. The distribution of non-agricultural incomes (Fig. b), on the other hand, confirms the regional disparity in which Federal District, South, and Southeast regions serve as home to the greatest share of income, while the North and Northeast states have lower levels of off-farm income. In image (c), we show that the relative importance of non-agricultural income changes between Brazilian states, given its significant prevalence in the North and Northeast. However, these states are home to the most precarious and informal agricultural jobs, reinforcing the importance of studying the rural labor market and its dynamics and particularities.

Figure 2 shows that despite the smooth distribution of agriculture incomes, income from non-agricultural jobs and other sources are not normally distributed among households. We consider the logarithm for different source of incomes, and their difference are statistically significant. From Figure 2 we can see that average effects could indeed mask specific effects: there is a concentration of off-farm income in the upper quantiles. We then expect that the effect on the overall household income will be distinct for wealthier households. The next subsection displays the results from our main estimates, where this possibility is explored.

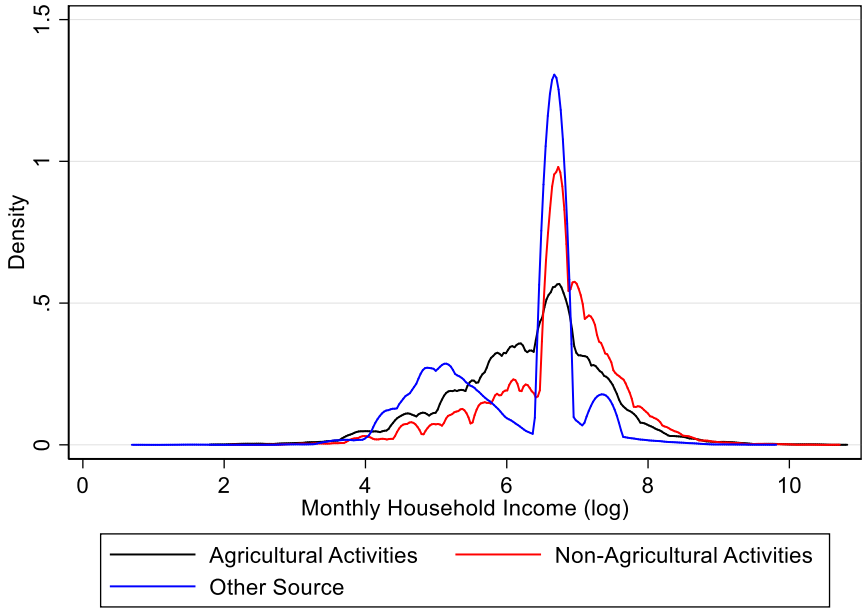

Figure 2 Monthly Household Income in Rural Brazilian Households, 2015
Source: Authors' elaboration based on PNAD 2015.

5.2 Income Inequality and Non-Agricultural Jobs

In this section we present the estimated results of the effects of income from non-agricultural jobs on total household income. Table 5 depicts the results of our outcome variable obtained from an OLS model and four RIF models: the first model (1) considers only the effect of non-agricultural income; the second (2) adds individual characteristics; followed by adding household (3) and work (4) characteristics. We report only the effects of our interest variable, off-farm labor income. After OLS, each column represents the effects of off-farm labor income on the 10th (Q10) to 90th (Q90) income quantiles, so these results indicate the effect of off-farm income on Brazilian household income concentration.

Table 5 Effects of Non-Agricultural Income on Rural Income Inequality in Brazil, 2015

	OLS	**Q10**	**Q25**	**Q50**	**Q75**	**Q90**	**OLS**
(1) Baseline Model	1.104***	0.135***	0.164***	0.243***	0.684***	1.765***	1.104***
	(0.0126)	(0.0131)	(0.0155)	(0.0221)	(0.0601)	(0.140)	(0.0126)
(2) Individual Characteristics	0.947***	0.113***	0.134***	0.195***	0.532***	1.381***	0.947***

	(0.0130)	(0.0126)	(0.0145)	(0.0202)	(0.0521)	(0.119)	(0.0130)
(3) Household Characteristics	0.930***	0.108***	0.132***	0.205***	0.501***	1.313***	0.930***
	(0.0122)	(0.0122)	(0.0141)	(0.0208)	(0.0481)	(0.110)	(0.0122)
(4) Work Characteristics	1.153***	0.0244***	0.0526***	0.146***	0.453***	1.489***	1.153***
	(0.0148)	(0.00540)	(0.00794)	(0.0208)	(0.0623)	(0.188)	(0.0148)
Observations				**38,297**			

Source: Authors' elaboration based on PNAD 2015.
Notes: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Our results confirm that average effects (OLS) could mask the real impact of off-farm income over the distribution. We demonstrate that off-farm income has a positive effect over household revenue, indicating that rural households benefit from such jobs. We can also see that the inclusion of covariates does not systematically change our main estimates and only a small decrease in the total household income is noted. However, the quantile impacts indicate that even though this source of income is indeed responsible for increasing total household income, the impact is greater in higher quantiles, reinforcing inequality.

On one hand, the covariates in the first income quantile actually decrease the impacts of off-farm labor income. On the other hand, in the higher quantiles, even though individual and household characteristics smooth the effects comparing the baseline model, work controls perform the opposite function. For example, in the 90th quantile, the impact on the outcome considering such particularities more than doubles. To check the determinants of the covariates over the distribution, Table 6 shows the results for all variables considered in the model.

Table 6 Estimates of Unconditional Quantile Effects on Monthly Income of Rural Households in Brazil, 2015

Variables	**Q10**	**Q25**	**Q50**	**Q75**	**Q90**	**OLS**
Non-Agricultural Income	0.0244***	0.0526***	0.146***	0.453***	1.489***	1.153***
	(0.00540)	(0.00794)	(0.0208)	(0.0623)	(0.188)	(0.0148)
Women	-31.34***	4.023	-15.63	-33.48*	-64.03	0.766
	(11.59)	(8.800)	(9.776)	(20.13)	(51.26)	(20.08)
White	73.28***	70.14***	71.75***	183.1***	627.4***	282.9***
	(11.20)	(8.893)	(10.25)	(21.37)	(53.97)	(21.24)
Non-Instruction	-127.9	-75.09	-93.74	-311.4**	-265.8	-232.2
	(102.2)	(75.07)	(72.78)	(148.4)	(293.3)	(161.9)
Elementary School	-40.55	12.23	35.24	-58.59	183.4	17.92
	(102.7)	(75.40)	(73.26)	(149.4)	(296.8)	(162.7)
High School	-10.70	69.04	143.9**	278.1*	1,144***	390.9**
	(102.6)	(75.37)	(73.41)	(150.1)	(301.4)	(163.0)
University	-30.52	72.45	251.7***	988.8***	3,669***	1,615***
	(105.0)	(78.26)	(79.99)	(170.5)	(413.7)	(174.8)
Age	4.418***	1.817***	3.663***	2.984***	7.139***	3.926***
	(0.338)	(0.277)	(0.325)	(0.695)	(1.778)	(0.666)
North	284.6***	127.7***	94.21***	291.8***	469.4***	297.9***
	(14.53)	(11.17)	(11.48)	(22.00)	(50.87)	(23.75)
Southeast	358.9***	274.9***	292.8***	579.3***	700.3***	518.1***
	(13.62)	(11.41)	(13.42)	(27.89)	(67.25)	(27.50)
South	322.9***	310.7***	469.0***	1,067***	2,163***	945.5***
	(14.35)	(11.82)	(14.92)	(33.89)	(95.20)	(30.81)
Midwest	438.9***	413.5***	449.1***	896.0***	1,723***	940.7***
	(15.43)	(13.77)	(18.55)	(40.76)	(110.4)	(36.92)
Elderly	275.0***	320.8***	554.9***	573.4***	837.7***	588.2***
	(6.541)	(5.363)	(6.857)	(15.89)	(44.27)	(14.71)
Children	0.632	-6.543*	-42.83***	-65.80***	-79.43***	-58.50***
	(5.231)	(3.939)	(4.027)	(7.731)	(18.76)	(8.312)
Occupied	141.7***	165.5***	227.5***	563.9***	1,059***	492.6***
	(4.765)	(3.740)	(4.505)	(9.573)	(26.23)	(8.402)
Single Mother	-22.68	51.71***	88.33***	111.2***	33.85	77.19**

	(19.07)	(13.62)	(15.36)	(30.19)	(70.58)	(31.69)
Travel time1	64.01***	25.74	10.20	-34.42	20.81	-70.22*
	(21.09)	(16.84)	(19.68)	(40.51)	(107.5)	(41.99)
Travel time 2	94.81***	49.31*	51.92	162.5**	225.9	212.9***
	(27.61)	(25.40)	(33.08)	(74.22)	(199.2)	(67.98)
Self-Consumption	-6.073	76.49***	83.53***	450.6***	1,038***	452.2***
	(22.17)	(15.61)	(16.43)	(34.31)	(93.46)	(34.43)
Formal	288.5***	327.9***	353.1***	431.4***	284.5***	153.9***
	(9.795)	(11.05)	(16.51)	(36.89)	(101.3)	(33.63)
Undefined Jobs	-134.9***	-25.91	-1,966***	-2,966***	-5,568***	-2,548
	(25.41)	(19.35)	(22.08)	(48.71)	(140.3)	(1,744)
Directors	-11.07	53.85	-4.735	30.37	310.6	-1,084***
	(37.02)	(33.20)	(59.95)	(157.7)	(505.1)	(112.6)
Teachers of Science and Arts	72.10**	110.3***	20.28	-198.2*	-1,321***	-1,262***
	(33.38)	(29.84)	(48.43)	(119.4)	(370.2)	(83.67)
Technics	107.5***	160.3***	44.47	-18.51	-1,077***	-1,127***
	(26.43)	(25.14)	(43.55)	(111.7)	(332.4)	(78.66)
Managers	8.588	6.053	35.79	-85.46	-448.9	-689.4***
	(23.69)	(25.00)	(39.77)	(106.8)	(346.3)	(84.98)
General Services	59.95***	22.85	-103.8***	-485.3***	-1,552***	-988.1***
	(19.43)	(17.32)	(24.34)	(56.65)	(155.8)	(41.44)
Trade Services	63.29**	46.54*	-88.82***	-245.4***	-1,351***	-934.0***
	(28.06)	(24.12)	(32.59)	(74.17)	(203.8)	(59.69)
Agricultural	-231.7***	-207.8***	-286.1***	-579.2***	-1,094***	-511.6***
	(15.43)	(11.43)	(12.44)	(25.48)	(63.75)	(25.70)
Industrial	24.11	26.78	-146.8***	-330.6***	-1,641***	-1,175***
	(21.08)	(17.95)	(26.46)	(67.94)	(191.9)	(40.77)
Army	120.0*	199.2**	126.5	62.70	492.9	-923.3***
	(70.56)	(78.29)	(136.0)	(336.3)	(1,137)	(298.7)
Constant	-144.5	190.6**	698.4***	803.2***	465.9	366.3**
	(104.5)	(76.45)	(74.16)	(151.7)	(302.8)	(164.8)
Observations			**38,297**			
R-squared	**0.123**	**0.209**	**0.341**	**0.296**	**0.233**	**0.356**

Source: Own elaboration.
Notes: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The interpretation of the above results could be tricky given their magnitude. We can observe that only for the last quantile are the effects of non-agricultural income higher than one, suggesting that these effects have more than a proportional influence on household income for wealthier families. These findings, as indicated in Table 5, show that even though non-agricultural jobs indeed raise overall rural household incomes, they also increase income inequality since the poorest households do not seem to benefit from such revenue.

This result supports our main hypothesis and correlates with previous literature. According to Ney and Hoffmann (2008), non-agricultural activities are responsible for worsening the Gini index in rural households, in the sense that public policies for rural income distribution should focus not only on the primary sector, but also the industrial and service sectors. Similar results were found in other developing countries and the evidence reinforces that argument that disparities among workers and the type of jobs actually increase off-farm income in wealthier households and, therefore, accentuate the concentration (Adams, 1994; Flachsbarth et al., 2017)

In the same sense, the effects of individual characteristics are present, especially for the distribution extremes. White people contribute more household income compared to black and indigenous workers, and this effect is more than eight times greater in the higher quantiles. Income from female workers is related to worse household revenues in the 10^{th} and 75^{th} quantiles, which is explained by their majority presence in informal and worse-paid jobs, despite the fact that women engage mainly in unpaid work and domestic tasks (Rao, 2011). Also, the influence of educational levels is clear for those with either a completed high school or university background in the upper quantiles. Average effects (OLS model) are also only statistically significant for these categories. These effects are expected, given that most agricultural

activities do not require formal education and inhabitants of rural areas tend to be less educated than those in urban zones,[5] which can reinforce a brain drain in rural areas and, therefore, a depreciation among agricultural jobs. It also confirms the higher returns of education related to non-agricultural activities (Ferreira and Lanjouw, 2001).

As we show in Section 5.1, the Northeast has a greater number of workers exclusively engaged in agricultural activities; all other regions have higher returns in terms of household income, especially South and Midwest Brazil. The vulnerability of the Northeast is also perceptible in terms of access to public services and income inequality (Lima et al., 2016; Madeira, 2017; Neves et al., 2018). Also, the presence of elderly people increases average household income, while children decrease income levels. On one hand, the presence of children may hamper the access to paid activities given care needs – mainly for women. On the other hand, given the informality of agricultural activities it is more common to find elder people performing them (see Table 2), connecting this age asymmetry to income effects.

The number of employed individuals in the household increases average income, which can be related not only to the total revenue contribution, but also to a spillover effect observed in off-farm jobs (Yang, 1997). Surprisingly, individuals who live in households headed by a single mother are located in the middle of the income distribution scale (quantiles 25–75) and tend to be better off than those in other households. Even though these are the most vulnerable group (Braga, 2018), the fact that the effects are not perceived among the poorest nor the wealthiest could be related to other sources of income such as retirement savings and government payments.

The effects of commuting are only significant for the first quantile, indicating that living closer to their place of work is beneficial for workers. Production for self-consumption also increases household income. This effect is especially high in the upper quantile. Formal jobs, in turn, confirm the need for rural assistance given its positive effect, especially for the poorest workers.

5.3 Inequality Decomposition

We showed that different observed characteristics influence rural household inequality. However, as we have pointed out in the theoretical section, there is an individual choice regarding participation in the labor market and engagement in specific jobs defined by unobservable characteristics. By definition, such characteristics cannot be measured and are captured by the error term. In this subsection we address this problem by decomposing inequality through return and composition effects of the covariates. Figure 3 shows the aggregation of these effects.

[5] Individuals more than 15 years old in urban areas study, on average, for nine years, while those in rural areas study for six.

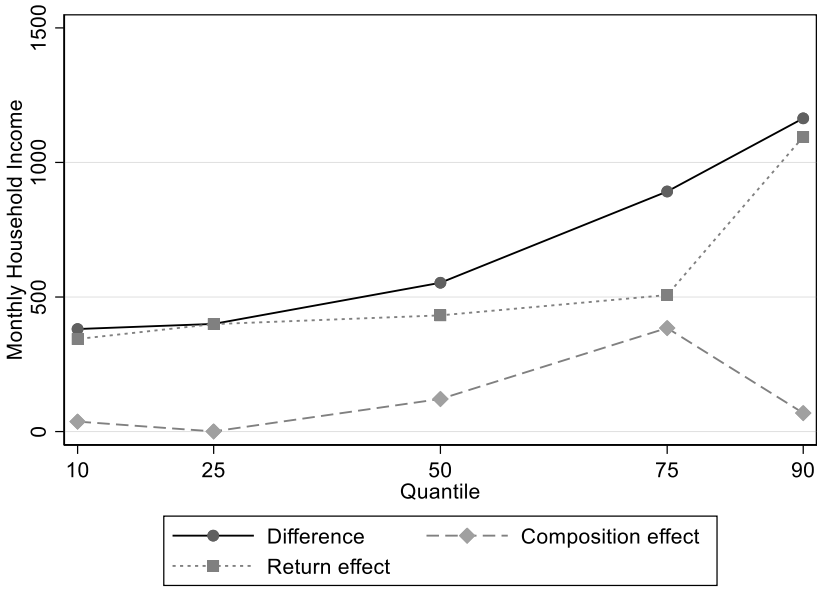

Figure 3 Oaxaca-Blinder Decomposition of Return and Composition Effects on Monthly Rural Household Income in Brazil, 2015
Source: Authors' elaboration.

Figure 3 illustrates the income differences across the distribution between individuals who perform agricultural and non-agricultural jobs. In terms of composition effects, that is, differences in the distribution of observable variables, the difference is observed on median income and in the 75th percentile. This suggests, then, that the major effects of inequality manifested in the extremes of the distribution are due to structural effects (return effects). That is, intrinsic characteristics differ between on and off-farm workers especially in the poorest and wealthiest groups, reinforcing inequality, as we explore below.

Regarding composition effects, the main characteristic that differentiates agricultural from non-agricultural contributions to household income is schooling, as shown in Figure 4. This effect accounts for the sum of all instruction decomposed coefficients and confirms that qualification is determinant for increasing rural revenues. Furthermore, it indicates that most qualified rural residents perform significantly better in the upper quantiles. The importance of educational background is highlighted in the literature given the direct relationship between years of study and income. In rural areas, a higher level of education allows workers to apply for more diverse labor market opportunities, therefore a great differential (Aziz et al., 2017; Ferreira and Lanjouw, 2001; Zhang et al., 2008).

In the same sense, work characteristics, age, and experience (clustered in the category "other"), increase the difference. Household composition (presence of the elderly, the employed, and children) tends to smooth this inequality. From that we can see that rural households generally maintain a similar structure and the best workers may be leaving for urban areas.

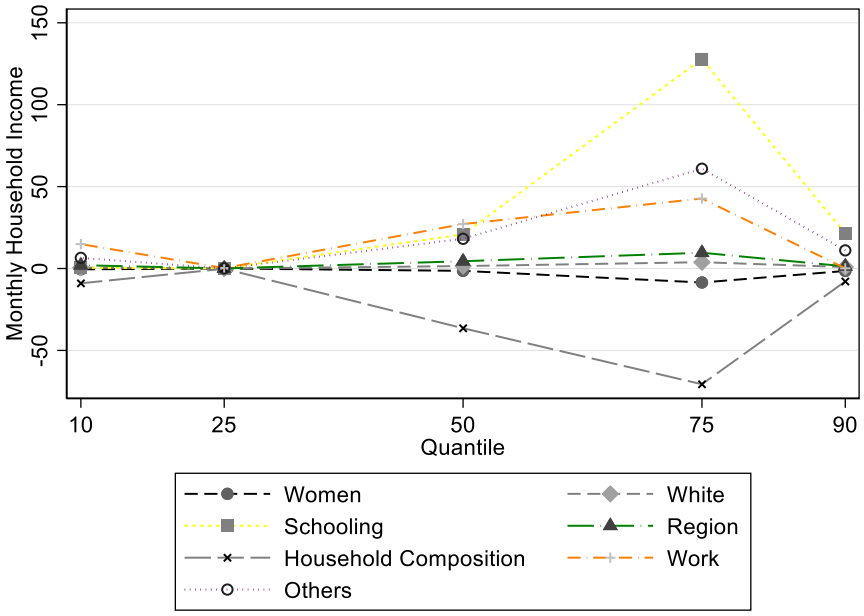

Figure 4 Composition Effects of Rural Income Inequality in Brazil, 2015
Source: Authors' elaboration.

Regional effects do not seem to collectively affect the output, and Figure 5 depicts the differences in regional effects when they have been decomposed. The base for comparison is the Northeast region, which has at least one member in the family engaged in off-farm activities and the highest share of poor families. In this region, according to Lima (2008), non-agricultural income is indeed responsible for reducing poverty levels and income concentration in rural areas.

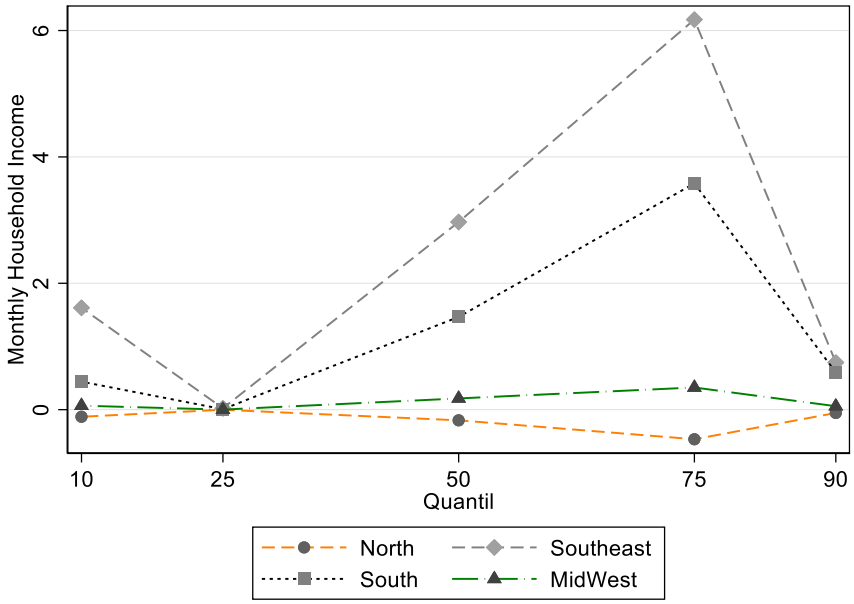

Figure 5 Composition Effects of Brazilian Regions on Household Inequality, 2015
Source: Authors' elaboration.

Two regions have the most disparate effects: the Southeast and the South. The differences, which are particularly high in the 75th quantile, but also have differences in the first quantile, explain the constant migratory flow throughout the country, especially in industrial activities. Moreira et al. (2011) stated that even though work diversification is associated with less developed regions, in the Southeast there is an observed increase in off-farm work associated with the higher technological level and ecotourism activities.

Additionally, the modernization in the region demands non-agricultural work in rural areas, such as maintenance, cleaning, and administrative tasks, among others (Schneider, 2006).

In the South, Escher et al. (2015) have demonstrated that pluriactive households (where the residents combine agricultural and non-agricultural activities) are present among major producers as well as small farmers, as it is seen in the Northeast region. This difference can be explained by the diversity in activities performed by rural residents in the South, both agricultural and nonagricultural (see Tables 3 and 4).

Finally, we present the return effects, which account for the differences in observable and unobservable characteristics. These effects are also more relevant in the 75th quantile and show that household composition explains a significant part of income inequalities in rural households. Further, educational background, age, and experience (others) also play an important role in explaining these inequalities. As the theoretical model indicated, this relates to the intrinsic characteristics that more highly educated individuals bring to activities that are more profitable and, consequently, can result in a spillover effect for the household.

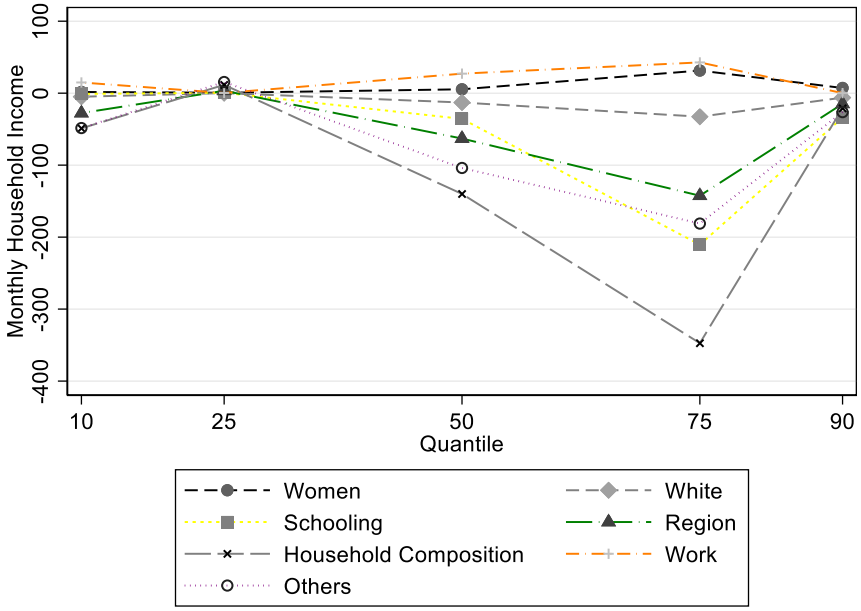

Figure 6 Return Effects of Rural Household Income in Rural Brazil, 2015
Source: Authors' elaboration.

The nature of return effects is endogenous, referring to unobserved features. In a related study, Adepoju and Oni (2012) showed that in rural Nigeria, social capital and household welfare have non-linear interactions due to unobservable variables. Similarly, educational background is positively related to income, and Figure 6 shows that endogenous effects are especially relevant as an explanation for income concentration. According to Coady and Dizioli (2018), the unobservable factors of income inequality and inequality of schooling are clearly connected, particularly in developing countries. These combined factors show that even though the richest households in rural Brazil benefit from off-farm income in a very straightforward manner, households in the upper intermediary quantile (the middle class) have several intrinsic characteristics that affect their income composition.

6. Final Remarks

In this paper we analyzed the effects of work diversification on inequality in rural areas of Brazil. Specifically, we estimated the effect of income from non-agricultural jobs income on monthly household revenues. To do so, we used the RIF approach in income quantiles and, additionally, decomposed the effects on return and composition as proposed by Oaxaca-Blinder to address unobservable effects.

We showed that engagement in non-agricultural activities by rural residents increases average income in these areas but also highlights disparities, as wealthier families benefit the most from diversified sources

of income. Also, average effects or more simple measures cannot accurately capture these disparities in terms of distribution. Furthermore, we confirmed that unobservable characteristics play a major role in income inequality when labor market impacts are analyzed. As a result, we have argued that basic infrastructure and proper education must be provided to avoid a brain drain in rural areas. Further, access to markets and rural assurance must be provided, such as rural credit and subsides to guarantee that producers and other agricultural workers do not suffer from adverse circumstances and exogenous shocks. Guarantees of social reproduction in all spheres in rural areas and the prevention of flight from rural areas is imperative to improve the living conditions of its residents and for economic development more broadly.

That said, public policies must be combined in terms of i) providing formal and technical education, particularly for young people and ii) regulating agricultural jobs in order to avoid precarious conditions. Additionally, off-farm work could actually alleviate such inequalities if democratic access was guaranteed; that is, with adequate conditions and opportunities for all. For further research, we suggest analyzing the gender effects on the rural labor market, such as explore the endogeneity in education and informal employment.

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