Cooperatives and income inequality in Brazilian rural sector

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Abstract

Agricultural production in Brazil has increased in recent decades. Despite this increase, the rural population continues to face income inequality. Market access aimed at the commercialization of production can minimize this issue, thereby improving income. In this article, we estimate the influence of cooperativism—as a method of market access—in income generation and distribution in rural areas of Brazil. To determine the influence of cooperativism on household income, we use an income decomposition and the household survey "National Household Sample Survey – PNAD". The results indicate that, in addition to raising income, cooperativism has the potential to minimize the inequality of income distribution among cooperative members. It was also determined that higher levels of education, credit, and access to rural extension increased the effect of marketing with cooperatives on income. The findings of the present study suggest that public policies integrating cooperativism, rural credit, rural extension, and human capital promotion would be more effective due to the synergy of these elements.

Keywords: Cooperatives, Marketing, Income inequality, Unconditional quantile regression.

JEL: Q12, O15, C31, R58.

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1 Introduction

In recent decades, Brazil has increased agricultural production and has experienced stronger participation in the global food market (Chaddad, 2015; Buanain et al., 2019). Despite increased production, rural populations continue to cope with high-income inequality. Commercial agricultural production remains concentrated in large farms, with approximately 85% of gross farm income being generated by 11.4% of Brazilian farms (Alves et al., 2013). Barros et al. (2006) and Helfand et al. (2009) found evidence of a high-income inequality in rural areas of Brazil. Although income inequality has declined over time, much remains to be addressed to achieve the desired scenario of no income inequality in rural Brazil.

Several factors can contribute to more equitable income distribution in rural areas, including access to markets (Fafchamps, 2003; Jayne et al., 2006; Carletto et al., 2017), rural extension (Danso-Abbeam et al. 2018; Freitas et al., 2018; Junior et al., 2020), and financial services (Wan and Zhou, 2005; Mahjabeen, 2008; Luan and Bauer, 2016; Neves et al., 2020). Farm product commercialization is associated with higher farm income. Marketing farm products can increase income and contribute significantly to improving food security, poverty reduction, and agricultural development. These points were verified by Fafchamps (2003) in his work on sub-Saharan Africa and by Carletto et al. (2017), who analyzed these issues in Malawi, Tanzania, and Uganda. Continuing within the African context, Jayne et al. (2006) demonstrated that better coordination and transparency among actors are required to achieve reasonable levels of food price, which would culminate in raising income in rural areas. Notably, in developing countries, where trade is often characterized by market failures and monopolistic structures, cooperatives can represent an

attractive option for commercialization (Bernard and Spielman, 2009). These ventures favor vertical integration by improving the linkage of their members to the market. According to data from the Brazilian Institute of Geography and Statistics - IBGE (2019), approximately 75% of farmers marketed their products in Brazil in 2014. These products were primarily sold to final customers (35.7%), intermediaries (31.5%), companies (22.8%), and cooperatives (7.6%).

However, small producers face challenges in choosing the best destination for production due to market failures that may lead them to not being able to access the best marketing channels and contractual arrangements, failing to increase their earnings (Jayne et al., 2006). Cooperatives[1] in rural areas have appeared as an alternative. These are mainly made up of associated rural producers seeking to meet the needs related to their activities. These organizations serve as a means of coordinating actors in the primary sector of the economy. Cooperatives enable members to access and adopt technologies and inputs through technical assistance services. It also provides members with greater bargaining power to obtain better prices (Sexton, 1986; Sexton and Iskow, 1988; Valentinov, 2007; Zhang et al., 2007; Novkovic, 2008). In Brazil, these organizations account for approximately 40% of the gross value of agricultural production (GVP) in agriculture and livestock (IBGE, 2019). As seen in **Erro! Fonte de referência não encontrada.**, there seems to be a positive effect of cooperativism on the income of its members. Notably, those farmers who transacted their products with the cooperatives obtained a higher income with more individuals concentrated around the average (median) of the distribution of monthly

[1] Although the word "cooperative" can be applied to different types of collectively developed activities, we use the term to describe a democratically controlled and managed business model. In many countries, including Brazil, cooperatives are legally defined as a specific type of corporation and are subject to specific legislation (Zeuli and Radel, 2005).

income. This fact is indicated by the existence of more producers in the graph region of higher income since this income is superior to the other verified cases (in farm consumption, selling to companies, and selling to other marketing channels).

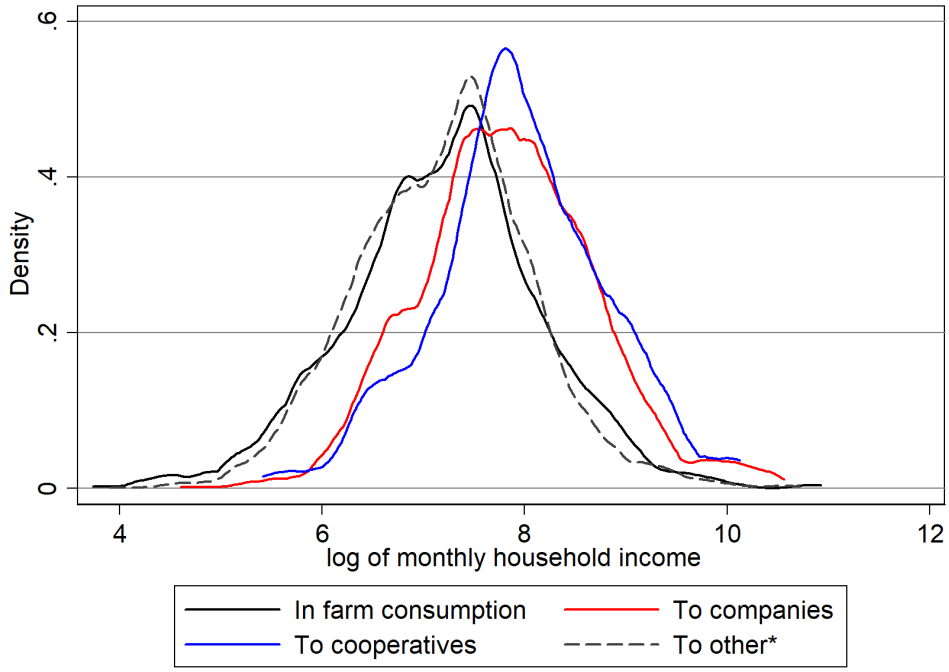

Figure 1 Monthly household income density distribution by marketing channel, Brazilian rural area, 2014
Note: *Includes middleman, final consumer, and other destinations.
Source: Own elaboration based on PNAD 2014 (IBGE, 2017).

In this paper, we estimated the effect of marketing through cooperatives on household income, as well as in their distribution in rural areas of Brazil. To determine the influence of selling to cooperatives on family income, the National Household Sample Survey (PNAD) of 2014 was used, which has a supplement with relevant information regarding the rural environment and the method of income decomposition proposed by Firpo et al. (2007). This approach consists of two steps: i) income regressions are estimated for different non-conditional quantile of income distribution; ii) the income differential is decomposed to identify the main factors (e.g., farmers' schooling and access to rural

extension) that explain income differences between those who are cooperated and those who are not cooperated for each quantile analyzed.

In addition to this introduction, the present article contains a section presenting the empirical strategy and data used to obtain the results, which are discussed in the following section, then followed by the final considerations.

2 Empirical strategy

To estimate how marketing production affects (not causally) household income, data were used from the National Sample Survey of Households (PNAD) 2014, provided by IBGE (2019). For 2014, there was a special questionnaire that included questions related to access to credit and technical assistance (extension) in rural areas. In PNAD, marketing of agricultural production[2] is categorized into: i) Company; ii) Cooperative; iii) Government; iv) Owner of the land; v) Intermediate; iv) Direct consumer, and; vii) Another buyer. In this work, a dummy variable with a value of 1 was constructed when the option "Cooperative" was chosen. This was the proxy used to define whether farmers marketed with cooperatives.

The database used in this work is a sub-sample of the PNAD and follows the objective of evaluating the effect of marketing with cooperatives before marketing alternatives. Thus, it includes only rural households that have commercialized their production. Similar to Ely et al. (2017), the sub-sample considers rural producers as being: 1) economically active; 2) employers or self-employed workers (these being the individuals

[2] The PNAD question for which the variable of interest of this research is based on is the following: "Buyer who acquired all or most of the main production of the farm that was sold in the 365-day reference period".

interviewed in the questionnaire); 3) individuals with agricultural activity as their primary occupation. The sample also covers rural producers living in urban areas. After the exclusion of missing values and possible outliers, the sample was 15,402 individuals. Then, considering the domicile focus of this study (i.e., those who marketed), the final sample was 11,419 individuals (see Table 1).

The dependent variable was the monthly household income in R$, which served as a proxy for rural property income. To control other factors besides marketing through cooperatives, which may influence the level of household income, the model also includes other variables:

a) *Rural credit* – dummy that assumes a value of 1 if the individual has obtained rural credit (includes the Family Agriculture Strengthening Program - PRONAF and credit from other sources);
b) *Rural extension* – a dummy variable equals 1 if the individual has received technical assistance and rural extension from a private or governmental source;
c) *Gender* – a dummy variable equals 1 if the individual is male;
d) *Race* – a dummy variable equals 1 if the individual is black;
e) *Schooling* – several dummy variables split into the categories “does not read and write” (base), “incomplete elementary school”, “complete elementary school”, “incomplete high school”, “complete high school”, “incomplete higher education”, and “complete higher education”;
f) *Age* – Several dummies, distributed in "up to 25 years" (base), "age 26 to 35 years", "age 36 to 45 years", "age 46 to 55 years", "age 56 to 65 years", and "age 65 years or higher";
g) *Rural* – a dummy variable equals 1 if the individual resides in a rural area;

h) *Land ownership* – several dummy variables seek to identify the condition of the producer concerning the land, such as whether the producer is a partner, tenant, occupant, owner (base), or another condition;

i) *Farm size* – four dummy variables represent farm size, which is divided into very small (up to 10 hectares (ha)) (base), small (10 to 100 ha), medium (100 to 1000 ha), and large (> 1000 ha);

j) *Regions* – five dummy variables represent Brazilian macro-regions – North, Northeast (base), Southeast, South, and Midwest.

Table 1 Mean and standard deviation of the variables used for the total sample and by producers who commercialize the production, producers who do not trade with cooperatives, and producers that trade with cooperatives, Brazil, 2014

Variables	Farmers		Marketing production		Non-cooperative members		Cooperative members	
	Average	SD	Average	SD	Average	SD	Average	SD
Monthly household income (R$)	2,505	3,473	2,609	3,520	2,489	3,442	4,067	4,084
Rural credit	0.013	0.025	0.146	0.353	0.128	0.335	0.362	0.481
Rural extension	0.141	0.348	0.161	0.368	0.145	0.352	0.363	0.481
Gender	0.855	0.352	0.857	0.350	0.856	0.351	0.865	0.342
Race	0.073	0.261	0.077	0.266	0.080	0.272	0.030	0.170
Don't read and write	0.004	0.063	0.004	0.066	0.004	0.067	0.003	0.059
Incomplete elementary	0.223	0.416	0.207	0.405	0.217	0.412	0.078	0.268
Complete elementary	0.518	0.500	0.521	0.500	0.517	0.500	0.565	0.496
Incomplete high school	0.084	0.278	0.088	0.283	0.087	0.281	0.103	0.305
Complete high school	0.033	0.178	0.034	0.181	0.035	0.184	0.022	0.146
Incomplete higher education	0.107	0.309	0.111	0.315	0.107	0.309	0.163	0.370
Complete higher education	0.032	0.175	0.035	0.184	0.032	0.177	0.065	0.247
Up to age 25	0.054	0.226	0.053	0.224	0.056	0.231	0.015	0.121
Age 26 to 35	0.150	0.357	0.149	0.356	0.150	0.357	0.129	0.335
Age 36 to 45	0.218	0.413	0.222	0.416	0.223	0.416	0.206	0.404
Age 46 to 55	0.261	0.439	0.267	0.442	0.263	0.440	0.320	0.467
Age 56 to 65	0.206	0.405	0.205	0.404	0.204	0.403	0.225	0.418
Age 65 or higher	0.110	0.313	0.104	0.305	0.104	0.305	0.106	0.308
Rural	0.733	0.443	0.741	0.438	0.741	0.438	0.744	0.437
Partner	0.057	0.232	0.055	0.228	0.056	0.231	0.041	0.199
Tenant	0.053	0.224	0.048	0.214	0.047	0.211	0.064	0.245
Occupant	0.047	0.211	0.048	0.213	0.050	0.219	0.015	0.121
Owner	0.754	0.430	0.766	0.423	0.760	0.427	0.835	0.372
Other condition	0.088	0.284	0.083	0.276	0.086	0.281	0.045	0.207
10 ha. or less (very small)	0.600	0.490	0.579	0.494	0.590	0.492	0.442	0.497
10 to 100 ha. (small)	0.262	0.440	0.276	0.447	0.264	0.441	0.420	0.494
100 to 1000 ha. (medium)	0.070	0.256	0.076	0.265	0.078	0.269	0.049	0.217
1000 ha. or higher (large)	0.047	0.211	0.048	0.215	0.047	0.211	0.071	0.257
Northeast	0.378	0.485	0.329	0.470	0.352	0.478	0.049	0.217
North	0.269	0.443	0.297	0.457	0.313	0.464	0.099	0.298
Southeast	0.114	0.317	0.120	0.325	0.110	0.313	0.234	0.424
South	0.158	0.365	0.170	0.376	0.143	0.350	0.507	0.500
Midwest	0.066	0.248	0.068	0.252	0.066	0.248	0.092	0.289
# Observations	**15,402**		**11,419**		**10,548**		**871**	

Source: Own elaboration based on PNAD 2014.

Notes: SD - Standard deviation.

Average exchange rate in 2014, R$ 3.22 / US$.

The descriptive statistics presented in Table 1 consider the different categories of commercialization. Based on the sample used in the present study, approximately 70% of rural households held the marketing of their agricultural production. Of these, nearly 8% were sold to cooperatives in 2014.

The average income of those who traded in production was R$ 2,609.00, which was higher than the average of the rural producers (R$ 2,505.00), yet significantly lower than those who dealt with cooperatives (R$ 4,670.00). In addition, it is possible to verify a high level of heterogeneity in household income, as demonstrated by the large standard deviation for this variable.

Other notable trends include the higher overall levels of education among those who traded with cooperatives. These individuals also had more access to rural credit and rural extension services.

The majority of those who traded with cooperatives in 2014 were in the South region of Brazil (50.7%), followed by those living in the Southeast (23.4%). In contrast, only ~5% of those who marketed their products in the Northeast did so through cooperatives.

Based on this data, we sought to determine the effects (not causality) of marketing with cooperatives on family income. First, we used the non-conditional quantile regression method to identify the effect of marketing via cooperatives on producers in different income levels in the Brazilian rural area according to the methods of Firpo et al. (2007, 2009). Then, we identified family characteristics that can generate income disparities given the marketing of rural production to cooperatives.

2.1 The unconditional quantile regression approach

To identify the effects (not causality) of marketing products with cooperatives on rural income and income inequality, we used the unconditional quantile regression approach proposed by

Firpo et al. (2009) and the concept of recentered influence function (RIF). The influence function[3] facilitates the identification of the relative effect (influence) of an individual observation on a statistic of interest (Silva and França, 2017). That is, for a distribution statistic $v(F_y)$, the influence of each observation on $v(F_y)$ is given by the influence function $IF(y; v, F_y)$. The incorporation of the statistic $v(F_y)$ in the influence function results in the so-called RIF, $RIF(y; v) = v(y) + IF(y; v)$. This allows an analysis of the effects of individual covariates on the statistical distribution of interest. While we are interested in the distribution of the quantiles, it can also be applied to different statistical distributions such as the Gini coefficient, variance, or others that represent income inequality[4].

We define the τ-*th* quantile (q_τ) of the income distribution *Y* as$q_\tau = v_\tau(F_y) = inf_q\{q: F_y(q) \geq \tau\}$, and its influence function $IF(y; q_\tau, F_y)$ as:

$$IF(y; q_\tau, F_y) = \frac{\tau - 1\{y \leq q_\tau(F_y)\}}{f_y(q_\tau(F_y))} \quad (1)$$

where $1\{y \leq q_\tau(F_y)\}$ is an indicator function that shows whether the variable *Y* (monthly household income) is less than or equal to the quantile q_τ, and $f_y(q_\tau(F_y))$ represents the marginal density function of the distribution of *Y* evaluated in q_τ.

The RIF, which will replace the dependent variable *Y* in the unconditional quantile analysis, is defined by the sum of the distribution statistics and their respective influence function, $RIF(y; v, F_y) = v(F_y) + IF(y; v, F_y)$. Thus, adapting the expression to the τ - *th* quantile (q_τ), the RIF for each income quantile is given by:

[3] The influence function method provides a linear approximation for a nonlinear function of a statistical distribution of interest, such as quantiles, variance or others, thus allowing an estimate of the effect of one or more covariates on the distribution of the statistics of interest (Chi and Li, 2008).

[4] For an average, e.g., $\mu(F_y)$, the influence function - IF, would be given by $IF(y; \mu(F_y)) = y - \mu(F_y)$, with the RIF specified as: $RIF(y; \mu) = IF(y; \mu) + \mu$. Firpo et al. (2007) present the RIF regressions for the case of the variance and Gini coefficient.

$$RIF(y; q_\tau, F_y) = q_\tau + \frac{\tau - 1\{y \leq q_\tau(F_y)\}}{f_y(q_\tau(F_y))} = c_{1\tau}.\, 1\{y \leq q_\tau(F_y)\} + c_{2\tau} \quad (2)$$

where $c_{1\tau} = \frac{1}{f_y(q_\tau)}$ and $c_{2\tau} = q_\tau - c_{1\tau}.(1-\tau)$ and the conditional expectation is $\upsilon(F_y)$ (Firpo et al., 2009; Silva and França, 2017). This implies that:

$$E\big[RIF(y; \upsilon, F_y)\big] = \upsilon(F_y) \quad (3)$$

We first obtain the sample quantile $\hat{q_\tau}$ (Firpo et al., 2009; Koenker and Basset, 1978) and then the marginal density function $\hat{f_y}\left(\hat{q_\tau}\right)$ through kernel functions[5]. After obtaining these estimates, they are incorporated in equation (3).

We assume a covariate vector *X* and the conditional expectation of the RIF as a function of *X*; i.e. $E\big[RIF(y; \upsilon, F_y)|X = x\big]$. Then, it can be represented as a linear regression in the function *X*,$RIF(y; \upsilon, F_y) = X\beta + \varepsilon$. Assuming $E[\varepsilon|X] = 0$ and applying the Law of Iterated Expectations, we have the unconditional quantile regression:

$$\upsilon(F_y) = E_x\left[E\big[RIF(y; \upsilon, F_y)\big]\right] = E[X].\beta \quad (4)$$

where *y* represents the monthly rural household income; $RIF(y; \upsilon, F_y)$ is the RIF, which replaces the observed *y* in each observation; *X* is the vector of explanatory variables described in the previous section; and β are the coefficients of interest, which capture the effect of changing the distribution of a variable on the unconditional quantile of *y* or the unconditional quantile partial effect (Firpo et al., 2009). These coefficients can be estimated by ordinary least squares (OLS) or another linear estimator[6].

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[5] According to Koenker and Basset (1978), the τ - *th* quantile estimator of the marginal distribution of *Y* $(\hat{q_\tau})$ can be defined as: $\hat{q_\tau} = arg\,\min_q \sum_{i=1}^{N}(\tau - 1\{Yi - q \leq 0\}).(Yi - q)$. The density function of *Y* is obtained by estimating the kernel density: $\hat{f_y}\left(\hat{q_\tau}\right) = \frac{1}{N.b}.\sum_{i=1}^{N} K_y\left(\frac{Y_i - \hat{q_\tau}}{b}\right)$, where $K_y(z)$ is a kernel function and *b* is a positive scalar bandwidth. For more details, see Firpo et al. (2009).

[6] Firpo et al. (2009) present three possibilities of estimators: OLS, logistic estimator, and a non-parametric estimator—all with very similar results.

The conditional quantile regression approach proposed by Koenker and Basset (1978) differs from the unconditional quantile regression proposed by Firpo et al. (2007, 2009) that is used in the present study. The former approach only allows the estimation of the "within-group"[7] effect (Firpo et al., 2009), while the unconditional quantile regression allows the estimation of both the "within-group" effect and the "between-group" effect. The latter effect represents the influence of a given variable throughout the entire distribution.

2.2 Decomposition of income differentials

We use an income decomposition procedure proposed by Firpo et al. (2007)[8] to estimate the income differentials between groups (i.e., farmers that have marketed with cooperatives and farmers that did not). This involves estimating the RIF regression along with a reweighting scheme proposed by DiNardo et al. (1996). It is an adaptation of the Oaxaca-Blinder[9] decomposition approach, which allows us to expand the decomposition to other statistics of interest such as quantiles, variance, and Gini coefficient.

We assume two groups of households: *A* (farmers that have accessed rural credit) and *B* (farmers that have not accessed rural credit); a result variable *Y* (logarithm of household incomes); and a group of covariates that represent individuals' characteristics. The decomposition seeks to identify the difference in the income distribution of the two groups based on some statistics of these distributions, as opposed to only analyzing the mean. This is represented as:

$$\Delta^{v} = v(F_{yA}) - v(F_{yB}) \tag{5}$$

[7] The result for each quantile depends on the *X* characteristics of the individuals in that group and cannot be extrapolated to the other quantiles. It does not allow the analysis of the effect of a given variable on the entire *Y* distribution.
[8] This method has been used in other studies, such as Machado and Mata (2005).
[9] For more details, see Jann (2008).

where $\upsilon(F_{yt})$ represents a statistic of the income distribution (income quantiles, in this paper) for two groups $t = A, B$.

The term Δ^{υ} is then divided into two components: the difference in the observable individual characteristics (*composition effect*) and the difference in coefficients between the two groups (*return effect*). To implement this decomposition, a counterfactual distribution (F_{yc}) must first be obtained in addition to its statistics of interest $\upsilon(F_{yc})$ such as in equation (4). This allows us to simulate an income distribution with the characteristics of group *A* and the returns (coefficients) to the characteristics of group *B*. We can insert F_{yc} in equation (5) to obtain:

$$\begin{gathered}\Delta^{\upsilon} = \left[\upsilon(F_{yB}) - \upsilon(F_{yc})\right] + \left[\upsilon(F_{yC}) - \upsilon(F_{yA})\right] \\ \Delta^{\upsilon} = \Delta_R^{\upsilon} + \Delta_X^{\upsilon}\end{gathered} \tag{6}$$

where the total income differential is decomposed into two terms: Δ_R^{υ}, which represents the portion of the differential resulting from the differences in the returns (coefficients) of the characteristics (*return effect*); and Δ_X^{υ}, which represents the portion of the differential associated with the differences in the distributions of the characteristics (*composition effect*).

To obtain equation (6) we re-estimate the RIF regressions for each of the groups and obtain the conditional expectation of the recentered functions of influence. This allows us to obtain the expected value of the RIF for the observed distributions $\upsilon(F_{yt})$ and the counterfactual distribution$\upsilon(F_{yC})$ in a linear specification:

$$\upsilon(F_{yt}) = E[RIF(y_t; \upsilon_t)|X, T = t] = X_t\beta_t \tag{7}$$

$$\upsilon(F_{yC}) = E[RIF(y_A; \upsilon_C)|X, T = B] = X_C\beta_C \tag{8}$$

for $t = A, B$. To obtain the parameters of interest β, Firpo et al. (2007) used a reweighting technique based on DiNardo et al. (1996). The reweighting factors for each group are:

$$\hat{\omega_A}(T) = \frac{T}{\hat{\rho}}, \tag{9}$$

$$\hat{\omega}_B(T) = \frac{1-T}{1-\hat{\rho}}, \text{ and}$$

$$\hat{\omega}_C(T;X) = \left[\frac{\hat{\rho}(X)}{1-\hat{\rho}(X)}\right].\left[\frac{1-T}{\hat{\rho}}\right]$$

where T is either 1 or 0 and indicates whether the individual participates in group A (value 1) or B (value 0); $\hat{\rho}$ is an estimator of the probability that a farmer has marketed with cooperatives (group A, or $T = 1$) given the characteristics vector X and may be estimated using a probability model such as *Logit* or *Probit* (Chi and Li, 2008).

After obtaining the reweighting factors, the RIF regressions for each group can be estimated by OLS:

$$\hat{\beta}_t = \left(\sum_{i\in t} \hat{\omega}_t . X_i . X_i'\right)^{-1} . \sum_{i\in t} \hat{\omega}_t . \hat{RIF}(y_{ti}; \upsilon_t) X_i \tag{10}$$

for t = A, B and for the counterfactual, the RIF is estimated as:

$$\hat{\beta}_C = \left(\sum_{i\in A} \hat{\omega}_C(X_i) .. X_i . X_i'\right)^{-1} . \sum_{i\in A} \hat{\omega}_C(X_i) . \hat{RIF}(y_{Ai}; \upsilon_C) X_i \tag{11}$$

where the decomposition presented in equation (11) can be obtained as:

$$\begin{gathered} \hat{\Delta}^{\upsilon} = \left[\overline{X}_B . \hat{\beta}_B - \overline{X}_C . \hat{\beta}_C\right] + \left[\overline{X}_C . \hat{\beta}_C - \overline{X}_A . \hat{\beta}_A\right] \\ \hat{\Delta}^{\upsilon} = \hat{\Delta}_R^{\upsilon} + \hat{\Delta}_X^{\upsilon} \end{gathered} \tag{12}$$

We can also identify the contribution of each covariate X_k, where k = 1,..., K, on each of the effects obtained in equation (12) as:

$$\hat{\Delta}_X^{\upsilon} = \sum_{k=1}^{K} \left(\overline{X}_{ck} - \overline{X}_{Ak}\right) \hat{\beta}_A \tag{13}$$

$$\hat{\Delta}_R^{\upsilon} = \left(\hat{\beta}_{B1} - \hat{\beta}_{C1}\right) + \sum_{k=2}^{K} \overline{X}_{Bk} \left(\hat{\beta}_{BK} - \hat{\beta}_{CK}\right) \tag{14}$$

where the first term (difference in the returns of the covariate $k = 1$) represents the difference in the intercepts of the regressions of groups *A* and *B*, while the second term represents the contribution of the return of each covariate in the total *return effect*. In the next section, we present the results obtained using the two methods.

3 Results and Discussion

3.1 The influence of marketing via cooperatives on income

In this section, we present the results of the RIF regressions for the quantiles of the logarithm for the monthly household income of those who market their products through cooperatives, as well as the estimation by OLS. The coefficients we estimated exhibited some variation along the income quantiles with the estimated coefficients obtained for the mean. This result reinforces the need to use the non-conditional quantile regression approach. In Table 2, we present the results of the RIF regressions. The results suggest a positive effect if farmers commercialize with cooperatives, except for those producers in income quantile q75, for whom the effect was not significant. This influence on income becomes greater in the highest income quantiles. For example, in the two lower quantiles (q10 and q25), the household income of those who trade with cooperatives is related to incomes of 5.9% (or R$ 29.92 on average) and 11.1% (or R$ 97.90 on average) higher than those who do not market via cooperatives. The effect on the median (q50) is 17.9% higher (R$ 303.94 on average) and is higher in q90 (R$ 988.93). These results demonstrate that commercialization through cooperatives can be related to positive effects on household income throughout all quantiles considered. Positive effects of better coordination with the productive chains via corporate bodies could exist, as recommended by Sexton (1986), Sexton and Iskow (1988), Valentinov (2007), Zhang et al. (2007)

and Novkovic (2008) as well as by Jayne et al. (2006) and Bernard and Spielman (2009) for African cases.

Also, within the scope of Table 2, we can verify how other variables considered in this study influenced the quantiles of the logarithm for monthly household income in the rural environment among those who market their products. Rural credit had a positive and increasing relation with income quantiles—except for q90, where it was not significant. That is, despite rising income in rural areas, access to rural credit increases its uneven distribution. This result is similar to Neves et al. (2020) as well as Vega (1987), Bacha, Danelon and Belson (2005), and Araújo (2011), who found evidence of large farmers gaining more access to credit than small farmers.

Table 2 Estimates of unconditional quantile regression, Brazil, 2014

ln (Yi)	OLS	q10 [R$ 509]	q25 [R$ 882]	q50 [R$ 1,698]	q75 [R$ 2,948]	q90 [R$ 5,124]
Marketed with cooperatives	0.140***	0.059*	0.111***	0.179***	0.077 NS	0.193**
	(0.027)	(0.034)	(0.037)	(0.032)	(0.048)	(0.085)
Rural credit	0.182***	0.076**	0.190***	0.187***	0.293***	0.017 NS
	(0.022)	(0.034)	(0.032)	(0.026)	(0.038)	(0.061)
Rural extension	0.269***	0.158***	0.213***	0.186***	0.366***	0.487***
	(0.022)	(0.032)	(0.032)	(0.027)	(0.038)	(0.064)
Gender	-0.046**	-0.053 NS	-0.212***	-0.042 NS	0.007 NS	0.083**
	(0.021)	(0.046)	(0.036)	(0.026)	(0.028)	(0.042)
Race	-0.097***	-0.028 NS	-0.055 NS	-0.115***	-0.086***	-0.113***
	(0.029)	(0.070)	(0.054)	(0.034)	(0.033)	(0.039)
Incomplete elementary	0.062NS	0.396 NS	0.238 NS	-0.181 NS	-0.223*	-0.037 NS
	(0.118)	(0.345)	(0.222)	(0.136)	(0.126)	(0.072)
Complete elementary	0.186NS	0.444 NS	0.313 NS	-0.068 NS	-0.049 NS	0.177**
	(0.117)	(0.343)	(0.221)	(0.135)	(0.126)	(0.071)
Incomplete high school	0.339***	0.566 NS	0.498**	0.066 NS	0.128 NS	0.361***
	(0.119)	(0.345)	(0.224)	(0.139)	(0.132)	(0.095)
Complete high school	0.416***	0.625*	0.576**	0.084 NS	0.327**	0.446***
	(0.123)	(0.353)	(0.232)	(0.144)	(0.140)	(0.121)
Incomplete higher education	0.521***	0.597*	0.658***	0.280**	0.336**	0.589***
	(0.119)	(0.345)	(0.223)	(0.138)	(0.132)	(0.095)
Complete higher education	1.041***	0.611*	0.615***	0.412***	0.977***	2.097***
	(0.124)	(0.344)	(0.226)	(0.141)	(0.141)	(0.164)
Age 26 to 35	-0.019NS	0.042 NS	-0.044 NS	-0.129***	-0.116**	-0.011 NS
	(0.037)	(0.096)	(0.073)	(0.046)	(0.046)	(0.075)
Age 36 to 45	0.088**	0.256***	0.128*	-0.055 NS	-0.051 NS	-0.041 NS
	(0.036)	(0.091)	(0.070)	(0.045)	(0.046)	(0.073)
Age 46 to 55	0.131***	0.138 NS	0.217***	0.036 NS	0.008 NS	0.029 NS
	(0.036)	(0.092)	(0.069)	(0.045)	(0.047)	(0.077)
Age 56 to 65	0.343***	0.377***	0.634***	0.245***	0.145***	0.131 NS
	(0.037)	(0.092)	(0.071)	(0.048)	(0.049)	(0.080)
Age 65 or higher	0.618***	0.674***	1.039***	0.593***	0.196***	0.097 NS
	(0.041)	(0.092)	(0.072)	(0.053)	(0.057)	(0.089)
Rural	-0.300***	-0.287***	-0.314***	-0.229***	-0.284***	-0.366***
	(0.017)	(0.032)	(0.030)	(0.022)	(0.026)	(0.042)
Partner	-0.112***	-0.071 NS	-0.035 NS	-0.172***	-0.214***	-0.241***
	(0.032)	(0.073)	(0.063)	(0.041)	(0.042)	(0.056)
Tenant	-0.018 NS	0.012 NS	0.015 NS	0.001 NS	-0.090*	-0.056 NS
	(0.032)	(0.066)	(0.058)	(0.044)	(0.052)	(0.081)
Occupant	-0.137***	-0.089 NS	-0.125 NS	-0.136***	-0.124***	-0.151***
	(0.039)	(0.095)	(0.081)	(0.047)	(0.035)	(0.037)
Other condition	-0.152***	-0.110 NS	-0.046 NS	-0.179***	-0.203***	-0.090**
	(0.027)	(0.069)	(0.054)	(0.034)	(0.030)	(0.046)
10 to 100 ha. (Small)	0.241***	0.239***	0.183***	0.185***	0.276***	0.365***
	(0.018)	(0.032)	(0.029)	(0.022)	(0.027)	(0.042)
100 to 1000 ha. (Medium)	0.384***	0.183***	0.163***	0.212***	0.451***	0.954***
	(0.030)	(0.047)	(0.046)	(0.034)	(0.045)	(0.089)
1000 ha. or higher (Large)	0.250***	0.239***	0.227***	0.171***	0.255***	0.376***
	(0.036)	(0.048)	(0.057)	(0.047)	(0.058)	(0.094)
North	0.190***	0.444***	0.359***	0.196***	0.143***	-0.067**
	(0.022)	(0.042)	(0.036)	(0.024)	(0.023)	(0.028)
Southeast	0.444***	0.539***	0.614***	0.510***	0.385***	0.297***
	(0.023)	(0.045)	(0.040)	(0.031)	(0.037)	(0.058)
South	0.504***	0.538***	0.612***	0.540***	0.550***	0.451***
	(0.023)	(0.043)	(0.040)	(0.030)	(0.036)	(0.056)
Midwest	0.555***	0.582***	0.590***	0.541***	0.536***	0.536***
	(0.034)	(0.042)	(0.047)	(0.037)	(0.047)	(0.083)
Intercept	6.847***	5.364***	6.036***	7.215***	7.739***	8.082***
	(0.124)	(0.357)	(0.232)	(0.145)	(0.138)	(0.111)
# Observations	11,419	11,419	11,419	11,419	11,419	11,419
R-square	0.318	0.078	0.159	0.226	0.241	0.176
F-statistic	-	28.12	76.65	148.9	133	45.21

Source: Own elaboration.

Notes: ***significant at 1%, **significant at 5%, *significant at 10%, NS non-significant. Monthly average household income per quantile in **brackets**. Standard errors in **parentheses**. Average exchange rate in 2014, R$ 3.22 / US$.

The rural extension is another public policy associated with agricultural production that seeks to generate improvements in agricultural production and income. This policy helps farmers access new technologies and knowledge and is traditionally associated with cooperativism in Brazil (Cechin, 2014). The results suggest that access to rural extension also generates higher income in all quantiles of the distribution, like Freitas et al. (2018). Throughout the larger quantiles of income distribution (q75 and q90) farmers who had access to rural extension obtained 37% and 49% higher income, respectively, than those that did not have access to the service.

Variables such as gender and race, when significant, did not exhibit large variation among income quantiles. However, men in Q90 had higher incomes than women. The farmers' experience—represented by the age classes—had a great effect on the oldest class (age 65 or higher) and was concentrated in the median of the income distribution (q50).

Schooling, regardless of its class, always has a positive effect throughout the quantiles when compared to those who cannot read or write. Oliveira and Silveira Neto (2015), Costa et al. (2016), and Reis et al. (2017) also identified the positive effects of human capital investments on income. We noticed a greater effect of other classes of schooling in the initial quantiles, which demonstrates its potential to reduce income inequality from investment in human capital in the countryside.

Owning land and living in urban areas leads to a higher household income. We believe that farm owners have a greater incentive to invest in long-term innovations and technologies that contribute to increasing rural incomes. Already living in urban areas can lead to greater access to information about market entry, banking institutions, and other services.

The results suggest that the larger the property, the higher the income, and that the families in the South, Midwest and Southeast are more financially secure compared to families in the North and mainly Northeast (base category). These differences were also identified in the literature (Assunção and Chein, 2007; Souza, Ney and Ponciano, 2013; Oliveira and Neto, 2015; Costa et al., 2016). In

summary, these results indicate the relevance of using the decomposition of income differentials to better understand the factors that explain such variations along the income quantiles.

3.2 Decomposition of income differentials

Data analysis indicated differences in the characteristics of rural properties with and without marketing with cooperatives. The results presented in the previous subsection also indicated differences in the return of the commercialization with cooperatives on household income in the different quantiles. In this section, we identify the magnitude of the income differential and the factors that explain this difference. The income decomposition method is used in conjunction with RIF regressions to evaluate how much of the income differences observed between the groups of households is attributed to the composition effect and the return effect. The first effect represents differences in the distribution of the characteristics of the individuals, while the second represents differences in the returns of these characteristics. This allows us to identify the contribution of each covariate in each of the estimated effects. The results of this analysis are presented in Table 3, as well as in Figure 2-6.

There are indications that rural households that opted for marketing through cooperatives obtained income gains in all estimations made (one for each quantile) compared to those who did not sell to cooperatives (see Figure 2). We also noticed that the influence of cooperativism on income is greater among the smaller quantiles (q10 and q25). This result is important since it indicates a potential effect of reducing inequality of income in rural areas, among its members. The higher the income quantiles, the lower the effect of cooperativism on the income differential between those who are cooperative members. In other words, a good contribution is made to small and poor farmers. There is a more intense reduction of the income differential for the lowest quantiles. It indicates the potential relevance of this organizational arrangement for the poorest producers.

As verified by Neves et al. (2020) for rural credit, and by Freitas et al. (2018) for rural extension, minimizing income inequality in rural areas remains a significant challenge to be overcome by Brazilian public policies for the primary sector of the economy. Cooperativism is also fostered by some public policies, such as RECOOP[10], the PRODECOOP[11], and the PROCAP-AGRO[12]. This has the potential to raise the income of those who trade with them, as advocated by Zeuli and Radel (2005) and Zhang et al. (2007). Moreover, in addition to this benefit to the cooperative producers, we can affirm that by working to minimize market failures they are also managing to reduce income inequality in the Brazilian countryside.

Table 3 Decomposition of the income differentials: marketing with cooperatives *vs.* does not trade with cooperatives, Brazil, 2014

	q10	**q25**	**q50**	**q75**	**q90**
Income differential [*ln(Yi)*]	0.699	0.855	0.551	0.555	0.552
Composition effect	0.317	0.409	0.409	0.498	0.516
Return effect	0.382	0.446	0.142	0.057	0.035
Detailed *composition effect*	**q10**	**q25**	**q50**	**q75**	**q90**
Rural credit	0.017	0.038	0.039	0.051	0.018
Schooling	0.016	0.027	0.042	0.066	0.095
Age	0.013	0.030	0.016	0.010	0.012
Rural extension	0.035	0.047	0.048	0.084	0.142
Farmer condition	0.008	0.005	0.014	0.015	0.010
Farm size	0.038	0.032	0.030	0.036	0.044
Others[#]	-0.002	-0.004	0.003	0.000	-0.001
North	-0.054	-0.047	-0.024	-0.017	0.009
Southeast	0.059	0.067	0.054	0.047	0.026
South	0.179	0.207	0.177	0.198	0.155
Midwest	0.006	0.006	0.005	0.005	0.005
Detailed *return effect*	**q10**	**q25**	**q50**	**q75**	**q90**
Rural credit	0.108	0.011	0.025	-0.015	-0.039
Schooling	-1.485	-1.247	0.523	0.620	-0.018
Age	-0.683	-0.292	-0.101	0.099	-0.596
Rural extension	0.002	-0.059	-0.089	-0.238	-0.325
Farmer condition	-0.094	-0.048	-0.020	-0.023	0.021
Farm size	0.103	-0.008	0.068	0.118	-0.029
Others[#]	0.047	0.247	-0.001	-0.032	0.250
North	0.004	-0.016	-0.005	0.001	0.012

[10] Programa de Revitalização das Cooperativas Agropecuárias Brasileiras (Program for the Revitalization of Brazilian Agricultural Cooperatives). Created by Ministerial Order no. 26 of February 13, 1998. Regulated by Decree no. 2936 of January 11, 1999.

[11] Programa de Desenvolvimento Cooperativo para Agregação de Valor à Produção Agropecuária (Cooperative Development Program for Aggregation of Value to Agricultural Production). Established by the Resolution of the Central Bank of Brazil n. 2987 of July 3, 2002.

[12] Programa de Capitalização de Cooperativas Agropecuárias (Capitalization Program of Agricultural Cooperatives). Created by Resolution of the Central Bank of Brazil (BACEN) n. 3739, dated June 22, 2009. It has funds from the National Bank for Economic and Social Development (BNDES) for financial reorganization and working capital of cooperatives.

Southeast	0.061	0.016	-0.002	0.009	-0.025
South	0.143	-0.031	-0.057	0.039	-0.049
Midwest	0.032	0.006	0.007	0.022	0.022

Note: #Includes *Gender* and *Race*.
Source: Own elaboration.

In general, we highlight that the composition effect (total explained) accounts for most of the total income difference, especially when considering quantiles above q25. This implies that differences in personal characteristics, such as schooling, access to credit, and rural extension explain—in most quantiles—much of the total income gap in these quantiles. Below q25, the income difference is explained equally by both composition effect and return effect (total unexplained).

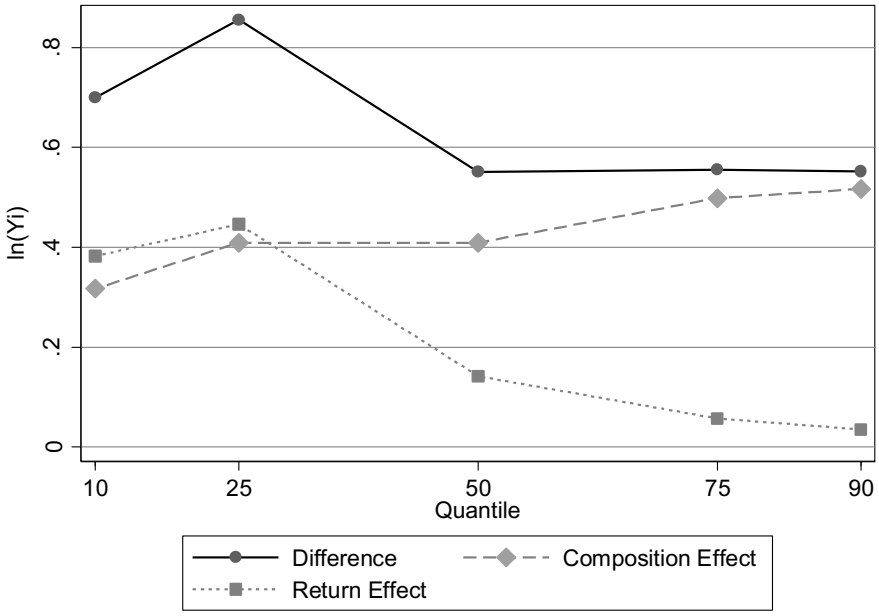

Figure 2 Decomposition of the income differential: marketing with cooperatives *vs.* does not trade with cooperatives, Brazil, 2014
Source: Own elaboration.

In both Table 3 and Figure 3, we detail the composition effect in its various components. Above q25, access to rural extension is the factor that best explains the higher level of income of households that market with cooperatives in comparison with those that do not. Cechin (2014) states that Brazilian cooperatives are an important source of technical assistance. In addition, it is worth noting that rural extension provides both knowledges of production techniques and managerial skills,

which is important in guiding farmers in the process of marketing their products (Christoplos, 2010, Danso-Abbeam et al., 2018).

From q50, we highlight the relevance of schooling in explaining part of the difference between cooperative and non-cooperative. Freitas et al. (2021) consider that higher levels of education enable rural producers to better assimilate information, make better crop choices, and implement technical recommendations more accurately. Greater access to information reduces information asymmetry and has the potential to make the marketing process fairer to farmers.

We point out that rural credit (including the Family Agriculture Strengthening Program - PRONAF) appears as a relevant factor in explaining the income gap between cooperative and non-cooperative farmers. Access to rural credit allows farmers to invest in new technologies, increase yield, and better market their products (Luan and Bauer, 2016). Rural credit has a lower effect on q10, but gains importance mainly between q25 and q75, with less relevance in q90. Moreover, there is an effect on the increase in inequality between the lowest income quantile (q10) and the others, with a reduction in the effect on the inequality between those households with co-workers who obtain credit in quantiles from q25 to q75 compared to those in q90.

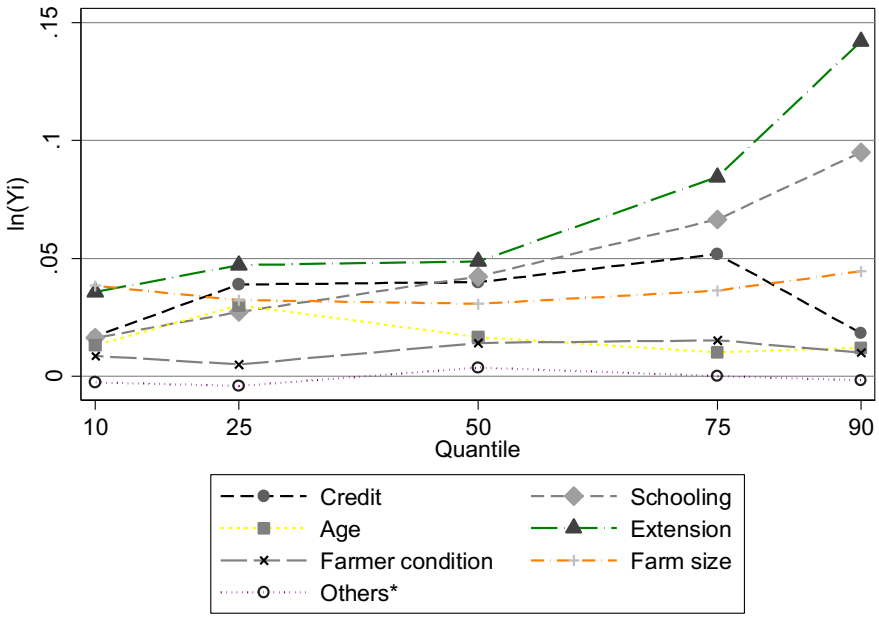

Figure 3 Detailed decomposition of the *composition effect* of income differential, Brazil, 2014
Note: *Includes *Gender* and *Race*.
Source: Own elaboration.

The effect of property size is U-shaped, indicating that additional farm area has the greatest effect on q10 and q90 in explaining the higher income of the cooperative over the non-cooperative groups. Therefore, it's a characteristic that interacted with the commercialization with cooperatives, reducing income inequality up to the median, and raising it from the median onward.

Regional disparities continue to be relevant in Brazilian rural areas, as suggested by Azzoni (2001), Alves (2013) and Costa et al. (2016). The effect of living in the South region explains the higher level of income of households marketing with cooperatives in comparison with those that do not (Northeast – base category) (see Figure 4). On a smaller scale, living in the Southeast represents a gain for the cooperative group compared to those living in the Northeast. These results are unsurprising given the relevance of the cooperative movement in the South and Southeast regions. The study of Neves et al. (2019) demonstrates the relevance of cooperativism in the gross value of agricultural production (GVP) of the Brazilian regions. It highlights positive effects in the South, Southeast and—to a lesser extent—the Central-West. The North and Northeast Regions are negatively influenced by the cooperative activity in their GVPs.

It is important to note that if the cooperatives in the Northeast had the same attributes as those living in the South and Southeast at their disposal, they would have greater gains in income compared to those non-members.

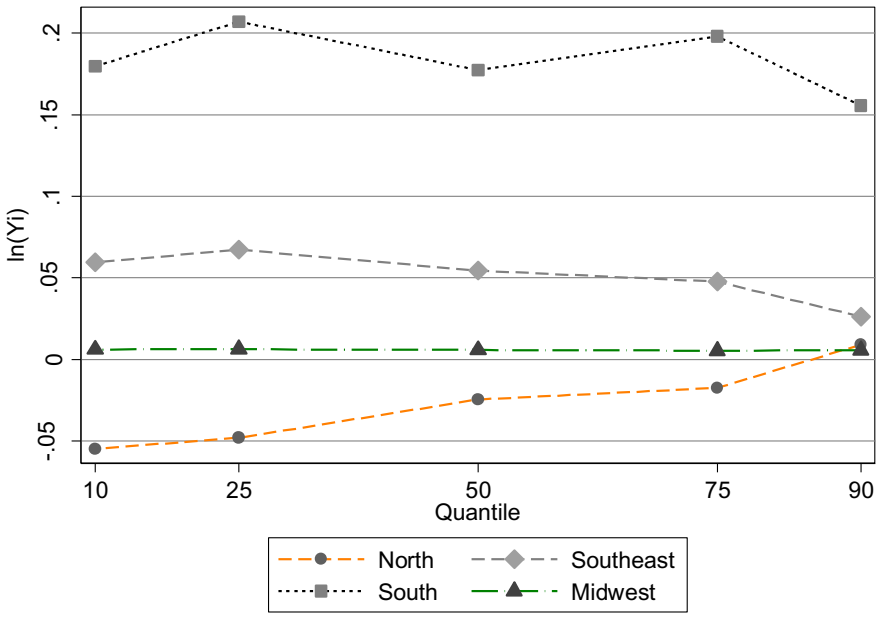

Figure 4 Regional decomposition of the *composition effect* of income differential, Brazil, 2014
Source: Own elaboration.

We also performed a decomposition of the return effect, as seen in Table 3 and Figure 5. This was performed to better understand how the return to household characteristics affects income. Although an erratic effect of schooling on rural income can be observed, this variable contributes considerably to income in the median (q50) and q75. The opposite is true for the lowest quantiles (q10 and q25). In general, most variables had a similar and negative influence on income differentials.

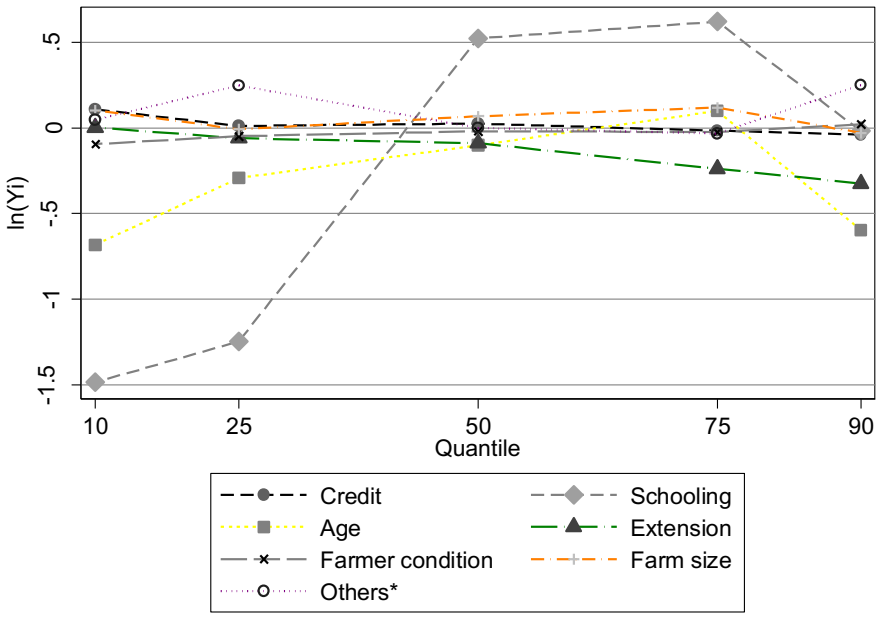

Figure 5 Detailed decomposition of the *return effect* of income differential, Brazil, 2014
Note: *Includes *Gender* and *Race*.
Source: Own elaboration.

Considering regional differences (Figure 6), we note that there is an important effect on q10 when considering the South region and, to a lesser extent, the Southeast region. The results suggest that the South and Southeast regions present greater opportunities for the better performance of cooperatives in the contingent of producers under poverty conditions. That is, these regions favor the most efficient use of the characteristics considered (schooling, extension, credit, and others - gender and race).

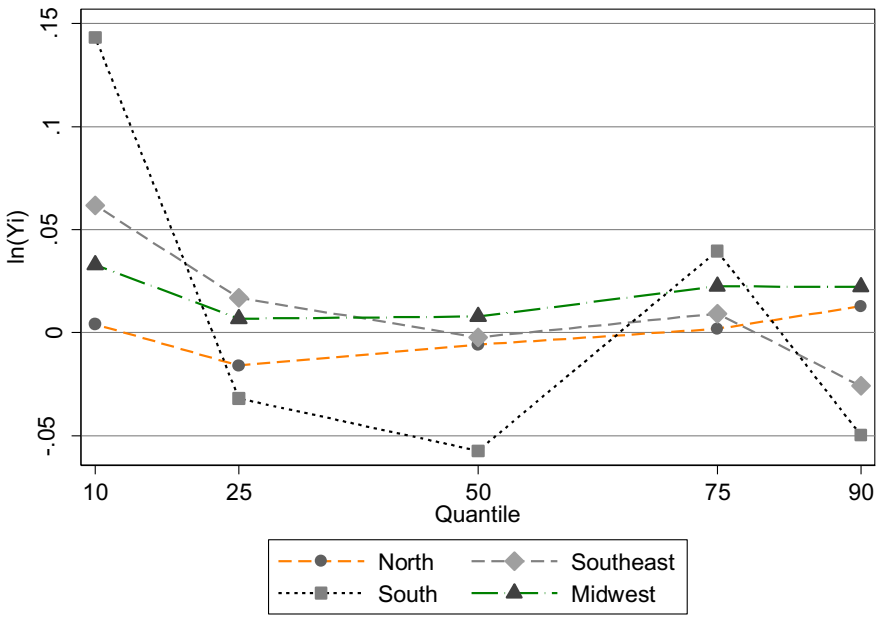

Figure 6 Regional decomposition of the *return effect* of income differential, Brazil, 2014
Source: Own elaboration.

In addition, the lower proportion of farms under good conditions in these regions also contributes to the increase of the marginal effect of the attributes analyzed in the research. SESCOOP-PE (2007), in a specific analysis of the Northeastern state of Pernambuco, found low schooling even among those producers who run cooperatives. This reflects the Northeastern regional reality, which is also among the findings of Silva et al. (2003). There are other possible explanations: poor infrastructure and the distance of the consumer market in the North and Northeast can make it unfeasible for farmers to exercise their full potential.

4 Concluding remarks

In this paper, we estimated the influence of cooperativism in the generation and distribution of income since income inequality persists in rural areas of Brazil. The results indicated that, rather than increasing income, Brazilian cooperativism has the potential to minimize the disparity in its distribution.

There was a greater effect for the larger income quantiles, as demonstrated by non-conditional quantile regression. However, the difference in income among the cooperative members decreases with increasing income quantiles, as perceived by the decomposition of the income differential. Thus, the results suggest that cooperativism emerges as a relevant marketing channel to raise the income of small farmers.

Furthermore, important regional disparities have been verified. It is possible that in the Northeast and North regions, cooperativism is not the organizational form most appropriate to the context of the development of collective movements. In these places, informal groups, associations, rural unions, and other types of associative enterprises can be the most indicated, generating positive results by the congregation of rural producers. The results also highlight that characteristics such as schooling and access to extension are potentialized when the producer resides in the South and Southeast of the country. Notably, poor infrastructure and distance from the consumer market in the North and Northeast may be related to this finding.

Collective action, in general, and cooperativism, more specifically, are not synonymous with increased income and rural development. There are many possibilities of failure and deviation from the course. This makes it more relevant to understand which factors and which situations lead cooperativism to achieve success. We consider that the estimates presented in this paper are useful for public policymakers since they measure the performance of cooperatives as a means of growth and economic development in rural communities. Although we consider public policies when we verify that higher levels of education, credit, and access to rural extension have increased the effect of marketing with cooperatives on income, we suggest that policies integrating cooperativism, rural credit, rural extension, and the promotion of human capital would be more effective due to the synergy of these components.

For farmers, they must consider joining cooperatives as a viable strategy to raise their income. Before being organizational forms that aim to minimize market failures, cooperatives are

arrangements of people. We cannot impose cooperation. But it is possible to educate and to explain the possible beneficial effects of cooperation for rural producers and their communities. This could be the role of cooperatives' representative bodies and professional associations, such as unions and associations, in addition to government policies. Also, they can use the results of studies of this nature to demonstrate the importance of the participation of cooperatives in the economy.

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