

The Brazilian agribusiness labor market: measurement, characterization and analysis of income differentials

O mercado de trabalho do agronegócio brasileiro: mensuração, caracterização e análise de diferenciais de rendimento

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Abstract: Although the Brazilian agribusiness sector's relevance to the country has been widely recognized nowadays, to date, no study has been developed to evaluate the level of employment in this sector as a whole for Brazil. Therefore, the first objective of this study is to access the Brazilian agribusiness labor market, and to measure it, analyze its structure and characterize its workers. Agribusiness worker income differentials were also contrasted with income differentials in the aggregated non-agribusiness labor force. The main results from the study are as follows: a) in 2017, 18.2 million individuals, 20.1% of the country's labor force, worked in the Brazilian agribusiness sector; b) agribusiness workers were predominately unskilled or semi-skilled with a low level of schooling; c) a large proportion of the sector's labor force were not formally employed; and d) the average income of agribusiness employees was lower than that of individuals in other economic sectors. There is also extreme labor market heterogeneity among agribusiness sector segments – with the primary segment presenting a noticeably dissimilar profile – and a significant income differential associated with different labor market statuses, economic sub-sectors and locations, and with individual characteristics such as level of schooling, skin tone and gender.

Keywords: agribusiness, earnings regression, labor market, methodological approach.

Resumo: Embora a relevância do agronegócio brasileiro seja atualmente amplamente reconhecida, ainda não existe um estudo que avalie o nível de emprego deste setor como um todo para o Brasil. O objetivo principal desse estudo é analisar o mercado de trabalho do agronegócio brasileiro, realizando a sua mensuração, analisando sua estrutura e caracterizando seus trabalhadores. Também foram avaliados os diferenciais de rendimentos no agronegócio, confrontando-os com os diferenciais no setor agregado não agronegócio. Como principais resultados, verificam-se: a) 18,2 milhões de pessoas, 20,1% da força de trabalho do País, trabalharam no agronegócio brasileiro em 2017; b) os trabalhadores do agronegócio são predominantemente não qualificados com pouca educação formal; c) há participação relevante da mão de obra informal entre os trabalhadores do setor; e d) o rendimento médio dos trabalhadores do agronegócio foi inferior ao dos indivíduos em outros setores econômicos. Existe também elevada heterogeneidade do mercado de trabalho entre os segmentos do agronegócio – com o primário apresentando um perfil destoante – e um diferencial de rendimentos significativo associado a diferentes posições na ocupação e categorias de emprego, subsetores econômicos e regiões geográficas, e com características individuais, como nível de escolaridade, raça e gênero.

Palavras-chaves: agronegócio, equação de rendimentos, mercado de trabalho, abordagem metodológica.



1. Introduction

It is well known that agribusiness is of great importance to Brazil, having a major impact on the country's gross domestic product (GDP), trade balance and productivity. In 2016, agribusiness accounted for approximately 20% of the Brazilian GDP (Centro de Estudos Avançados em Economia Aplicada, 2017b) and 46% of the country's total exports (Brasil, 2017). Moreover, agricultural labor productivity has also increased at an average annual rate of 4.5% between 1995 and 2009, five times more than the 0.8% average annual rate of productivity growth of Brazilian economy for the same period (Squeff, 2012).

Given that the vertical coordination of agribusinesses expands the relationships between the primary production segment and upstream and downstream activities, it is expected that each segment's labor market also become more strongly related with each other. It is also well known that the expressive growth of agricultural productivity is strongly linked with technological change; alongside this change, there have also been significant changes in the agricultural factors markets, particularly in the labor market (Gasques et al., 2015; Staduto et al., 2004).

With closer relationships existing between links in the agribusiness chain, the set of institutional changes that permeated the sector in an aggregate manner affected the rural labor market (Garcia, 2014). Therefore, if agriculture could be characterized as an autarkic sector with its own labor market and internal equilibrium, it is no longer possible to separate this sector from its input suppliers and/or its product buyers (Garcia, 2014).

Despite the importance of this sector and the interrelationships between the labor market dynamics of each of the agribusiness segments, no employment evaluation approach analyzing the whole chain in Brazil exists in the literature.

Data and publications from the Brazilian Institute of Geography and Statistics (IBGE) have historically guided the analysis of employment in Brazil. Since February 2016, the Continuous National Household Sample Survey-Quarterly Edition (Continuous PNAD) has been the only IBGE household survey focused on the production of short-run Brazilian labor force indicators. In this survey, sectoral assessments are made for a variety of grouped economic activities as follows: a) agriculture, livestock, forestry, fishing and aquaculture; b) general industry (and the processing industry sub-group); c) construction; d) trade, repair of motor vehicles and motorcycles; e) transport, storage and mail; f) accommodation and food; g) information, communication and financial services, real estate, professional and administrative activities; h) public administration, defense, social security, education, human health and social services; i) other services; and j) domestic services (Instituto Brasileiro de Geografia e Estatística, 2018a).

It is well known that agribusiness includes all occupations in the primary sector (agriculture, livestock, forestry, fishing and aquaculture). In addition, occupations of other groupings, such as the processing industry, commerce, transport and other services should also be included, following the seminal work of Davis & Goldberg (1957). Therefore, the first objective of this study is to access the Brazilian agribusiness labor market, and to measure it, analyze its structure and characterize its workers. Furthermore, the methodological procedure used to measure the size of the agribusiness labor market is applied so as to remain consistent with the definitions and methodology used by Cepea¹ to estimate the GDP of the agribusiness sector.

Morais et al. (2015) measured the sector's labor market using data from the annual edition of the National Household Sample Survey (PNAD). Their calculations were based on estimated coefficients from input-output matrices (MIP) that Cepea provided for the research. These coefficients, however, were calculated using production value and/or value added information, which is not exactly related to labor and employment measures as our study does.

Castro et al. (2017) measured and analyzed the agribusiness labor market specifically for the state of Minas Gerais, Brazil. The methodological procedure adopted by Castro et al. (2017) has more similarities with the one used in our study; however, their paper presents a

¹ The Center for Advanced Studies on Applied Economics (Cepea) carries out agribusiness-research structured according to productive chains and considering its economic interconnections since 1982. Cepea/Esalq/USP is also the Brazilian institution responsible for the calculation and monitoring of the GDP of Brazilian agribusiness (Centro de Estudos Avançados em Economia Aplicada, 2017c).

localized analysis performed in a single Brazilian state and, therefore, some simplifications for this type of local analysis were adopted by them. The major novelty in our study is to present an extended methodology covering the labor market analysis of Brazilian agribusiness as a whole. We will detail these issues in Section 3.

In the second phase of the study, we perform an empirical exercise in which we analyze the effects of the main determinants of income on income differentials among agribusiness workers and compare these effects with those of the aggregated non-agribusiness Brazilian economic sectors. The contribution of this analysis is to improve understanding of labor market distortions and thereby to provide useful information for the formulation of policies aimed at poverty alleviation and improving well-being (Tansel & Bodur, 2012).

As stated, our study then moves forward by measuring the Brazilian agribusiness labor market in accordance with Cepea methodological definitions and by using specific coefficients for employment data; moreover, due to the fact that our procedure allows for the quarterly monitoring of the agribusiness labor market. Finally, the income analysis reports a situation that is predominantly unfavorable to agribusiness, whether in comparison with other economic sectors or among the sector's own workers. This result provides important information that can support sectoral public policies focused on this sector and the well-being of its workers.

The rest of this paper is organized as follows: the next section presents methodological aspects, data source and definitions, and the theoretical basis and specification for the earnings equation, while Section 3 presents the procedure used to measure the agribusiness labor market. Section 4 presents our results. Finally, our concluding remarks are presented in Section 5.

2. Materials and methods

2.1. Data source and definitions

This research employed the definition of agribusiness used by Cepea, which is briefly described in the following subsection. As its main database this study uses quarterly microdata from the Continuous PNAD survey carried out by the IBGE. Specifically, the study's earnings equations make use of that database's quarterly microdata from 2012 through 2017, while the measurement and characterization of the agribusiness labor market uses the last year of that period, 2017. In addition, the database from the Brazilian Ministry of Labor and Employment's (MTE) Annual Social Information Report (RAIS) is employed to refine our labor statistics; as such, data are also taken from Cepea estimations to achieve this – the procedure in which such additional data is used is presented in Section 3.

Several studies related to the labor market in Brazil make use of the annual PNAD; however, the Continuous PNAD (that had its first official data from 2012 released in 2014) has some characteristics that make it more suitable for our research. Since the data are quarterly rather than annual, seasonal effects can be properly accounted for in the evaluation. Furthermore, the Continuous PNAD investigates a larger number of households in its sample than the annual PNAD, which allows for considerable improvement in the accuracy of estimation, particularly with regard to rural areas² (Instituto Brasileiro de Geografia e Estatística, 2014).

The Continuous PNAD considers individuals 14 years of age and older to be of working age³. People of working age are then classified as "employed" or "unemployed" based on information provided by the individual for the week prior to the survey. Persons are considered to be "employed" if they were paid in cash, goods, merchandise or benefits for at least one hour of work; had unpaid work for at least one hour helping a household member who was self-employed or an employer; or had unpaid work for at least one hour helping a household member who was an employee (independent of the employee's production activity).

Therefore, using the definition of employment status provided by the Continuous PNAD, people who work in production for the sole purpose of home consumption (subsistence

² The annual PNAD sample design is well known for being more urban-oriented during data collection in the field.

³ Fifteen years is typically the minimum age for legal employment according to International Labor Organization (International Labour Organisation, 2008).

farmers) are not considered to be employed. The definition of “employment” adopted by the Continuous PNAD differs from the one used in both the annual PNAD and in the Brazilian Agricultural Census, which includes production for home consumption as employment, but matches with the definition used in the Brazilian Monthly Employment Survey. This exclusion has particular relevance for the agricultural sector since there are numerous Brazilian subsistence farmers: using data from the annual PNAD, we calculated that from 2012 to 2015, 30.4% of the employed persons in agriculture were subsistence farmers (Instituto Brasileiro de Geografia e Estatística, 2017).

This study only considers persons classified as employed in the Continuous PNAD microdata. To the purpose of our analysis, these individuals are divided into two groups — those employed in the agribusiness sector and those employed in non-agribusiness sectors.

2.2. Earnings equation: theoretical basis and empirical strategies

Earnings equations seek to empirically relate the income earned by a worker with his/her personal characteristics and the characteristics of his/her work (Menezes-Filho, 2002). We estimated earnings equations using Mincer’s (1974) contributions to Human Capital Theory. The Schultz (1961) and Becker’s (1962) pioneering articles on Human Capital Theory posit that an individual’s salary can be represented as a function of his/her professional qualities, expressed by years of schooling, training and experience (Cirino & Lima, 2012). According to Cirino & Lima (2012), to put the theory of investment in human capital into an empirical context compatible with economic theory, Mincer (1974) proposed an equation that considers the influence of both schooling and experience on the individual’s salary: the Mincer wage equation (also known as the Mincer earnings function).

Mincer’s regression model (1974) emphasizes the life cycle dynamics of earnings and the relationship between observed earnings, potential earnings and investment in human capital (whether formal schooling or on-the-job training). If P_t is the potential earnings at age t , we can express C_t , the cost of investments in training or schooling, as a fraction k_t of potential earnings: $C_t = k_t \cdot P_t$. Taking ρ_t as the average return on training investments made at age t , we can express the potential earnings at t using Equation (1) (Heckman et al., 2006):

$$P_t = P_{t-1}(1 + k_{t-1} \cdot \rho_{t-1}) \equiv \prod_{j=0}^{t-1} (1 + k_j \cdot \rho_j) \cdot P_0 \quad (1)$$

Assuming additional propositions, and with some algebraic manipulation, one arrives at the relationship between the observed earnings and schooling and the observed earnings and experience in the labor market through the use of the Mincer Equation (2):

$$\ln Y(s, x) \approx \alpha_0 + \rho_s \cdot s + \beta_0 x - \beta_1 x^2 \quad (2)$$

In which: $\ln Y(s, x)$ are the observed earnings, x is the amount of work experience as of age t and s is equal to the years of schooling. In (2), the Napierian logarithm of earnings is linear with respect to years of schooling, and is linear and quadratic with respect to years of experience in the labor market (Heckman et al., 2006).

Other variables in addition to those presented in Human Capital Theory (schooling and work experience) are included in our specification to give a more complete control of other factors influencing earnings. The specification of our earnings equations model is based on both the theoretical framework presented above and the empirical literature, and can be summarized as follows:

$$\ln income_i = \alpha + \delta_j H_i + \beta_s X_i + \varepsilon_i \quad (3)$$

In (3), the dependent variable for each i th worker is the Napierian logarithm of real monthly income from the worker's main job, $\ln income_i$. H_i is the vector of explanatory variables presented in Human Capital Theory (e.g., schooling and work experience), with δ_i being the associated coefficients; X_i is the vector of the additional control variables of socio-demographic characteristics and job characteristics, with β_s being the associated coefficients; α being the constant parameter; and ε_i representing random errors with the usual properties.

The option for the logarithmic model is justified because there is a high income distribution asymmetry and because the effects are approximately multiplicative or proportional to income (Hoffmann & Ney, 2004). Table 1 presents a complete description of all variables ($s + j$) considered by the study's empirical model.

Table 1. Description of the variables used in the empirical model

Variable	Description
	- Formal education*:
No_inst	1 for no instruction and 0, otherwise (base category)
Basic_Inc	1 for incomplete basic schooling and 0, otherwise
Basic_Comp	1 for complete basic schooling and 0, otherwise
Second_Inc	1 for incomplete secondary schooling and 0, otherwise
Second_Comp	1 for complete secondary schooling and 0, otherwise
College_Inc	1 for incomplete college education and 0, otherwise
College_Comp	1 for complete college education and 0, otherwise
	-Age and gender:
Age	Individual's age (years)
Age2	Squared individual's age (years)
Women	1 if is women and 0, otherwise
	- Race or skin self-declared
White	1 if is white and 0 otherwise (base category)
Black	1 if is black and 0 otherwise
Yellow	1 if is yellow and 0 otherwise
Brown	1 if is brown and 0 otherwise
Indigene	1 if is indigene and 0 otherwise
Other_race	1 if race was not declared and 0 otherwise
	- Employment status controls:
Emp_formal**	1 for employed with a formal contract and 0, otherwise (base category)
Emp_informal**	1 for employed without a formal contract and 0, otherwise
Employer	1 for employer and 0, otherwise
Self-employed	1 for self-employed and 0, otherwise
Other_status	1 for military/statutory servants/auxiliary family workers and 0, otherwise
	- Geographic region controls:
Center-West	1 for the Center-West region and 0, otherwise (base category)
North	1 for the North region and 0, otherwise
Northeast	1 for the Northeast region and 0, otherwise
Southeast	1 for the Southeast region and 0, otherwise
South	1 for the South region and 0, otherwise
	- Economic sub-sector controls
econ_set1	1 if Agricultural and forestry activities of section A of the CNAE and 0, otherwise
econ_set2	1 if Livestock, fishing and aquaculture activities of section A of the CNAE and 0, otherwise
econ_set3	1 if Extractive industry (Section B) and 0, otherwise
econ_set4	1 if Production of food, beverages and tobacco of section C of the CNAE and 0, otherwise
econ_set5	1 if Production of textiles, clothing and leather and footwear of section C of the CNAE and 0, otherwise
econ_set6	1 if Production of wood products, pulp, paper and paper products of section C of the CNAE and 0, otherwise
econ_set7	(base-category) 1 if section C of the CNAE except industries included in dset4, dset5 and dset6, and 0, otherwise

Table 1. Continued...

Variable	Description
econ_set8	1 if electricity, gas, water and sewage (CNAE sections D and E) and 0, otherwise
econ_set9	1 if construction (CNAE section F) and 0, otherwise
econ_set10	1 if trade, transport and accommodation and food services (CNAE sections G, H and I) and 0, otherwise
econ_set11	1 if information, financial services and real estate activities (CNAE sections J, K and L) and 0, otherwise
econ_set12	1 if professional, scientific and technical activities (CNAE section M) and 0, otherwise
econ_set13***	1 if CNAE sections N, O, P, Q, R, S, T, U and V, and 0, otherwise
	- Time controls:
Jan-mar	1 if data is collected from January–March quarter and 0, otherwise (base category)
Apr-jun	1 if data is collected from April–June quarter and 0, otherwise
Jul-sept	1 if data is collected from July–September quarter and 0, otherwise
Oct-dec	1 if data is collected from October–December quarter and 0, otherwise
2012	1 if data is from 2012 and 0, otherwise (base category)
2013	1 if data is from 2013 and 0, otherwise
2014	1 if data is from 2014 and 0, otherwise
2015	1 if data is from 2015 and 0, otherwise
2016	1 if data is from 2016 and 0, otherwise
2017	1 if data is from 2017 and 0, otherwise

Notes: * highest level of instruction achieved; ** both in the private and public sectors and also as domestic workers; *** includes administrative activities; public administration, defense and social security; education; human health and social services; arts, culture, sports and recreation; other service activities; domestic services; international organizations and other extraterritorial institutions; and activities not defined.

Source: Author's results.

The variables Age and Age2 are used as proxies for work experience, with the use of the quadratic term intending to capture this relationship's nonlinearity. Regarding the economic sub-sector variable (labelled as econ_set1 to econ_dset13), we created categories based on sections of the CNAE-domicile, but with additional divisions in the agricultural and livestock section (section A) and in the processing industry section (section C), thus seeking to capture section-related intrinsic factors that may affect the type of work and the income.

According to IBGE (Instituto Brasileiro de Geografia e Estatística, 2014), the Continuous PNAD adopts as its sampling design a conglomerate in two stages with stratification of the Primary Sampling Units (PSU). It is therefore a complex sample, which is considered in our study by the use of the Taylor-linearized variance estimation, as adopted by the IBGE to approximate the variances of the Continuous PNAD (Instituto Brasileiro de Geografia e Estatística, 2014).

In addition to the data filtering to be discussed in Section 3, to make the sample more homogeneous, we considered only individuals aged between 18 and 65 and with a self-reported level of schooling. The minimum age of 18 years is adopted because the Federal Constitution (article 7º, XXXIII) considers youths to be workers aged between 16 to 18 years (Brasil, 1988). The maximum sample age considered aspects of retirement in Brazil. For instance, the minimum retirement age ranges from 55 to 65 years, depending on the worker's gender and whether they live in rural or urban areas. Workers with no self-reported level of schooling were excluded due to the importance of this variable in the determination of income, as noted in the theoretical model in the next subsection. In addition, those workers with earnings at the extremes (more than R\$ 100,000.00 per month or less than R\$ 100.00 per month) were also excluded of the sample.

3. Procedure for measuring the Brazilian agribusiness sector's labor market

This section details the filtering steps to distinguish which economic activities among the diverse categories in the Classification of Economic Activities–Domicile 2.0 (CNAE-Domicile 2.0) – the classification of activity categories delineated in the Continuous PNAD – are to be considered agribusiness, which are partial agribusiness and which can be termed non-agribusiness. The

filtering process comes from the agribusiness activity definitions developed by Cepea during the estimation of sectoral GDP.

Cepea (Centro de Estudos Avançados em Economia Aplicada, 2017a) defines agribusiness as a chain system, with both upstream and downstream linkages to agricultural activities. Thus, this sector involves not only agricultural and livestock production, but also the production of inputs for such production; product processing, trade and transportation; and other services necessary to make the products available to the final consumer, whether domestic or foreign. Based on these standards, Cepea calculates the GDP of the agribusiness sector. For analytical purposes, Cepea also divides the sector's GDP into four segments: inputs, agriculture and livestock production (primary segment), industry (agricultural or livestock product processing) and agro-services. This division is adopted in our study. Cepea (Centro de Estudos Avançados em Economia Aplicada, 2017a) identifies which economic segments are related to agribusiness in its calculation of agribusiness GDP. In summary, the relationship is established according to the intensity of an activity's linkage with agriculture and livestock and is based on the Brazilian Input-Output Matrices (IPM) displayed in IBGE's Brazilian National Accounts. Box 1 presents the major activities Cepea associates with agribusiness, their respective codes in CNAE 2.0, and the agribusiness segment they are linked with. Note that the codes are from CNAE 2.0, and are different from those of the CNAE-Domicile used in both the Continuous PNAD and in this study.

Box 1. Activities and segments of agribusiness and their respective CNAE 2.0 codes

CNAE 2.0	Segment	Activity
2012; 2013	Inputs	Fertilizers and soil correctives
20517	Inputs	Agricultural pesticides
10660	Inputs	Animal feed
21220	Inputs	Veterinary medicines
283	Inputs	Agricultural machinery
011; 012; 013; 014; 02	Primary	Agriculture and forestry
015; 017; 03	Primary	Livestock, fishing and aquaculture
101; 102	Industry	Meat and fish slaughter and preparation
105	Industry	Dairy products
107; 193	Industry	Sugar and ethanol
108	Industry	Coffee industry
103	Industry	Canned fruit and vegetables
104	Industry	Oil and fat
106 (except 10660)	Industry	Grinding and starch products (except animal feed)
109	Industry	Other food products
11	Industry	Beverage
12	Industry	Tobacco industry
1311; 1312; 1321; 1322	Industry	Natural-based textiles
14	Industry	Clothing and clothing accessories (natural-based)*
1510; 1529; 1531	Industry	Leather goods and leather footwear
16	Industry	Wood products
17	Industry	Pulp, paper, and paper products
3101	Industry	Wooden furniture
46, 47, 49 to 53, 55, 56, 58 to 66, 68 to 75, 77 to 82, 84	Agro-services	Several* **

Source: Cepea (Centro de Estudos Avançados em Economia Aplicada, 2017a) using CNAE 2.0 category definitions. * For "Clothing and clothing accessories" and "agro-services," only a percentage of the CNAE defined activities are considered to belong to agribusiness. ** CNAE 2.0 activities defined as services: wholesale and retail trade, except vehicles; transport; storage and mail; food services; information and financial services; real estate activities; legal, accounting and consulting services; architectural, engineering, testing and analysis; research and development; other scientific and technical activities; non-real estate rentals; other administrative activities; surveillance and security; public administration, defense and social security; telecommunications; media activities; editing and printing; and food services.

Without adjustment, some Continuous PNAD data could not be transferred from one CNAE-Domicile category to the corresponding CNAE 2.0 subcategory, and the number of workers employed in agribusiness activities could not be then identified in the datasets. For example, Continuous PNAD data may show that 1,000 persons work in the broad CNAE-Domicile "chemical industry" activity category, but no subcategory exists that distinguishes workers producing

agricultural inputs (e.g., fertilizer) from those producing beauty products. Thus, worker data cannot be fully identified to either the CNAE 2.0 chemical industry “fertilizer mixer” subcategory, an agribusiness activity, or to the “beauty product fabricator” sub-category. This shortcoming was found when attempting to transfer data from the following categories: 1) grinding and starch products (except animal feed); 2) animal feed; natural-based textiles; 3) clothing and clothing accessories; 4) wooden furniture; and 5) all industries in the inputs segment.

To deal with these difficulties, the labor data available in the MTE’s RAIS database are used to build coefficients that are subsequently applied to Continuous PNAD data. Through the application of the coefficients, Continuous PNAD data could be transferred from a broad CNAE-Domicile category to a more disaggregated CNAE 2.0 subcategory, allowing the determination of the number of workers employed in an agricultural-based activity in that particular category.

The RAIS database was selected because it is the only Brazilian labor force-oriented survey that separates data into CNAE 2.0 categories. But it includes only formally employed workers. In order to rationalize the Continuous PNAD data for informally and formally employed persons in terms of the RAIS data on formally employed persons, the Continuous PNAD data are adjusted using the assumption that the percentage of individuals in a RAIS CNAE-2.0 category that are shown to be employees in an agribusiness sector activity is the same as the percentage of people employed in this agribusiness activity in the Continuous PNAD CNAE-Domicile category. In our study, this percentage is called the “category coefficient,” and in cases when Continuous PNAD data ascribed to a CNAE-Domicile category must be adjusted to coincide with a CNAE 2.0 category, the category coefficient is applied to the data accordingly.

Table 2 shows the average values of the coefficients category from 2012–2017. It should be noted that the coefficients of each specific year are applied to the data of that same year.

Table 2. Category coefficients used to disaggregate the CNAE-Domicile

Agribusiness activity /CNAE-Domicile activity category	Coefficient
Fertilizers and soil correctives / Manufacture of other chemical products.	0.194
Agricultural pesticides / Manufacture of other chemical products n.e.c.	0.046
Animal feed / Grinding and starch products and animal feed	0.368
Veterinary medicines / Manufacture of pharmaceutical products	0.090
Agricultural machinery / Manufacture of machinery and equipment	0.198
Grinding and starch products (except animal feed) / Grinding and starch products and animal feed	0.632
Natural-based textiles / Preparation of fibers, spinning and weaving	0.397
Clothing and clothing accessories (natural-based)* / Clothing and clothing accessories	0.357
Wooden furniture / Manufacture of furniture	0.742

Sources: Author’s results; based on Cepea (Centro de Estudos Avançados em Economia Aplicada, 2017a) and MTE (Brasil, 2018). *For “Clothing and clothing accessories (natural-based),” the disaggregation could not be made even using the CNAE reaching the classes level. This category coefficient is the same coefficient that Cepea (Centro de Estudos Avançados em Economia Aplicada, 2017a) uses to calculate agribusiness GDP.

Although RAIS data and the aforementioned procedure are successfully used to disaggregate data in many broad CNAE-Domicile categories, the “clothing and clothing accessories (natural-based)” industry could not be transposed using RAIS data, nor could the categories in the agro-service segment. In the case of the clothing and clothing accessories industry, we applied the category coefficient calculated by Cepea using the 2009 Brazilian National Accounts (information obtained upon request): 0.357. For the agro-services segment, a category coefficient of 0.145 was applied to the Continuous PNAD data; this percentage represents the agribusiness sector’s share of final demand for services as a percentage of total final demand for services as determined by Cepea (information obtained upon request) in its Brazilian agribusiness GDP calculations. Based on this information and these procedures, it was possible to measure and characterize the Brazilian agribusiness labor market in 2017.

The aforementioned procedure used to construct a coefficient structure based on employment information is the main methodological difference between the present

research and that of Morais et al. (2015). On the other hand, the procedures applied by Castro et al. (2017) are similar to those implemented in this study, but were applied to the agribusiness labor market in Minas Gerais, while our focus is the whole country.

Morais et al. (2015) applied coefficients provided by Barros et al. (2014) when calculating the GDP of Brazilian agribusiness. These coefficients were used by Barros et al. (2014) to disaggregate the value added by broader activities to isolate the value added by specific agribusiness sectors. The coefficients were calculated from production information (value added, industrial transformation value, value of production and, in the last case, mass wage) and not by the number of workers. In our study, we used specific employment relationships and that can be updated annually. Castro et al. (2017), in turn, also used the Continuous PNAD as their main database and the RAIS as the basis for calculating category coefficients, while these coefficients being calculated specifically for the agribusiness labor market in Minas Gerais in 2014. These authors found that in 2014, 2.5 million people worked in the agribusiness in Minas Gerais, representing 26% of the state's employed population.

A category coefficient from Table 2 can easily be applied to an absolute number of workers to find a portion of that total that can be considered as belonging to one activity; however, there is an additional difficulty in the estimation step of two separate earnings equations for the agribusiness and non-agribusiness sectors. In the estimation based on the individual microdata, each specific individual from the sample (and all of his/her individual and work characteristics) needs to be allocated between the groups, and not even the use of coefficients makes this allocation possible. For example, from Table 2 it is known that 19.4% of the individuals working in the "Manufacture of other chemical products" sector can be considered as working in "fertilizers and soil correctives" activities and belonging to agribusiness. Despite this, it is still impossible to know the exact individuals in this broader industry who work in the fertilizer industry to allocate them to a groups for the estimation.

To deal with this difficulty, individuals were allocated to agribusiness and non-agribusiness groups according to their Table 2 calculated coefficients predominance. If the activity's coefficient was greater than 0.5 – understood here as agribusiness predominance – it was considered to be an agribusiness activity, and all workers in this activity were considered as working in agribusiness for the estimation of the equations. The worker activities added to the agribusiness sector were in the "Manufacture of furniture" and the "Grinding, starch products and animal feed" categories. Data for the other Table 2 categories that had not already been directly allocated to agribusiness were allocated to the non-agribusiness group.

The multitude of extremely heterogeneous activities in the services segment also made the accurate separation of individuals into the agribusiness or non-agribusiness groups a task beyond our capabilities. For this reason, data regarding all members of the labor force of the services segment were included in the non-agribusiness group and not included in the earnings equations for the agribusiness group.

In summary, the quarterly microdata from Continuous PNAD, whose activity classification follows the CNAE-Domicile 2.0, is the main database of the study – 2017 being the basis for the measurement and characterization of the labor market, and the period from 2012 to 2017 being used in the stage of earnings equations estimation. For the calculation of the category coefficients, three types of information were used: 1) 2012 to 2017 RAIS database from the MTE for all activities that needed disaggregation except the industrial clothing and clothing accessories subsegment and the services segment; 2) 2009 Cepea information on the participation of natural products in the industrial clothing and clothing accessories subsegment; and 3) 2010 Cepea information on agribusiness participation in the total service activities. Other than these, the Extended National Consumer Price Index (Instituto Brasileiro de Geografia e Estatística, 2018b) was used to deflate income data between 2012 and 2017 for 2017 prices.

4. Results and discussion

4.1. Dimension of the agribusiness labor market and distribution among its segments and activities

We found that agribusiness accounted for 20.1% of the total number of persons employed in the Brazilian economy in 2017, or 18.2 million people. The primary segment occupied by far the greatest number of people in the sector, holding 46.16% of the sector's labor force and almost 10% of the entire Brazilian labor market in 2017. As summarized in Table 3, the primary segment is followed by the agro-services segment, the agro-industrial segment and, finally, the inputs segment. Proportionally speaking, the distribution of Brazilian agribusiness workers among its various segments is similar to that observed by Castro et al. (2017) for the agribusiness in Minas Gerais, in which the input segment accounted for 1.1%, the primary, for 46.5%, the agroindustry, for 17.7% and the agro-services, for 34.8%. Comparing our results with those of Castro et al. (2017), agroindustry has a relatively smaller weight and agro-services a relatively larger weight in Minas Gerais than in Brazil.

Table 3. Agribusiness Labor Market composition - 2017

Segment	Employed Persons	%
Inputs production	218,929	1.20%
Primary activities	8,418,141	46.16%
Industry	3,873,653	21.24%
Agro-services	5,728,084	31.41%
Agribusiness	18,238,807	

Source: Author's results.

In the agriculture subsegment of agribusiness' primary segment (not shown), cereal and coffee crops employed the most individuals —11% and 12% of that labor force, respectively. In addition, a heterogeneous group of "other crops" stood out, employing an impressive 35% of the workers in this subsegment. In the "other crops" classification, the CNAE includes banana, cassava and other crops not already specified. Value-of-production data from the IBGE Municipal Agricultural Production survey from 2017 (Instituto Brasileiro de Geografia e Estatística, 2018c) are used to compare the distribution of workers among crops and the generation of value among crops. The values of the soybean, sugarcane and corn harvests were the highest among the agriculture subsegment of crops, contributing 35.1%, 17% and 10.3% of this primary activity's total production value, respectively. Given the significant number of persons employed in the "other crops" grouping, it is evident that job generation differs from value generation in Brazilian agriculture, which is related to transformations that have occurred in recent decades within the primary segment. Technical progress and intensified mechanization have made some crops extremely important as value producers but less important as job creators. Labor-intensive crops, instead, are important job creators but are less relevant as value producers.

In the livestock, poultry and fisheries subsegment of the primary agribusiness segment (not shown), it was estimated that 68.3% of employed individuals work with cattle (steers and cows). Using data from IBGE's Animal Slaughter, Milk, Leather, Chicken, and Eggs surveys, Cepea calculated that 61.5% of the value of production derived from the livestock, poultry and fisheries subsegment is related to cattle (information obtained upon request). We note the predominance of bovine in the generation of both income and jobs. The predominance of cattle in the total number of jobs related to livestock was also verified by Pinto And Cunha (2014).

In the agribusiness industry segment, the greatest labor participation is found to be in the agriculture-based subsegment (73.8%). Within this subsegment, the following industries employed the greatest number of individuals: natural-based clothing and clothing accessories (19.9%); wood furniture (15.6%); and other wood products (13.8%). According to Galinari et al. (2013), the barriers to entry in these relatively labor-intensive industries, which require little financial, technological or intellectual investment to begin production, are low. The

agribusiness industry segment's livestock-based subsegment accounted for 26.2% of the segment's active labor force, with the slaughtering industry accounting for 48.7% of this total.

Regarding the agribusiness inputs segment, many of the industries represented in it — such as the fertilizer production industry, where workers are, for the most part, operating imported raw material mixers — are not labor intensive.

4.2. Profile of the agribusiness worker

Table 4 shows the distribution of workers in each segment of the agribusiness sector and in Brazil as whole by “employment status” classifications and by their level of schooling. Of note was the disparity between the percentage of those employed with a formal work contract in the agribusiness sector, 36.1%, and in Brazil, 40.1%, and the relatively high percentage of self-employed persons working in agribusiness, 32.5%, when compared with all Brazilian sectors, 25.0%. The high percentage of self-employed persons working in agribusiness-related activities is linked with the large weighting of the primary segment in the number of individuals employed in the sector, with 46.16% of those employed in agribusiness working in this segment.

Table 4. Distribution by employment status and by level of schooling (Brazil, agribusiness, and its segments) - 2017

	Agribusiness				Brazil	
	Primary	Inputs	Industry	Agro-services	Total	
Employment status						
Employed w. formal contract	61.8%	16.7%	62.9%	45.4%	36.1%	40.1%
Employed w/o formal contract	8.1%	21.4%	10.5%	13.6%	16.5%	19.1%
Employers	2.6%	3.5%	3.7%	6.0%	4.3%	4.7%
Self-employed	15.9%	44.6%	20.3%	23.5%	32.5%	25.0%
Other	11.6%	13.7%	2.6%	11.5%	10.6%	11.1%
Final level of schooling						
No instruction	6.9%	14.6%	3.6%	2.3%	8.3%	4.0%
Incomplete basic	26.5%	52.7%	26.6%	16.6%	35.5%	23.5%
Completed basic	7.3%	9.7%	12.0%	8.0%	9.6%	8.9%
Incomplete secondary	5.9%	5.7%	8.4%	6.6%	6.6%	6.5%
Completed secondary	29.7%	14.2%	35.7%	37.9%	26.4%	32.6%
Incomplete college	5.9%	0.9%	4.3%	7.3%	3.7%	5.7%
Completed college	17.8%	2.1%	9.4%	21.3%	9.9%	18.8%

Source: Author's results.

The primary segment differs sharply from the other agribusiness segments in regards to employment status. In the inputs, industry and agro-services segments, approximately two-thirds of the jobs are formal, providing all the social benefits to the worker. However, the situation is reversed in the primary segment, in which informally employed and self-employed workers account for roughly 66.0% of the total number of employed individuals. Cunha (2008) found that the proportion of employed persons with a formal contract increased in the agricultural sector between 1980 and 2005; however, she also points out that the agricultural sector maintained the lowest degree of formalization in the Brazilian economy in that period.

As for schooling levels, it turns out that almost 60% of the persons employed in agribusiness activities do not have completed their high school education, well above the national average of about 43% (Table 4). We also note that the differences in schooling levels between Brazilian agribusiness and average Brazilian workers are largely at the extremes of the schooling level range: 60% of the persons employed in agribusiness have no secondary level schooling, while only 13.6% have attended an institute of higher education. For all

Brazilian economic sectors, 43% have no secondary level schooling while 24.5% have got higher education. Among the segments, the primary agribusiness segment exhibits the most discrepant results in relation to all the other economic sectors in Brazil; more than 80% of the primary agribusiness segment's employed individuals have not achieved the secondary schooling level.

Both in terms of employment status and schooling levels, the results do not significantly differ from those of Castro et al. (2017) for Minas Gerais in 2014. In this specific Brazilian state, agribusiness also has relatively low levels of formalization and education of workers, a result greatly influenced by the primary segment.

Some studies have pointed out that the level of schooling in Brazil's primary agribusiness segment is traditionally low; however, a recent increase in mechanization and the implementation of newer technologies in the segment, combined with the spread of large, multinational agroindustrial concerns, have led to a demand for increasingly skilled farm labor. These changes have caused a corresponding reduction in the demand for unskilled workers in the countryside (Moraes, 2007). Hoffmann & Ney (2004) note that the low schooling level of a great number of those employed in agriculture has been an obstacle to the increase of labor productivity in the segment. The authors also point out that it could be argued that agriculture demands a less skilled labor force than other economic sectors do, because it is less sophisticated and dynamic. However, the authors note that a large part of the difference in schooling levels between those employed in agriculture and those employed in other sectors is the fact that there are fewer opportunities for advanced schooling in rural Brazil than in urban areas.

4.3. Earnings equation estimation results

Table 5 presents the descriptive statistics of the selected employment-related income determinant variables for two different groups: agribusiness workers and non-agribusiness workers. The income determinant variables are formal schooling, gender, age, race/skin tone, employment status, geographic location and economic sub-sector. Note that the sample of agribusiness workers does not include data from those working in the agro-services segment or in a number of industrial segments for reasons discussed in the methodology section.

As verified in the previous section, there are significant differences between the observable characteristics of the individuals that compound each group regarding schooling level and employment status. Data in Table 5 shows that there are also important differences between female participation in the agribusiness labor market and female participation the non-agribusiness sectors. On the other hand, regarding the average age of the individuals, there was no relevant difference between agribusiness and non-agribusiness.

As for skin tone, there is relatively greater participation of white individuals in non-agribusiness and of brown individuals in agribusiness. The most noticeable effect of geographic location on regional labor forces was a higher percentage of agribusiness workers in Brazil's Northeast and a relatively higher percentage of non-agribusiness workers in the Southeast (Table 5).

The analysis by economic sub-sector shows that, in agribusiness, the majority of workers take part in agricultural, forestry, livestock and fishing activities (econ_set1 and econ_set2), with the remainder largely distributed between the food, beverages and tobacco, and wood-related industries (econ_set4 and econ_set6). For the non-agribusiness aggregate sector, as expected, workers are concentrated in the non-agricultural part of the industry and in the services sector, particularly, in trade, transport, accommodation and food services activities (Table 5).

Table 5 also shows that there is a difference between the average worker incomes in the two groups considered. Comparing agribusiness with the rest of the economy, the average worker in the non-agribusiness sectors earns R\$ 752/month more than the average agribusiness worker (the last quarter of 2017 is considered as price base).

Table 5. The descriptive statistics of the sample of each group (other sectors and agribusiness) and mean t-tests between groups

Variable/statistic	Agribusiness		Non-agribusiness	
	Mean	t-test	Mean	t-test
Income	1,412.72	2,114.26	2,164.99	2,981.62
No_inst (schooling)	0.13	0.34	0.03	0.18
Basic_Inc	0.47	0.50	0.21	0.41
Basic_Comp	0.10	0.31	0.10	0.30
Second_Inc	0.05	0.23	0.06	0.23
Second_Comp	0.19	0.39	0.35	0.48
College_Inc	0.02	0.13	0.06	0.24
College_Comp	0.04	0.19	0.19	0.39
Women (gender)	0.23	0.42	0.46	0.50
Age	39.66	12.49	38.24	11.88
White (Race or skin tone)	0.41	0.49	0.48	0.50
Black	0.07	0.26	0.08	0.27
Yellow	0.00	0.05	0.01	0.08
Brown	0.51	0.50	0.43	0.49
Indigene	0.00	0.05	0.00	0.04
Other_race	0.00	0.02	0.00	0.02
Emp_formal (employment status)	0.33	0.47	0.45	0.50
Emp_informal	0.17	0.38	0.18	0.38
Employer	0.03	0.17	0.04	0.21
Self-employed	0.36	0.48	0.21	0.41
Other_status	0.12	0.32	0.11	0.32
Center-West (region)	0.08	0.27	0.08	0.27
North	0.12	0.33	0.07	0.25
Northeast	0.30	0.46	0.23	0.42
Southeast	0.29	0.46	0.47	0.50
South	0.20	0.40	0.15	0.36
econ_set1	0.47	0.50	-	0.00
econ_set2	0.24	0.43	-	0.00
econ_set3	-	-	0.01	0.08
econ_set4	0.16	0.37	-	-
econ_set5	0.01	0.09	0.03	0.18
econ_set6	0.05	0.22	-	-
econ_set7	0.06	0.24	0.07	0.25
econ_set8	-	-	0.01	0.11
econ_set9	-	-	0.10	0.30
econ_set10	-	-	0.33	0.47
econ_set11	-	-	0.04	0.20
econ_set12	-	-	0.04	0.19
econ_set13	-	-	0.38	0.49

Source: Author's results.

Table 6 presents earnings equation estimates for agribusiness workers and non-agribusiness workers, as well as Wald tests regarding the equality of the coefficients estimated for the variables between the two groups (the equality of the coefficients being the null

hypothesis)⁴. The variables included in the regression explain approximately 48-49% of the variation in the dependent variable. According to Hoffmann & Ney (2004), this result can be considered satisfactory, especially seeing that many factors that affect individual income, such as ambition and creativity, are unquantifiable — and that some quantifiable factors are absent from the Continuous PNAD.

Table 6. Earnings equation estimates and Wald test of coefficients equality results

	Agribusiness	Percentage difference ^a Agrib.	Non-agribusiness	Percentage difference ^a Non-agrib.	p-value
Black	-0.1570*** (0.0064)	-14.53	-0.1242*** (0.0031)	-11.68	0.0000
Yellow	0.1253*** (0.0432)	13.35	0.0928*** (0.0179)	9.72	0.5029
Brown	-0.1638*** (0.0040)	-15.11	-0.1151*** (0.0022)	-10.87	0.0000
Indigenous	-0.2276*** (0.0302)	-20.36	-0.0798*** (0.0140)	-7.67	0.0000
Other_race	-0.1107** (0.0450)	-10.48	-0.1033*** (0.0255)	-9.81	0.8827
Basic_Inc	0.1882*** (0.0043)	20.71	0.1534*** (0.0032)	16.58	0.0000
Basic_Comp	0.3560*** (0.0059)	42.76	0.3112*** (0.0036)	36.51	0.0000
Second_Inc	0.3809*** (0.0074)	46.36	0.3518*** (0.0039)	42.16	0.0003
Second_Comp	0.4895*** (0.0066)	63.15	0.4814*** (0.0038)	61.83	0.2643
College_Inc	0.7009*** (0.0140)	101.56	0.6616*** (0.0050)	93.79	0.0059
College_Comp	1.1348*** (0.0152)	211.06	1.1689*** (0.0077)	221.85	0.0190
Women	-0.3595*** (0.0044)	-30.20	-0.3669*** (0.0016)	-30.71	0.1079
Age	0.0438*** (0.0008)		0.0486*** (0.0005)		0.0000
Age2	-0.0004*** (0.0000)		-0.0005*** (0.0000)		0.1683
Emp_informal	-0.4093*** (0.0060)	-33.59	-0.3228*** (0.0020)	-27.59	0.0000
Employer	0.5013*** (0.0129)	65.09	0.5195*** (0.0057)	68.12	0.1766
Self-employed	-0.4881*** (0.0073)	-38.62	-0.2171*** (0.0023)	-19.52	0.0000
Other_status	0.0000 (.)	0.00	0.2279*** (0.0039)	25.60	0.0000
North	-0.4326*** (0.0119)	-35.12	-0.1987*** (0.0061)	-18.02	0.0000
Northeast	-0.7222*** (0.0088)	-51.43	-0.3469*** (0.0056)	-29.31	0.0000
Southeast	-0.1588*** (0.0080)	-14.68	-0.0706*** (0.0051)	-6.82	0.0000

⁴ To facilitate readers' visualization, we chose to not present the control variables' coefficients by years and quarters in the table.

Table 6. Continued...

	Agribusiness	Percentage difference ^a Agrib.	Non-agribusiness	Percentage difference ^a Non-agrib.	p-value
South	-0.0429*** (0.0087)	-4.20	-0.0512*** (0.0050)	-4.99	0.3729
Econ_set1	-0.2063*** (0.0084)	-18.64	0.0000 (.)	0.00	0.0000
Econ_set2	-0.0826*** (0.0090)	-7.93	0.0000 (.)	0.00	0.0000
Econ_set3	0.0000 (.)	0.00	0.1926*** (0.0142)	21.24	0.0000
Econ_set4	-0.0949*** (0.0085)	-9.05	0.0000 (.)	0.00	0.0000
Econ_set5	-0.1315*** (0.0182)	-12.32	-0.2243*** (0.0058)	-20.09	0.0000
Econ_set6	-0.0685*** (0.0105)	-6.62	0.0000 (.)	0.00	0.0000
Econ_set8	0.0000 (.)	0.00	-0.1543*** (0.0075)	-14.30	0.0000
Econ_set9	0.0000 (.)	0.00	-0.0542*** (0.0039)	-5.28	0.0000
Econ_set10	0.0000 (.)	0.00	-0.1176*** (0.0035)	-11.09	0.0000
Econ_set11	0.0000 (.)	0.00	0.0962*** (0.0067)	10.10	0.0000
Econ_set12	0.0000 (.)	0.00	0.0310*** (0.0058)	3.15	0.0000
Econ_set13	0.0000 (.)	0.00	-0.1678*** (0.0037)	-15.45	0.0000
_cons	6.4254*** (0.0188)		6.2032*** (0.0101)		0.0000
r2	0.49		0.48		
F	1819.08		5051.52		

Source: Author's results.

Standard error in parentheses. * $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$. ^a Percentage difference compared to base category income. If b is the coefficient, the difference is calculated as $100[\exp(b)-1]\%$ (Hoffmann & Ney, 2004).

For both groups, the higher the individual's schooling level, the higher his/her income (Table 6), as expected. When comparing the groups, we verified that the percentage income gains in relation to the increase in educational level is significantly higher in the agribusiness sector than in other economic sectors (with the category of individuals with a complete college education being the only exception).

Particularly in the agricultural primary activities, Hoffmann & Ney (2004) note that the explanation found in the literature for the fact that the schooling level of farmers and other agricultural manual laborers is lower than that of people employed in industry and services is that the rate of return for each additional year of study for those working in primary agricultural activities is lower than in other segments and sectors. The authors estimated earnings equations using annual PNAD data for the years 1999, 2001 and 2002 to analyze whether the returns on investment in schooling are actually lower in the agriculture sector. To simplify the analysis, the authors combined the industry and services sectors, calling this group the "non-agriculture sector." Their results showed that the higher economic returns from schooling for those in the non-agriculture sector relative to those in the agriculture sector were essentially a specification error: the proportion of individuals with a low level of schooling is higher in agriculture, and the returns due to schooling are lower if the schooling

level is low (less than a total of nine years of schooling). When the effect of schooling was estimated polygonically (not considering a constant rate of return for schooling), the percentage return from schooling was higher in the agricultural sector.

Our study analyzes schooling in a nonconstant way by including different binaries to capture its effects. The results obtained show that the aggregated average return from schooling is higher for those employed in the agribusiness sector than for those employed in the non-agribusiness sectors. From another perspective, a greater income differential related to schooling is observed in the agribusiness sector, with the income differential between those with more and less schooling being greater than that observed in other economic sectors (the highest schooling level is an exception).

Cunha (2008), who specifically analyzed the agricultural sector, found that the income differential associated with schooling decreased between 1980 and 2005, especially in the last decade. Nevertheless, after analyzing agriculture and livestock, Pinto & Cunha (2014) corroborated that schooling was one of the most important drivers in the search for higher income in the sector between 2002 and 2012.

For the study's gender variable, negative coefficients are observed in relation to the base category (male); thus, *ceteris paribus*, the income of women is lower than that of men, around 30.2% in the agribusiness sector and 30.71% in the non-agribusiness sectors. These two effects are not statistically different from each other. Analyzing only the agriculture activities, Cunha (2008) found an income differential of 27.5% between men and women in 2005. This result is close to that estimated in this study for agribusiness, indicating some persistence of the gender differentials both over time and in relation to the expansion of the sector to the agribusiness as a whole. Complementarily, Santos et al. (2010) pointed out that men tended to earn higher wages than women (by about 14%), and that the characteristics of rural activities, such as the need for physical effort in many cases, impacted the productivity of individuals, and subsequently their salaries and differentials. They analyzed the PNAD 2007 dataset.

The income effect of age and the square of age (proxies for work experience) for both groups corroborate the hypothesis that income is influenced by age but at a decreasing rate, corresponding with the human capital theory.

For the different categories of races/skin tones, holding white workers as the base category, we found that both in agribusiness and in the other sectors, lower average incomes were estimated for black, brown and indigene individuals, and higher average incomes for yellow ones; however, it is emphasized that the income differential between white and yellow individuals and black, brown or indigene individuals is statistically higher in agribusiness. In 2012, Pinto & Cunha (2014) also found a relevant and statistically significant differential of 17.3% between white and non-white workers in Brazilian agriculture.

Regarding employment status, holding the formal employed workers whether from the public or private sectors as the base category, agribusiness employers are found to earn 65.09% more than the base category, while self-employed individuals in the agribusiness sector and the average agribusiness employee working informally earned, respectively, 38.62% and 33.59% less than those in the base category. A similar result was observed for those employed in non-agribusiness sectors without a formal contract and the self-employed relative to the base category. However, the gap between these three categories of worker incomes is of a much lower statistically significant magnitude when compared with the gap estimated in the agribusiness. This result shows that employment status has a more intense effect on the income differential in agribusiness than in non-agribusiness.

Specifically analyzing the processing industry, Castro & Moreira (2019) found that although the differentials related to the formal contract are significant, the wage gap is similar in the agro-based industry and in the non-agro industry.

Brazil's Center-West base category is found to have the highest average income for both groups. We highlight the substantial income gap between agribusiness worker in the base compared, for instance, to the Northeast. We found that average income is approximately 51.43% smaller in the Northeast. Relatively higher labor incomes in the Center-West were also found by Cunha (2008), when analyzing agriculture alone in 2005, and by Pinto & Cunha (2014), analyzing agriculture in 2012. Specifically, Cunha's (2008) results demonstrate that

these relative income gains in the Center-West intensified sharply between 1980 and 2005. The unfavorable position of the Northeast was also noted by both Cunha (2008) and Pinto & Cunha (2014), in their respective periods of analysis.

Focusing on agribusiness as a whole, one of the possible explanations for the regional income differentials lies in the very distribution of workers among agribusiness segments in each region. According to Morais et al. (2018), the agribusiness labor market in the North and Northeast has a more predominant share of jobs in the primary segment (typically characterized by lower employment-related incomes); in the Center-West, Southeast and South, in turn, the agribusiness labor market becomes increasingly focused on industrial and services activities (activities with typically higher employment-related incomes).

Comparing agribusiness with the non-agribusiness sectors, we verified that regional earnings inequality is significantly higher in the agribusiness sector. Among the non-agribusiness sectors, the South, Southeast and Central-West present relatively similar income averages, while the North and Northeast incomes are below the base category in greater magnitude, 18.02% and 29.31%, respectively.

In the analysis of the economic subsectors, the base category is the variable *econ_set7* that represents the processing industry that is not primarily agricultural-based. In the agribusiness group, the lowest incomes relatively to the base are in agriculture (*econ_set1*), followed by the production of textiles, clothing and leather and footwear (*econ_set5*). Livestock (*econ_set2*) and the production of food, beverages and tobacco (*econ_set4*) also stand out with lower incomes than the base category. On the other hand, for the non-agribusiness group, the subsectors that stand out with higher incomes in relation to the base category are the extractive industry (*econ_set3*) and the groups of services that include information, financial services and real estate activities (*econ_set11*), and professional, scientific and technical activities (*econ_set12*).

Focusing on the processing industry, we note that the processing industry that is not primarily agricultural-based (base category) has relatively higher incomes than the essentially agro-based industries. Our result corroborates Castro & Moreira (2019), who verified that some characteristics of agroindustrial employment, particularly the workers holding relatively lower level of schooling compared to the remaining processing industry, reflected in relatively lower employment incomes for the workers in those industries. Complementarily, Borges & Ribeiro (2009) found that lower wages are paid in more fragmented sectors that demand a labor force with lower levels of schooling, such as the manufacture of textile products and food and beverages, which have a lower technological intensity. The authors pointed to the existence of a positive relationship between wages and the degree of technology in the sector.

A limitation this stage of our study is that some of the important unobservable factors that explain individual incomes, such as individual motivation, are not controlled in the model due to the lack of a panel data structure, and therefore the results should not be interpreted as a causal analysis (Cameron & Trivedi, 2005).

5. Conclusion

The objective of this paper is to measure the Brazilian agribusiness labor market, to characterize its structure and workers and to analyze the income differentials among its workers, comparing these gaps with those found among non-agribusiness workers.

In 2017, there were 18.2 million people — 20.1% of the country's labor force — working in the various segments of Brazilian agribusiness. Within agribusiness, employment is largely concentrated in the primary segment (46.16%), followed by agro-services (31.41%), agroindustry (21.24%) and input industries (1.20%). After further analysis of the distribution of the labor force within the agriculture-based primary segment, it was evident that job generation process differs significantly from value generation process, which is related to transformations that have occurred in recent decades in Brazilian agriculture. At the same time, this indicates a higher fragmentation of income, which is already relatively low in these activities. In the agribusiness industry segment, most jobs are also concentrated in relatively labor-intensive industries, such as clothing and furniture production.

Relative to workers in Brazil's as a whole, the average Brazilian agribusiness worker was found to have a lower level of schooling and is more likely to be engaged in an informal basis. These results are largely linked to the high proportion of primary segment workers in the total number of persons employed in agribusiness and the very different profile that this segment presents in relation to other segments in the sector.

Analysis of worker income data shows a relevant difference in the average income of agribusiness sector workers and non-agribusiness sector workers, which strongly favors the non-agribusiness worker. The average non-agribusiness monthly income was 53% higher than the average agribusiness income, a R\$ 752-month difference between both sectors. Our results might suggest the fact that the lack of schooling and the high proportion of informal employment make harder for agribusiness workers to obtain incomes equally sufficient compared with those received by workers in the non-agribusiness sectors and lessens the agribusiness worker's chance of obtain the benefits of formal employment.

Our results show that economic returns due to continued schooling tend to be proportionally greater in the agribusiness sector than in the non-agribusiness sectors, albeit rising from a lower baseline. Moreover, the income differential associated with different labor market statuses, economic sub-sectors and locations, and with other individual characteristics such as skin tone and gender was significant in the agribusiness labor market, and overall, higher than the differential found in the other economic sectors.

In summary, in addition to presenting a relatively low employment-related income, the Brazilian agribusiness also presents a more unequal distribution of this income among workers in the face of the different observable characteristics analyzed in this study.

A limitation inherent in the present study should be pointed out: the service segment could not be included in the income analysis of the agribusiness sector. It is important to mention that this segment has significant participation in the generation of income and jobs in the sector, which could scale up the average sector income. This task of separating and allocating the many different types of services is beyond our capabilities in light of the available datasets, and is left for future studies.

Despite the limitations, this study pioneers in shaping and analyzing the Brazilian agribusiness labor market. Moreover, it adds relevant and new insights to the literature and future studies. Finally, we are aware that our study also certainly did not exhaust the subject, but we do hope it will support and provide relevant information for public policies oriented to the whole agribusiness chain.

6. References

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