ECONOMIC IMPACTS OF THE COVID-19 PANDEMIC ON THE COFFEE SECTOR IN MANHUAÇU - MG, BRAZIL: EMPLOYMENT, INCOME, AND REGIONAL RESILIENCE

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Abstract:

This paper investigates the economic impacts of the Covid-19 pandemic on employment and income in the agricultural sector, with a particular focus on the coffee industry in Manhuaçu - Minas Gerais (MG), Brazil. We employ a comprehensive approach to analyze the spatial distribution of economic activities related to coffee, identifying alternative strategies adopted by local producers that may have contributed to the economic adaptation and development of the municipality during the pandemic period. Among the regional analysis tools used, we highlight the shift-share analysis, which allowed us to decompose employment variations and identify regional and structural components of economic growth. Our findings indicate that while the agricultural sector faced significant negative impacts due to the pandemic, the coffee sector demonstrated remarkable resilience, with growth above the state average despite the overall economic downturn. This growth was driven by factors such as external demand for coffee and the adoption of new technologies and agricultural practices that increased productivity. Additionally, we emphasize the importance of public policies and fiscal incentives in sustaining the coffee sector, especially in times of crisis. The study also utilizes location quotient and restructuring coefficient analyses to further understand the concentration and structural shifts within the sector. This study contributes to the literature by highlighting the adaptability of the agricultural industry in adverse contexts and suggesting the need for public policies focused on supporting strategic sectors like coffee in Manhuaçu - MG particularly, and in Brazil in general, to ensure their long-term regional resilience and sustainability. Future research should focus on longitudinal studies to monitor post-pandemic recovery and the effectiveness of policy interventions in the agricultural sector.

Keywords:

Regional Analysis, Economic Resilience, Shift-Share.

Resumo:

Este estudo investiga os impactos econômicos da pandemia de Covid-19 sobre o emprego e a renda no setor agrícola, com foco específico na indústria do café em Manhuaçu - Minas Gerais (MG), Brasil. Utilizou-se uma abordagem abrangente para analisar a distribuição espacial das atividades econômicas relacionadas ao café, identificando estratégias alternativas adotadas pelos produtores locais que podem ter contribuído para a adaptação econômica e o desenvolvimento do município durante o período pandêmico. Entre as ferramentas de análise regional empregadas, destaca-se a análise diferencial-estrutural, que permitiu decompor as variações de emprego e identificar componentes regionais e estruturais do crescimento econômico. Os resultados indicam que, enquanto o setor agrícola enfrentou impactos negativos significativos devido à pandemia, o setor do café demonstrou uma resiliência notável, com crescimento acima da média estadual, apesar da recessão econômica geral. Esse crescimento foi impulsionado por fatores como a demanda externa por café e a adoção de novas tecnologias e práticas agrícolas que aumentaram a produtividade. Além disso, enfatiza-se a importância das políticas públicas e dos incentivos fiscais na sustentação do setor do café, especialmente em tempos de crise. O trabalho também utiliza análises de quociente locacional e coeficiente de

reestruturação para entender melhor a concentração e as mudanças estruturais dentro do setor. Contribui-se para a literatura ao evidenciar a capacidade de adaptação do setor agrícola em contextos adversos e ao sugerir a necessidade de políticas públicas focadas em apoiar setores estratégicos como o de café em Manhuaçu - MG, particularmente, e no Brasil, de uma forma geral, para garantir sua resiliência regional e sustentabilidade a longo prazo. Sugere-se que pesquisas futuras foquem em estudos longitudinais para monitorar a recuperação pós-pandemia e a eficácia das intervenções políticas no setor agrícola.

Palavras-chave:

Análise Regional, Resiliência Econômica, Análise Diferencial-Estrutural

Área temática:

Teoria, métodos e modelos de economia regional

Classificação JEL do trabalho:

R11 Regional Economic Activity: Growth, Development, Environmental Issues, and Changes

1. INTRODUCTION

The first case of Covid-19[1], a disease characterized by respiratory infections among other symptoms (Lima, 2020), was reported in late 2019 in China. In Brazil, the initial cases were identified on February 26th, 2020. Generally, infected individuals develop fever and respiratory problems within five to six days after infection, which can lead to more severe cases and even death (Lima, 2020). Diagnosis is conducted through the collection of materials from the respiratory tract in specialized laboratories. The increase in reported cases led to global lockdowns during peaks of infection, significantly reducing mobility in various sectors, including the coffee sector.

Sergeant Major Francisco de Mello Palheta introduced coffee to Brazil in 1727, bringing seeds from French Guiana to Belém, Pará – PA (Martins, 2012). The favorable Brazilian climate and soil, along with the slave-based agricultural system, facilitated the expansion of coffee production and its export. According to Rodrigues et al. (2015), coffee became an important economic driver in the 18th century, contributing significantly to Brazil's economic development. Additionally, the formation of the coffee elite in the municipality of Manhuaçu - MG during the late 19th century played a crucial role in shaping local power dynamics and economic structures (Santos, 2019).

Quality is a crucial factor in coffee classification, which is based on attributes such as flavor and type. According to the Brazilian Ministry of Education – MEC (2005), the primary evaluation method is sensory analysis, where professionals assess the color, taste, texture, and aroma of coffee. Quality classification involves analyzing samples for defective grains and impurities, with color being a critical determinant. The main color grades for Arabica coffee are blue-green, green-cane, yellowish, and leaden, while Conilon coffee is classified by brown shades (MEC, 2005).

[1] "Covid" is an acronym formed from the following words: "corona" (co), "virus" (vi), and "disease" (d). The number 19 refers to the year 2019, when the first cases were publicly reported.

The expansion and quality of Brazilian coffee have led to the development of major urban centers in São Paulo (SP), Paraná (PR), and southern Minas Gerais (MG), boosting infrastructure investments (Rodrigues et al., 2015). Brazil's prominence as a leading coffee producer and exporter prompted the construction of railways to lower transportation costs. This historical importance is reflected in Brazil's dominant position in the global coffee market (Sugai et al., 2004). Over time, Brazil remains the largest producer and exporter of coffee in the world, according to data from the United States Department of Agriculture – USDA (2023).

In 1996, coffee exports contributed approximately BRL 2.05 billion to Brazil's GDP (Sugai et al., 2004). From January to November 2022, Brazil's coffee export revenue reached a record USD 8.50 billion, with an average price of USD 235.85 per bag[2], marking a 55.1% increase compared to 2021 (Brazilian Coffee Exporters Council – Cecafé, 2022). However, recent water shortages and frosts pose significant challenges to the agricultural sector, particularly coffee, despite a positive biennial cycle in 2022 (Garcia et al., 2022).

The economic uncertainties brought about by the pandemic, along with a depreciating Brazilian real (BRL) against the US dollar (USD), have exacerbated inflation and increased production costs for essential inputs like fertilizers and herbicides (Rosa et al., 2021). However, the depreciation has also enhanced the international competitiveness of Brazilian coffee due to lower prices in the global market (Castro et al., 2005). The National Consumer Price Index (IPCA) showed a significant rise in ground coffee prices, from 7.7% in December 2020 to 50.2% in December 2021 (Brazilian Institute of Geography and Statistics – IBGE, 2022).

Minas Gerais stands out as one of the largest coffee-producing states in Brazil, significantly contributing to employment and economic activity in the region (Santos et al., 2009). The Southeast region accounts for 84.5% of Brazil's total coffee production, with Minas Gerais alone contributing 47.0%, making it the largest coffee-producing state (IBGE, 2021).

Manhuaçu - MG, located in the Zona da Mata region of Minas Gerais (MG), relies heavily on the coffee sector (Espindula, 2018). Historical migrations and investments in railroads facilitated the transportation of coffee, fostering the area's economic growth (Espindula, 2018). The 2017 Agricultural Census reported five tons of roasted and ground coffee production in Manhuaçu – MG (IBGE, 2019). The Covid-19 pandemic brought significant economic and behavioral changes aimed at preventing the spread of the virus (Esteves et al., 2021).

Given these factors, it is crucial to evaluate the economic impact of the pandemic on Manhuaçu - MG, particularly on coffee sector workers. We aim to analyze the economic impacts of the Covid-19 pandemic on the coffee sector in Manhuaçu - MG, considering the local and regional perspectives. Coffee production is a vital component of the local and regional economy, providing employment opportunities and contributing to the income of numerous households.

In Manhuaçu - MG, the coffee sector is a significant economic driver, with a substantial number of productive plantations extending to neighboring municipalities. Therefore, our research will contribute valuable insights and observations to the area, as specific details on these topics remain relatively scarce. In the following section, we present a market analysis of the coffee industry in the years leading up to and during the pandemic. Section three details the methods employed in this study, while section four presents and analyzes the following results: i. secondary data on formal employment and income in the coffee sector of Manhuaçu - MG, collected and analyzed in terms of concentration, specialization, and shift-share (differential-structural) methods; and ii. data on productivity and coffee prices per bag in MG and the Zona da Mata region within the state.

[2] Each bag is equivalent to 60kg.

2. IMPACT OF COVID-19 ON THE COFFEE SECTOR AROUND THE WORLD

The Covid-19 pandemic has profoundly impacted commercial centers worldwide. In Brazil, there are still gaps in the literature linking the coffee sector with the pandemic scenario. Here, we explore existing literature, despite the relatively short time since the pandemic context, on how Covid-19 has affected agricultural producers and the economy in general, in Brazil and globally.

Coffee is a crucial agricultural sector in various parts of the world. In Ethiopia, coffee is a crucial crop for over 5 million farmers, with approximately 95% of the coffee in the country produced by small-scale farmers (Tamru et al., 2020). This sector is a key part of Ethiopia's export economy. The Covid-19 pandemic led to a notable reduction in both export and local consumption demand. Tamru et al. (2020) report that the International Coffee Organization (ICO) found that a 1% drop in global GDP resulted in a 0.1% decrease in coffee consumption. This drop in global consumption was worsened by export barriers during the peak periods of the pandemic (Sänger, 2020).

In 2020, logistical challenges further increased coffee marketing costs. Higher transportation costs and limited transportation access due to rising Covid-19 cases created significant barriers for market operations (Tamru et al., 2020). As a result, Ethiopia, which depends heavily on international trade, faced higher local marketing costs, reducing the profits of farmers. Although high prices initially boosted sales of washed coffee in 2019, not all of it could be exported due to pandemic-related warehouse closures and decreased international purchasing (Tamru et al., 2020). By April 2020, natural and washed coffee exports had declined by 26.0% and 32.0%, respectively, compared to 2018 and 2019 levels.

Similarly, coffee holds significant importance in Central America, employing approximately 1.2 million people in Honduras, Guatemala, Costa Rica, El Salvador, and Nicaragua (Fromm, 2022). Despite its positive contribution to GDP through exports, poverty remains prevalent in these regions. The Covid-19 pandemic exacerbated existing challenges, including low productivity and fluctuations in international coffee prices. Two years into the pandemic, small-scale producers in these regions continued to struggle with adapting to ongoing disruptions (Fromm, 2022).

Coffee is a primary agricultural export for countries like El Salvador, Honduras, and Nicaragua, predominantly produced on small farms. In Honduras, for instance, about 95.0% of coffee production comes from small farmers. The pandemic's immediate impacts were evident in the early months as sanitary measures were implemented by local governments. Covid-19 restrictions led to a 5.8% decline in coffee exports from January to March 2020 compared to the average exports in 2018 and 2019, dropping from 30.78 million bags to 29.01 million bags (Fromm, 2022). By restricting cafes and restaurants, major consumers of coffee in North America and Europe, global demand decreased, further impacting the economic slowdown and reducing labor availability for agriculture and other business activities due to lockdown measures.

Changes in consumer behavior during the pandemic also affected coffee markets, with a shift from regular in-store purchases to increased online coffee buying (Karima & Mulia, 2021). Sales of Arabica coffee at Indonesia's Jotey Coffee Shop declined significantly post-pandemic, while online sales saw continued growth (Karima & Mulia, 2021). Sanitary restrictions, particularly in 2020, accelerated this trend in Indonesia and globally.

The Covid-19 pandemic not only caused significant health damage but also exacerbated unemployment rates. In Brazil, one of the key sectors contributing to the GDP in 2020 was the

coffee industry, which saw an 18.2% increase (Prado et al., 2021). However, despite increased production, demand decreased. According to the ICO, there was a decline in coffee consumption in cafes, restaurants, and bakeries worldwide, while domestic consumption increased significantly (Sänger, 2020). Prado et al. (2021) attribute this rise to the uncertainty caused by the Covid-19 pandemic, prompting many to stockpile large quantities of food.

The pandemic adversely affected coffee harvesting in Brazil as it coincided with the coffee harvest season. New safety measures, such as social distancing and the use of masks, were implemented for rural work (Prado et al., 2021). The transportation of coffee also faced various obstacles, negatively impacting sales compared to previous periods. To counter this decline, many sectors adapted by selling through pre-orders and delivery services (Prado et al., 2021).

The pandemic introduced numerous changes to the labor market (Felipe et al., 2021). These changes include the adoption of remote work and distance learning, among other adjustments to daily life. The social, economic, political, and cultural impacts of Covid-19 are extensive, affecting the entire population. The economic recession resulting from this scenario led to an increase in unemployment in Brazil, with 40.0% of businesses closing due to the impact, according to IBGE (2020).

For the years 2021 and 2022, Brazil's coffee production was projected to reach 164.8 million bags, which, although lower than in previous years, would sustain the rising demand (Brainer & Ximenes, 2021). Besides pandemic-related effects, physiological factors like negative biennial cycles and climatic conditions also contributed to this reduction. Nevertheless, global coffee consumption remained high, with the United States of America (USA), Brazil, and the European Union accounting for about 55.5% of it. Consequently, Brazil might consume 23.7 million bags of coffee, reducing exports by 22.0% (Brainer & Ximenes, 2021). Brazil remained the largest coffee producer, accounting for 39.8% of global production.

The international coffee market has seen higher prices compared to pre-pandemic years, driven by increased shipping costs and delays due to new conditions, which concern importing countries (Brainer & Ximenes, 2021). These changes in the national and international markets are a result of restrictive measures such as lockdowns. Brainer and Ximenes (2021) note that Brazilian exports are on the rise due to currency valuation and reduced coffee supply. In 2021, Brazil exported an average of 2.17 million tons, or 76.0% of its total production, with Minas Gerais being one of the largest coffee-producing states (Brainer & Ximenes, 2021).

The reduced coffee supply and production disruptions caused by the Covid-19 pandemic, along with market volatility, have led to higher coffee prices for international buyers. For example, from January to November 2021, exports to the USA accumulated USD 5.58 billion, and to Germany, USD 958.34 million (Brainer & Ximenes, 2021). The restructuring of trade due to the impact of Covid-19 has consolidated factors in the agricultural sector, where small producers facing liquidity issues have partnered to achieve economies of scale. These factors, among others, have kept Brazil attractive for international investments.

3. METHODS

In this section, we focus on presenting the methods used for the descriptive and regional analysis suggested in this paper. The methods are divided into four subsections. First, we present regional and locational measures for the description of the obtained results. Next, we demonstrate the initial components of the shift-share method, which include specialization and location measures. In the third subsection, we provide the typology and general description of

the data, discussing how descriptive analyses are conducted. Finally, we present the databases used.

3.1. REGIONAL AND LOCATIONAL MEASURES

We employed various sectoral measures to describe the data, focusing on the geographic distribution of activities. These measures include the Location Quotient (LQ) and the Redistribution Coefficient (RdC). Subsequently, we analyzed the production structure of each region to explore the degree of specialization in regional economies over a specific period (Haddad, 1989). A key coefficient used in this study then is the Restructuring Coefficient (RsC).

3.1.1. Location Quotient

The Location Quotient (LQ) allows us to compare the proportion of employment in a specific sector within a region to the proportion of employment in that sector nationwide (Haddad, 1989). If the LQ is greater than 1, it indicates that the region has a higher concentration of employment in that sector compared to the national average, suggesting the region's significance in that sector. We calculated the LQ for sector i in region j using the Equation 1:

$$LQ_{ij} = \frac{E_{ij}/E_{i.}}{E_{.j}/E_{..}} \quad (1)$$

where E_{ij} is the number of workers in sector i in region j; $E_{i.}$ is the total number of workers in sector i; $E_{.j}$ is the total number of workers in region j; and $E_{..}$ is the total number of workers in the entire country.

An LQ value greater than 1 indicates that the region has a basic (export-oriented) activity. Conversely, an LQ value less than 1 suggests that the activity is oriented towards the internal market of the region. If the LQ equals 1, it shows that the region's share in the analyzed sector is proportional to its share in the total economy. Thus, with LQ we analyze the importance of the coffee sector within agriculture in the city of Manhuaçu - MG and determine if the activity is basic.

3.1.2. Redistribution Coefficient

The Redistribution Coefficient (RdC) allows us to examine the changes in the spatial distribution of employment in a sector between two time periods, highlighting whether there has been a trend towards spatial concentration or dispersion. We calculated the RdC to compare the periods before and during the pandemic (2017-2018 and 2019-2020, respectively). Equation 2 illustrates the calculation:

$$RdC_i = \frac{\sum_j(\left|e_{ij}^{t_1} - e_{ij}^{t_0}\right|)}{2} \quad (2)$$

where e_{ij} represents the proportion of employment in sector i in region j, calculated as $\frac{E_{ij}}{\sum_i E_{ij}}$. The RdC ranges from 0 to 1, where a value close to zero indicates no significant change in the spatial distribution, and a value close to one indicates a substantial change (Haddad, 1989).

3.1.3. Restructuring Coefficient

The Restructuring Coefficient (RsC) measures the extent of changes in the employment structure of a region over two distinct periods, indicating shifts in regional specialization (Haddad, 1989). We calculated the RsC using Equation 3:

$$RsC_i = \frac{\sum_i(\left|e_{ij}^{t_1} - e_{ij}^{t_0}\right|)}{2} \quad (3)$$

where e_{ij} is the employment share of sector i in region j. According to Haddad (1989), a coefficient value of zero indicates no change in the sectoral composition, while a value of one signifies significant restructuring. We analyzed the RsC to determine changes in Manhuaçu – MG's sectoral composition between the pre-pandemic and pandemic periods.

3.2. SHIFT-SHARE ANALYSIS

We used shift-share analysis to understand regional economic dynamics and to identify appropriate incentives for regional development. This method decomposes regional economic growth into three components: regional – or theoretical – variation (R), proportional – or structural – variation (P), and differential variation (D) according to Haddad and Andrade (1989).

The regional variation (R) represents the employment change that would occur if a region's employment grew at the national rate. We calculated this using Equation 4:

$$R = \sum_i\left[E_{ij}^0(r_{tt} - 1)\right] \quad (4)$$

where r_{tt} is the national employment growth rate. The proportional variation (P) reflects the additional employment a region may experience due to its industrial composition, as shown in Equation 5:

$$P = \sum_i\left[E_{ij}^0(r_{it} - r_{tt})\right] \quad (5)$$

where r_{it} is $\sum_j E_{ij}^1 / \sum_j E_{ij}^0$, the employment growth rate in sector i, and r_{tt} is the national employment growth rate. Positive P values indicate specialization in high-growth sectors, while negative values suggest slower growth (Haddad & Andrade, 1989). If $r_{it} > r_{tt}$, we conclude that the analyzed sector is dynamic, whereas if $r_{it} < r_{tt}$, it indicates that the sector has slow growth (Porsse & Vale, 2020).

The differential variation (D) measures the positive or negative employment change in region j due to sector-specific growth rates differing from the national average, calculated using Equation 6:

$$D = \sum_i\left[E_{ij}^0\left(r_{ij} - r_{it}\right)\right] \quad (6)$$

where r_{ij} is the employment growth rate in sector i of region j, and r_{it} is the employment growth rate in a particular sector i.

Thus, a distinction is often made between actual and hypothetical growth. However, one can segregate which part of this distinction results from a structural factor and which from another differential factor. According to Porsse and Vale (2020), regional employment variation is given in Equation 7:

$$\sum_i\left[E_{ij}^1 - E_{ij}^0\right] - \sum_i\left[E_{ij}^0(r_{tt} - 1)\right] = \sum_i\left[E_{ij}^0(r_{it} - r_{tt})\right] - \sum_i\left[E_{ij}^0\left(r_{ij} - r_{it}\right)\right] \quad (7)$$

where $\sum_i [E_{ij}^1 - E_{ij}^0]$ is the actual variation, and $\sum_i [E_{ij}^0 (r_{tt} - 1)]$ means the theoretical variation. The difference between the two forms the total net variation (TNV). $\sum_i [E_{ij}^0 (r_{it} - r_{tt})]$ is the Proportional – or Structural – Net Variation (PNV), and $\sum_i [E_{ij}^0 (r_{ij} - r_{it})]$ is the Differential Net Variation (DNV). The difference between the actual employment variation in region *j* and the hypothetical variation depends on a structural and a differential factor, which together result in the TNV.

Thus, when analyzing TNV, it is possible to observe whether the sector under review grew above or below the national average (Porsse & Vale, 2020). Consequently, when the real variation exceeds the theoretical variation, there are indications that sector i in region *j* achieved growth higher than the national average, with this study focusing on the state average. This demonstrates the presence of external or internal dynamic elements positively influencing the region. Conversely, if the real variation is lower than the theoretical variation, it indicates that sector i in region *j* lacks the same dynamism, showing slower expansion compared to the national average. This factor is crucial in assessing whether the coffee cultivation and agricultural sectors in Manhuaçu - MG grew above or below the state average during the Covid-19 pandemic.

Moreover, PNV reflects the positive or negative additional value that a specific region may derive from its structural composition, i.e., the presence or absence of typical dynamic sectors in its production structure (Simões, 2005). Regions lacking dynamic sectors will experience proportional variations less than zero. To analyze sectoral specialization, location quotients are commonly used. The structural component of the shift-share methodology indicates a region's specialization in the analyzed sectors through its positive sign. Hence, it is through the proportional effect that we can ascertain whether sector *i* in region *j* experienced higher growth than the national economy (Simões, 2005). This reflects effects stemming from the region's industrial composition, such as technological progress, spending patterns, and productivity, among others.

On the other hand, DNV symbolizes the positive or negative amount that a region may attain, as growth in particular sectors tends to be higher or lower in the region *j* compared to the national average. Thus, it indicates the benefits or drawbacks of the locality. According to Haddad (1989), through the differential component, also known as regional, variations in transportation, fiscal incentives, and differences in input prices, for example, can be perceived. Therefore, this component is essential for exploring the locational advantages that the region possesses, which may attract slow or dynamic growth compared to the national/state level. This component aims to explain the situation of the researched region in terms of each sector individually rather than analyzing the sectoral composition as a whole (Carvalho, 1979). The shift-share method allows for detailed information generation about the researched region.

Equation 7 may be written in another format. Through the shift-share, as explained, we identify factors similar to the national/state level, as well as specific to a region through Equation 8, as in Carvalho (1979):

$$\sum_i TNV = \sum_i [PNV - DNV] \quad (8)$$

However, some issues such as sensitivity to sectoral or regional aggregation, and trend revelation rather than cause-and-effect relationships, are drawbacks of the model. Moreover, calculations can be distorted, as different base years or variable choices can yield distinct results (Carvalho, 1979). Shift-share analyses typically use employment as the variable, implicitly assuming no asymmetry in labor productivity across the analyzed regions.

Additionally, by calculating TNV using employment as the initial base year variable, another issue arises in not considering other potential structural changes in employment between the analyzed years. Thus, a final analysis may be flawed due to changes or lack thereof in the specialization of dynamic sectors. Nonetheless, employment data is preferred due to its availability for regions.

3.3. TYPOLOGY AND DATABASE DESCRIPTION

We conducted both qualitative and quantitative research to gather specific and objective data. Qualitative research, being descriptive, emphasizes the researcher's analytical approach (Gil, 2008). It avoids statistical tools and explores descriptive data through direct engagement with the research context. Quantitative research complements this by elucidating ideas through numerical data and metrics.

The novelty of the pandemic has introduced gaps, inaccuracies, and uncertainties in databases. Our methodology aims to quantify the impact of the Covid-19 pandemic on the coffee sector of Manhuaçu - MG. We used secondary data from the Annual List of Social Information (RAIS) and the General Registry of Employed and Unemployed (Caged) for employment and income data (RAIS, 2022). The variables included formal employment and income for the coffee sector, agriculture, and other major sectors of IBGE. We compared annual data for 2019 and 2020, covering producers and formal workers in Manhuaçu - MG.

We also investigated how productivity and coffee prices per bag were affected between 2019 and 2021 in MG and in the Zona da Mata region, where Manhuaçu - MG is located. We sourced pricing data from the Technical Assistance and Rural Extension Company (Emater, 2022) and the National Supply Company (Conab, 2020, 2021). Our analysis aims to understand the current coffee trade scenario during Covid-19, its impact on employment, and how the population of Manhuaçu - MG adapted through social or spatial interactions.

4. RESULTS AND DISCUSSION

In this section, we present the primary results of this research. We include calculations in regional economics based on the employment variable (formal employment of coffee workers in the Manhuaçu – MG municipality) and their respective incomes. Finally, we provide a descriptive analysis of the variables related to productivity levels in MG and the Zona da Mata region, and the values of Arabica coffee in the Zona da Mata of MG for the years 2019, 2020, and 2021, regions where the municipality of Manhuaçu - MG is located.

4.1. SPATIAL CONCENTRATION, AND LOCATION AND SPECIALIZATION MEASURES

We explain the entire process of analyzing the concentration of the coffee sector and the measures of location and specialization here, according to the methodology presented in the previous section. Additionally, we describe how we gathered data on agriculture and the coffee sector. According to Haddad (1989), to formulate policies for understanding regional economic growth patterns, we must use a set of location and specialization measures to analyze regional behavior.

Tables 1, 2, and 3 present information matrices for analyzing regional measures for the years 2019 and 2020, with data available for the base variable – employment – involving the beginning and expansion of the Covid-19 pandemic. The data pertain to the municipality of Manhuaçu - MG, the state of MG, and Brazil as a whole, referring to the eight major sectors of economic activity according to IBGE classification: Mineral Extraction (Mining); Manufacturing Industry; Public Utility Industrial Services; Civil Construction; Commerce; Services; Public Administration; and Agriculture, Forestry, Hunting, and Fishing. The latter is the major sector that includes coffee, the main focus of this work.

Table 1: Information Matrix, Manhuaçu - MG

Sectors	2017	2018	2019	2020
1. Mineral Extraction	46	46	44	43
2. Manufacturing Industry	1,895	1,920	2,101	2,411
3. Public Utility Services	165	154	153	156
4. Civil Construction	4,737	5,050	5,550	5,667
5. Commerce	5,114	5,325	5,185	5,038
6. Services	5,820	6,016	6,257	5,974
7. Public Administration	2,660	2,778	2,785	2,608
8. Agriculture	415	454	404	381
8.1. Coffee Cultivation	376	394	350	349
8.2. Other Agriculture	39	60	54	32
Total	21,267	22,197	22,479	22,278

Source: own elaboration based on RAIS and Caged data (RAIS, 2022).

We chose the employment variable due to its ability to measure the regional economic development process and provide a uniform basis for measuring and comparing sectors and activities. Tables 1, 2, and 3 show information matrices for December 31st of the years 2017 to 2020 for formal employees in the respective localities, covering pre-pandemic (2017 and 2018) and pandemic (2019 and 2020) periods. In Table 1, we organized employment data by economic activity sectors in Manhuaçu - MG from 2017 to 2020. This matrix enabled the calculation of location and specialization measures.

The same employment decline observed in Table 1 can be seen in Table 2 for the coffee cultivation sector, likely due to sanitary barriers imposed during the pandemic, particularly in 2020, which affected coffee production. A similar effect occurs in the agriculture sector. Formal employment in agriculture decreased during the pandemic years, both in Manhuaçu - MG (Table 1) and in MG (Table 2).

Table 2: Information Matrix, MG

Sectors	2017	2018	2019	2020
1. Mineral Extraction	59,069	58,815	62,798	64,898
2. Manufacturing Industry	738,493	744,232	755,593	763,115
3. Public Utility Services	41,684	42,941	41,748	42,141
4. Civil Construction	218,895	234,254	249,787	278,129
5. Commerce	967,468	968,003	967,742	939,311
6. Services	1,569,930	1,618,103	1,674,945	1,634,665
7. Public Administration	858,646	839,120	855,947	846,967
8. Agriculture	256,734	255,362	247,465	245,648
8.1. Coffee Cultivation	55,724	55,322	52,420	51,953

8.2. Other Agriculture	201,010	200,040	195,045	193,695
Total	4,967,653	5,016,192	4,856,025	4,814,874

Source: own elaboration based on RAIS and Caged data (RAIS, 2022).

Finally, Table 3 organizes employment data for the eight major IBGE sectors across Brazil, covering the years before and the initial years of the Covid-19 pandemic.

Table 3: Information Matrix, Brazil

Sectors	2017	2018	2019	2020
1. Mineral Extraction	212,337	212,629	222,260	227,666
2. Manufacturing Industry	7,105,206	7,098,152	7,135,063	7,188,734
3. Public Utility Services	425,427	438,048	444,163	455,009
4. Civil Construction	1,838,958	1,861,846	1,850,749	1,970,686
5. Commerce	9,230,750	9,219,684	9,221,315	9,054,514
6. Services	16,772,645	17,228,663	17,508,912	17,215,415
7. Public Administration	9,195,215	9,080,653	8,864,849	8,662,695
8. Agriculture	1,501,052	1,491,440	1,469,181	1,461,457
Total	46,281,590	46,631,115	46,716,492	46,236,176

Source: own elaboration based on RAIS and Caged data (RAIS, 2022).

Through Table 3, we observed a continuous decline in employment in the agriculture sector in Brazil from 2017 to 2020. As previously stated, creating these matrices was the starting point for calculating location and specialization measures.

Next, we analyze the results related to the LQ. The comparison is made between coffee cultivation and agriculture, forestry, hunting, and fishing (referred to as agriculture here) in Table 4.

Table 4: Location Quotient, Coffee Cultivation vs. Agriculture, Manhuaçu - MG and MG

LQ_{ij}	Coffee Cultivation - Agriculture
2017	4.17
2018	4.01
2019	4.09
2020	4.33

Source: own elaboration based on RAIS and Caged data (RAIS, 2022).

Using the LQ, we compared the percentage share of Manhuaçu - MG in the coffee cultivation sector with the percentage share of the same municipality in the total employment in agriculture in the state of MG. We observed that coffee cultivation holds significant importance compared to other agricultural sectors in MG, with LQ values of approximately 4.17 and 4.01 for the pre-pandemic years (2017 and 2018) and 4.09 and 4.33 for the pandemic years (2019 and 2020). Values greater than 1 indicate that Manhuaçu - MG is relatively more important in the coffee cultivation sector compared to the overall agricultural sector in MG. This significance was observed even before the Covid-19 pandemic, but the value increased in 2020 when the pandemic began in Brazil.

This increase in LQ from one year to another shows that coffee cultivation in Manhuaçu - MG became even more relevant within the state context compared to other agricultural sectors. With a $LQ > 1$, we understand that the coffee sector in Manhuaçu - MG has greater potential for export activities (indicating that the activity in this region is basic, oriented beyond the borders of the municipality), as opposed to a $LQ < 1$, which would indicate a non-basic activity (oriented towards the local market).

These results highlight the importance of the sector to the municipality and its strong indication for export beyond the borders of the municipality, leading to greater capacity for employment and income generation. Using the Redistribution Coefficient (RdC), we examined the percentage distribution of a specific sector in a locality compared to the entire region. We analyzed Manhuaçu - MG with MG and MG with the entire Brazil for the coffee cultivation and agriculture sectors in pre-pandemic and pandemic years (2017-2018 and 2019-2020, respectively). According to the RdC calculations, there were no significant changes in the spatial location pattern for coffee cultivation between the analyzed periods, resulting in a value of zero. The same results were observed for the agriculture sector. Thus, no change in the percentage distribution was noted in either case.

Using the Restructuring Coefficient (RsC), we related the employment structure in a particular region over two distinct periods. We associated the employment structure of coffee cultivation and agriculture with other sectors in Manhuaçu - MG between 2017 and 2020, seeking to analyze the level of change in the specialization of the region. Based on RsC calculations, we found no change in the sectoral composition in Manhuaçu - MG. The coefficient values were zero for both agriculture and coffee cultivation, indicating no change in the sectoral composition in the municipality.

Table 5: Shift-Share Components, Agriculture and Coffee Cultivation, Manhuaçu - MG

Sector	r_{tt}	r_{it}	r_{ij}	Regional $E^0_{ij}(r_{tt}-1)$	Proportional $E^0_{ij}(r_{it}-r_{tt})$	Differential $E^0_{ij}(r_{ij}-r_{it})$
Agriculture (2017-2018)	1.011	0.995	1.094	4.397	-6.615	41.218
Agriculture (2019-2020)	0.992	0.993	0.943	-3.424	0.457	-20.034
Coffee Cultivation (2017-2018)	1.011	0.993	1.048	3.984	-6.696	20.713
Coffee Cultivation (2019-2020)	0.992	0.991	0.997	-2.966	-0.152	2.118

Source: own elaboration based on RAIS and Caged data (RAIS, 2022).

Using the shift-share method, we described the economic growth of Manhuaçu - MG in terms of its production structure. Table 5 shows the regional, proportional, and differential variations, with their components: r_{tt} (employment growth rate in the state of MG), r_{it} (employment growth rate in sector i), and r_{ij} (employment growth rate in sector i in region j, Manhuaçu - MG). For agriculture, the sector experienced slow growth in the pre-pandemic years (2017-2018), with $r_{it} < r_{tt}$. However, from 2019 to 2020, when the pandemic began, the sector showed dynamism and high growth, with $r_{it} > r_{tt}$. Coffee cultivation experienced slow growth in both pre-pandemic (2017-2018) and pandemic (2019-2020) years, as indicated by $r_{it} < r_{tt}$.

Additionally, we noted that the theoretical variation (R) showed a negative balance in agriculture of 3.4 between 2019 and 2020. The same occurred for coffee cultivation, with a negative balance of approximately 3.0 in the same period. This indicates a decline for both sectors. The comparison of the proportional and differential components shows the significance of regional characteristics and industrial composition in the growth of the sector. Table 6 shows the real, theoretical, and net variations (Total Net Variation – TNV), where $TNV = \left(E^1_{ij} - E^0_{ij}\right) - E^0_{ij}(r_{tt} - 1)$. The real variation is expressed by E^1_{ij}/E^0_{ij}, showing the actual change between the analyzed year and the base year.

Table 6: Real, Theoretical, and Net Variation, Manhuaçu - MG

Sector	Real Variation	Theoretical Variation	TNV
Agriculture (2017-2018)	39.0	4.4	34.6

Agriculture (2019-2020)	-23.0	-3.4	-19.6
Coffee Cultivation (2017-2018)	18.0	4.0	14.0
Coffee Cultivation (2019-2020)	-1.0	-3.0	2.0

Source: own elaboration based on RAIS and Caged data (RAIS, 2022).

Table 6 reveals that the real variation in agriculture and coffee cultivation was negative between 2019 and 2020. The difference between the real and theoretical variation, or TNV, shows a negative value for agriculture. Thus, the real variation was lower than the theoretical variation or R (which compares the municipality – micro-region – to the state – macro-region), resulting in a negative TNV of -19.6, indicating that the sector grew below the state average during the pandemic years. In contrast, the sector showed a TNV of 34.6 in 2017 and 2018, growing above the state average during this period.

For coffee cultivation, the same operation showed a positive TNV of 14.0 between 2017 and 2018, indicating growth above the state average during this period. Similarly, growth above the MG average was observed in 2019 and 2020, with a TNV of 2.0, despite slow growth indicated by $r_{it} < r_{tt}$.

Therefore, coffee cultivation holds significant importance in Manhuaçu - MG. The region outperformed the state of MG despite logistical changes and uncertainties affecting Brazil, currency depreciation of the real against the dollar, labor shortages, and reduced manual coffee picking due to Covid-19 sanitary protocols in 2020, according to Brainer (2020). However, both sectors warrant attention, as agriculture and coffee cultivation shifted from positive real variation in pre-pandemic years to negative real variation during the pandemic (2019 and 2020). This can be explained by the differential component (D) of the shift-share in Table 5. The D component measures how local characteristics (diversification, infrastructure, and others) can inhibit or promote regional growth, showing improvement in the sector between 2019 and 2020.

In contrast, during the same period, the D component caused below-average growth in agriculture in Manhuaçu - MG. Comparing the structural and differential elements, the latter shows significant negative values of approximately -20.0, suggesting it is the main factor for below-average growth in agriculture during the pandemic. Conversely, the proportional or structural component (P) showed a positive value of approximately 0.5 in agriculture, indicating that Manhuaçu - MG is specialized in this sector.

Table 7: Average Remuneration, Agriculture and Coffee Cultivation, Manhuaçu - MG, 2017-2020

Sector	2017	2018	2019	2020
Agriculture	520,999.82	552,466.07	504,233.30	479,023.23
Coffee Cultivation	481,009.21	432,002.76	385,453.24	409,063.98
Other Agriculture	39,990.61	120,463.31	118,780.00	69,959.00

Source: own elaboration based on RAIS and Caged data (RAIS, 2022).

The agriculture sector saw an increase in worker remuneration between 2017 and 2018. However, as analyzed by the shift-share methodology, below-average state growth in agriculture led to a decrease in average worker remuneration of about 5.0% between 2019 and 2020. Coffee cultivation showed a decreasing trend in worker remuneration from 2017 to 2019, but it increased in 2020, the year the pandemic began. Despite slow growth, the sector's above-average state growth was mirrored by an increase in worker remuneration, with a 6.1% increase from 2019 to 2020.

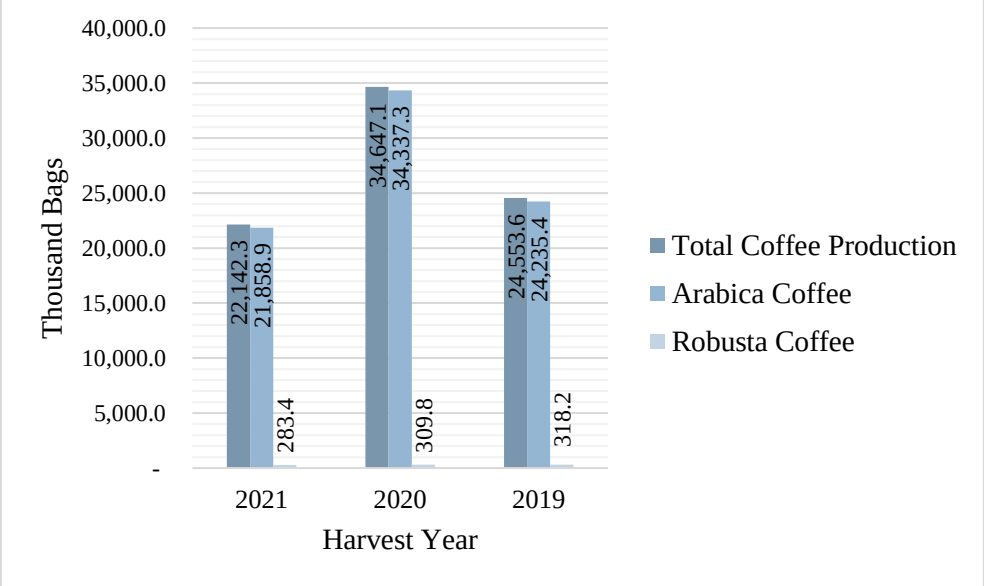
These findings highlight the importance of new methods for coffee cultivation in Manhuaçu - MG, where efforts to improve the sector amid the Covid-19 pandemic were evident. Other

agriculture sectors saw a significant 41.1% drop in remuneration from one year to the next, nearly halving.

In summary, the above-average growth of coffee cultivation in MG from 2017 to 2020 emphasizes its importance in Manhuaçu - MG. The coffee cultivation sector had the highest number of formal workers and the highest remuneration among agricultural sectors. Coffee cultivation workers accounted for approximately 86.6% in 2019 and 91.6% in 2020 of agricultural workers, and coffee cultivation contributed about 76.4% and 85.4% of total agricultural income in 2019 and 2020, respectively. This significance aligns with Brainer (2020), reporting that MG has 54.8% of the area and 51.7% of national coffee production, making it the largest producer in Brazil.

4.2. DESCRIPTIVE ANALYSIS OF COFFEE PRODUCTIVITY

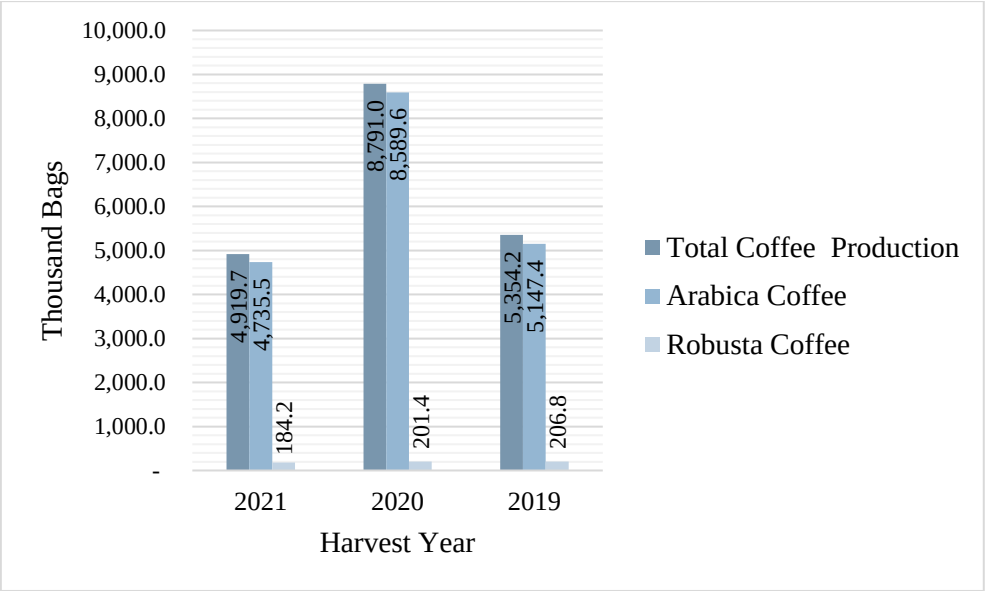
Figure 1 shows the total coffee production in MG from 2019 to 2021, indicating the contributions of Arabica and Conilon coffee.



Source: own elaboration based on Conab (2020, 2021) data.

Figure 1: Coffee Production 4th Survey, Thousand Bags, MG, 2019-2021.

According to Figure 1, the 2020 harvest saw a 41.1% increase in total coffee production compared to the previous year, potentially due to favorable climatic conditions and investments in new technologies. However, from 2020 to 2021, production decreased by 36.1%, likely due to the negative biennial cycle and climatic factors like floods and pandemic-related sanitary barriers. Conilon coffee has shown a decreasing trend since 2019. Nevertheless, MG remained the largest coffee producer in Brazil during the analyzed years (Conab, 2020, 2021). The significant fluctuations in productivity highlight the vulnerability of the sector to external shocks and the importance of adaptive measures. Figure 2 illustrates coffee production in the Zona da Mata region, including Manhuaçu - MG, for the same period.



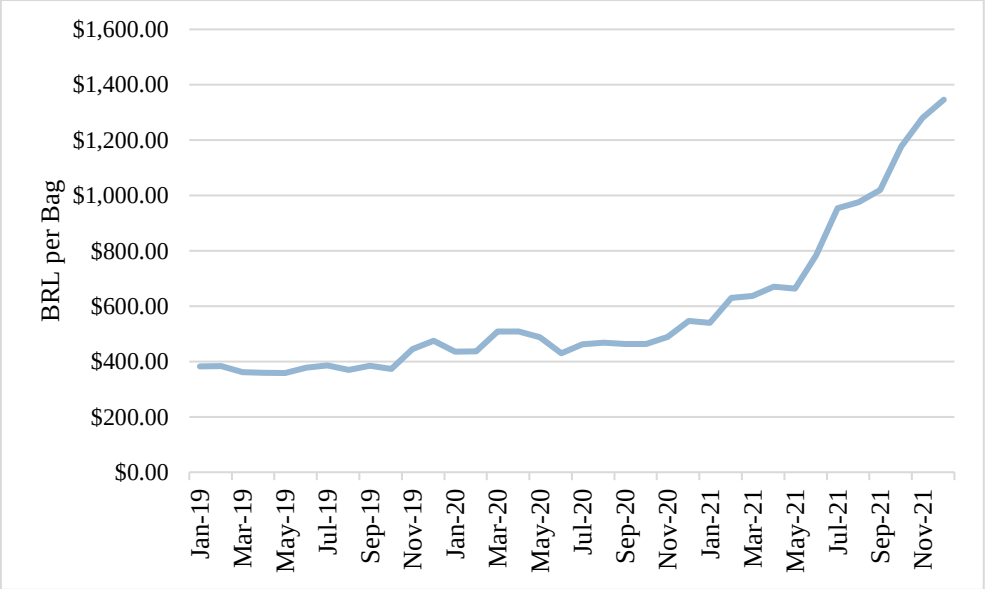
Source: own elaboration based on Conab (2020, 2021) data.

Figure 2: Coffee Production 4th Survey, Thousand Bags, Zona da Mata, 2019-2021.

Figure 2 shows a continuous decline in Conilon coffee production from 2019 to 2021. Conversely, Arabica coffee, the main export coffee in Brazil and the primary production in the Zona da Mata region of MG, increased by 66.9% from 2019 to 2020. This positive factor for Manhuaçu - MG, as indicated by the LQ calculation, shows the sector's strong export potential. However, the following year saw a sharp 44.9% decline, likely due to the negative biennial cycle and pandemic-related factors. Total coffee production in the Zona da Mata region varied by 64.2% from 2019 to 2020 and decreased by 44.0% from 2020 to 2021.

4.3 DESCRIPTIVE ANALYSIS OF COFFEE PRICES PER BAG

Figure 3 presents the average price of Arabica coffee in the Zona da Mata region of MG, calculated as the average of the highest and lowest monthly prices from 2019 to 2021.



Source: own elaboration based on Emater (2022) data.

Figure 3: Average Production Prices of Arabica Coffee, Zona da Mata, 2019-2021.

Figure 3 shows a significant increase in Arabica coffee prices, with a notable rise in 2021, a year of low coffee production in MG and the Zona da Mata region. Prices increased by 351.9% from January 2019 to December 2021. According to the Brazilian Confederation of Agriculture and Livestock (CNA) and the National Rural Learning Service (Senar), this increase reflects global logistical issues caused by the Covid-19 pandemic and the depreciation of the Brazilian real against the dollar in 2021 (CNA & Senar, 2021). Additionally, low supply and high demand for coffee from local and international consumers during the pandemic contributed to the price surge (CNA & Senar, 2021). Emater (2022) data only included Arabica coffee prices in the Zona da Mata region, where Manhuaçu - MG is located, with Conilon coffee prices presented for other regions.

Furthermore, the impact of global trade dynamics on local prices underscores the interconnectedness of coffee markets. As detailed in USDA (2023), the logistical challenges and increased production costs during the pandemic significantly affected coffee prices and availability.

5. CONCLUSION

The objective of this study was to analyze the significance of the coffee sector within agriculture, focusing on the formal employment variable in Manhuaçu - MG. By doing so, we identified certain trends that traverse the current economic and the pandemic scenario in the municipality. Understanding the dynamics of how economic activities are distributed is crucial for perceiving regional economic development. Therefore, we collected data on the agriculture and coffee sectors to compare their dynamics and assess the impact of the Covid-19 pandemic.

Manhuaçu - MG, like the rest of the world, faced changes in social and economic behavior due to the pandemic. After applying the shift-share method, we observed considerable dynamism in the municipality's agricultural sector in 2019 and 2020, while the coffee sector experienced slow growth in Manhuaçu - MG, a trend that has been apparent since 2017. However, this slow growth intensified during the onset of the Covid-19 pandemic in 2019 and 2020. Additionally, regional analysis revealed a negative real growth in the sectors studied since the beginning of the pandemic.

Despite this, the coffee sector in Manhuaçu - MG exhibited positive total net variation (TNV), indicating growth above the state average, even if slow. This underscores the importance of the sector to the city. Despite adversities such as logistical challenges and a reduction in field workers due to pandemic-related health protocols, the relevance of the sector remained evident. The sector also showed a 6.1% increase in worker remuneration from 2019 to 2020, linked to the rising value of coffee bags. Moreover, the differential component of the shift-share analysis highlighted transportation and input price variations, revealing the susceptibility of the sector to fuel price increases and logistical inconsistencies, which negatively impact the coffee market.

The differential component also highlighted the lack of fiscal incentives, particularly for the agricultural sector. The results suggested that reinforcing fiscal incentives from the government and their proper utilization could benefit this sector. Despite this, the coffee cultivation sector showed a positive differential component value, although it warrants attention due to its low differential component result. This reflects the need for public policies to prevent the slow growth observed from 2019 to 2020 in the coffee sector of Manhuaçu - MG. Furthermore, the Location Quotient (LQ) analysis confirmed the significant relevance of the coffee sector compared to other agricultural sectors in Minas Gerais. The LQ indicated the strong potential of the municipality for exporting beyond municipal boundaries, enhancing income and

employment capacity for workers. For these reasons, among others, this sector requires increased attention from policymakers, not only for the well-being of workers but also for the economic development of the municipality, given its high potential for growth and development.

This study aims to serve as a catalyst for future research and analysis on the topic, as the demonstrated results are preliminary. By utilizing formal employment data in the agricultural and coffee sectors and monitoring coffee productivity and pricing, future studies can extend beyond the pandemic period for more comprehensive analyses.

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