DOI: http://dx.doi.org/10.1590/0103-6351/6113

Wage inequality and employment composition in Brazil: a VEC estimation for the period 2004-2019

Desigualdade salarial e composição do emprego no Brasil: uma estimação VEC para o período 2004-2019

Clara Brenck [1]

[1] The New School for Social Research

Abstract

During the first decade of the 21st century, the Brazilian economy stood out by conciliating growth with income inequality reductions. To better understand this growth process, I propose to study the dynamics of Brazil's employment and wage inequality structure based on the hypothesis that there was a cumulative circular movement in which the reduction of income inequality, changes in the composition of the employment and growth reinforced each other. By econometrically testing the existence of this cumulative mechanism for Brazil for the years 2004-2019, I find that the employment composition and wage inequality are mutually related. The results highlight existing research gaps in understanding the relations between wage inequality and employment composition and avenues for further research.

Keywords

growth, distribution, wage inequality, employment composition

JEL Codes E12, E24, C32.

Resumo

Durante a primeira década do século 21, a economia brasileira se destacou por conciliar crescimento com redução da desigualdade de renda. Para melhor compreender esse processo de crescimento, proponho estudar a dinâmica da estrutura do emprego e da desigualdade salarial do Brasil naquele período partindo da hipótese de que houve um movimento circular cumulativo em que a redução da desigualdade, mudanças na composição do emprego e o crescimento reforçaram-se mutuamente. Testando econometricamente a existência desse mecanismo cumulativo para o Brasil para os anos de 2004-2019, concluo que a composição do emprego e a desigualdade salarial estão mutuamente relacionadas. Os resultados destacam as lacunas de pesquisa existentes na compreensão das relações entre desigualdade salarial e composição do emprego e caminhos para pesquisas futuras.

Palavras-chave

crescimento, distribuição, desigualdade salarial, composição do emprego.

Códigos JEL *E12, E24, C32.*

1 **Introduction**

The economic debate about the increase in income concentration in Brazil during the 1960s opposed, on the one hand, diagnoses based on the neoclassical theory of income determination and wage differentials as a reflection of the productivity gaps of agents, and, on the other, critical views that considered the class conflict and the repressive policies responsible for increasing inequality (Wells, 1974). Tavares and Serra (1972) take a particular path in that debate. In addition to agreeing on government policies' importance, they also point out the effects of changes in the productive structure, whose dynamics were engendered mainly by industrial dynamics, on income distribution. In an approach led by aggregate demand, the authors argue that the growth of the industrialized sectors, that employed more qualified workers, and the increase in inequality were positively related in a cumulative income-concentrating process.

However, the role of the productive structure in the income distribution debate has been abandoned since then, allowing the neoclassical side to endure the approach of technology and education as the determinants of workforce productivity – and, thus, inequality. In contrast, the other side remained with the debate centered on politics, institutions, and class conflicts, resulting from workers' and capitalists' bargaining power.

In the 2000s, the publication of Piketty (2014)'s book Capital in the 21st century, where he documented the increase in income concentration in developed countries, highlighted the debate about income inequality. In this context, Brazil's and other South American countries' trajectory during the first decade of the 21st century stands out: they combined falling inequality and growth. The explanations for this are commonly associated with the commodity boom characterized by a rise in commodity prices. According to IMF data, the non-fuel commodity price index increased, on average, 11.05% per year between 2003 and 2010. Carvalho and Rugitsky (2015), however, argue that while the external scenario represented a positive shock to South American economies, the internal policies adopted are also crucial in explaining the dynamics experienced by these countries.

From a perspective similar to that of Tavares and Serra (1972), Rugitsky (2017) unifies two arguments: the one from Giovannetti (2013), where changes in income distribution – due to economic policies of real minimum wage hikes and government transfers, especially after 2004 – alter

the consumption pattern of society; and the other of Carvalho and Rugitsky (2015) that such changes in the consumption pattern have repercussions in the employment structure of the economy. Adding the final effect that these changes in the productive structure echo in the improvement of income distribution in favor of the poorest, Rugitsky (2017) claims that the combination of these effects results in a circular and cumulative process in which inequality and employment (our output) composition are related. In other words, income inequality and employment composition reinforce each other in the sense that redistributing income to more impoverished workers increases the demand for services and goods intensive in less qualified labor – such as services – thus reducing wage disparities.

Brenck and Carvalho (2020) builds a two-sector open economy Kaleckian model with two types of workers to represent this cumulative causation. At first, they consider the income distribution to be exogenous, as is common in the Kaleckian framework. They show that wage inequality changes among workers affect the output composition of the economy towards an increase in the non-tradable sector. In a second exercise, they consider an endogenous response of the wage-share in the non-tradable sector to changes in the employment composition. Consequently, the reduction in wage inequality seems to have a more substantial positive effect on non-tradable output.

Motivated by this approach, this paper intends to contribute to the empirical literature on such a growth experience by econometrically testing the existence of this cumulative mechanism for Brazil. It consists, then, of four more sections, besides this introductory one. The next section discusses the policies that took place in Brazil, allowing the circular cumulative causation to occur. The third section presents the data used in this exercise and the criteria for selecting the sectors affected by this process. The subsequent section offers the econometric exercise, and its results. The last section concludes and discusses possibilities for further research.

2 **The years 2004-2013 in Brazil: economic policies**

The first and second Lula governments, from 2003 to 2010, were based on two main strategies: the expansion of mass consumption through policies of economic inclusion of the less favored and increases in household

credit, and the rise in public investment in social infrastructure – public investments grew, on average and in real terms, 27.6% per year between 2006 and 2010, according to Brazilian Institute of Geography and Statistics (IBGE) data (Carvalho; Rugitsky, 2015; Carvalho, 2018). Already in the first year of its administration, the government created the Fome Zero[1] program and in 2004-2005, a program that combined several actions aimed at reducing extreme poverty was implemented: the Bolsa Família Program (PBF)[2]. The program significantly increased its scope over the years: it benefited around 3.6 million families at its launching, but reached over 11 million families in 2006, according to its administrative records.

Besides direct income transfers, the minimum wage (MW) real value increased by 73% between 2002 and 2013, if deflated by the National Consumer Price Index (INPC). Minimum wage hikes were an essential channel for inequality reduction, not only because they reduced the difference between the minimum and the average wage, but also because some relevant government transfers are indexed by it, such as unemployment insurance and the Continuous Provision Benefit (BPC)[3]. Orair and Gobetti (2010) show that government transfers to households were responsible for almost 80% of the increase (of 2.5 pp of GDP) in the government's non-financial expenditures between 2002 and 2010, with 40% of that being due to minimum wage hikes.

The literature that studies income inequality in Brazil (Soares *et al*., 2007; Barros *et al*., 2007; Hoffmann; Oliveira, 2014; Medeiros, 2015; Komatsu; Filho, 2015; Maurizio; Vazquez, 2016), has shown that these programs (mainly PBF, BPC, and minimum wage hikes) were successful in reducing inequality, especially extreme poverty, although with different magnitudes depending on the methodology used. Hoffmann and Oliveira (2014) by decomposing the factors associated with the GINI index, show

1 *Fome Zero* was a program aiming to reduce hunger.

2 *Bolsa Família* is a federal program for families living in poverty and extreme poverty, with per capita income of up to R$154 per month. It associates the transfer of financial benefits with access to fundamental social rights – health, food, education, and social assistance. It combined the Income Program Education ("Bolsa Escola Federal"), the National Access to Food ("Cartão Alimentação"), the National Minimum Health Income Program ("Bolsa Alimentação"), and the Gas Assistance Program. In 2005, the PBF also incorporated the Child Labor Eradication Program (PETI). Through *Bolsa Família*, the federal government grants monthly cash benefits to needy families (bolsafamilia.datasus.gov.br).

3 BPC, or Continuous Provision Benefit is the benefit that pays a minimum wage per month to seniors over 65 or people who have a disability. It is a welfare benefit provided in the Law of Social Assistance.

that between 2002 and 2012 "44% of the decrease in the GINI index is associated with changes in earnings of the private sector employees and 18% is due to changes in the interest, shares and government transfers component". The share of the lower official pensions (pensions near or below MW) in per capita household income also increased from 4.11% in 2001 to 6.58% in 2012 and can be explained mainly due to rising minimum wage. Loureiro (2018), by decomposing the shares of different sources of income, concludes that CCTs were more relevant for reducing extreme poverty, that is, at the very bottom of the distribution. Simultaneously, greater employment formalization benefited the first quartile and rising minimum wage and pensions the second (and, to some extent, the third). Komatsu and Filho (2015) and Maurizio and Vazquez (2016) highlight the role of the real minimum wage increase in reducing wage inequality, especially at the lower tail of wage distribution in Brazil.

Medeiros (2015) analyzes the two Household Budget Surveys (POF) available for 2002-03 and 2008-09 and shows that total average income increased 20.4% and, for the 50% poorer families, it increased by 30%. He found that the share of families with income up to two minimum wages total consumption went from 4.8% to 6.5%, and those with incomes between two and five minimum wages went from 17.9% to 28.7% of total consumption.

As shown by Carvalho *et al*. (2016), expenditures by lower-income ranges rose[4] significantly – expenditures as a share of total income[5] increased from 0,68% to 1,32% for the first income range and from 0,86% to 1,05% for the second one. Interestingly, the number of families in this same ranges decreased while their participation in total consumption rose. As argued by the authors, this can be explained by the expansion of credit to households in the period, playing an important role in consumption growth. The increase in household credit between 2003 and 2009 is a result of the income gains in the lower classes, which causes relatively poorer households to enter the credit market, of the reduction of interest

4 The six income ranges are measured by *Reais* of 2003, in which a) less then R$400,00; b) between R$400,00 and R$600,00; c) between R$600,00 and R%1.000,00; d) between R$1.000,00 and R$1.600,00; e) between R$1.600,00 and R$3.000,00 and f) more than R$3.000,00.

5 Total income includes monetary income added to non-monetary, which includes all consumption realized in a non-monetary way, with the production for self-consumption representing the greater part of the latter.

rates and the creation, in 2004, of a loan system called *crédito consignado*[6] (Carvalho and Rugitsky, 2015). Despite the importance of this mechanism in expanding demand, I will not explore its role and consequences specifically, as it would incorporate one more dimension in the analyses, making it too complex. It is left, then, for further research.

The expansion of consumption, if accompanied by changes in consumption patterns, together with technical progress, constitutes a fundamental vector of the process of structural change that characterizes economic development (Medeiros, 2015). As lower-income individuals have a higher propensity to consume out of income, increasing their income increases consumption, but not in a homogeneous way. "Income distribution, in addition to its impact on effective demand, may have an impact on demand composition, if the consumption baskets of households from different income groups differ significantly" (Rugitsky, 2017). That can be theoretically understood with Engel's law. As an individual income rises, it increases the share of services and manufactured goods consumed, given that these goods have, characteristically, high income-elasticity. Carvalho *et al*. (2016) look at the participation of specific products in total consumption, based on Household Budget Research (POF). The following process becomes evident: for classes earning under two minimum wages, between 2003 and 2008, the participation in total consumption of fresh and industrialized food declined from 14.25 and 18.52 to 10.61 and 13.31, respectively, while electronic and communication equipment and other services[7] increased from 1.45 and 1.12 to 3.04 and 1.39, respectively. Additionally, according to data from the Central Bank of Brazil, the share of services consumed by households increased substantially at the bottom of the income distribution, reducing its significance as the income scale rises (Carvalho and Rugitsky, 2015).

This change in demand composition impacts prices and production. However, it had a particular effect on the composition of the Brazilian employment structure since part of the new products consumed by the families, or part of their production process. was fulfilled by imports, given the over-

6 *Credito consignado* is a loan with automatic repayment in installments deducted directly from the payroll check or benefit account of the individual. This system provides the bank with greater security regarding the individual payments and, therefore, allows it to charge lower rates.

7 Other services include maintenance and repair services, associated services and services provided for companies.

valuation of the Real and the Brazilian productive structure. The nominal exchange rate started at 2.89 R$/US$ in 2003, achieving its lowest value (in the period analyzed) of 1,67 R$/US$ in 2010. As argued by Loureiro (2018):

> *Import penetration, defined as imports divided by total domestic supply, increased from 6.6 to 7.5% for the whole economy between 2003 and 2013.[...] The macroeconomically most relevant rises of import penetration were in three products, which jointly accounted for about 13% of imports in 2013. These products were electronic machinery and telecommunications equipment, whose import penetration increased from 33.6% in 2003 to 44.5% in 2013, inorganic chemicals (from 23.9 to 32.8%), and automobiles (from 7.6 to 17.8%) (Loureiro, 2018, p. 99).*

Santos *et al*. (2015) analyze the relative income and exchange rate elasticity of goods and services imported by Brazil, and conclude that, given the Brazilian productive structure, the evolution of imports in the last decade was benefited by the increase in household income (Loureiro, 2018). The authors show that although final consumption goods, durable and non-durable, like vehicles, electronic products, furniture, pharmaceutical products, clothing, and industrialized food, have a high income and exchange rate elasticity, they represented less than 10% of total imports on average between 2000 and 2013, according to data from the Foundation for the Study of Foreign Trade (Funcex). Intermediate goods imports, the most relevant group in Brazilian imports, represented on average 18% of total imports between 2000 and 2013. On the other hand, capital goods are mainly stimulated by internal demand since their income elasticity is high. To provide some of the products demanded by households, producers needed to resort to imports.

The goods whose internal production grew relatively more were the non-tradable ones, such as services, construction, transports, and recreation activities. These sectors had their capacity expanded, boosting employment demand and affecting employment composition. The rise in demand, coupled with the greater formalization of employment and the minimum wage hikes, made the average wage in those sectors grow faster than those who had their relative participation in employment reduced.

Medeiros (2015) argues that

> *Economically, [...] the main movement [for the increase in the formalization of employment] was the increase in demand, due to a rise in domestic consumption and changes in consumption patterns associated with both income growth and credit diffusion. Consumption was displaced for goods and services regularly offered in cities' markets, leading to an increase in employment in larger establishments (Medeiros, 2015, p. 88).*

According to him, based on IBGE data, formal employment grew 63.3% between 2001 and 2011 and, for domestic services, formal contracts grew 32.8% against a 6% increase of informal contracts. The author also shows that the increase in formal employment occurred mainly in the services and construction sectors.

The difference in the growth rate of minimum and the average wage was also crucial for reducing wage inequality. It ensured an increase in income at the base of the distribution, given that these sectors are characteristically labor intensive, that is, the jobs created are mainly filled by more lower income and low-skilled workers. Rugitsky (2017) resumes this mechanism by arguing that increasing the income of the most disadvantaged populations, as a consequence of the extension of state pensions, the PBF program, and minimum wage hikes, along with the formalization of the labor market, impacts the economy in a way to create a positive feedback mechanism in which income distribution, changes in consumption patterns and changes in the composition of the productive (or employment) structure are circularly reinforcing each other.

3 **Employment, consumption, wages and productivity**

To better understand how the sectoral composition of employment and wage inequality are related, I first present a careful analysis of the sectoral data for consumption, employment, productivity, and wages. By doing so, I select the sectors whose dynamics is better described by the circular mutual causation briefly described previously.

I use the Household Budget Surveys (POF) of 2002-03 and 2008-09 for consumption data and the National Account System (SCN) for employment, aggregate value[8], wages, and imports. To ensure compatibility with the two POF's available, I used the National Account System (SCN) from 2003 to 2008.

The sector's selection was made in 3 steps. The first step was to eliminate the sectors from the SCN classification[9] in which families do not con-

8 I will use aggregate value when calculating a proxy for productivity: the ratio between Value-added and Employment.

9 I used the 55 groups of SCN. The translation from SCN to the POF classification can be found in Appendix A and was done with the aid of the dictionary available at the

sume directly, such as metallurgy of non-ferrous metals, iron ore, public administration, and social security. I am aware of the possible problems that this first exclusion can generate since it ignores the possible relations that specific intermediate sectors can have with the final products directly consumed by families. However, given the data availability, I was not able to incorporate such intermediate channels in the analyses, leaving them for further research. The second step to select the sectors was based on import coefficients, calculated by the ratio between total imports and total supply. Sectors with coefficients above the average were excluded, such as chemicals, office machines and equipment, and electronic material. Appendix A shows the excluded sectors in these two first steps.

Subsequently, I analyzed the remaining sectors according to the consumption by families earning up to three minimum wages, employment growth, the average wage of the sector, and its productivity[10]. The cut-off point of 3 minimum wages was chosen based on the number of families that suffered a more significant impact from the income distribution process, representing a significant part of domestic demand. Medeiros (2015) uses POF data and shows that the number of families earning less than three minimum wages grew from 30.38% to 39.05% of total families, and the participation of the ones between 3 to 5 minimum wages went from 20.9% to 29.36%. Besides, families whose income is below three minimum wages were responsible for 10.6% of total consumption in 2002/03, which grew to 14.3% in 2008/09. Medeiros (2015) also argues that the period's major transformation was the increase in real income of the 25% most impoverished families (below two minimum wages).

The sectors selected had to meet four requirements: positive consumption growth, positive employment growth, wages below the average, and productivity below the average. Table 1 summarizes the selection process, and Table 2 shows the results, *i.e.*, the selected sectors.

Those sectors corresponded to 30.3% of employment, on average, between 2004 and 2015, and 13.7% of GDP, on average, during the same period, according to data from the National Accounts System (IBGE).

IBGE website.

10 For productivity, I used the ratio between value-added and employment in 2003 as our base, since I was interested in those sectors with low productivity at the beginning of the cycle. I also considered the average wage at the beginning of the period.

Table 1 **Process of selecting the sectors**

1) Translate the POF to the SCN and exclude the intermediate sectors that are not directly consumed by families (Appendix A)
2) Eliminate products with import coefficient above average (Appendix A)
3) Select the remaining sectors based on the four criteria: 3.1) Positive consumption growth of families receiving up to 3 MW 3.2) Positive employment growth 3.3) Productivity in 2003 – measured by VA / employment – below average 3.4) Average wage in 2003 below the average

Source: Author's own elaboration.

To analyze the cumulative mechanism of interest, two indices for changes in the employment composition and wage inequality were elaborated, based on the General Register of Workers and Unemployed (CAGED) data.

Table 2 **Selected Sectors**

Clothing, footwear and textiles
Construction
Furniture and products of various industries
Maintenance and repair services
Services provided to families and associations
Domestic services
Accommodation and Food Services

Source: Author's own elaboration.

The data has a monthly frequency, between January 2004 and March 2019, resulting in 183 observations. The series were seasonally adjusted by the X-12-ARIMA method. Before discussing the indicators, I should add a note on informal jobs since CAGED refers only to formal employees' data. The circular and cumulative causation mechanism described previously, which I intend to empirically evaluate in this paper, stresses the effect of increasing employment in lower-wage sectors, which employs lower-skilled workers, to reduce inequality. These sectors are, in turn, those with the highest levels of informality in Brazil. Despite the increase in the formalization of work – between 2003 and 2011, formal employment in Brazil rose from 51.6% to 61.6% – informality is still a problem in the Brazilian labor market. Maurizio (2014) shows that the probability of formalization of labor is more significant in the public sector and large companies

while commerce, construction, and domestic services represent the lowest incidence of formalization. However, not taking into account these informal workers create an underestimated analysis of this process: the effect of circular and cumulative causation could be even greater if the informal jobs created are also considered.

Hence, the first indicator represents changes in the composition of employment over the months, in which I use the difference between the monthly balance of hired and dismissed workers in the selected sectors, subtracted from this same balance in the remaining sectors of the economy. The equation (1), below, presents the indicator, where $\Delta i = Admitted_i - Dismissed_i$, with $i = selected\_sectors, other\_sectors$.

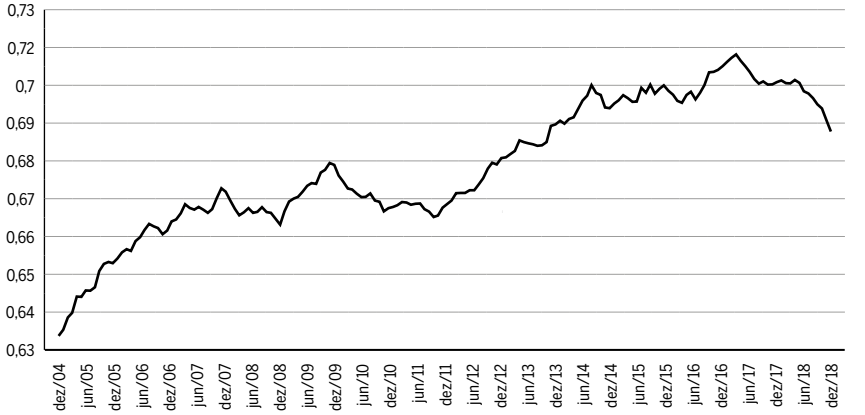
$$comp\_employment = \Delta selected\ sectors - \Delta remaining\ sectors \quad (1)$$

The second indicator measures the changes in the wage inequality in the two groups of sectors (the "selected" and the "remaining") for each month – it consists of the logarithm of the ratio between the average admission wage of the selected sectors and the average admission wage of the remaining sectors. Thus, when this indicator increases, it means that workers being hired in these sectors are earning more relative to workers in other sectors. As workers in the selected sectors have a lower average wage, the increase in this indicator, combined with the increase in employment, means that wage inequality decreases.

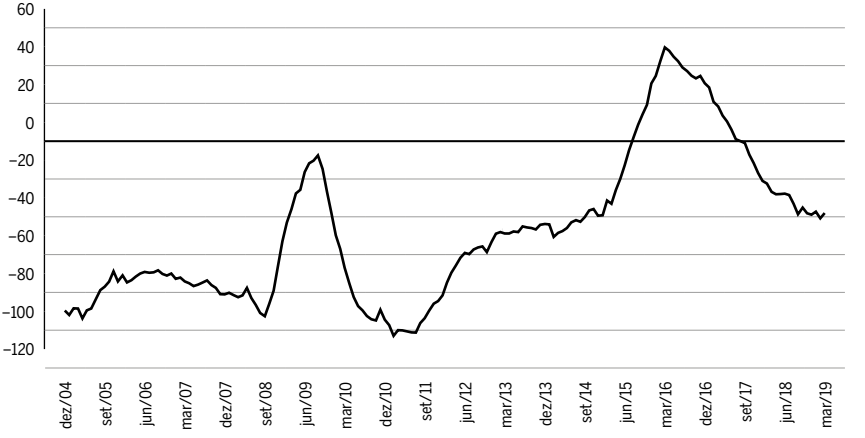
In Figure 1, the wage inequality indicator is upward sloped, meaning that the workers hired in the selected sectors were receiving a higher initial wage relative to the ones in the remaining sectors of the economy. This trend may reflect the effect of an increase in the labor demand in these sectors, coupled with a lower unemployment rate, allowing workers to demand higher wages at the time of admission. In other words, it could illustrate the gain in bargaining power for the workers in the selected sectors. Additionally, the minimum wage hikes also help explain this upward slope found in the data. The sectors selected, have a higher impact on the average wage, since these sectors characteristically pay lower wages. At the end of the graph, the apparent slope reversion may signal the effects that the crisis of 2014 to 2016 still exerts on Brazil, as unemployment and informality in the labor market began to increase again.

Figure 1 **Evolution of the wage inequality series between admissions and changes in the composition of employment from the selected sectors in Brazil, from 2004 to 2019 – 12-month moving average**

a **Ratio of the average wage of the admitted workers in the selected sectors over the average wage of the admitted workers in the remaining sectors (12-month moving average)**



b **Difference in the net hiring between the selected sectors and the remaining sectors (12month moving average)**



Source: CAGED.

The second subfigure, of the 12-month moving average of employment composition index, also shows a general growth trend, but with two cy-

cles over these years. The first is associated with the 2008 crisis when the calculated indicator shows the first most significant peak – average from August 2008 to August 2009 – indicating a more than proportional decrease in the hiring of other sectors, including the manufacturing industry and agricultural production. Between November 2008 and April 2009, the hiring balance was negative for all sectors of the economy (the selected and the remaining ones), but it was much larger for the other sectors – the selected sectors had an average balance of approximately 7,400 layoffs, while the other sectors' economy had a negative balance of approximately 34,550 in the same period. From May 2009 on, however, the economy already started recovering, and the balance of hiring in other sectors surpasses that of the selected sectors, bringing the indicator close to its pre-crisis value. However, this difference in the hiring balance gets closer to zero and crosses the X-axis in April 2015, amid the most recent economic crisis. The reasons for this accelerated growth of the indicator built here are similar to those observed in the 2008 crisis: the non-selected sectors laid off more than the selected ones. From the second peak, in April 2016, the drop in the indicator reflects the effects of the crisis on the selected sectors, which were more impacted by it, proportionally to the others. From April 2016 to March 2019, the average monthly employment balance in construction, food and housing services, domestic services, maintenance and repair services, services provided to family and associations, clothing, footwear and textiles, and furniture sectors was approximately minus 15,300, *i.e.*, 15,300 layoffs more than hiring on average, compared to a positive balance of approximately 100 on average per month in the other sectors.

Although both series have a general rising tendency, attributing any causality from a descriptive analysis seems to be hasty. They will be better explored econometrically in the next section, where I will use these same indices in a time series model, from which I can draw more specific conclusions about the relationship between these variables in the referred period.

4 **The relationship between variations in the composition of employment and wage inequality: a VEC estimation**

I performed unit root tests in the series of the employment composition and wage inequality, both in level and in first difference, and concluded

that both series are integrated in first order, that is, I(1). The results are based on the Augmented Dickey-Fuller (ADF) tests, with the Akaike criteria for choosing the lags, Phillips-Perron (PP) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS)[11].

By confirming that both variables are integrated in first order, I conducted the Jonhanson cointegration test, and found that the variables are cointegrated (see Appendix B.2). Therefore, I estimated a Vector Error Correction estimation, whose results can be found in the next subsection.

4.1 **Results**

The results of the estimated coefficients are reported in Table 3, while the impulse-response function is shown in Figure 2. Cholesky's ordination followed the economic theory: wage inequality is more exogenous than changes in the employment composition[12]. Residuals tests are reported in Appendix B.

The results of the coefficients and their respective significance levels are reported in Table 3. The coefficient related to the cointegration equation is negative and significant at a 1% level for the wage inequality equation, as desired in this type of model, but positive and not significant for the employment composition equation. Within the cointegration equation, the employment composition coefficient was significant at 1% and had a negative sign. This negative sign is consistent with the hypothesis stated here since it symbolizes the positive relation between reducing wage inequality and the change in the employment composition. To better understand this result, it is important to recall the error correction equation, particularly: $e_t = Y_t - \alpha_0 - \alpha_1 X_t$, where et is the error term, αi are parameters and Y_t and X_t are the time series. Note that there is a negative sign in front of the coefficient of X_t, which in our case represents the employment composi-

11 Since some of the tests were conflicting, I also analyzed the test for the variables in first difference and looked at their autocorrelation function. All these tests can be found in Appendix B.

12 In the Kaleckian framework, the income distribution is usually considered exogenous. As mentioned earlier in this paper, Brenck and Carvalho (2020) represents in a formal model this causality assumed here: changes in the income distribution affect changes in the output composition – which can, again, affect the income distribution, if the last is considered endogenous, as is the case in this paper and the second part of Brenck and Carvalho (2020)'s paper. However, I also estimated the inverted Cholesky order for robustness test, and the results did not significantly change.

tion, while the Y_t represents the wage inequality. That is, for them to be positively related, the coefficient must be negative.

Table 3 **VEC Estimation output**

Cointegrating Eq	**CointEq**
wage inequality$_{-1}$	1
employment composition$_{-1}$	−3.60E−07 *** (−3.98246)
@trend	−0.000267*** (−3.54661)
C	0.388291

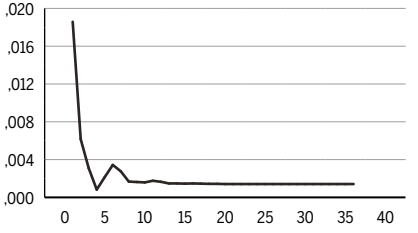
Error Correction	***D(wage inequality)***	***D(employment composition)***
CointEq	−0.457824*** (−4.78164)	212411.8 (1.41211)
D(wage inequality)$_{-1}$	−0.210201** (−2.19261)	−117447.7 (−0.77980)
D(wage inequality)$_{-2}$	−0.158272* (−1.75966)	−34043.31 (−0.24092)
D(wage inequality)$_{-3}$	−0.196534** (−2.40174)	−86072.91 (−0.66952)
D(wage inequality)$_{-4}$	−0.09909 (−1.38828)	74813.17 (0.66717)
D(employment composition)$_{-1}$	−1.17E−07** (−2.17286)	−0.439087*** (−5.19899)
D(employment composition)$_{-2}$	−7.15E−08 (−1.24902)	−0.103774 (−1.15320)
D(employment composition)$_{-3}$	−1.31E−07** (−2.32055)	−0.072872 (−0.82475)
D(employment composition)$_{-3}$	−1.31E−07** (−2.32055)	−0.072872 (−0.82475)
D(employment composition)$_{-4}$	−1.42E−08 (−0.28336)	−0.121191 (−1.54235)
C	0.000746 (0.53213)	830.1007 (0.37675)
R^2	0.357177	0.242517
Adj. R^2	0.32274	0.201938
F-statistic	10.37192	5.97635

** for 10% of significance; ** for 5% of significance; *** for 1% of significance t-statistics in ( ).*

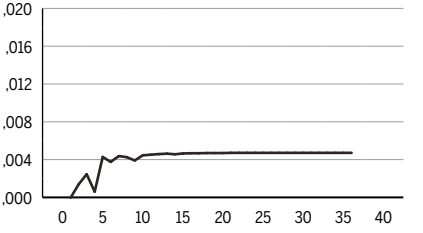
Figure 2 **VEC Impulse Response Function**

Response to Cholesky One S.D (d.f. adjusted Innovations)

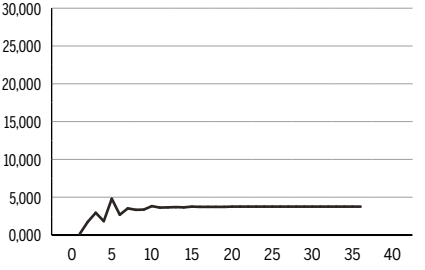
Response of wage inquality to wage inequality



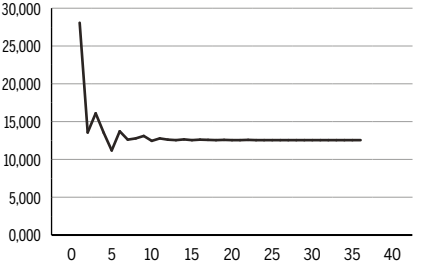
Response of wage inequality to employment composition



Response of employment composition to wage inequality



Response of employment composition to employment composition



Source: Author's own elaboration.

As for the short-term effects, one can perceive that the wage inequality equation has more exciting results. The employment composition seems to respond only to it's lagged value. Hence, wage inequality seems to respond more in the short run to changes in the employment composition and changes in the wage inequality itself.

In the impulse response function (Figure 2), the mutual and positive relationship between the variables studied here is clear. A more than proportional increase in the average wage of workers from the selected sectors (a shock in the wage inequality variable) is accompanied by a permanent increase in the economy's employment composition. In other words, when wage income is redistributed towards the selected sectors, an increase in hiring in those sectors, relatively to the others, follows. If this continues for a long period – which seems to be the case here –

we see that employment composition is also shifting towards low-wage (and low-productive) sectors. This is a significant result to illustrate the effect of reducing the wage inequality in the increase of employment level in less qualified sectors. The increase in employment in the low-productivity and labor-intensive sectors, as a response to the increase in wages from lower-skilled sectors, can symbolize precisely the effect of the increased demand for these sectors due to income growth.

The impact in the other direction, of changes in the employment composition in the wage inequality, also follows the expected path: a permanent increase in the hired workers' initial wage in the selected sectors. In other words, a shock in the employment composition reduces the wage inequality – increasing the index created. This second effect may symbolize the bargaining power gain that a greater demand for the labor force in the selected sectors generates since these sectors' labor market would be more active.

Even though most of the short-run coefficients were not significant at a 5% level, the impulse-response functions confirm the hypothesis that changes in the composition of employment and changes in wage inequality are mutually and positively correlated in a way to reinforce each other.

5 **Concluding remarks**

This paper aimed to econometrically verify the relationship between the reduction in (wage) inequality and changes in the productive (or employment) composition for Brazil in the 2000s. It was inspired by the hypothesis that thosevariables were circularly related, reinforcing each other. This hypothesis, formalized by Rugitsky (2017) and modeled in a Kaleckian framework by Brenck and Carvalho (2020), evidences the need to incorporate sectoral heterogeneity and wage inequalities into the analyses so that their relationship can be better understood.

Firstly, a careful selection of the more affected sectors by the circular and cumulative causation mechanism was made. I selected those sectors where import penetration is low, the consumption of low-income families increased, employment increased, and the employment composition and wage inequality measures were built. By estimating a VEC model with the employment composition and wage inequality measures created, the

positive relationship between those variables can be analyzed. The reactions in the impulse-response functions are positive in both directions of the shocks. Thus, the hypothesis of Rugitsky (2017) seems to be confirmed. However, further analysis with different measures of employment composition and wage inequality should be carried out to guarantee the robustness of this result.

It is also important to note that many relevant channels that can explain the Brazilian trajectory were disregarded, such as firms' financial dynamics, price dynamics, global economic changes, political considerations, and so forth. Incorporating some of these variables would make the analysis more precise and provide insights into some of the economy's limitations. These could be either inherent difficulties to this distribution and the productive composition change or, in some cases, result from exogenous shocks (*e.g.*, political and international changes). After the fast recovery from the 2008 economic crisis, the recent Brazilian economic crisis provides additional challenges to analyzing these mechanisms.

Still, the recent Brazilian trajectory serves as a lesson, indicating that the path to income distribution and growth is not trivial and faces inherent difficulties beyond political disputes. Incorporating heterogeneities and other inequality dimensions in the analyses can help understand and overcome these challenges by imagining sustainable alternatives for achieving equal income distribution and growth.

References

BARROS, R. P. de; CARVALHO, M. de; FRANCO, S.; MENDONÇA, R. *A queda recente da desigualdade de renda no Brasil*. Instituto de Pesquisa Econômica Aplicada, 2007.

BRENCK, C.; CARVALHO, L. The equalizing spiral in early 21st century brazil: a kaleckian model with sectoral heterogeneity. *Structural Change and Economic Dynamics*, Elsevier, v. 55, p. 298–310, 2020.

CARVALHO, L. *Valsa brasileira: do boom ao caos econômico*. [S.l.]: Editora Todavia SA, 2018.

CARVALHO, L.; RUGITSKY, F. *Growth and distribution in Brazil the 21st century: revisiting the wage-led versus profit-led debate*. [S.l.], 2015. Disponível em: <https://EconPapers.repec.org/RePEc: spa:wpaper:2015wpecon25>.

CARVALHO, S. S.; SANTOS, C. H.; ALMEIDA, V. A.; JOEL, Y. K. Z.; PAIVA, K. C.; CALDAS, L. F. *O Consumo das Famílias no Brasil entre 2000 e 2013: uma análise estrutural a partir de dados do Sistema de Contas Nacionais e da Pesquisa de Orçamentos Familiares*. Texto para Discussão, nº 2209, Instituto de Pesquisa Econômica Aplicada, 2016.

GIOVANNETTI, L. F. L. *Inflação de serviços no Brasil: pressão de demanda ou de custos?* Dissertação (Mestrado) — Mestrado Profissional – Fundação Getúlio Vargas, SP, 2013.

HOFFMANN, R.; OLIVEIRA, R. The evolution of income distribution in brazil in the agricultural and the non-agricultural sectors. *World Journal of Agricultural Research*, v. 2, n. 5, p. 192–204, 2014.

KOMATSU, B. K.; MENEZES FILHO, N A. *Salário mínimo e desigualdade salarial: um estudo com densidades contrafactuais nas regiões metropolitanas brasileiras*. Instituto de Pesquisa Econômica Aplicada, 2015.

LOUREIRO, P. *The Ebb and Flow of the Pink Tide: reformist development strategies in Brazil and Argentina*. Tese (Doutorado) — Department of Economics, SOAS, University of London, 2018.

MAURIZIO, R. *Labour formalization and declining inequality in argentina and brazil in 2000s: a dynamic approach*. ILO Research Paper, n. 9, 2014.

MAURIZIO, R.; VAZQUEZ, G. Distribution effects of the minimum wage in four latin american countries: Argentina, brazil, chile and uruguay. *International Labour Review*, Wiley Online Library, v. 155, n. 1, p. 97–131, 2016.

MEDEIROS, C. A. *Inserção externa, crescimento e padrões de consumo na economia brasileira*. Instituto de Pesquisa Econômica Aplicada (Ipea), 2015.

ORAIR, R. O.; GOBETTI, S. W. *Governo gastador ou transferidor? um macrodiagnóstico das despesas federais no período de 2002 a 2010*. Instituto de Pesquisa Econômica Aplicada (Ipea), 2010.

PIKETTY, T. *Capital in the twenty-first century*. Harvard University Press, 2014.

RUGITSKY, F. , 2017. "*The rise and fall of the Brazilian economy (2004-2015)*: the economic antimiracle". Working Paper 27, Department of Economics, University of São Paulo (FEA-USP). 2017.

SANTOS, C. H. M.; CIEPLINSKI, A. G.; PIMENTEL, D.; BHERING, G. *Por que a elasticidade-câmbio das importações é baixa no brasil? evidências a partir das desagregações das importações por categorias de uso*. Instituto de Pesquisa Econômica Aplicada (Ipea), 2015.

SOARES, S.; OSÓRIO, R. G.; SOARES, F. V.; MEDEIROS, M.; ZEPEDA, E. *Programas de tranferência condicionada de renda no brasil, chile e méxico: impactos sobre a desigualdade*. Instituto de Pesquisa Econômica Aplicada (Ipea), 2007.

TAVARES, M. C.; SERRA, J. *Além da estagnação. Da substituição de importações ao capitalismo financeiro*. Zahar: Rio de Janeiro, p. 153–207, 1972.

WELLS, J. Distribution of earnings, growth and the structure of demand in brazil during the 1960's. *World Development*, Elsevier, v. 2, n. 1, p. 9–24, 1974.

About the author

Clara Zanon Brenck – clara.brenck@newschool.edu
The New School for Social Research, New York, NY, United States.
ORCID: https://orcid.org/0000-0002-0110-8668.

The author thanks the National Council for Scientific and Technological Development (CNPq) of Brazil for her Master's scholarship. The author is also grateful for her Master's advisor Laura Carvalho, for the discussions, help and incentives

regarding this work, and for Gilberto Tadeu Lima, Fernando Rugitsky, Lucas Freddo, Matias Rebello Cardomingo and two anonymous referees for their helpful comments on this article. All remaining errors are the author's responsibility.

About the article

Submission received on April 05, 2020. Approved for publication on January 17, 2021.

APPENDIX A

A1 **Data Treatment and Sector Selection**

To make the translation between the classification of Household Budget Surveys (POF) and National Account System (SCN), we benefited from the dictionary for the POF microdata, available from the IBGE website. Because the description of the POF data has a very different aggregation than that of the production data, we have chosen to join some of the sectors of the SCN into larger groups, which helped us to better fit the consumption categories into them. This can be found in Table A1.

Table A1 **Joined sectors**

Agriculture, livestock and fisheries food and beverages	**Food**
Services provided to families and associations Domestic services	Other services
Pulp and paper products	CD, newspapers, magazines and other paper products
Newspapers, magazines cds	
Textiles Clothing and accessories Leather artifacts and shoes	Clothing, footwear and textiles
Wood products – Excluding furniture	Wood, rubber and plastic products – Excluding furniture
Rubber & plastics	

POF	**SCN**
1 Total expenditures	
2 Current expenditures	
2.1 Consumption expenditures	
2.1.1 Food	Agriculture Livestock and fisheries Food and beverages
2.1.2 Housing	
2.1.2.1 Rents	Construction
2.1.2.2 Services and taxes	Accommodation and food services

(continues on the next page)

Table A1 **(continuation)**

POF		SCN
2.1.2.2.1 Electric energy		Electricity generation and distribution of gas and water and urban cleaning
2.1.2.2.2 Telephone		Information services
2.1.2.2.3 Cell phone		Office machines and electronic equipment
2.1.2.2.4 Gas		Electricity generation and distribution of gas and water and urban cleaning
2.1.2.2.5 Water and sewage		Electricity generation and distribution of gas and water and urban cleaning
2.1.2.2.6 Other		Accommodation and food services
2.1.2.3 House maintenance		Accommodation and food services
2.1.2.4 Cleaning products		Perfumes and personal hygiene
2.1.2.5 Furniture and home objects		Furniture and products of various industries
2.1.2.6 Home electric appliances		Electrical equipment
2.1.2.7 Repair of home objects		Maintenance and repair services
2.1.3 Clothing		
2.1.3.1 Men clothes		Clothing, footwear and textiles
2.1.3.2 Woman clothes		Clothing, footwear and textiles
2.1.3.3 Child clothes		Clothing, footwear and textiles
2.1.3.4 Shoes		Clothing, footwear and textiles
2.1.3.5 Jewelery and costume jewelery		Clothing, footwear and textiles
2.1.3.6 Textiles		Textiles
2.1.4 Transportation		
2.1.4.1 Urban transportation		Transportation, warehousing and mail
2.1.4.2 Gasoline – Own vehicle		Oil refining and coke
2.1.4.3 Alcohol – Own vehicle		Alcohol
2.1.4.4 Maintenance – Own vehicle		Maintenance and repair services
2.1.4.5 Vehicle acquisition		Automobiles, trucks and buses
2.1.4.6 Travel		Accommodation and food services
2.1.4.7 Other		Transportation, warehousing and mail
2.1.5 Hygiene and personal care		
2.1.5.1 Perfume		Perfumes and personal hygiene
2.1.5.2 Hair products	29	Perfumes and personal hygiene
2.1.5.3 Soap		Perfumes and personal hygiene
2.1.5.4 Tools and products for personal use		Perfumes and personal hygiene

(continues on the next page)

Table A1 **(continuation)**

POF	SCN
2.1.6 Health assistance	
2.1.6.1 Medicine	Pharmaceutical products
2.1.6.2 Health insurance	Financial intermediate insurance and supplementary pension and related services
2.1.6.4 Medical appointments	Health
2.1.6.5 Outpatient treatment	Health
2.1.6.6 Surgery services	Health
2.1.6.7 Hospitalization	Health
2.1.6.8 Examinations	Health
2.1.6.9 Treatment equipment	Health
2.1.6.10 Others	Health
2.1.7 Education	
2.1.7.1 Regular courses	Education
2.1.7.2 Graduation and post graduate courses	Education
2.1.7.3 Other courses	Education
2.1.7.4 Books and academic journals	Pulp and paper products
2.1.7.5 Schools papers	Pulp and paper products
2.1.7.6 Others	Education
2.1.8. Recreation and culture	
2.1.8.1 Games and toys	Wood, rubber and plastic products excluding furniture
2.1.8.2 Cell phone and accessories	Office machines and electronic equipment
2.1.8.3 Books, journals and magazines	Newspapers magazines and CDs
2.1.8.4 Recreation and sports	Services provided to families and associations
2.1.8.5 Others	Services provided to families and associations
2.1.9 Smoking products	Smoking products
2.1.10 Personal services	
2.1.10.1 Hair stylist	Services provided to families and associations
2.1.10.2 Manicure and pedicure	Services provided to families and associations
2.1.10.3 Repair of personal items	Services provided to families and associations
2.1.10.4 Others	Services provided to families and associations
2.1.11 Miscellaneous expenditures	
2.1.11.1 Games and betting	Services provided to families and associations
2.1.11.2 Communication	Information services

(continues on the next page)

Table A1 **(continuation)**

POF	SCN
2.1.11.3 Parties and ceremonies	Services provided to families and associations
2.1.11.4 Professional services	Services provided to families and associations
2.1.11.5 Properties for occasional use	Accommodation and food services
2.1.11.6 Others	Services provided to families and associations
2.2 Others current expenditures	
2.2.1 Taxes	
2.2.2 Labor contributions	Financial intermediate insurance and supplementary pension and related services
2.2.3 Baking services	Financial intermediate insurance and supplementary pension and related services
2.2.4 Pensions, allowances and donations	Financial intermediate insurance and supplementary pension and related services
2.2.5 Private pension	Financial intermediate insurance and supplementary pension and related services
2.2.6 Others	
2.3 Assets increase	
2.3.1 Real estate (acquisition)	Construction
2.3.2 Real estate (renovation)	Maintenance and repair services
2.3.3 Other investments	
2.4 Decrease in liabilities	
2.4.1 Loan and monthly payments	Financial intermediate insurance and supplementary pension and related services
2.4.2 Property rent	

Table A2 **Excluded sectors**

Oil and natural gas	Imports
Chemicals	Imports
Miscellaneous chemical products and preparations	Imports
Pesticides	Imports
Office machines and electronic equipment	Imports
Oil refining and coke	Imports
Manufacture of resins and elastomers	Imports
Commerce	Not directly consumed
Other mining and extractive products	Not directly consumed
Iron ore	Not directly consumed

(continues on the next page)

Table A2 **(continuation)**

Oil and natural gas	**Imports**
Manufacture of steel and steel products	Not directly consumed
Metallurgy of nonferrous metals	Not directly consumed
Cement and other non-metallic mineral products	Not directly consumed
Public administration and social security	Not directly consumed
Business services	Not directly consumed
Paints, varnishes and enamels	Not directly consumed
Parts and accessories for motor vehicles	Not directly consumed
Other transportation equipment	Not directly consumed
Metal products – Exclusive machinery and equipment	Not directly consumed
Machinery and equipment including maintenance and repairs	Not directly consumed

APPENDIX B

B **Econometric tests**

B.1 **Unit root tests**

In order to confirm that both employment composition and wage inequality indexes are integrated in the first order, we analyzed the autocorrelation function for the variables in level and in first difference, in addition to the unit root tests. With these visualizations, the unit root in both variables is clear.

Figure B1 **Correlogram for wage inequality variable in level**

Date: 07/19/21 Time: 16:02
Sample: 2004M01 2019M03
Included observations: 183

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob.
		1	0.777	0.777	112.39	0.000
		2	0.704	0.252	205.08	0.000
		3	0.657	0.140	286.32	0.000
		4	0.644	0.155	364.78	0.000
		5	0.641	0.138	442.90	0.000
		6	0.618	0.054	515.93	0.000
		7	0.598	0.046	584.72	0.000
		8	0.596	0.084	653.41	0.000
		9	0.575	0.013	717.71	0.000
		10	0.531	−0.063	772.97	0.000
		11	0.552	0.123	833.03	0.000
		12	0.497	−0.111	881.84	0.000
		13	0.503	0.057	932.14	0.000
		14	0.494	0.030	981.00	0.000
		15	0.507	0.084	1032.8	0.000
		16	0.516	0.060	1086.8	0.000
		17	0.462	−0.108	1130.3	0.000
		18	0.438	−0.013	1169.7	0.000
		19	0.403	−0.082	1203.1	0.000

(continues on the next page)

Figure B1 **(continuation)**

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob.
		20	0.405	0.025	1237.2	0.000
		21	0.384	−0.024	1268.0	0.000
		22	0.379	−0.010	1298.3	0.000
		23	0.351	−0.021	1324.3	0.000
		24	0.329	−0.063	1347.3	0.000
		25	0.327	0.058	1370.2	0.000
		26	0.318	0.008	1392.0	0.000
		27	0.310	−0.001	1412.9	0.000
		28	0.276	−0.031	1429.5	0.000
		29	0.300	0.085	1449.3	0.000
		30	0.281	−0.018	1466.8	0.000
		31	0.281	−0.016	1484.3	0.000
		32	0.287	0.085	1502.8	0.000
		33	0.304	0.081	1523.6	0.000
		34	0.263	−0.099	1539.4	0.000
		35	0.212	−0.107	1549.7	0.000
		36	0.163	−0.144	1555.8	0.000

Figure B2 **Correlogram for wage inequality in first differences**

Date: 07/19/21 Time: 16:03
Sample: 2004M01 2019M03
Included observations: 182

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob.
		1	−0.382	−0.382	26.998	0.000
		2	−0.032	−0.209	27.191	0.000
		3	−0.109	−0.250	29.431	0.000
		4	0.019	−0.186	29.502	0.000
		5	0.034	−0.108	29.714	0.000
		6	0.010	−0.074	29.734	0.000
		7	−0.048	−0.114	30.173	0.000
		8	0.022	−0.070	30.267	0.000
		9	0.080	0.058	31.505	0.000
		10	−0.146	−0.126	35.657	0.000
		11	0.189	0.124	42.688	0.000

(continues on the next page)

Figure B2 **(continuation)**

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob.
		12	−0.169	−0.053	48.347	0.000
		13	0.051	−0.034	48.865	0.000
		14	−0.062	−0.092	49.640	0.000
		15	0.045	−0.065	50.037	0.000
		16	0.113	0.104	52.615	0.000
		17	−0.055	0.032	53.224	0.000
		18	0.012	0.095	53.254	0.000
		19	−0.079	0.005	54.523	0.000
		20	0.096	0.085	56.447	0.000
		21	−0.060	0.063	57.193	0.000
		22	0.046	0.039	57.638	0.000
		23	−0.034	0.088	57.878	0.000
		24	−0.036	−0.055	58.160	0.000
		25	0.039	0.011	58.479	0.000
		26	−0.022	−0.037	58.587	0.000
		27	0.070	0.026	59.659	0.000
		28	−0.124	−0.080	62.987	0.000
		29	0.095	−0.001	64.976	0.000
		30	−0.046	0.023	65.444	0.000
		31	−0.110	−0.008	65.457	0.000
		32	−0.029	−0.095	65.641	0.000
		33	0.122	0.054	69.010	0.000
		34	−0.011	0.063	69.037	0.000
		35	0.028	0.150	69.217	0.000
		36	−0.147	−0.087	74.173	0.000

The unit root tests are reported in the table B1, where "no c,t" stands for no constant or deterministic trend, "c" means that we included a constant and "c,t" means that both constant and trend. It is worth remembering here the null hypothesis of the tests: for the ADF and PP, the null hypothesis is that the series has a unit root, while for the KPSS the null hypothesis is that the series is stationary.

Figure B3 **Correlogram for employment composition variable in level**

Date: 07/19/21 Time: 16:03
Sample: 2004M01 2019M03
Included observations: 183

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob.
		1	0.760	0.760	107.58	0.000
		2	0.733	0.367	208.14	0.000
		3	0.663	0.083	290.70	0.000
		4	0.598	−0.010	358.36	0.000
		5	0.581	0.098	422.58	0.000
		6	0.524	−0.008	475.08	0.000
		7	0.472	−0.055	517.92	0.000
		8	0.458	0.060	558.46	0.000
		9	0.423	0.028	593.29	0.000
		10	0.394	−0.017	623.60	0.000
		11	0.385	0.043	652.73	0.000
		12	0.356	0.012	677.84	0.000
		13	0.348	0.019	701.96	0.000
		14	0.318	−0.031	722.23	0.000
		15	0.296	−0.009	739.89	0.000
		16	0.296	0.048	757.62	0.000
		17	0.289	0.039	774.69	0.000
		18	0.262	−0.045	788.80	0.000
		19	0.248	−0.018	801.46	0.000
		20	0.190	−0.107	808.93	0.000
		21	0.210	0.080	818.11	0.000
		22	0.126	−0.165	821.45	0.000
		23	0.155	0.104	826.51	0.000
		24	0.117	−0.024	829.40	0.000
		25	0.147	0.131	834.02	0.000
		26	0.161	0.053	839.57	0.000
		27	0.129	−0.067	843.16	0.000
		28	0.164	0.085	849.01	0.000
		29	0.167	0.031	855.12	0.000
		30	0.182	0.035	862.45	0.000
		31	0.172	−0.051	869.02	0.000

(continues on the next page)

Figure B3 **(continuation)**

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob.
		32	0.169	0.007	875.46	0.000
		33	0.131	−0.092	879.33	0.000
		34	0.145	0.013	884.09	0.000
		35	0.149	0.082	889.19	0.000
		36	0.138	−0.017	893.56	0.000

Figure B4 **Correlogram for employment composition in first differences**

Date: 07/19/21 Time: 16:03
Sample: 2004M01 2019M03
Included observations: 182

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob.
		1	−0.434	−0.434	34.822	0.000
		2	0.083	−0.130	36.092	0.000
		3	−0.008	−0.029	36.103	0.000
		4	−0.109	−0.142	38.324	0.000
		5	0.079	−0.039	39.495	0.000
		6	−0.001	0.020	39.495	0.000
		7	−0.082	−0.091	40.789	0.000
		8	0.045	−0.056	41.176	0.000
		9	−0.018	−0.020	41.239	0.000
		10	−0.043	−0.076	41.592	0.000
		11	0.056	−0.022	42.207	0.000
		12	−0.054	−0.043	42.783	0.000
		13	0.052	0.010	43.324	0.000
		14	−0.017	−0.011	43.384	0.000
		15	−0.054	−0.076	43.967	0.000
		16	0.012	−0.071	43.995	0.000
		17	0.051	0.029	44.518	0.000
		18	−0.036	−0.007	44.788	0.000
		19	0.092	0.071	46.543	0.000
		20	−0.157	−0.105	51.646	0.000
		21	0.215	0.151	61.256	0.000
		22	−0.232	−0.130	72.477	0.000
		23	0.136	0.005	76.367	0.000

(continues on the next page)

Figure B4 **(continuation)**

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob.
		24	−0.152	−0.168	81.249	0.000
		25	0.040	−0.072	81.583	0.000
		26	0.095	0.048	83.517	0.000
		27	−0.151	−0.124	88.462	0.000
		28	0.068	−0.066	89.466	0.000
		29	−0.024	−0.064	89.593	0.000
		30	0.056	0.033	90.272	0.000
		31	−0.015	−0.031	90.321	0.000
		32	0.074	0.061	91.538	0.000
		33	−0.117	−0.045	94.590	0.000
		34	0.030	−0.101	94.795	0.000
		35	0.026	0.002	94.950	0.000
		36	−0.016	−0.006	95.008	0.000

Table B1 **Unit root test**

Variable	P-value						T-statistics	
	ADF			PP			KPSS	
	no c,t	c	c,t	no c,t	c	c,t	c	c,t
In Level								
wage inequality	0.231	0.060	0.000	0.293	0.0003	0.000	1.481	0.130*
employment composition	0.023	0.025	0.014	0.004	0.0003	0.000	0.898***	0.101
In 1st difference								
wage inequality	0.000	0.000	0.000	0.000	0.000	0.000	0.500**	0.281***
employment composition	0.000	0.000	0.000	0.000	0.000	0.000	0.131	0.123*

*Notes: * for 10% of significance; ** for 5% of significance; *** for 1% of significance.*

B.2 **Cointegration tests**

For the cointegration test, I considered the one with linear deterministic trend in data, but no intercept in VAR. This was mainly due to the observation of the data, that clearly shows a trend over time. The results of the test are shown in Table B2.

In order to check the cointegration results for other models' specifications, I attach Table B3, where it can be seen that, depending on the model, the cointegration test shows different results. However, most of them show a cointegration relationship between the variables in question. I, thus, continue to consider the model with a deterministic trend for this exercise.

Table B2 **Cointegration test – Model with linear deterministic trend**

Sample (adjusted): 2004M06 2019M03
Included observations: 178 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		**Trace**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None *	0.129455	33.23857	25.87211	0.005
At most 1	0.046959	8.561405	12.51798	0.2092

Notes: Trace test indicates 1 cointegrating eqn(s) at the 0.05 level.

** Denotes rejection of the hypothesis at the 0.05 level; **MacKinnon-Haug-Michelis (1999) p-values.*

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		**Max-Eigen**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None *	0.129455	24.67716	19.38704	0.0077
At most 1	0.046959	8.561405	12.51798	0.2092

Notes: Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level.

** Denotes rejection of the hypothesis at the 0.05 level; **MacKinnon-Haug-Michelis (1999) p-values.*

Table B3 **Summary of cointegration tests**

Sample: 2004M01 2019M03
Included observations: 178
Series: RAZAO_SAL DIF_SALDO Lags interval: 1 to 4

Selected (0.05 level*) Number of Cointegrating Relations by Model					
Hypothesized		**Trace**		**0.05**	
Data Trend	**None**	**None**	**Linear**	**Linear**	**Quadratic**
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	0	1	2	1	2
Max-Eig	0	1	2	1	2

*Notes: *Critical values based on MacKinnon-Haug-Michelis (1999)*

B.3 Causality test

After estimating the VEC model, I performed a Granger causality test to verify that the two variables are, in fact, endogenous. The number of lags used was selected base on the information criteria – FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: HannanQuinn information criterion – where I selected the lags suggested by the largest number of criteria. The Granger causality test pointed to a mutual causality between the variables, at a level of 10% significance. Although the Granger causality of the wage inequality to the employment composition was not significant at 5%, the estimations seem to follow the theoretical hypothesis that both variables are endogenous. Hence, the Granger Causality test supports the circular and cumulative causation hypothesis.

Table B4 **Granger causality test**

Sample: 2004M1 – 2019M3
Lags: 4

Null hypothesis	**Obs**	**F-statistics**	**Prob.**
wage inequality does not Granger-cause employment composition	179	1.988	0.0985
employment composition does not Granger-cause wage inequality		3.910	0.0046

B.4 **Residuals Tests**

The residuals test for Autocorrelation (Table B5), Heteroskedasticity (Table B6) and Normality (Table B7) are shown below.

Firstly, the residuals do not show autocorrelation for the first 12 lags (no probability lower than 10%), allowing the estimation to stay with the lag structure suggested by the information criteria – 4 lags.

Secondly, residuals do not show Heteroskedasticity at a 5% confidence level (Table B6). Even though the test's p-value is not too high (0.06), I continued the analysis with this data and estimation. As pointed out in the paper, the employment composition variable is too volatile. Correcting this would mean a significant change in this variable, probably constructing another index for employment composition – this is, therefore, left for future research.

Lastly, residuals do not look normal. However, as correctly pointed out by one of the referees of this paper, normality is hard to achieve in the short-run time series. The Law of Large Number states that when sample size tends to infinity, the sample mean converges to the population mean, and the error term becomes normally distributed so that the lack of normality can be due to shorter term data. Additionally, the failure of normally distributed residuals may be due to outliers' presence and the high volatility of the indexes used in this exercise – especially the employment composition one. As in the Heteroskedasticity case, estimations with a more stable index are left for future research.

Table B5 **Autocorrelation Residual Test**

VEC Residual Serial Correlation LM Tests
Sample: 2004M01 2019M03 Included observations: 178

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	0.637183	4	0.9588	0.158967	(4, 330.0)	0.9588
2	1.111562	4	0.8924	0.277517	(4, 330.0)	0.8924
3	1.166616	4	0.8836	0.291286	(4, 330.0)	0.8836
4	2.494147	4	0.6457	0.624001	(4, 330.0)	0.6457
5	4.20594	4	0.3789	1.054997	(4, 330.0)	0.3789
6	0.45059	4	0.9781	0.112384	(4, 330.0)	0.9781
7	1.252168	4	0.8694	0.312687	(4, 330.0)	0.8694
8	6.14254	4	0.1888	1.54529	(4, 330.0)	0.1888
9	1.272373	4	0.866	0.317743	(4, 330.0)	0.866
10	2.971403	4	0.5626	0.743941	(4, 330.0)	0.5626
11	1.413613	4	0.8418	0.353089	(4, 330.0)	0.8418
12	2.787925	4	0.5939	0.69781	(4, 330.0)	0.5939

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	0.637183	4	0.9588	0.158967	(4, 330.0)	0.9588
2	1.918783	8	0.9834	0.238355	(8, 326.0)	0.9834
3	4.429799	12	0.9744	0.365979	(12, 322.0)	0.9744
4	10.79204	16	0.8221	0.671055	(16, 318.0)	0.8222
5	13.93307	20	0.8339	0.692061	(20, 314.0)	0.8341
6	17.17533	24	0.8411	0.709939	(24, 310.0)	0.8414
7	20.08555	28	0.8613	0.710233	(28, 306.0)	0.8617
8	22.77837	32	0.8852	0.7031	(32, 302.0)	0.8857
9	24.27493	36	0.9316	0.663136	(36, 298.0)	0.9321
10	31.86088	40	0.8171	0.787575	(40, 294.0)	0.8184
11	35.11521	44	0.8282	0.787824	(44, 290.0)	0.8299
12	35.62322	48	0.9069	0.728071	(48, 286.0)	0.9082

**Edgeworth expansion corrected likelihood ratio statistic.*

Table B6 **White Heteroskedasticity test**

VEC Residual Heteroskedasticity Tests (Levels and Squares)
Sample: 2004M01 2019M03
Included observations: 178

Null hypothesis: No heteroskedasticity Joint test		
Chi-sq	**df**	**Prob.**
71.00441	54	0.0602

Table B7 **Residuals Normality test**

VEC Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: Residuals are multivariate normal
Sample: 2004M01 2019M03
Included observations: 178

Null hypothesis: No serial correlation at lag h				
Component	**Skewness**	**Chi-sq**	**df**	**Prob.***
1	−0.150534	0.67226	1	0.4123
2	0.41547	5.120911	1	0.0236
Joint		5.793172	2	0.0552
Component	**Kurtosis**	**Chi-sq**	**df**	**Prob.**
1	4.390893	14.34815	1	0.0002
2	5.180188	35.25306	1	0
Joint		49.60122	2	0
Component		**Jarque-Bera**	**df**	**Prob.**
1		15.02041	2	0.0005
2		40.37397	2	0
Joint		55.39439	4	0

**Approximate p-values do not account for coefficient estimation.*