ECONOMIC COMPLEXITY AND LOCAL EMPLOYMENT MULTIPLIERS

Arthur Ribeiro Queiroz[1];
Elton Eduardo Freitas[2];
João Prates Romero[3];

Abstract: This article integrates indicators from the economic complexity approach with techniques from the literature that measures local employment multipliers. The objective is to assess the heterogeneity of employment multipliers across 558 Brazilian micro-regions, considering the regional complexity level and segmenting the economy into two sectors: complex and non-complex. The results indicate that the complex sector has higher employment multipliers, and these multipliers vary according to the complexity of the regions. Notably, the multipliers of the complex sector are more significant in regions with high economic complexity. Specifically, in these regions, the complex sector can generate between 1.06 and 1.46 jobs within the sector and between 1.71 and 3.25 jobs in the non-complex sector for each additional job created.

Keywords: employment multipliers, economic complexity, regional development.
Código JEL: O4; R11
Área Temática: 1.4 Padrões de especialização produtiva e desenvolvimento

---

COMPLEXIDADE ECONÔMICA E MULTIPLICADORES DE EMPREGO LOCAL

Resumo: Este artigo integra indicadores da abordagem da complexidade econômica com técnicas da literatura que medem multiplicadores de emprego locais. O objetivo é avaliar a heterogeneidade dos multiplicadores de emprego em 558 microrregiões brasileiras, considerando o nível de complexidade regional e segmentando a economia em dois setores: complexo e não complexo. Os resultados indicam que o setor complexo tem maiores multiplicadores de emprego, e esses multiplicadores variam de acordo com a complexidade das regiões. Notavelmente, os multiplicadores do setor complexo são mais significativos em regiões com alta complexidade econômica. Especificamente, nessas regiões, o setor complexo pode gerar entre 1,06 e 1,46 empregos dentro do setor e entre 1,71 e 3,25 empregos no setor não complexo para cada emprego adicional criado.

Palavras-chave: multiplicadores de emprego, complexidade econômica, desenvolvimento regional.

[1] Mestre em Economia pela Universidade Federal de Minas Gerais. E-mail: queirozrarthur@gmail.com
[2] Professor Adjunto na Universidade Federal de Sergipe.
[3] Professor Adjunto na Universidade Federal de Minas Gerais.

1 Introduction

It is well established now that economic complexity is a very good predictor of future growth of GDP and employment (Hidalgo and Hausmann, 2009; HAUSMANN et al., 2014; ROMERO et al., 2024; QUEIROZ et al., 2023). The accumulation of capabilities makes it possible for regions to diversify and become competitive across a wide range of goods, which ultimately impacts overall economic performance. In a nutshell, the higher the number of capabilities a region has, the higher the activities it can perform competitively and the higher its GDP and employment growth rates.

Nonetheless, the fact that different goods require distinct capabilities for their competitive production makes the process of economic diversification strongly path-dependent. Regions with scarce capabilities face severe limitations in their ability to diversify, while regions with a high number of capabilities can easily diversify into a wide variety of areas. Following the Principle of Relatedness (HIDALGO et al., 2018), economic diversification tends to occur in sectors that are related to existing regional productive structures (FRENKEN et al., 2007; BOSCHMA; IAMMARINO, 2009; NEFFKE et al., 2011; RIGBY, 2015; ESSLETZBICHLER, 2015; BALLAND et al., 2018; FREITAS et al., 2024; QUEIROZ et al., 2024). This leads to a situation where regional inequalities tend to expand rather than reduce, as originally proposed by Myrdal (1957) and many others, and as recently verified also by Pinheiro et al. (2022) among European regions using relatedness and complexity indicators.

In parallel to the growing literature on related diversification and economic complexity, a large body of studies has been estimating local employment multipliers (e.g. KAZEKAMI, 2017; WANG; CHANDA, 2018; MACEDO; MONASTERIO, 2016; LOYO; MOISÉS; MENDES, 2018; ROCHA; ARAUJO, 2021). This literature was built upon the seminal contribution of Moretti (2010), which proposed to use shift-share instrumental variables to deal with the endogeneity involved in the estimates of local employment multipliers. Interestingly, recent studies indicate that high-tech sectors tend to present higher multipliers (e.g. Moretti and Thulin, 2013; Dijk, 2015).

In this context, the objective of this paper is to test two hypotheses using data for Brazilian micro-regions. The first one is that the multiplier of complex industries is greater than that of non-complex industries. This hypothesis is based on the reasoning that the presence of complex and less ubiquitous activities (manufacturing and modern services) in the local economy tends to create a greater demand for less complex and more ubiquitous activities (trade of food and beverages, services of cleaning, construction materials). The second one is that the multiplier of complex industries is greater in regions that are more complex. These regions tend to have more organized institutions, higher labor competition between sectors and greater labor mobility. These characteristics make the labor supply more responsive to changes in complex sectors.

In order to examine the heterogeneity of local employment multipliers in Brazilian micro-regions due to differences in the complexity of sectors and regions, micro-region's economies were divided into two sectors, complex and non-complex, and micro-regions were divided into four groups according to their complexity levels: low, medium-low, medium-high and high. Using formal labor market data from three different time points (2009, 2014 and 2019), employment multipliers between complex and non-complex sectors were examined in all groups of regions. Potential endogeneity issues were addressed by employing shift-share instrumental variables. In addition to using the conventional shift-share instrument, an instrument that takes into account regional structural changes was also explored. Finally, a bootstrap analysis was also employed to assess changes in employment within the same sector.

The econometric tests reported in the paper suggest the validity of both hypotheses. These findings reinforce the results already found in the literature on related diversification, which indicate that more complex regions tend to grow faster than less complex regions. Nonetheless, these results complement the relatedness literature by indicating that the process of growing regional inequality occurs, at least partially, due to differences in employment multipliers across sectors and regions.

Hence, this paper presents three important contributions to the broad literature on regional development, combining contributions from the literatures on economic complexity, on related diversification and on local employment multipliers. The first one is to show that employment multipliers are larger in complex sectors than in non-complex sectors. The second one is to show that the employment multiplier of the complex sector is even larger in more complex regions. The third one, which is a methodological contribution, is to propose a new shift-share instrument that takes into account structural changes during the period of analysis.

The paper is organized as follows. Section 2 reviews the literature on local employment multipliers. Section 3 presents the adaptation of the conceptual framework using the economic complexity approach. Section 4 presents the data used and the econometric specification for measuring employment multipliers adapted from Moretti and Thulin (2013). Section 5 presents the results of the econometric estimates accompanied by the discussion. Finally, Section 6 presents the concluding remarks.

2 Local Employment Multipliers

The methodology employed to measure regional employment multipliers is derived from the seminal paper by Moretti (2010). The author investigated the implications of a permanent increase in jobs in the tradable goods sector, which can result from the arrival of a new firm or a substantial increase in demand from existing firms. Such a shock affects the general equilibrium of prices, and as a result, workers' wages and housing costs increase, unless the supply curves are perfectly elastic. On the one hand, this process leads to an expansion of the city's budget constraint, with more jobs and higher wages, consequently increasing demand in non-tradable sectors such as personal services, restaurants and cleaning services. This represents the multiplier effect for the non-tradable sector. On the other hand, the shock also impacts the tradable sector through three distinct effects. First, the rise in local labor costs makes the existing tradable sector less competitive, as prices are not subject to the same local dynamics. Second, there may be increased demand in intermediate tradable sectors, and the extent of this impact depends on the geographic concentration of these industries. Third, agglomeration effects occur as a consequence of the initial employment shock. The combined influence of these factors gives rise to the multiplier effect for the tradable sector. Formally, Moretti (2010) proposes the following solution:

$$\Delta N_{ct}^{NT} = \alpha + \beta \Delta N_{ct}^{T} + \gamma d_t + \epsilon_{ct} \quad (1)$$

$$\Delta N_{ct}^{T_1} = \alpha' + \beta' \Delta N_{ct}^{T_2} + \gamma' d_t + \epsilon'_{ct} \quad (2)$$

Where ΔN_{ct}^{NT} and ΔN_{ct}^{NT} are the changes over time in the log number of jobs in the non-tradable and tradable sectors, respectively. Moreover, $\Delta N_{ct}^{T_1}$ is the change in the log number of jobs in a randomly selected part of tradable sector and $\Delta N_{ct}^{T_2}$ represents the change in the log number of jobs in the remaining part of the tradable sector. Finaly, d_t is a dummy variable used to indicate the last period under consideration.

However, the estimation of equations (1) and (2) through OLS can lead to biased estimators due to endogeneity problems and omitted variables. Factors such as increased employment in non-tradable sectors that generate more jobs in tradable sectors, as well as unobservable time-varying shocks to local labor supply, can confound the causal effect of the shock. To address this, Moretti (2010) adopts an instrumental variable approach using a shift-share instrument (BARTIK, 1991). The instrumental variable is constructed as the average nationwide employment growth in manufacturing industries, weighted by the share of these industries in cities during the initial period. By assuming that national changes in employment are exogenous to region-specific dynamics, regression with this instrumental variable can provide unbiased estimators.

In Moretti (2010)'s pioneering study, he provided the initial estimates of multipliers that served as a benchmark for subsequent research. He found that for each additional job created in the tradable sector, 1.6 jobs are generated in the non-tradable sector within the same city. Moreover, Moretti (2010) argues that skilled jobs have a greater multiplier effect due to their concentration of higher wages. Specifically, he found that each additional skilled job generates 2.5 non-tradable jobs. Furthermore, the author suggests that the multiplier for the tradable sector should be relatively smaller, or potentially negative, due to the increase in labor costs associated with it. Formally, Moretti's analysis reveals that an additional job in a specific part of the tradable sector generates 0.26 jobs in the remaining part. This framework and analysis have been replicated and adapted in studies conducted for various countries, expanding the understanding of regional multipliers.

Moretti and Thulin (2013) conducted a similar exercise to assess local employment multipliers in Sweden. They changed the instrumental variable used by excluding the reference region in the instrument's measurement to address potential violations of the exogeneity assumption due to the region under analysis being included in the calculation. The findings of Moretti and Thulin (2013) revealed a statistically significant multiplier, although smaller than that observed in the United States. Specifically, the addition of one job in the tradable sector generated between 0.4 and 0.8 jobs in the non-tradable sector. The multiplier was notably higher for skilled jobs and the high-tech industry. In terms of the non-tradable sector, the multiplier was closer to the range of 0.3 to 0.4, similar to the findings in the United States.

Dijk (2015) replicated Moretti (2010)'s analysis while also calculating the multipliers using the alternative instrumental variable that excludes the reference city from the calculation. The author argues that estimates obtained with the new instrument are more robust as they align with the plausibility of exogeneity. The results of this exercise yield statistically significant but smaller multipliers. Specifically, the creation of one job in the tradable sector leads to the generation of 0.84 non-tradable jobs in the same city. In the case of skilled jobs, each additional job generates 1.46 jobs in local non-tradable sectors. These multipliers are lower than the 1.6 and 2.5 estimates previously found by Moretti (2010).

Apart from the studies conducted in the United States and Sweden, several other countries have been analyzed using a similar methodology. The literature includes contributions that examine the cases of Italy (BLASIO; MENON, 2011), Spain (GEROLIMETTO; MAGRINI, 2014), United Kingdom (FAGGIO; OVERMAN, 2014), Japan (KAZEKAMI, 2017), China (WANG; CHANDA, 2018), Mexico (HERNANDEZ; ROJAS, 2020) and Brazil (MACEDO; MONASTERIO, 2016; LOYO; MOISÉS; MENDES, 2018; ROCHA; ARAÚJO, 2021).

While not all studies specifically focus on non-tradable and tradable multipliers, they adopt the same measurement methodology to assess the employment multiplier effects in regional economies. For instance, the methodology was employed to calculate employment multipliers in the public sector (FAGGIO; OVERMAN, 2014), in creative industries (GOOS; KONINGS; VANDEWEYER, 2018), and in cultural industries (GUTIERREZ-POSADA et al., 2023). Moreover, the same methodology was utilized to gauge the impact of job creation on other variables, including the unemployment rate and the total number of unemployed individuals (ROCHA; ARAÚJO, 2021).

Three studies have examined employment multipliers for the case of Brazil. Macedo and Monasterio (2016) conducted an analysis similar to Moretti (2010) using data from 21 different economic activities across 123 meso-regions in Brazil. The authors found that for each additional industrial job, 3.78 new jobs were created in the service sector, excluding the metropolitan region of São Paulo. However, when including São Paulo, the multiplier increased to 6.58. Additionally, Macedo and Monasterio (2016) found a multiplier of 6.94 for the influence of high technology industries on local services, which aligns with previous research findings. It's important to note that the authors caution against overgeneralizing these results, as the multipliers are average estimates and may not capture the unique development experiences of each region. Factors such as sector, technology, strategy, and other local characteristics can significantly impact the effect of employment shocks.

Loyo, Moisés and Mendes (2018) conducted a study focusing on employment multipliers in the Brazilian public sector, similar to the work of Faggio and Overman (2014). The study analyzed the period of the first two terms of President Lula, from 2003 to 2010. The findings suggest a change in the multiplier effect between the two terms. During the period of contractionary fiscal policy (2003-2006), an increase in public sector employment led to a displacement of private sector employment (negative multiplier), with approximately 0.46 private jobs being displaced for every additional public job. In contrast, during the period of expansionary fiscal policy (2007-2010), the increase in public sector employment was complementary to private sector employment (positive multiplier), resulting in the creation of approximately 0.79 new private jobs for each additional public job.

Rocha and Araújo (2021) conducted a recent study for Brazil building upon the previous research on job multipliers. They applied a similar econometric strategy to estimate the effects of increased industrial employment on various labor market outcomes. The findings of their study indicate that an additional job in the industrial sector leads to a reduction of 2.6 unemployed individuals and to an increase of 8.4 new jobs in the non-tradable sector, on average. This suggests that industrial employment growth has a positive impact on reducing unemployment and generating employment opportunities in other sectors of the economy. The study also found supporting evidence for the inverse relationship between the growth of industrial employment and the unemployment rate, further highlighting the importance of industrial sector expansion for improving labor market conditions in Brazil.

Following the developments of the literatures on economic complexity, related diversification and on local employment multipliers, the objective of this paper is to investigate whether the employment multipliers of complex industries are higher than of non-complex industries and heterogeneous across regions with distinct levels of economic complexity.

3 Conceptual Framework Adapted for Economic Complexity

Moretti and Thulin's (2013) framework is based on several key assumptions that enable the measurement of local employment multipliers. First, it considers each city as a competitive economy that produces two types of goods and services: tradables and non-tradables. Tradables have prices determined at the national or international level, outside the control of the cities, while non-tradables have locally determined prices.

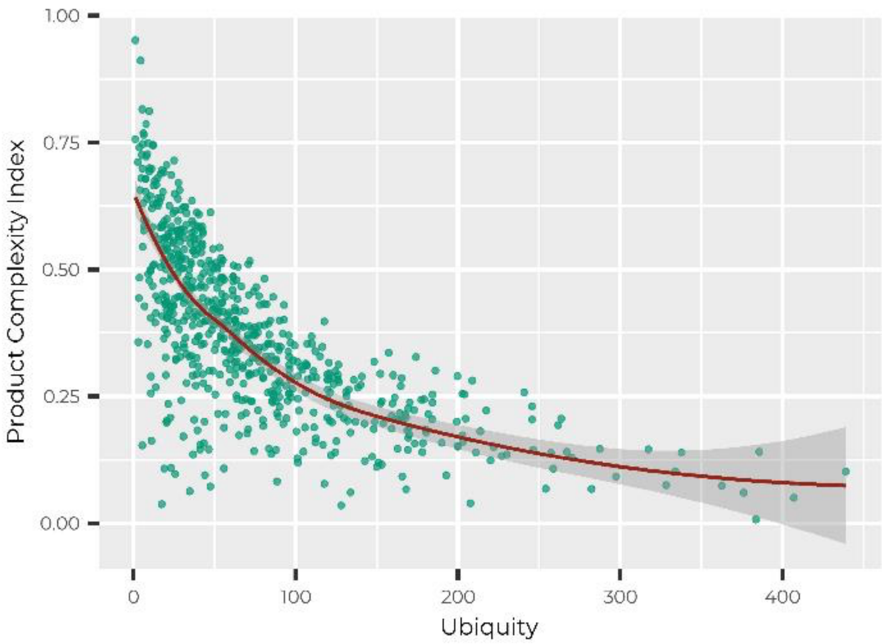
Moreover, the framework assumes that labor is perfectly mobile across sectors within cities. This assumption ensures that the marginal product and the marginal wage are equalized within cities, leading to efficient allocation of labor resources. Additionally, the utility of workers is influenced by local net wages, the cost of living, and individual preferences for specific locations. The extent of idiosyncratic location preferences affects the geographic mobility of labor, with weaker preferences leading to greater labor mobility and higher elasticity of labor supply. It is also assumed that the housing supply curve is upward sloping, with the slope being influenced by geographical factors and land use regulations. These assumptions collectively form the foundation for estimating local employment multipliers.

The adaptation of these assumptions to take into account the economic complexity of sectors is facilitated by the nature of the main indicators used in this approach. The Economic Complexity Index (ECI) and the Product Complexity Index (PCI) are built from two concepts: diversification and ubiquity. Diversification refers to the quantity of different goods produced competitively in a region, indicating greater complexity. Conversely, ubiquity refers to the widespread production of a good across different regions, indicating lower complexity. On the other hand, goods that are produced by fewer regions competitively are considered more complex. This notion of ubiquity allows us to classify the economy into the production of complex and non-complex goods and services, as well as tradable and non-tradable sectors.

The greater the presence of a sector in local economies (high ubiquity), the more influential local dynamics are in determining its price. Conversely, sectors with a smaller presence in local productive structures (low ubiquity) are less susceptible to local factors in determining their price. As a result, highly ubiquitous activities such as the sale of beverages, food, construction materials, bakery products, cleaning services, and accommodation services are considered less complex. These activities compete with other local actors, and their prices are primarily defined locally. On the other hand, activities with lower ubiquity, such as manufacturing, financial and banking services, and information intelligence services, are more complex and compete at the national or international level. Therefore, their prices are largely determined by factors beyond the local context. Figure 1 illustrates the comparison between the levels of complexity and ubiquity of a range of productive activities in Brazil.

Therefore, this paper's conceptual framework begins by distinguishing between complex and non-complex goods and services. Each micro-region in Brazil can be seen as a competitive economy that allocates its workforce between the production of complex and non-complex sectors. The prices of complex goods and services are determined outside the local dynamics, while non-complex sectors are influenced by local factors. Finally, the hypotheses related to labor force mobility and the upward sloping labor and housing supply curves still apply to the analysis of local employment dynamics within the region.

Figure 1 – Product Complexity Index (PCI) and Ubiquity - Brazilian Economic Activities



Source: authors' own elaboration.

This paper's research focuses on examining the impact of shocks on labor demand in both complex and non-complex sectors of regions, similar to the approach taken by Moretti (2010) in studying the tradable sector. More specifically, the paper aims at understanding the effects of permanent growth in these sectors, whether it be through the attraction of new industries or exogenous increases in labor productivity within existing industries. These shocks not only directly affect employment in the respective sectors but they also have indirect effects on the rest of the economy.

Hence, an adapted conceptual framework is employed here to examine the effects of shocks on both complex and non-complex sectors in Brazilian micro-regions. This investigation aims to assess the following hypotheses:

- *Hypothesis 1:* The employment multipliers of the complex sector is greater than that of the non-complex sector.
- *Hypothesis 2:* The employment multiplier of the complex sector is greater in regions with higher levels of economic complexity.

Hypothesis 1 is based on the premise that the attraction of complex (less common) jobs, such as manufacturing activities, leads to an increased demand for less complex (more common) activities, such as basic services. This relationship is analogous to the one observed between tradables and non-tradables. Conversely, the opposite reasoning lacks the necessary transmission channels to generate significant job creation. Hypothesis 2 suggests that the complex sector has varying impacts on regions according to their levels of complexity. This is rooted in the understanding that more complex economies are also institutionally more developed regions, characterized by lower wage inequality between sectors and higher competitiveness. As a result, the labor supply in these regions is more sensitive to changes caused by permanent increases in employment within the complex sector.

4 Data and Method

4.1 Data

Employment data in economic activities across micro-regions in Brazil for the years 2009, 2014, and 2019 was gathered from the Annual Social Information Report (RAIS), which is linked to the Brazilian Ministry of Labor and Employment. It is important to note that the RAIS database contains administrative records of all formal establishments in the Brazilian labor market, making it a crucial data source already used in previous studies on Brazil (MACEDO; MONASTERIO, 2016; LOYO; MOISE´S; MENDES, 2018; ROCHA; ARAÚJO, 2021).

Similar to Rocha and Araújo (2021), the geographic unit used in this study was the micro-regions. Economic activities were classified based on the 6-digit class of the National Classification of Economic Activities (CNAE) provided by the Brazilian Institute of Geography and Statistics (IBGE).

Additionally, although data segmented according to this classification are available from 2006 to 2021, the intervals 2009-2014 and 2014-2019 were chosen due to the quality of the data, to avoid the years of the covid-19 pandemic, and to follow the literature on multipliers, which have used three time points and two intervals for their analyses (MORETTI, 2010; MORETTI; THULIN, 2013; DIJK, 2017; MACEDO; MONASTERIO, 2016; ROCHA; ARAÚJO, 2021). The final database includes 558 Brazilian micro-regions and 670 productive activities, resulting in 373,860 observations per year and a total of 1,121,580 observations.

Finally, employment data were also used to calculate the complexity indicators according to the method outlined by Hidalgo and Hausmann (2009). Employment data has gained significant traction in subnational analyses due to its timeliness, comprehensive coverage across all territorial dimensions, and detailed specificity (FREITAS et al., 2024; ROMERO et al., 2024; Cardoso et al., 2024).

4.2 Econometric Specifications

The econometric specification employed to estimate the multipliers was adapted from the approach used by Moretti and Thulin (2013). Their methodology allows the identification of indirect effects resulting from a permanent increase in the tradable sector. In this paper, however, this approach was adapted to examine the indirect effects of exogenous employment shocks in both complex and non-complex sectors.

The estimated equations are listed below. Equations (3) and (4) estimate the multipliers resulting from a shock in the complex sector. In equation (3) this effect is verified on the non-complex sector of region. In equation (4), a part of the complex sector is randomly selected to check the employment multiplier over the rest of the complex sectors. The logic is the same for the non-complex sector in equations (5) and (6).

$$E_{m,t}^{NC} - E_{m,t-5}^{NC} = \beta_0 + \beta_1\left(E_{m,t}^{C} - E_{m,t-5}^{C}\right) + \beta_2 Time + \varepsilon_{m,t} \quad (3)$$

$$E_{m,t}^{C_1} - E_{m,t-5}^{C_1} = \beta_0 + \beta_1\left(E_{m,t}^{C_2} - E_{m,t-5}^{C_2}\right) + \beta_2 Time + \varepsilon_{m,t} \quad (4)$$

$$E_{m,t}^{C} - E_{m,t-5}^{C} = \beta_0 + \beta_1\left(E_{m,t}^{NC} - E_{m,t-5}^{NC}\right) + \beta_2 Time + \varepsilon_{m,t} \quad (5)$$

$$E_{m,t}^{NC_1} - E_{m,t-5}^{NC_1} = \beta_0 + \beta_1\left(E_{m,t}^{NC_2} - E_{m,t-5}^{NC_2}\right) + \beta_2 Time + \varepsilon_{m,t} \quad (6)$$

Therefore, $E_{m,t}^{NC}$ and $E_{m,t}^{C}$ represent the amount of employment, respectively, in the non-complex and complex sectors in micro-region *m* and in period *t*. $E_{m,t}^{C_1}$ reflects employment in a randomly selected portion of the complex sector and $E_{m,t}^{C_2}$ the amount of employment in the rest of the sector. The same is represented for $E_{m,t}^{NC_1}$ and $E_{m,t}^{NC_2}$ for non-complex sector parts. The *Time* variable is a dummy that takes the value 1 referring to the last period (2014-2019). This strategy is adopted to control for possible national shocks in employment in the sector that is the dependent variable. Finally, $\varepsilon_{m,t}$ is the error term. In all equations, the regional employment multiplier is hypothetically represented by β_1.

However, the OLS estimations of these models are likely to be inconsistent. As summarized by Dijk (2015), this is because β_1 is capturing three types of effects. First, it captures the causal effect of job growth in one sector on the other, which is the effect to be measured. Second, endogeneity is very likely, since an increase in jobs in the non-complex sector might affect the number of jobs in the complex sector (equation 3) or vice versa (equation 5). Third, there may be inconsistencies due to omitted variables, such as changes caused by local public services that influence employment in both sectors.

To address these problems, Moretti and Thulin (2013) propose using an instrumental variable estimation with a shift-share instrument (BARTIK, 1991). The shift-share analysis decomposes employment growth into three distinct effects: growth resulting from the increase in total national employment (national), growth due to the composition of local productive structures (structural), and growth resulting from the performance of these sectors locally compared to the performance of the same sectors in the overall economy (differential). The strategy employed by Moretti and Thulin (2013) is to isolate potentially exogenous changes in job demand by calculating the structural growth component. In this case, the instrumental variable aims to isolate the variation in employment in the tradable sector that is due to national changes, separate from the variation that is due to local changes. The calculation of this instrument was adapted in this paper to focus on complex and non-complex sectors:

$$IV_1 = \sum_j E^{\varphi}_{m,j,t-5} \left(\ln\left(E^{\varphi}_{j,t} - E^{\varphi}_{m,j,t}\right) - \ln\left(E^{\varphi}_{j,t-5} - E^{\varphi}_{m,j,t-5}\right)\right) \quad (7)$$

Where φ = {C (equation 3), C_2 (4), NC (5), NC_2 (6)}.

This instrument, represented by equation (7), includes the national share and the sector-specific shares but excludes regional variation. Unlike Moretti (2010), where the instrument did not exclude the variation of the city itself, this adaptation proposed by Moretti and Thulin (2013) addresses the potential violation of the exogeneity assumption. By excluding the variation of the reference micro-region, the instrument isolates changes in employment in industry j of micro-region m that arise from national variations in industry j. However, the impact of these changes differs across micro-regions due to their unique composition in the base year ($E^{\varphi}_{m,j,t-5}$). According to Moretti and Thulin (2013), the instrument captures exogenous changes in local labor demand, as national changes do not reflect local economic dynamics.

As an additional robustness test, another type of instrument was used to further assess potential changes in the multiplier. The instrument proposed in equation (7) is based on the composition of the productive structure of micro-regions in the base year, thereby not capturing the effects of structural changes within each local economy over the 5-year interval. To address this limitation, an instrument that isolates changes resulting from national variations and local variations was employed, taking into account the portfolio of economies in the final period ($E^{\varphi}_{m,j,t}$) rather than the initial period. Consequently, changes in the overall economy will continue to manifest differently across micro-regions, but now considering the structural changes observed during the period. This adaptation is inspired by Stilwell (1969)'s proposal, which modifies the shift-share method to calculate the expected net change in employment in a given region based on its final industrial structure. Formally:

$$IV_2 = \sum_j E^{\varphi}_{m,j,t} \left(\ln\left(E^{\varphi}_{j,t-5} - E^{\varphi}_{m,j,t-5}\right) - \ln\left(E^{\varphi}_{j,t} - E^{\varphi}_{m,j,t}\right)\right) \quad (8)$$

Still, two important points regarding the estimation strategy should be addressed. Firstly, it is worth noting that most of the studies in this literature do not incorporate control variables in their estimations, with a few exceptions (FAGGIO; OVERMAN, 2014; DIJK, 2017; WANG; CHANDA, 2018; LEE; CLARKE, 2019). In these cases, the variables are typically used to control for city or regional size, the skill level of the workforce or inhabitants, and the unemployment rate. The same strategy was used in the tests reported in this paper. More specifically, all regressions control for: (i) the population size of each micro--region; (ii) the share of employment occupied by individuals with at least an incomplete undergraduate degree as a measure of the region's labor market qualification; (iii) the average salary of the micro-region as a control for productivity; and (iv) the local average relatedness of the micro-region to account for the attraction of new jobs in related sectors. All variables were constructed using data from RAIS, except for population, which was obtained from IBGE. It is important to note that unemployment rate at the micro-region level is not available. Regressions including these control variables are available in Appendix A.2.

Second, a different estimation strategy was employed for equations (4) and (6). In the literature that examines the effect of a portion of the tradable sector on the rest of the same sector (MORETTI, 2010; MORETTI; THULIN, 2013), there is no specific guidance on how the samples are selected. The authors only mention that a part of the sector is randomly chosen. However, when conducting a single estimation and selecting only one sample, the resulting multiplier is solely determined by that particular sample. As a result, it is not possible to assess the sensitivity of the multiplier to the sample selection process. In other words, the value of the multiplier may significantly differ if a different sample were randomly selected. To address this issue, a bootstrap analysis was implemented[4]. By randomly selecting multiple samples, it is possible to determine the variability of the resulting multipliers and their trends. This approach allows for a more robust estimate that is not contingent on the selected sample.

Finally, it is worth emphasizing that the estimates were conducted for all micro-regions as well as for sub-samples composed of groups based on their level of complexity. The criteria for classifying regions' complexity levels and for categorizing complex and non-complex sectors are presented in Appendix A.1.

5 Econometric Results

Table 1 presents the results of employment multipliers in complex sectors over employment in non-complex sectors. Columns (1) and (2) show the OLS results without and with controls, respectively. The remaining columns follow the same pattern but using instrumental variables to address potential endogeneity issues. Columns (3) and (4) utilize the instrumental variable proposed by Moretti and Thulin (2013), specified in equation (7). Columns (5) and (6) present the results using the instrumental variable proposed in this study, specified in equation (8). Full regression results are presented in Appendix A.2.

As expected, the complex sector has a significant impact on the rest of the economy in most cases. On average, the results indicate that one new job in the complex sector leads to the generation of 1.76 to 2.36 additional jobs in the non-complex sector. Furthermore, when controlling for factors such as human capital, relatedness, average salary, and population, the magnitude of the multipliers remains consistent.

However, it is important to note that the choice of instrument affects the magnitude of the multiplier. The use of an instrument that considers the variation in the composition of local employment in the final period reduces the multiplier by approximately 0.3. Nevertheless, the overall findings remain statistically and economically significant in all cases.

Table 1 – Complex Employment Multipliers over Non-complex Employment

	Dependent variable:					
	Non-complex employment					
	OLS	OLS	IV1	IV1	IV2	IV2
	(1)	(2)	(3)	(4)	(5)	(6)
General Model	1.76***	1.71***	2.25***	2.36***	1.89***	1.87***
	(0.35)	(0.37)	(0.33)	(0.32)	(0.32)	(0.33)
Low	-2.26	-1.90	1.95	1.33	-2.71	-2.45
	(2.01)	(1.85)	(4.66)	(4.61)	(2.43)	(1.93)
Medium-low	1.74**	0.83	22.17	19.53	2.20***	1.15*
	(0.78)	(0.61)	(20.85)	(18.96)	(0.79)	(0.60)
Medium-high	1.95***	1.86***	3.25***	3.50***	2.05***	1.98***
	(0.29)	(0.32)	(0.32)	(0.44)	(0.29)	(0.34)
High	1.56***	1.51***	2.18***	2.39***	1.71***	1.72***
	(0.39)	(0.37)	(0.39)	(0.45)	(0.36)	(0.34)
Controls	No	Yes	No	Yes	No	Yes

Notes: Significance: *p<0.1; **p<0.05; ***p<0.01. Robust standard-errors (clustered at the micro-region) are in parentheses.
Source: authors'own elaboration.

The analysis of the multipliers by complexity groups reveals a more diverse scenario. The results indicate that the most significant effects are observed in regions that present medium-high and high complexity levels. In these regions, the complex sector has a substantial impact on the rest of the economy when experiencing a permanent increase in employment. However, in low complexity regions the complex sector appears to be insufficient to exert a significant influence on the rest of the economy. Medium-high and high complexity regions consistently demonstrate significant multipliers at 1% in all regressions. For the former, an increase of one job in the complex sector leads to the generation of 3.5 additional jobs in the non-complex sector. For the later, an increase in employment ranging from 1.51 to 2.39 jobs in the non-complex sector is observed for each additional job created in the complex sector.

Interestingly, for medium-low complexity regions the results show a high multiplier effect only when considering the effect of structural change in the alternative instrumental variable estimation but not when using the classic instrument. One possible explanation for this finding is that the structural change during the period of analysis is particularly relevant in these regions, since it seems to have made their economies complex enough to enable a significant effect of the complex sector on employment in the rest of the economy.

Table 2 presents the non-complex employment multipliers over employment in the complex sector. Once again, full regression results are presented in Appendix A.2. As expected, the results indicate smaller multipliers than those in the opposite direction. On average, one additional job in the non-complex sector results in the generation of 0.37 to 0.45 additional jobs in the complex sector. These findings highlight the asymmetric relationship between the complex and non-complex sectors, with the complex sector exerting a stronger influence on job creation in the non-complex sector compared to the reverse relationship.

Micro-regions with medium-high and high complexity levels continue to exhibit the highest multipliers. In these regions, an increase of one job in the non-complex sector generates between 0.36 and 0.47 new jobs in the complex sector. Once again, the absence of a robust complex sector in low and medium-low complexity regions limits the potential impact of permanent increases in the non-complex sector. In these cases, the multipliers are close to zero or even negative, suggesting a crowding-out effect in the complex sector, although very small. These findings highlight the importance of a strong and developed complex sector for employment growth.

Table 2 – Non-complex Employment Multipliers over Complex Employment

	Dependent variable:					
	Complex employment					
	OLS (1)	OLS (2)	IV1 (3)	IV1 (4)	IV2 (5)	IV2 (6)
General Model	0.39*** (0.05)	0.38*** (0.04)	0.45*** (0.06)	0.43*** (0.05)	0.39*** (0.05)	0.37*** (0.05)
Low	-0.01* (0.00)	-0.01* (0.00)	-0.01** (0.00)	0.00 (0.01)	-0.01** (0.00)	-0.01*** (0.00)
Medium-low	0.04*** (0.01)	0.02* (0.01)	0.05** (0.02)	0.05 (0.03)	0.04*** (0.01)	0.02** (0.01)
Medium-high	0.22*** (0.04)	0.18*** (0.03)	0.28*** (0.04)	0.28*** (0.04)	0.24*** (0.03)	0.19*** (0.04)
High	0.40*** (0.06)	0.38*** (0.06)	0.47*** (0.07)	0.43*** (0.06)	0.41*** (0.07)	0.36*** (0.06)
Controls	No	Yes	No	Yes	No	Yes

Notes: Significance: *p<0.1; **p<0.05; ***p<0.01. Robust standard-errors (clustered at the micro-region) are in parentheses.
Source: authors' own elaboration.

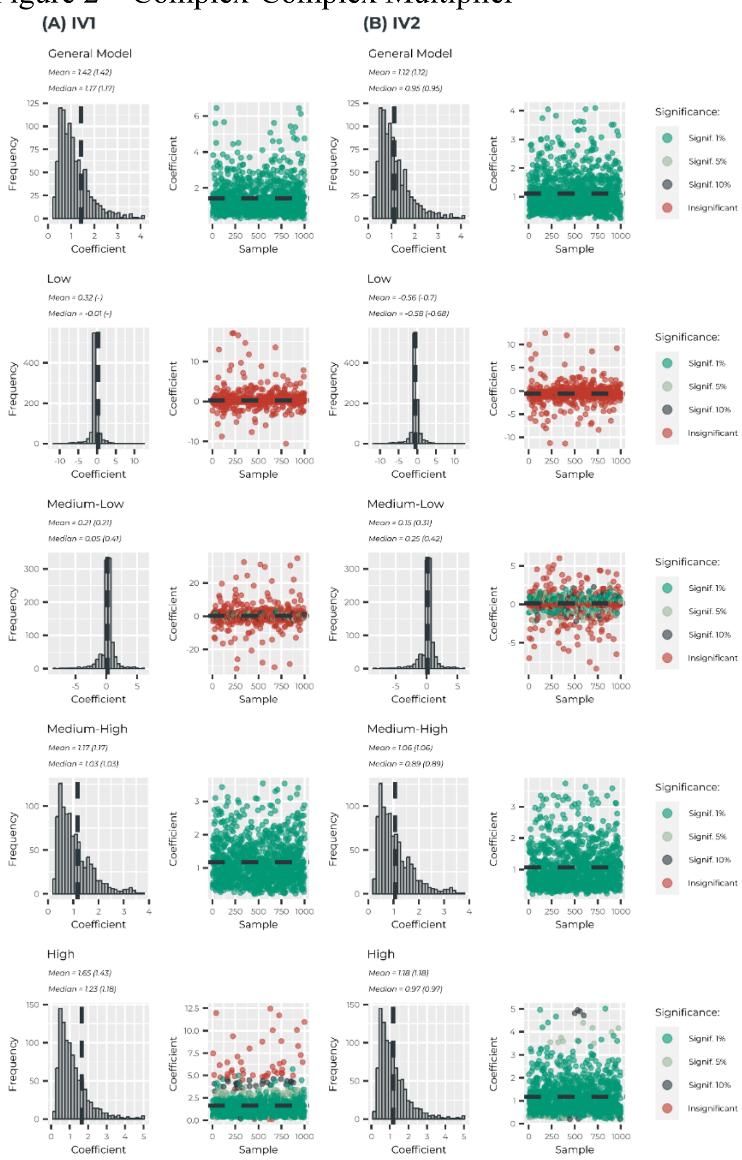
Finally, Figures 2 and 3 provide a summary of the remaining regressions, which focus on the influence of a portion of complex and non-complex sectors on the rest of the same sector. Since the literature does not specify the method for selecting the sample for this analysis, a bootstrap approach was employed, randomly selecting parts of the reference sector 1,000 times. The bootstrap estimations presented in the figures only include the instrumental variable specification without control variables. As observed in the robustness regressions reported in Appendix A.2, the inclusion of control variables does not alter the results significantly.

Figures 2 and 3 displays the results for equation (4) and (6), respectively, for all groups of micro-regions. Column (A) shows the estimates using the conventional shift-share instrument, while column (B) presents the estimates with the end-period shift-share instrument. The first graph is a histogram plot depicting the distribution of estimated multipliers across the replicates, and the second graph shows the multiplier values for each sample from 1 to 1,000, indicating whether they are statistically significant. Additionally, the mean and median values of the resulting multipliers are provided for each estimate. The values in parentheses represent standard deviations for the significant multipliers up to 10% significance level.

Figure 2 shows that the average multiplier for the rest of the complex sector, resulting from an increase of 1 job in a portion of this sector, ranges from 1.12 to 1.42. However, the level of complexity of the micro-region affects the magnitude of this multiplier. In low and medium-low complexity regions, the multiplier is less robust, with only a few estimates being statistically significant, particularly in low complexity micro-regions. For medium-low complexity regions, the significant multiplier estimates are 0.21 (A) and 0.31 (B). As the level of complexity increases, the magnitude of the multiplier also increases. With the conventional shift-share instrument, an increase of 1 job in a portion of the complex sector generates, on average, 1.65 jobs in the rest of the sector in high complexity regions and 1.17 jobs in medium-high complexity regions. These findings align with the earlier results, indicating the reduced relevance of the complex sector in less complex regions.

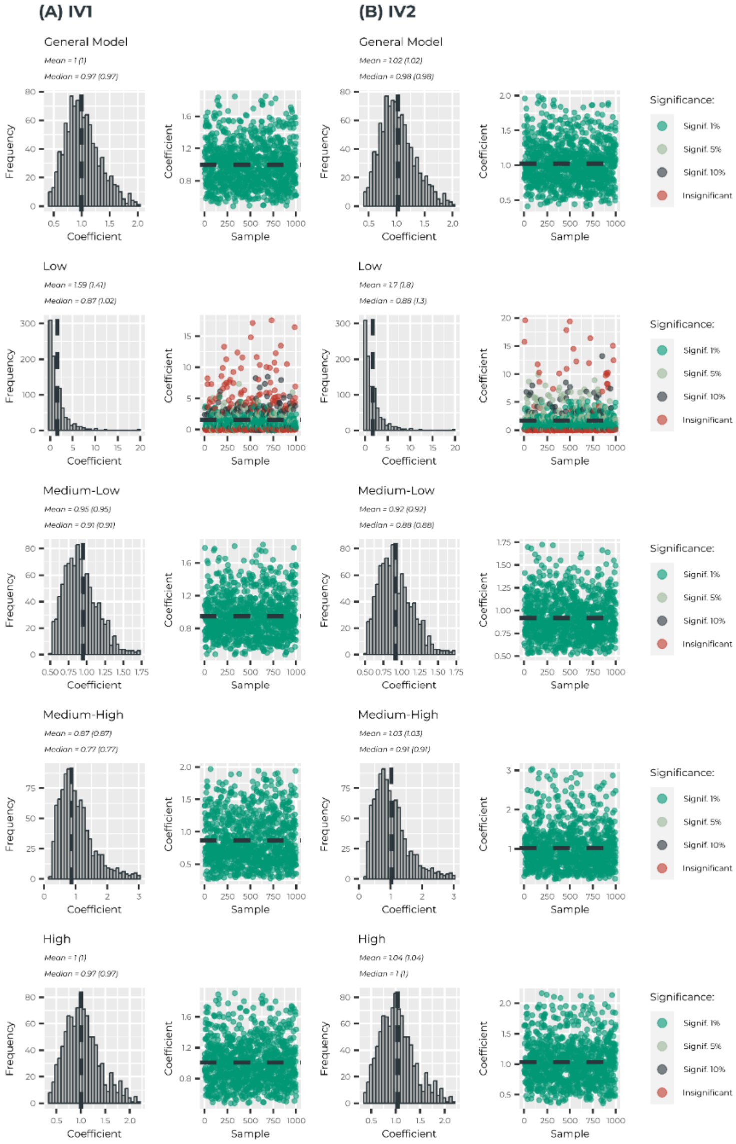
However, the evaluation of non-complex multipliers reveals a slightly different scenario. Figure 3 reveals that the increase of one job in the non-complex sector generates one job in the rest of the sector. Interestingly, low micro-regions stand out in this case. The significant multipliers for the non-complex sector in these regions are 1.41 (A) and 1.8 (B). This indicates that the impact of job creation in the non-complex sector is more pronounced in low complexity micro-regions. Additionally, when considering the structural change of these regions, there is an observed increase of 0.4 in the average multipliers for the non-complex sector. On the other hand, the other micro-regions exhibit multipliers similar to the general average in both types of estimates.

Figure 2 – Complex-Complex Multiplier



Source: authors' own elaboration.

Figure 3 – Non-Complex-Non-Complex Multiplier



Source: authors' own elaboration.

Table 3 – Multipliers Summary Table

Multiplier:		
	Complex Employment Multiplier over	*Non-complex Employment*
	IV1 (1)	IV2 (2)
General Model	2.25***	1.89***
Low	1.95	-2.71
Medium-Low	22.17	2.20***
Medium-High	3.25***	2.05***
High	2.18***	1.71***
	Non-complex Employment Multiplier	*over Complex Employment*
	IV1 (1)	IV2 (2)
General Model	0.45***	0.39***
Low	-0.01**	-0.01**
Medium-low	0.05**	0.04***
Medium-high	0.28***	0.24***
High	0.47***	0.41***
	Complex Employment Multiplier over Complex Employment[b]	
	IV1 (1)	IV2 (2)
General Model	1.42	1.12
Low	-	-0.7
Medium-low	0.21	0.31
Medium-high	1.17	1.06
High	1.43	1.18
	Non-complex Employment Multiplier over Non-complex Employment[b]	
	IV1 (1)	IV2 (2)
General Model	1.00	1.02
Low	1.41	1.80
Medium-low	0.95	0.92
Medium-high	0.87	1.03
High	1.00	1.04

[b] As the estimates were via bootstrap, the mean value of the multipliers that were significant up to 10% are reported.
Notes: Significance: *p<0.1; **p<0.05; ***p<0.01.
Source: authors' own elaboration.

The results of the econometric tests are summarized in Table 3. As the multipliers do not vary considerably with the inclusion of control variables, the two main specifications are reported: IV_1 (1) refers to the regression only with the conventional shift-share instrument, and IV_2 (2) with the end-period shift-share instrument. The complex sector presents the highest multipliers, indicating a substantial impact of this sector on local employment. However, the extent of this influence varies significantly among micro-regions, depending on their level of complexity. In low and medium-low complexity regions, the complex sector exhibits limited effects, not only on itself but also on the non-complex sector. In contrast, medium-high and high complexity regions present a pronounced influence of the complex sector on the labor market, as indicated by the large multipliers.

6 Concluding Remarks

This paper sought to adapt the methodology of local employment multipliers (MORETTI, 2010; MORETTI; THULIN, 2013) to assess the regional multipliers of complex and non-complex sectors across regions of distinct complexity levels (Hidalgo and Hausmann, 2009). The most recent literature has been mainly concerned with evaluating employment multipliers of high-tech sectors (e.g. LEE; CLARKE, 2019). Nonetheless, no previous work has assessed employment multipliers based on the levels of complexity of sectors and regions. This intention resides in the scarcity of literature in evaluating possible implications of the uneven regional development to which the regions are submitted in light of the findings of the literature on economic complexity and regional related diversification (e.g. PINHEIRO et al., 2022).

The econometric results presented in this paper offer important contributions to the literatures on regional related diversification, economic complexity and employment multipliers.

First, the tests confirm the hypothesis that the employment multiplier of the complex sector is larger than that of the non-complex sector. Second, the tests confirm also the hypothesis that the employment multiplier of the complex sector is higher in micro-regions with higher levels of complexity. It appears that in less complex regions, the complex sector does not have a significant effect both on the non-complex sector and on other parts of itself. The most positive effects in these regions are reserved for the influence that the non-complex sector has on other parts of itself. The exact opposite is observed in regions that are already complex, as they are where the complex sector exerts the strongest influence on the labor market.

In short, the econometric results represent bad news for less complex regions, where the complex sector is incapable of increasing employment substantially, and good news for more complex regions, where the complex sector is capable of generating robust employment growth.

These findings quantify one of the implications of the uneven development faced by Brazil's regions. It shows that the development path followed by less complex regions limits severely their diversification opportunities, which encompasses most often non-complex sectors only. As a result, these regions are unable to develop a complex sector that can have positive spillover effects on the rest of the economy, perpetuating the vicious cycle of underdevelopment. This lack of diversification leads to almost non-existent multipliers for the complex sector in these regions. On the other hand, regions that are already complex benefit from related diversification into more complex sectors, resulting in a complex sector that can exert a significant influence on the overall economy. Hence, the multipliers of the complex sector in these regions are substantial.

While this work provides valuable contributions to the literature, it is important to acknowledge some limitations. First, it is important to note that the classification of sectors as complex or non-complex is a subjective decision and may influence the magnitude of the multipliers. Choosing a more inclusive classification would likely decrease the multipliers' magnitude and favor medium-low complexity regions, as shown by the robustness tests presented in Appendix A.2. Moreover, the level of aggregation of economic activities can also impact the multipliers, with higher levels potentially yielding different magnitudes. Additionally, it is crucial to note that the estimates represent average impacts and do not account for variations in local conditions within each region group. Local factors and the specific characteristics of individual activities within the complex or non-complex sectors can also influence the multiplier effect. Therefore, the multipliers are still sensitive to local and sector-specific factors.

References

BALLAND, P.-A. et al. Smart specialization policy in the European Union: relatedness, knowledge complexity and regional diversification. *Regional Studies*, p. 1–17, 2018.

BARTIK, T. J. Who Benefits from State and Local Economic Development Policies? Kalamazoo: W.E. Upjohn Institute for Employment Research, 1991.

BLASIO, G. de; MENON, C. Local Effects of Manufacturing Employment Growth in Italy. *Giornale degli Economisti*, v. 70, n. 3, p. 101–112, 2011.

BOSCHMA, R.; IAMMARINO, S. Related Variety, Trade Linkages, and Regional Growth in Italy. *Economic Geography*, v. 85, n. 3, p. 289–311, 2009.

DIJK, J. J. V. Local multipliers, mobility, and agglomeration economies. Discussion Paper No. 771, University of Oxford, 2015.

DIJK, J. J. V. Local employment multipliers in U.S. cities. *Journal of Economic Geography*, v. 17, n. 2, p. 465–487, 2017.

EFRON, B.; TIBSHIRANI, R. An Introduction to the Bootstrap. New York: Chapman & Hall, 1993.

ESSLETZBICHLER, J. Relatedness, Industrial Branching and Technological Cohesion in US Metropolitan Areas. *Regional Studies*, v. 49, n. 5, p. 752–766, 2015.

FAGGIO, G.; OVERMAN, H. The effect of public sector employment on local labour markets. *Journal of Urban Economics*, v. 79, n. C, p. 91–107, 2014.

FREITAS, ELTON; BRITTO, Gustavo; AMARAL, Pedro. Related industries, economic complexity, and regional diversification: An application for Brazilian microregions. *Papers in Regional Science*, v. 103, 2024.

FRENKEN, K.; OORT, F. V.; VERBURG, T. Related Variety, Unrelated Variety and Regional Economic Growth. *Regional Studies*, v. 41, n. 5, p. 685–697, 2007.

GEROLIMETTO, M.; MAGRINI, S. Spatial analysis of employment multilpliers in Spanish labor markets. RIEDS - Rivista Italiana di Economia, Demografia e Statistica - The Italian Journal of Economic, Demographic and Statistical Studies, v. 68, n. 3-4, p. 87–94, 2014.

GOOS, M.; KONINGS, J.; VANDEWEYER, M. Local high-tech job multipliers in Europe. *Industrial and Corporate Change*, v. 27, n. 4, p. 639–655, 2018.

GUTIERREZ-POSADA, D. et al. Creative Clusters and Creative Multipliers: Evidence from UK Cities. *Economic Geography*, v. 99, n. 1, p. 1–24, 2023.

HARTMANN, D.; PINHEIRO, F. Economic complexity and inequality at the national and regional level. arXiv.org, n. 2206.00818, 2022.

HAUSMANN, R. et al. The Atlas of Economic Complexity: Mapping Paths to Prosperity. 1. ed. Cambridge: The MIT Press, 2014. v. 1.

HERNANDEZ, N.; ROJAS, I. Employment local multipliers in Mexico. Sobre México. *Revista de Economía*, v. 1, p. 5–37, 2020.

HIDALGO, C. et al. The Principle of Relatedness: Proceedings of the Ninth International Conference on Complex Systems. p. 451–457, 2018.

HIDALGO, C.; HAUSMANN, R. The Building Blocks of Economic Complexity. Proceedings of the National Academy of Sciences of the United States of America, v. 106, p. 10570–5, 2009.

HIDALGO, C. et al. The Product Space Conditions the Development of Nations. *Science*, v. 317, p. 482–487, 2007.

KAZEKAMI, S. Local Multipliers, Mobility, and Agglomeration Economies. Industrial Relations: A *Journal of Economy and Society*, v. 56, n. 3, p. 489–513, 2017.

LEE, N.; CLARKE, S. Do low-skilled workers gain from high-tech employment growth? High- technology multipliers, employment and wages in Britain. *Research Policy*, v. 48, n. 9, 2019.

LOYO, A. O. L.; MOISES, A. R. F.; MENDES, V. Impacto de mudanças no emprego no setor público sobre o mercado de trabalho local: evidências para as mesorregiões brasileiras de 2003 a 2010. *Estudos Econômicos*, v. 48, p. 77–106, 2018.

MACEDO, G.; MONASTERIO, L. Local multiplier of industrial employment: Brazilian mesoregions (2000-2010). *Brazilian Journal of Political Economy*, v. 36, n. 4, p. 827–839, 2016.

MORETTI, E. Local Multipliers. *American Economic Review*, v. 100, n. 2, p. 373–377, 2010.

MORETTI, E.; THULIN, P. Local multipliers and human capital in the United States and Sweden. *Industrial and Corporate Change*, v. 22, n. 1, p. 339–362, 2013.

NEFFKE, F.; HENNING, M.; BOSCHMA, R. How Do Regions Diversify over Time? Industry Relatedness and the Development of New Growth Paths in Regions. *Economic Geography*, v. 87, n. 3, p. 237–265, 2011.

PINHEIRO, F. et al. The Dark Side of the Geography of Innovation. Relatedness, Complexity, and Regional Inequality in Europe. Papers in Evolutionary Economic Geography (PEEG), n. 2202, 2022.

QUEIROZ, A. R.; ROMERO, J. P.; FREITAS, E. E. Economic complexity and employment in Brazilian states. *CEPAL Review*, p. 177–196, 2023.

QUEIROZ, A.R., ROMERO, J.P.; FREITAS, E.E. Relatedness and regional economic complexity: Good news for some, bad news for others. *EconomiA*, Vol. ahead-of-print No. ahead-of-print, 2024.

RIGBY, D. L. Technological Relatedness and Knowledge Space: Entry and Exit of US Cities from Patent Classes. *Regional Studies*, v. 49, n. 11, p. 1922–1937, 2015.

ROCHA, R. M.; ARAÚJO, B. C. Local multiplier effect of the tradable sector on the Brazilian labor market. *Letters in Spatial and Resource Science*s, v. 14, n. 3, p. 269–286, 2021.

Romero, J. P.; Freitas, E.; Silveira, F.; Britto, G., Cimini, F.; Jayme Jr., F. G. (2024). Complexity-based diversification strategies: a new method for ranking promising activities for regional diversification. *Spatial Economic Analysis*, 1–24.

STILWELL, F. J. B. Regional Growth and Structural Adaptation. *Urban Studies*, v. 6, n. 2, p. 162–178,

1969.
WANG, T.; CHANDA, A. Manufacturing growth and local employment multipliers in China. *Journal of Comparative Economics*, v. 46, n. 2, p. 515–543, 2018.

Appendix A.1 – Complexity Classification of Micro-Regions and Sectors

As in Queiroz et al. (2024), micro-regions were divided according to their complexity levels. The classification adopted considers the value of the regions' ECI and separates the regions into 4 distinct groups:

(1) *Low complexity:* micro-regions with an ECI up to 0.25.

(2) *Medium-low complexity:* micro-regions with an ECI between 0.25 and 0.50.

(3) *Medium-high complexity:* micro-regions with an ECI between 0.50 and 0.75.

(4) *High complexity:* micro-regions with an ECI above 0.75.

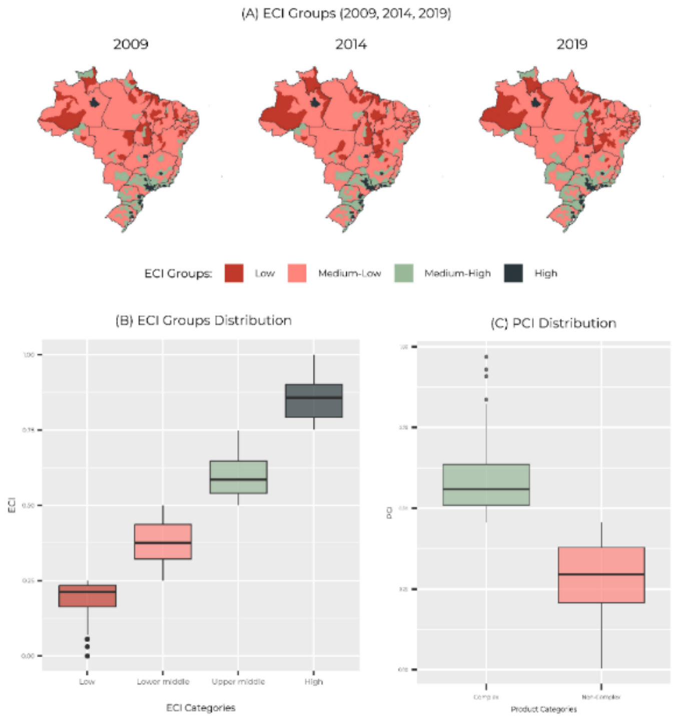
The existing literature has yet to establish a consensus on a method for classifying regions according to their complexity levels. While previous studies, such as Freitas (2024), often categorize regions based on the distribution of the ECI, this approach leads to the aggregation of regions with vastly different complexity levels. To overcome this, regions were assessed based on their individual index values. This approach allows for a more nuanced understanding of complexity levels, even if it results in groups with varying sizes. However, it's important to acknowledge that this strategy relies on setting arbitrary thresholds for differentiating ECI values.

The classification of complex and non-complex sectors in this study differs from the classification of tradables and non-tradables. As no other work has estimated multipliers for sectors of different complexity levels, a criteria was used to differentiate economic activities based on their Product Complexity Index (PCI). Two strategies were adopted. The first strategy is more aggressive, classifying activities in the last tertile of the PCI ranking as "complex" and those in the first and second tertiles as "non-complex". Additionally, robustness tests were conducted considering the PCI value itself, rather than its distribution. The second strategy categorizes activities as complex when they have a positive PCI and as non-complex when they have a negative PCI, before normalizing the indicator between 0 and 1. This classification includes many more sectors as complex compared to the previous categorization. The results are reported in Appendix A.2.

Figure A.1 provides a descriptive analysis of the classifications used for regions and productive activities according to their complexity. Figure A.1 (A) presents the micro-regions according to the ECI groups for the years considered in the analysis. It is observed that the level of complexity of the regions remains considerably constant in the years 2009, 2014, and 2019, showing few perceptible changes. The high and medium-high complexity groups are mainly concentrated in the South and Southeast regions, around large urban centers, while the low and medium-low complexity groups are located in more inland regions and also in the North, Northeast, and Midwest regions. Figure A.1 (B) presents the distribution of observations by complexity groups. It is observed that the complexity value is relatively close between each group, except for a few extreme values in the low complexity group. Finally, Figure A.1 (C) refers to the distribution of the complexity of activities according to the complexity of sectors. The complex sector has a more asymmetric distribution than the non-complex sector, with some outliers having a PCI close to 1.

Building on the analysis conducted by Rocha and Araújo (2021), the location quotient was calculated for both the complex sector (Figure A.2 (A)) and the non-complex sector (Figure A.2 (B)) to evaluate their distribution and specialization within the region. The data reveals that employment in the complex sector is more concentrated, especially in the Southeast and South regions. In contrast, employment in the non-complex sector shows a more even distribution across the entire territory, with a significant presence in all regions of the country. This distribution pattern supports the notion that non-complex activities are more susceptible to local dynamics and driven by local consumption.

Figure A.1 – Complexity Classification - Sectors[1] and Micro-regions[2]

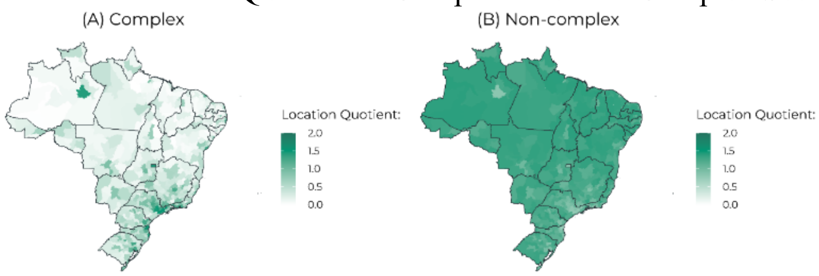


[1] Complex sectors are those falling within the third tertile of PCI values, while non-complex sectors are in the first and second tertiles.

[2] Micro-regions were categorized based on ECI: Low ($0,00 \leq ECI \leq 0,25$), Medium-low ($0,25 < ECI \leq 0,50$), Medium-high ($0,50 < ECI \leq 0,75$), High ($0,75 < ECI \leq 1,00$).

Source: authors' own elaboration.

Figure A.2 - Location Quotient of Complex and Non-Complex Sectors



Source: authors' own elaboration.

Appendix A.2 – Full Econometric Regressions and Robustness Tests

Table A.1 –Employment Multiplier of the Complex sector over Non-complex Employment – Brazil

	Dependent variable: Non-complex employment variation					
	OLS	OLS	IV1	IV1	IV2	IV2
	(1)	(2)	(3)	(4)	(5)	(6)
Complex emp. variation	1.757***	1.711***	2.246***	2.360***	1.878***	1.866***
	(0.351)	(0.371)	(0.326)	(0.318)	(0.323)	(0.334)
Skilled emp. share		189,349		97,949		167,492
		(137.268)		(93.460)		(109.712)
Average salary		−16.257		4,288		−11.344
		(11.647)		(25.084)		(10.863)
Relatedness		954.090***		98,842		749.570*
		(352.331)		(1,010.238)		(404.533)
Population		−0.001		−0.005*		−0.002
		(0.006)		(0.003)		(0.002)
Constant	6,635.350***	−1,862.114	5,155.273***	2.346,926	6,269.919***	−855.585
	(1,082.038)	(1,457.763)	(818.358)	(3,602.602)	(831.705)	(1,287.591)
Observations	1.116	1.116	1.116	1.116	1.116	1.116
R^2	0,705	0,717	0,703	0,705	0,705	0,716
Adjusted R^2	0,705	0,716	0,702	0,703	0,705	0,715
Residual Std. Error	16.806,120	16.498,140				
F Statistic	1,332.936***	468.713***	2,333.715***	2,455.329***	2,860.256***	3,063.636***

Note: *p<0.1; **p<0.05; ***p<0.01.

Table A.2 – Employment Multiplier of the Complex sector over Non-complex Employment – Low complexity regions

	Dependent variable: Non-complex employment variation					
	OLS	OLS	IV1	IV1	IV2	IV2
	(1)	(2)	(3)	(4)	(5)	(6)
Complex emp. variation	−2.260	−1.904	1,948	1,333	−2.712	−2.450
	(2.014)	(1.852)	(4.661)	(4.613)	(2.426)	(1.932)
Skilled emp. share		−10.482		−13.708		−9.938
		(13.905)		(12.546)		(11.307)
Average salary		−21.962**		−24.147***		−21.593***
		(9.010)		(7.733)		(7.669)
Relatedness		646.410***		740.381***		630.549***
		(241.171)		(252.101)		(222.223)
Population		0.010***		0.009***		0.010***
		(0.002)		(0.002)		(0.002)
Constant	1,755.006***	313,579	1,616.346***	174,052	1,769.886***	337,129
	(353.117)	(454.079)	(430.854)	(373.606)	(365.433)	(324.723)
Observations	84	84	84	84	84	84
R^2	0,131	0,421	0,080	0,391	0,130	0,420
Adjusted R^2	0,109	0,376	0,057	0,343	0,109	0,375
Residual Std. Error	1.677,151	1.403,568				
F Statistic	6.080***	9.336***	10.077***	51.858***	12.499***	56.520***

Note: *p<0.1; **p<0.05; ***p<0.01.

Table A.3 – Employment Multiplier of the Complex sector over Non-complex Employment – Medium-Low complexity regions

	Dependent variable: Non-complex employment variation					
	OLS	OLS	IV1	IV1	IV2	IV2
	(1)	(2)	(3)	(4)	(5)	(6)
Complex emp. variation	1.736**	0,826	22,172	19,534	2.202***	1.146*
	(0.780)	(0.613)	(20.851)	(18.963)	(0.794)	(0.602)
Skilled emp. share		29,340		−68.261		27,674
		(29.461)		(84.695)		(21.780)
Average salary		−8.927***		−15.880		−9.046**
		(3.312)		(13.896)		(3.586)
Relatedness		535.126***		194,948		529.319***
		(110.584)		(474.058)		(117.959)
Population		0.009***		−0.006		0.009***
		(0.002)		(0.020)		(0.002)
Constant	3,854.759***	−781.069	−1,868.199	2.668,596	3,724.303***	−722.186
	(298.359)	(785.104)	(5,800.894)	(3,274.697)	(286.111)	(639.169)
Observations	678	678	678	678	678	678
R^2	0,249	0,392	0,084	0,064	0,247	0,391
Adjusted R^2	0,247	0,387	0,081	0,056	0,244	0,386
Residual Std. Error	4.095,395	3.695,021				
F Statistic	112.050***	72.250***	25.246***	52.477***	244.952***	440.894***

Note: *p<0.1; **p<0.05; ***p<0.01

Table A.4 – Employment Multiplier of the Complex sector over Non-complex Employment – Medium-High complexity regions

	Dependent variable: Non-complex employment variation					
	OLS	OLS	IV1	IV1	IV2	IV2
	(1)	(2)	(3)	(4)	(5)	(6)
Complex emp. variation	1.952***	1.860***	3.249***	3.504***	2.049***	1.984***
	(0.293)	(0.320)	(0.316)	(0.439)	(0.291)	(0.339)
Skilled emp. share		46,610		−156.636		31,177
		(195.341)		(200.930)		(188.676)
Average salary		−11.811***		−3.768		−11.200***
		(4.524)		(4.974)		(4.149)
Relatedness		580.041***		359.693*		563.309***
		(203.150)		(197.803)		(178.600)
Population		0,002		−0.009		0,002
		(0.004)		(0.007)		(0.004)
Constant	9,662.240***	4.004,793	5,628.124***	6,168.414*	9,362.184***	4.169,087
	(936.456)	(3,719.961)	(1,005.297)	(3,589.663)	(902.486)	(3,580.855)
Observations	286	286	286	286	286	286
R^2	0,653	0,668	0,612	0,607	0,652	0,667
Adjusted R^2	0,650	0,661	0,610	0,599	0,650	0,660
Residual Std. Error	9.217,099	9.082,166				
F Statistic	266.085***	93.428***	452.372***	457.337***	546.452***	573.602***

Note: *p<0.1; **p<0.05; ***p<0.01

Table A.5 –Employment Multiplier of the Complex sector over Non-complex Employment – High complexity regions

	Dependent variable: Non-complex employment variation					
	OLS	OLS	IV1	IV1	IV2	IV2
	(1)	(2)	(3)	(4)	(5)	(6)
Complex emp. variation	1.564***	1.514***	2.178***	2.393***	1.713***	1.717***
	(0.391)	(0.374)	(0.394)	(0.447)	(0.365)	(0.342)
Skilled emp. share		3.191,032		−152.729		2.415,835
		(2,482.336)		(2,685.871)		(2,201.685)
Average salary		−58.344		48,504		−33.573
		(55.506)		(107.614)		(40.620)
Relatedness		1.462,201		−2,496.765		544,379
		(2,015.385)		(4,649.433)		(1,904.817)
Population		0,001		−0.008		−0.001
		(0.009)		(0.007)		(0.003)
Constant	31,845.440**	−4,265.097	11.092,800	40.474,100	26,828.230***	6.106,969
	(13,686.980)	(30,416.180)	(12,143.970)	(53,352.000)	(9,957.823)	(31,554.320)
Observations	68	68	68	68	68	68
R^2	0,743	0,755	0,724	0,717	0,741	0,752
Adjusted R^2	0,735	0,731	0,716	0,689	0,733	0,728
Residual Std. Error	61.867,360	62.336,340				
F Statistic	93.816***	31.307***	155.795***	148.934***	199.652***	200.799***

Note: *p<0.1; **p<0.05; ***p<0.01

Table A.6 – Employment Multiplier of the Non-complex sector over Complex Employment - Brazil

	Dependent variable: Complex employment variation					
	OLS	OLS	IV₁	IV₁	IV₂	IV₂
	(1)	(2)	(3)	(4)	(5)	(6)
Non-complex emp. variation	0.390***	0.379***	0.446***	0.428***	0.395***	0.375***
	(0.050)	(0.040)	(0.057)	(0.047)	(0.054)	(0.046)
Skilled emp. share		−22.396		−43.374		−20.723
		(55.198)		(44.677)		(42.455)
Average salary		−4.943		−1.510		−5.216
		(10.222)		(8.558)		(8.716)
Relatedness		100.566		−55.863		113.039
		(404.133)		(339.486)		(348.056)
Population		0.003		0.002*		0.003**
		(0.002)		(0.001)		(0.001)
Constant	−1,630.818***	−1,569.569	−2,302.735***	−937.847	−1,693.986***	−1,619.941
	(443.129)	(1,198.809)	(526.413)	(1,080.785)	(485.105)	(1,151.255)
Observations	1.116	1.116	1.116	1.116	1.116	1.116
R^2	0,692	0,704	0,692	0,703	0,692	0,704
Adjusted R^2	0,691	0,703	0,691	0,701	0,691	0,703
Residual Std. Error	7.914,573	7.767,226				
F Statistic	1,249.502***	440.224***	2,502.499***	2,689.932***	2,451.324***	2,579.722***

Note: *p<0.1; **p<0.05; ***p<0.01

Table A.7 – Employment Multiplier of the Non-complex sector over Complex Employment – Low complexity regions

	Dependent variable: Complex employment variation					
	OLS	OLS	IV₁	IV₁	IV₂	IV₂
	(1)	(2)	(3)	(4)	(5)	(6)
Non-complex emp. variation	−0.008*	−0.010*	−0.010**	0,001	−0.009**	−0.011***
	(0.004)	(0.006)	(0.005)	(0.010)	(0.004)	(0.004)
Skilled emp. share		0,879		1,007		0,861
		(0.926)		(0.778)		(0.712)
Average salary		0,453		0,694		0,420
		(0.346)		(0.494)		(0.347)
Relatedness		−22.334		−29.590		−21.320
		(16.626)		(24.364)		(19.428)
Population		0,0002		0,0001		0,0002
		(0.0002)		(0.0002)		(0.0002)
Constant	46.523*	45,315	49.623**	42,921	47.449**	45,650
	(24.678)	(34.691)	(23.105)	(41.260)	(23.405)	(43.501)
Observations	84	84	84	84	84	84
R_2	0,026	0,090	0,026	0,071	0,026	0,090
Adjusted R_2	0,002	0,019	0,002	−0,002	0,002	0,019
Residual Std. Error	100,244	99,376				
F Statistic	1,095	1,275	1,546	6,097	2,324	8,015

Note: *p<0.1; **p<0.05; ***p<0.01.

Table A.8 – Employment Multiplier of the Non-complex sector over Complex Employment – Medium-Low complexity regions

	Dependent variable: Complex employment variation					
	OLS	OLS	IV₁	IV₁	IV₂	IV₂
	(1)	(2)	(3)	(4)	(5)	(6)
Non-complex emp. variation	0.036***	0.020*	0.052**	0,046	0.042***	0.025**
	(0.010)	(0.011)	(0.025)	(0.031)	(0.011)	(0.011)
Skilled emp. share		4,560		3,659		4,377
		(4.003)		(3.693)		(3.797)
Average salary		0,540		0,771		0,587
		(0.545)		(0.590)		(0.572)
Relatedness		7,441		−7.285		4,447
		(16.630)		(20.488)		(18.427)
Population		0.001**		0,0004		0,001
		(0.0003)		(0.001)		(0.0004)
Constant	124.870***	−166.171**	56,149	−141.186**	98.799**	−161.092**
	(40.343)	(74.941)	(108.173)	(69.917)	(45.693)	(69.605)
Observations	678	678	678	678	678	678
R_2	0,085	0,150	0,083	0,133	0,084	0,149
Adjusted R_2	0,082	0,142	0,080	0,125	0,082	0,141
Residual Std. Error	587,623	568,035				
F Statistic	31.198***	19.688***	49.188***	120.827***	77.498***	124.621***

Note: *p<0.1; **p<0.05; ***p<0.01

Table A.9 – Employment Multiplier of the Non-complex sector over Complex Employment – Medium-High complexity regions

	Dependent variable: Complex employment variation					
	OLS	OLS	IV₁	IV₁	IV₂	IV₂
	(1)	(2)	(3)	(4)	(5)	(6)
Non-complex emp. variation	0.223***	0.185***	0.285***	0.277***	0.241***	0.189***
	(0.038)	(0.033)	(0.036)	(0.041)	(0.033)	(0.039)
Skilled emp. share		72,399		47,026		71,237
		(61.732)		(56.360)		(47.905)
Average salary		−1.019		0.900		−0.931
		(1.499)		(1.391)		(1.462)
Relatedness		−19.585		−95.689*		−23.071
		(52.492)		(53.969)		(54.235)
Population		0.004**		0.003		0.004***
		(0.002)		(0.002)		(0.001)
Constant	−395.127	−1,604.384*	−1,366.347***	−1,747.367*	−687.182	−1,610.934**
	(491.399)	(974.305)	(480.487)	(1.037.250)	(452.373)	(789.383)
Observations	286	286	286	286	286	286
R^2	0,505	0,587	0,500	0,564	0,504	0,586
Adjusted R^2	0,502	0,578	0,497	0,554	0,501	0,578
Residual Std. Error	3.114,047	2.866,343				
F Statistic	144.359***	65.967***	275.378***	400.046***	313.411***	397.771***

Note: *p<0.1; **p<0.05; ***p<0.01.

Table A.10 – Employment Multiplier of the Non-complex sector over Complex Employment – High complexity regions

	Dependent variable: Complex employment variation					
	OLS	OLS	IV₁	IV₁	IV₂	IV₂
	(1)	(2)	(3)	(4)	(5)	(6)
Non-complex emp. variation	0.397***	0.367***	0.470***	0.429***	0.406***	0.363***
	(0.061)	(0.062)	(0.066)	(0.057)	(0.068)	(0.064)
Skilled emp. share		519,451		−32.061		551,618
		(973.918)		(935.670)		(892.323)
Average salary		−32.608		−17.674		−33.480
		(42.528)		(34.549)		(33.583)
Relatedness		1.464,970		954,748		1.494,728
		(1,973.919)		(1,547.434)		(1,497.905)
Population		0,004		0.003		0.004*
		(0.003)		(0.002)		(0.003)
Constant	180.175	−21,054.210	−6,057.145	−16,044.010	−579.861	−21,346.430
	(3,809.242)	(19,788.340)	(3,942.946)	(18,464.360)	(4,398.631)	(17,987.960)
Observations	68	68	68	68	68	68
R^2	0,710	0,736	0,706	0,732	0,710	0,736
Adjusted R^2	0,702	0,710	0,697	0,705	0,701	0,710
Residual Std. Error	31.160,470	30.695,850				
F Statistic	79.732***	28.385***	157.040***	172.192***	159.020***	168.067***

Note: *p<0.1; **p<0.05; ***p<0.01.

Table A.11 – Employment Multiplier of the Complex sector over Non-complex Employment – Brazil: Alternative classification by PCI

	Dependent variable: Non-complex employment variation					
	OLS	OLS	IV₁	IV₁	IV₂	IV₂
	(1)	(2)	(3)	(4)	(5)	(6)
Complex emp. variation	0.999***	1.028***	1.066***	1.176***	0.997***	1.064***
	(0.105)	(0.097)	(0.066)	(0.039)	(0.075)	(0.063)
Skilled emp. share		96,728		61,921		88,142
		(73.833)		(61.693)		(65.796)
Average salary		−8.213		−1.327		−6.515
		(6.676)		(11.352)		(7.638)
Relatedness		559.590**		268.539		487.799*
		(232.639)		(433.044)		(269.444)
Population		−0.005*		−0.006*		−0.005*
		(0.003)		(0.003)		(0.003)
Constant	4,312.912***	365,142	3,955.080***	1.818,492	4,322.209***	723,624
	(550.285)	(996.362)	(318.825)	(1,598.182)	(367.036)	(984.612)
Observations	1.116	1.116	1.116	1.116	1.116	1.116
R^2	0,803	0,841	0,803	0,838	0,803	0,841
Adjusted R^2	0,803	0,840	0,803	0,837	0,803	0,840
Residual Std. Error	10.647,080	9.597,411				
F Statistic	2,272.685***	975.795***	3,935.483***	5,287.281***	4,377.301***	6,049.851***

Note: *p<0.1; **p<0.05; ***p<0.01.

Table A.12 – Employment Multiplier of the Complex sector over Non-complex Employment – Low complexity regions: Alternative classification by PCI

	Dependent variable: Non-complex employment variation					
	OLS	OLS	IV_1	IV_1	IV_2	IV_2
	(1)	(2)	(3)	(4)	(5)	(6)
Complex emp. variation	0,144	−0.593	−1.986	−1.679	0,527	−0.505
	(1.313)	(1.072)	(11.254)	(8.810)	(1.503)	(0.782)
Skilled emp. share		−11.781		−10.719		−11.867
		(14.355)		(12.750)		(11.775)
Average salary		−22.816**		−22.166***		−22.869***
		(8.863)		(7.452)		(8.138)
Relatedness		679.773***		660.766***		681.321***
		(240.649)		(211.839)		(255.261)
Population		0.010***		0.010***		0.010***
		(0.002)		(0.003)		(0.002)
Constant	1,641.155***	261,404	1,775.822**	296,669	1,616.955***	258,533
	(338.490)	(430.491)	(879.293)	(383.085)	(342.091)	(306.152)
Observations	84	84	84	84	84	84
R^2	0,114	0,408	0,097	0,404	0,113	0,408
Adjusted R^2	0,092	0,362	0,075	0,357	0,091	0,362
Residual Std. Error	1,676.910 (df = 81)	1,405.747				
F Statistic	5.202***	8.845***	10.228***	52.543***	10.479***	52.999***

Note: *p<0.1; **p<0.05; ***p<0.01.

Table A.13 – Employment Multiplier of the Complex sector over Non-complex Employment – Medium-Low complexity regions: Alternative classification by PCI

	Dependent variable: Non-complex employment variation					
	OLS	OLS	IV_1	IV_1	IV_2	IV_2
	(1)	(2)	(3)	(4)	(5)	(6)
Complex emp. variation	1.799***	1.407***	3.341***	3.072***	2.001***	1.633***
	(0.363)	(0.368)	(0.464)	(0.540)	(0.376)	(0.397)
Skilled emp. share		30,566		24,826		29,787
		(25.513)		(24.332)		(20.702)
Average salary		−9.159***		−9.789***		−9.245***
		(2.942)		(3.603)		(3.326)
Relatedness		416.782***		312.004**		402.560***
		(99.839)		(123.299)		(104.846)
Population		0.005***		0,001		0.004**
		(0.002)		(0.002)		(0.002)
Constant	2,577.400***	−200.015	1,451.190***	434,527	2,429.568***	−113.885
	(260.111)	(691.658)	(344.099)	(581.341)	(228.005)	(535.392)
Observations	678	678	678	678	678	678
R^2	0,390	0,446	0,357	0,391	0,389	0,445
Adjusted R^2	0,389	0,441	0,355	0,386	0,388	0,440
Residual Std. Error	3,365,879	3,217,535				
F Statistic	216.220***	90.152***	327.642***	456.230***	465.665***	563.294***

Note: *p<0.1; **p<0.05; ***p<0.01.

Table A.14 – Employment Multiplier of the Complex sector over Non-complex Employment – Medium-High complexity regions: Alternative classification by PCI

	Dependent variable: Non-complex employment variation					
	OLS	OLS	IV_1	IV_1	IV_2	IV_2
	(1)	(2)	(3)	(4)	(5)	(6)
Complex emp. variation	1.015***	1.103***	1.489***	1.662***	1.039***	1.157***
	(0.111)	(0.173)	(0.200)	(0.253)	(0.105)	(0.188)
Skilled emp. share		42,180		−52.903		32,934
		(164.167)		(157.954)		(157.862)
Average salary		−7.788**		−3.002		−7.322**
		(3.946)		(3.353)		(3.121)
Relatedness		457.385***		322.990**		444.316***
		(172.661)		(146.297)		(142.521)
Population		−0.004		−0.010**		−0.004
		(0.004)		(0.004)		(0.003)
Constant	6,802.463***	2,766,596	3,969.230***	3,437,298	6,659.012***	2,831,819
	(699.598)	(2,967.211)	(1,079.046)	(2,666.405)	(651.711)	(2,799.737)
Observations	286	286	286	286	286	286
R^2	0,652	0,674	0,629	0,648	0,652	0,674
Adjusted R^2	0,650	0,667	0,626	0,640	0,650	0,667
Residual Std. Error	7,752,148	7,560,655				
F Statistic	265.440***	96.105***	497.866***	531.921***	535.233***	586.689***

Note: *p<0.1; **p<0.05; ***p<0.01.

Table A.15 – Employment Multiplier of the Complex sector over Non-complex Employment – High complexity regions - Alternative classification by PCI

	Dependent variable: Non-complex employment variation					
	OLS	OLS	IV_1	IV_1	IV_2	IV_2
	(1)	(2)	(3)	(4)	(5)	(6)
Complex emp. variation	0.934***	0.977***	1.023***	1.190***	0.938***	1.027***
	(0.115)	(0.083)	(0.069)	(0.078)	(0.085)	(0.052)
Skilled emp. share		779,453		−504.135		481,939
		(1,406.949)		(1,405.941)		(1,289.456)
Average salary		−16.313		20,947		−7.677
		(33.743)		(49.254)		(32.473)
Relatedness		262,793		−1,079.397		−48.304
		(1,407.900)		(2,022.342)		(1,334.442)
Population		−0.005		−0.008		−0.005
		(0.003)		(0.005)		(0.004)
Constant	11,866.190*	15.630,890	6,963.532*	31.478,650	11,683.100***	19.304,140
	(6,359.463)	(20,850.930)	(4,210.323)	(25,900.780)	(4,207.490)	(20,549.060)
Observations	68	68	68	68	68	68
R^2	0,841	0,877	0,840	0,868	0,841	0,876
Adjusted R^2	0,836	0,864	0,835	0,855	0,836	0,864
Residual Std. Error	37.435,370	34.080,850				
F Statistic	172.342***	72.217***	304.936***	377.436***	337.955***	445.285***

Note: *p<0.1; **p<0.05; ***p<0.01.

Table A.16 – Employment Multiplier of the Non-complex sector over Complex Employment – Brazil: Alternative classification by PCI

	Dependent variable: Complex employment variation					
	OLS	OLS	IV_1	IV_1	IV_2	IV_2
	(1)	(2)	(3)	(4)	(5)	(6)
Non-complex emp. variation	0.788***	0.780***	0.904***	0.839***	0.812***	0.769***
	(0.101)	(0.068)	(0.051)	(0.024)	(0.046)	(0.044)
Skilled emp. share		−28.844		−48.895		−25.336
		(58.571)		(53.541)		(53.252)
Average salary		−2.809		0,508		−3.389
		(9.599)		(8.454)		(8.609)
Relatedness		−46.901		−199.739		−20.161
		(373.295)		(313.985)		(324.514)
Population		0.006***		0.006**		0.006**
		(0.002)		(0.003)		(0.003)
Constant	−2,262.525***	−2,228.733*	−3,380.496***	−1,653.450	−2,496.451***	−2,329.382*
	(801.776)	(1,242.802)	(339.895)	(1,139.275)	(283.250)	(1,208.741)
Observations	1.116	1.116	1.116	1.116	1.116	1.116
R^2	0,793	0,839	0,793	0,838	0,793	0,839
Adjusted R^2	0,793	0,838	0,792	0,837	0,793	0,838
Residual Std. Error	9.455,032	8.359,529				
F Statistic	2,135.419***	963.065***	4,040.601***	5,491.577***	4,332.588***	5,607.049***

Note: *p<0.1; **p<0.05; ***p<0.01.

Table A.17 – Employment Multiplier of the Non-complex sector over Complex Employment - Low complexity regions: Alternative classification by PCI

	Dependent variable: Complex employment variation					
	OLS	OLS	IV_1	IV_1	IV_2	IV_2
	(1)	(2)	(3)	(4)	(5)	(6)
Non-complex emp. variation	0,001	−0.004	0,001	0,015	0,001	−0.005
	(0.006)	(0.006)	(0.012)	(0.017)	(0.006)	(0.005)
Skilled emp. share		0,930		1,166		0,914
		(1.052)		(0.944)		(0.851)
Average salary		0,511		0.952*		0,479
		(0.421)		(0.507)		(0.396)
Relatedness		−14.881		−28.024		−13.944
		(17.828)		(24.700)		(20.179)
Population		0,0002		0,00002		0,0002
		(0.0002)		(0.0002)		(0.0002)
Constant	62.112**	33,387	61.552**	28,775	62.199**	33,716
	(25.636)	(38.033)	(28.414)	(41.702)	(24.791)	(43.706)
Observations	84	84	84	84	84	84
R^2	0,021	0,098	0,021	0,059	0,021	0,097
Adjusted R^2	−0.003	0,027	−0.003	−0.014	−0.003	0,027
Residual Std. Error	114,188	112,444				
F Statistic	0,872	1,388	1,743	8,734	1,743	8,458

Note: *p<0.1; **p<0.05; ***p<0.01.

Table A.18 – Employment Multiplier of the Non-complex sector over Complex Employment – Medium-Low complexity regions: Alternative classification by PCI

	Dependent variable: Complex employment variation					
	OLS	OLS	IV₁	IV₁	IV₂	IV₂
	(1)	(2)	(3)	(4)	(5)	(6)
Non-complex emp. variation	0.128***	0.090***	0.205***	0.204***	0.139***	0.097***
	(0.021)	(0.018)	(0.041)	(0.050)	(0.027)	(0.021)
Skilled emp. share		0,260		−3.763		0.012
		(6.012)		(5.998)		(5.301)
Average salary		1,155		2.135**		1,216
		(0.741)		(0.990)		(0.741)
Relatedness		17,459		−39.949		13,915
		(22.577)		(35.605)		(23.775)
Population		0.002***		0,001		0.002***
		(0.0004)		(0.001)		(0.0005)
Constant	232.376***	−314.945***	−66.165	−231.276*	190.150*	−309.779***
	(74.975)	(104.668)	(160.458)	(127.266)	(97.309)	(97.237)
Observations	678	678	678	678	678	678
R^2	0,270	0,404	0,263	0,346	0,270	0,403
Adjusted R^2	0,268	0,398	0,261	0,340	0,268	0,398
Residual Std. Error	897,734	813,757				
F Statistic	124.858***	75.736***	185.997***	387.741***	280.595***	467.634***

Note: *p<0.1; **p<0.05; ***p<0.01.

Table A.19 – Employment Multiplier of the Non-complex sector over Complex Employment – Medium-High complexity regions: Alternative classification by PCI

	Dependent variable: Complex employment variation					
	OLS	OLS	IV₁	IV₁	IV₂	IV₂
	(1)	(2)	(3)	(4)	(5)	(6)
Non-complex emp. variation	0.418***	0.345***	0.543***	0.525***	0.471***	0.359***
	(0.079)	(0.051)	(0.064)	(0.069)	(0.074)	(0.064)
Skilled emp. share		90,816		49,442		87,772
		(93.348)		(86.414)		(73.578)
Average salary		−2.615		0,487		−2.386
		(2.465)		(2.039)		(2.307)
Relatedness		−8.969		−139.039*		−18.538
		(94.449)		(79.502)		(87.174)
Population		0.009***		0.007***		0.009***
		(0.002)		(0.001)		(0.001)
Constant	599,071	−1,698.526	−1,007.929	−1,958.160	−79.365	−1,717.626
	(842.091)	(1,472.606)	(694.498)	(1,507.178)	(842.630)	(1,129.445)
Observations	286	286	286	286	286	286
R^2	0,524	0,660	0,517	0,633	0,522	0,660
Adjusted R^2	0,520	0,653	0,513	0,625	0,519	0,653
Residual Std. Error	4.972,767	4.230,193				
F Statistic	155.662***	90.382***	291.069***	515.041***	349.383***	549.036***

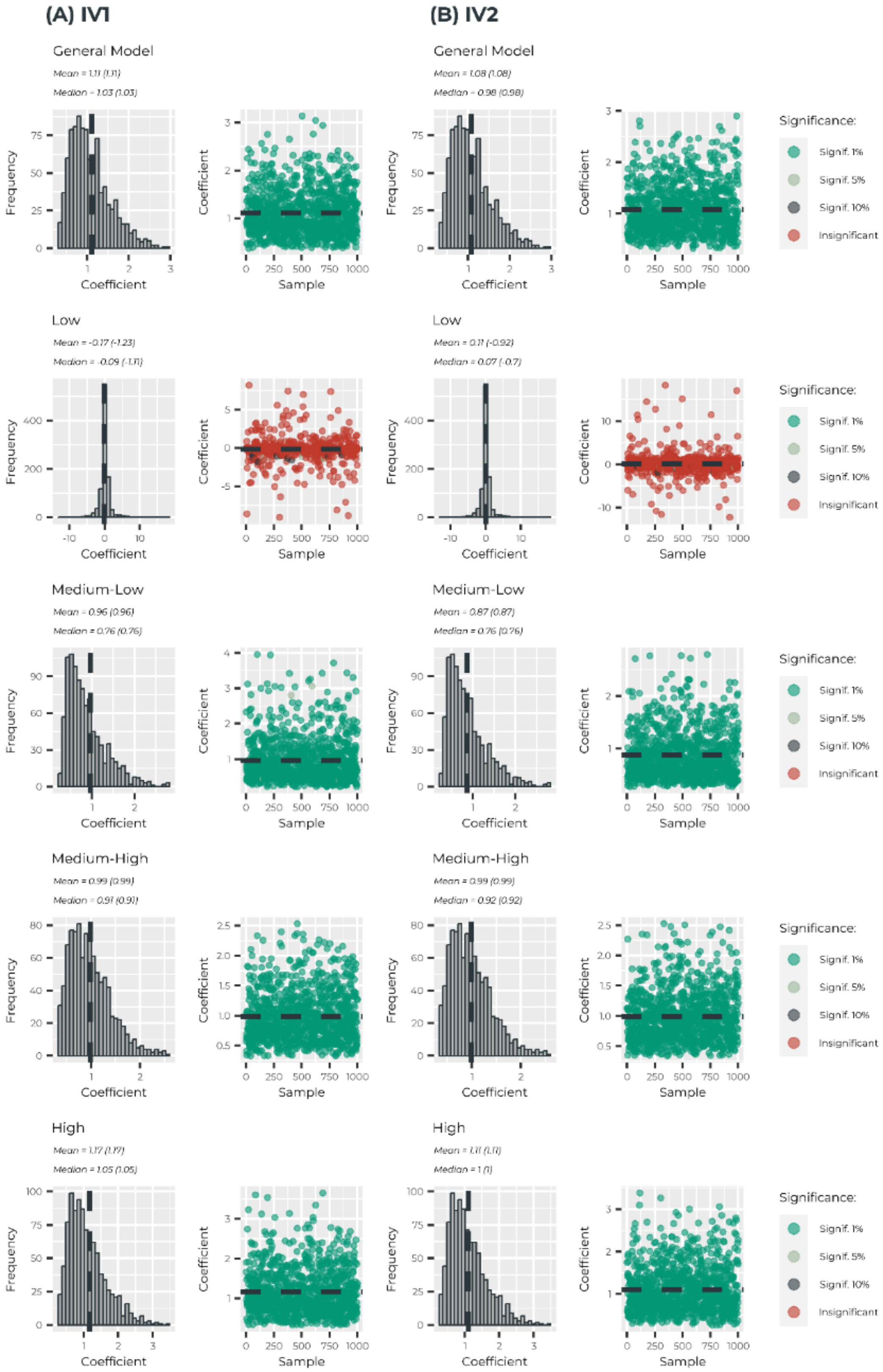
Note: *p<0.1; **p<0.05; ***p<0.01.

Table A.20 – Employment Multiplier of the Non-complex sector over Complex Employment – High complexity regions: Alternative classification by PCI

	Dependent variable: Complex employment variation					
	OLS	OLS	IV₁	IV₁	IV₂	IV₂
	(1)	(2)	(3)	(4)	(5)	(6)
Non-complex emp. variation	0.816***	0.790***	0.958***	0.843***	0.845***	0.778***
	(0.122)	(0.090)	(0.044)	(0.027)	(0.038)	(0.052)
Skilled emp. share		763,086		409,629		844,896
		(1,021.613)		(1,051.104)		(1,057.935)
Average salary		−27.138		−17.211		−29.436
		(40.048)		(35.010)		(34.755)
Relatedness		1.234,200		893,755		1.312,998
		(1,818.144)		(1,471.889)		(1,454.675)
Population		0.007**		0.007*		0.007*
		(0.004)		(0.004)		(0.004)
Constant	3.425,726	−29,372.390	−5,567.473**	−26,341.440	1.572,597	−30,073.930
	(6,393.797)	(20,538.380)	(2,768.934)	(19,683.990)	(3,706.937)	(19,590.250)
Observations	68	68	68	68	68	68
R_2	0,825	0,874	0,821	0,873	0,825	0,874
Adjusted R_2	0,820	0,862	0,815	0,861	0,820	0,862
Residual Std. Error	34.986,000	30.638,590				
F Statistic	153.567***	70.705***	280.847***	403.972***	311.900***	415.117***

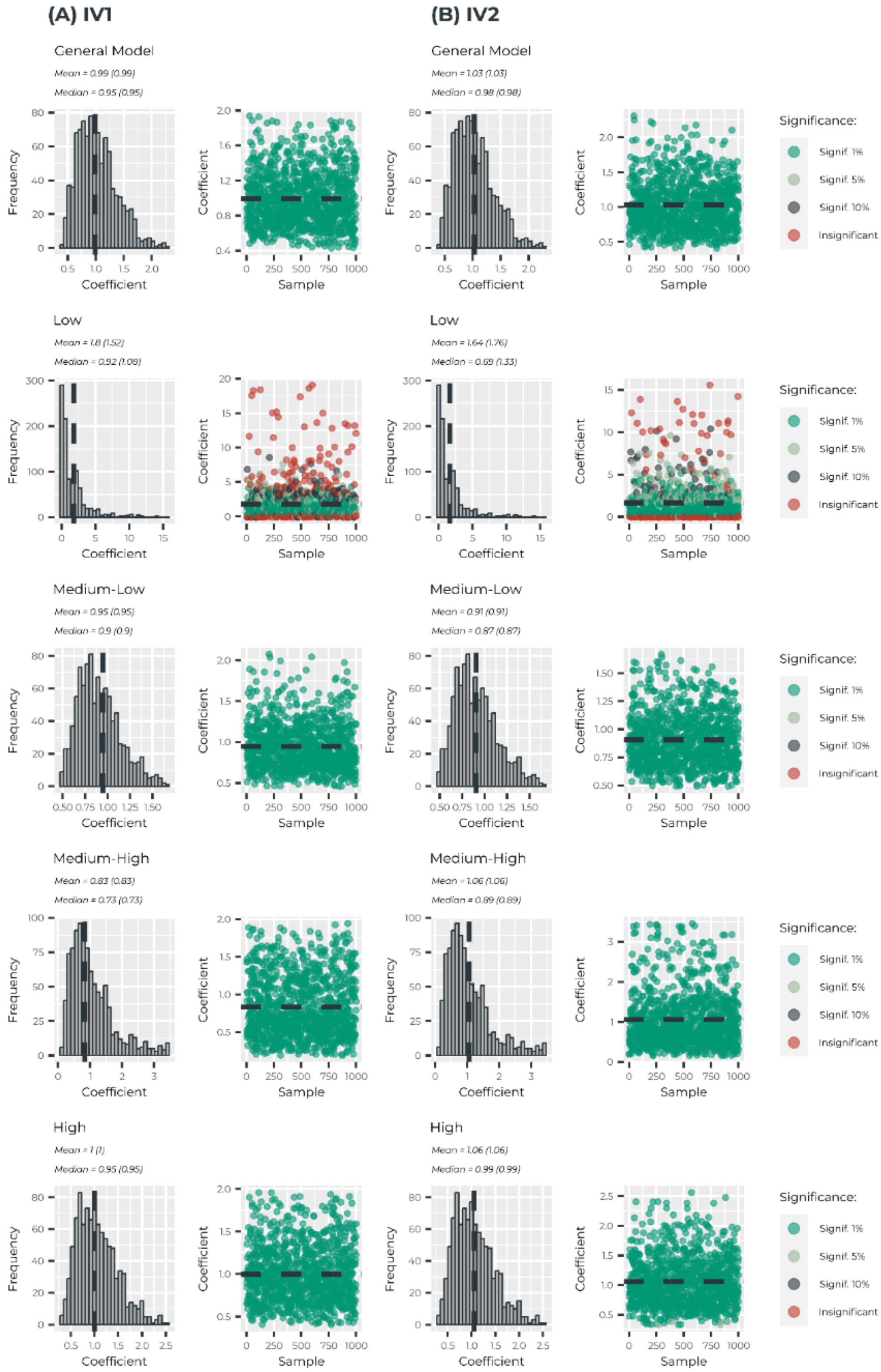
Note: *p<0.1; **p<0.05; ***p<0.01.

Figure A.3 - Complex-Complex Multiplier: Alternative classification by PCI



Source: authors' own elaboration.

Figure A.4 – Non-Complex-Non-Complex Multiplier: Alternative classification by PCI



Source: authors' own elaboration.