The STEM Wage Premium in the Main Brazilian Technology Clusters

P. Bonini* and C. F. Custodio

***Abstract*—This paper reports research results on Science Technology Engineering and Mathematics – STEM – wage premium in 10 main Brazilian technologic clusters: Manaus, Ilhéus-Itabuna, Belo Horizonte, Pouso Alegre, Curitiba, Porto Alegre, Florianópolis, Campinas, São Carlos and São Paulo. The study adjusts the Oaxaca decomposition method – which allows using the workers' occupation as a categorical variable – to estimate the median of the STEM wage premium in each of the clusters. The control variables are age, educational level, and experience, which are proxy variables for human capital. Inspection of data reveals that the STEM workforce is more educated and has more stability in the job. The statistical analysis suggests that the median of the STEM wage premium obtained by workers in the ten clusters is higher than observed in development countries. This may indicate that Brazilian STEM labor force should will is still grow to meet demand.**

***Index Terms*—Average wage difference, STEM wage premium, technology clusters**

I. Introduction

The Information and Communication Technology (ICT) industry is intricately linked to productive innovation and depends on complex processes. Also, the proximity to universities and research centers favors ICT endeavors. Decades of government efforts to encourage the emergence and maintenance of universities in Brazil have resulted in the spread of ICT nationwide. Technology clusters, always associated with universities and research centers, are characteristic of modern economies and are found throughout the country.

An essential feature of the ICT industry is the use of skilled labor with technical or scientific expertise, mostly from the set of areas referred to as STEM[1] (Science, Technology, Engineering, and Math). In the last three decades, the technological race induced governments in developed and emerging countries to give considerable attention to STEM careers qualification. This concern is justified by the prospect of growth in demand for STEM skilled workers and researchers. Indeed, STEM occupations have paid higher wages and offered better job prospects around the world. The quantitative analysis of the STEM wage advantage may indicate how close are demand and supply of STEM qualified workers. The thread running through this research is the assumption that, for being locus of intense interaction between workstations and teaching institutions, technologic clusters are national spots of STEM labor market. As such, the observation of high STEM wage advantages in cities that harbor technology cluster may suggest that the demand for STEM workers in Brazil is still ahead its supply.

In this context, the present paper aims to evaluate the STEM wage premium in ten important ICT technology clusters spread nationwide. These clusters are characterized by the universities, research centers, technology-based companies, incubators, technology parks, and other institutions that create an environment conducive to innovation, and that house the ICT sector.

II. Contextual and Theoretical Aspects

The world's production structure changed profoundly in the 1970s led to the growing importance of high-tech clusters. As pointed out by Carvalho and Chaves [1], the implications of these transformations started to occur in Brazil in the 1990s, in a process that decentralized the development of productive activities throughout the country, intensifying the resulting in the emergence of technology clusters.

The technology clusters studied in the present article were established close to universities, which emphasize the role of these institutions in enhancing the industry's knowledge spillovers and the companies' capacity to innovate [1]. Cooperation between universities and various small and medium-sized companies established in a technology cluster boosts research and development (R&D), which is an area that represents a challenge for small companies.

Porter [2] establishes the economic role of clusters for the regional competitiveness. Clusters are defined as the spatial concentration of producers with rare competitive success. According to Krugman [3], the concentration of production in specific locations occurs when there are external economies of scale that reduce the costs of the industry, even if each firm remains small. Clusters of a given industry have advantages in comparison to dispersed businesses because of the easy access to specialized support, the concentration of specialized workforce to meet the joint demand, and knowledge spillovers regarding the industry's production process. The latter is a crucial factor in highly innovative industries, considering the continuous innovation around the businesses.

The main cities identifying the clusters' territories selected in this study are Manaus, Ilhéus-Itabuna, Belo Horizonte, Pouso Alegre, Campinas, São Carlos, and São Paulo, Curitiba, Porto Alegre and Florianópolis. The research covered 31 municipalities that form ten regions. For each cluster, the study considered the municipalities that had a GDP higher than 4.5% of their Intermediate Geographic Region (RGI) GDP, between 2002 and 2019. Instituto

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[1] Careers and occupations that the US government considers STEM can be retrieved from http://nces.ed.gov/pubs2009/2009081.pdf.

Brasileiro de Geografia e Estatistica [4] provides the RGIs and the municipalities that form these regions[2]. Table A.1 of the Appendix lists the universities in each cluster and briefly exposes their characteristics and specialization.

In terms of STEM labor in Brazil, the research by Seemann *et al.* [5, 6] is the first effort to categorize core STEM labor force in Brazil. Based on the criteria of the US Department of Statistics, they find that in 2015, the Brazilian core STEM workforce accounted for 1,19% of total labor force. In Santa Catarina State, the estimated STEM wage premium was around 61%. In the United States, according to according to Langdon *et al.* [7], core STEM workforce represented 5.5% and, on average, STEM workers earned 26% more than non-STEM average in 2010. In addition, the STEM wage advantage vary across knowledge areas and across the country regions [8].

III. Methodology: Selection, Description, and Adjustment of Data to the Econometric Model

A. Model Adjusted to Estimate STEM Wage Premium

The STEM wage premium is estimated using an adaptation of Oaxaca-Ranson decomposition prepared to address dichotomous variables, as suggested by Gardeazabal and Ugidos [9]. The research considered occupying a STEM job position as a dichotomous variable, forming a set of characteristics of the worker that influences their average wage. Thus, the data-adjusted model allowed the estimation of wage differences and the extent to which these differences were a result of being a STEM or a non-STEM worker.

Based on ordinary least squares (OLS) method, the data was adjusted to the following semi-logarithm model:

$$ln\ y_i = \beta_0 + \beta_1 X_I + \beta_2 X_I^2 + \beta_3 X_E + \beta_4 D_{hs} + \beta_5 D_{uhe} + \beta_6 D_{he} + \beta_7 D_{gd} + \beta_8 D_G + u_i \quad (1)$$

where *ln yi* is the hourly wage logarithm of each employee *i* and the term β_0 is a constant representing unobserved heterogeneity. Taking into account the developments of the human capital theory, by [10] and [11], the explanatory variables are as follows: X_I and X_I^2 representing age and age-squared, measured in years; X_E the worker's experience based on the duration of employment in their last job, measured in months; D_{hs}, D_{uhe}, D_{he} and D_{gd} the dummies related to education divided into four intervals, complete high school, incomplete higher education, higher education, and graduate degree, respectively. Finally, D_G is the dummy variable that identifies the group of STEM (if D_G = 1) or non-STEM workers (if D_G = 0).

Equation (01) was adjusted to the data for each of the ten clusters, being the coefficient β_8 the STEM wage premium, excluding the last term $\beta_9 D_{cluster}$. The model yields the STEM wage premium in each of the clusters (coefficient β_8). The coefficients of the explanatory variables age, duration of the last job - a proxy for experience - and the dummies for educational levels, are expected to be positive, as these are characteristics associated with productivity. Also, the age-squared variable is included in the model to capture the decreasing marginal yields of this attribute.

Regarding the explanatory variable education, the category used for comparison was the non-STEM workers with education level lower or equal to incomplete high school. Therefore, each estimated coefficient indicates how a STEM worker earns more than a non-STEM worker with high school education level.

The study considered that wage premium for STEM workers there exists when the coefficient β_8 was positive and statistically significant to explain the salary since the occupation is not an attribute of productivity. It was assumed that the error term *ui* is stochastic, not autocorrelated, and with constant variance. The hypothesis was that there was no correlation between the error and its explanatory vector *xi*, *E(ui|xi) = 0.*

The Breusch-Pagan/Cook-Weisberg test was used to identify the presence of heteroscedasticity. The chi-square statistic value (1,160,000) and the test statistics (Prob>chi-square = 0.0000) indicated the rejection of the null hypothesis, so the model had heteroscedastic residuals. The correction was made using the robust estimation of heteroscedastic errors, eliminating the problem of heteroscedasticity by the White weighting matrix.

B. Data Selection and Description: Designation of STEM vs. non-STEM Occupations

This study is based on data from the [12], with information for registered worker in 2019. To identify the group of STEM workers, the filter applied to the data was the Brazilian Classification of Occupations (CBO) available at [13]. The entire set of 164 CBO occupation codes is listed by [6].

Table I shows the quantitative profile of each cluster in terms of STEM workers. Three clusters are located in the State of São Paulo (São Paulo, São Carlos, and Campinas). The largest technology cluster is São Paulo, with 59% of the total number of STEM workers within the clusters taken together. The city is the first consolidated technology cluster, with pioneering teaching institutions doing research and development of new technologies. Yet Campinas and São Carlos are most recent formation being the result technological parks associated to the local universities.

Belo Horizonte and Pouso Alegre are two clusters located in the State of Minas Gerais. The former is known as the San Pedro valley and the latter, as the electronics valley. Manaus is a cluster in Amazonas state. The two cities Ileus and Itabuna are an urban agglomeration in the south of Bahia and form the cluster with lower STEM proportion of workers in the sample. Curitiba, Florianópolis and Porto Alegre are the capital of the three states in southern Brazil.

Table I presents the main features of the sample clusters in 2019. Together, the ten clusters summed a total of 9.014.004 workers, of which 243.295 are STEM jobs, accounting for 2,7% of jobs.

Pouso Alegre and Campinas have the highest proportions of STEM workers in their job markets. Although these proportions seem small, they are higher than the average Brazilian proportion of STEM workers, which is around 1.19% [6].

[2] The document *Divisão Regional do Brasil em Regiões Geográficas Imediatas e Regiões Geográficas Intermediárias* (Regional Division of Brazil in Immediate Geographic Regions and Intermediate Geographic Regions) published in 2017 by the Brazilian Institute of Geography and Statistics (IBGE) was used to identify the clusters and to clarify the way IBGE currently understand the division of the Brazilian territory.

The smallest cluster in the study is Ilhéus-Itabuna both in terms of population size and in terms of the proportion of STEM jobs of the total employment. However, it has the highest uncontrolled wage premium for its STEM workers, as shown by column three in Table. Pouso Alegre is the second smallest cluster but has the highest proportion of STEM jobs within its labor market.

TABLE I: STEM LABOR FEATURES PER TECHNOLOGY CLUSTER 2019

Cluster	**Number of workers in the municipality**	% of STEM workers in the total	Average STEM Hour-wage (R$)
Manaus	438,928	1.26%	23.18
Ilhéus-Itabuna	60,679	0.59%	14.19
Belo Horizonte	1,377,331	2.2%	23.34
Pouso Alegre	11,534	6.4%	13.47
Curitiba	941,159	2.34%	28.88
Porto Alegre	729,884	2.07%	27.09
Florianópolis	389,080	2.3%	31.93
Campinas	468,287	3.80%	22.59
São Carlos	103,985	1.86%	19.38
São Paulo	4,676,606	3.1%	24.5
Total	9,197,473		

Source: Elaborated by the authors based on data from [12].

The average hour-wage, vary across the clusters, but the three southern cluster – Curitiba, Florianopolis and Porto Alegre – exhibit very close wages. The lowest average wage occurs in the northeast cluster Ilhéus-Itabuna.

The Appendix C brings the descriptive information for the explanatory variables, age, experience and schooling. Table C.1 presents experience and age of workers. The proxy for experience is the number of months the worker is in the actual job. Inspection of data reveals that, except for Pouso Alegre, the average duration of employment among STEM professionals was longer than for non-STEM workers, suggesting greater employment stability for the first group. In Curitiba and São Carlos, the duration of employment for STEM workers is 20 months more than their non-STEM counterparts.

Table C.1 in Appendix also indicates that the average age in all clusters and for both STEM and non-STEM workers was between 31 and 39 years old. The highest average age occurred for the STEM workers in Ilhéus-Itabuna (39.73 years), and the lowest average was for the STEM workers in Pouso Alegre (31.92 years). Also, almost all clusters in the STEM workers had a lower average age than the non-STEM professionals, although the differences were small. The exceptions are Manaus, Ilhéus-Itabuna and Belo Horizonte.

Regarding the education level of the population studied, the distribution of education in each cluster is shown in Figure (a) in Appendix C, which highlights that STEM workers, when examined as a general group, have higher level of education.

The proportion of individuals with a higher education degree among STEM workers ranged from 82% (in Pouso Alegre) to 89.8% (in Curitiba), while the proportion of non-STEM workers with higher education ranged from 10.39% (in Ilhéus-Itabuna) to 29% (in Florianópolis). It was expected that the STEM workers form a more homogeneous group regarding education level, as STEM jobs comprise a more restricted set of occupations that require more schooling. The non-STEM group, on the other hand, represents a broader set of occupations.

Among STEM workers, Pouso Alegre and São Carlos present the highest levels of education, where 92.7% and 91.7% of workers had at least college education, respectively. The cluster in Belo Horizonte showed the highest proportion of workers with college. As for the clusters in Ilhéus-Itabuna and Porto Alegre, they presented the highest proportions of STEM workers with high school diplomas, with 9% and 7.9%, respectively. This finding suggests that these clusters offered a higher proportion of technical jobs in comparison to other clusters analyzed.

As for the non-STEM workers in each cluster, Figure (b) in Appendix C shows that most of them completed high school, followed by the cases with incomplete high school or less education level. The southern clusters present the highest levels of education. In Florianópolis, Curitiba and Porto Alegre, respectively, 32.9%, 30.8% and 30.6% of workers hold college degree. Yet, Belo Horizonte, Ilhéus-Itabuna and São Carlos had the lowest proportion of workers with higher education, respectively, 13.7%, 14.4% and 16.9% of the total. The technology cluster of Ilhéus-Itabuna was the one with the most significant disparity regarding education for both STEM and non-STEM workers.

IV. DATA STATISTICAL ANALYSIS

This section presents the results of the data adjusted to the model represented by equation (01) in section III.A, made for each of the ten clusters. The study adopted the OLS method, robustly correcting the heteroscedasticity using the White matrix. The interpretation of regression coefficients is presented in Appendix B, Table B.I.

The coefficients in Table B.I are expressed in percentages. The coefficients of the quantitative variables (age, age squared, and experience) were multiplied by one hundred, and the result presented in the table indicates the percentage variation resulted from the median hourly wage by a unit variation in the explanatory variable.

A. Analysis of the Impact of Productivity Variables

For all clusters, the regressions had the joint significance test statistic (F test), indicating the rejection of the null hypothesis (all coefficients are equal to zero), since all p-values associated with the F tests were null (Prob > F = 0.0000 in all regressions). Also, all coefficients estimated in the ten regressions presented the null p-value for the t-tests of individual significance, indicating the rejection of the null hypothesis. In other words, all estimated coefficients have statistical significance to explain hourly wages at a 95% confidence level.

As for the coefficient of determination, R^2, Table B.I in Appendix C, the model explained between 46.58% and 63.21% of the observed changes in hourly wage. The cluster with the highest coefficient was Florianópolis (63.21%), followed by Curitiba (62.21%). The clusters with the lowest R^2 were Pouso Alegre (46.58%) and Manaus (48.45%).

The lower contribution of age for the average wage formation occurred in Ilhéus-Itabuna, with a regression coefficient of the age variable being 1.3%. Yet Belo Horizonte presented the highest value among all the technology clusters for the coefficient of age. Each additional

year of age in Belo Horizonte meant an increase in the hourly wage of about 5.71% for the base group. Regarding the variable age squared, its estimated coefficient was negative in almost all clusters (excepted in São Paulo – 0.06%), but as expected, was close to zero in all regressions. The variable experience, measured in months in the last job, showed positive and close to zero coefficients in all clusters, ranging from 0.3% to 0.4%, i.e., each additional month of employment meant an increase of either 0.3% to 0.4% in the base group average wage in all clusters.

As for the dummy variables of education, Fig. 1 helps to visualize the results referring to the coefficients interpreted in Table B.I in Appendix B. The dummy variables of education showed how much the median of hourly wage increased in the group analyzed, in comparison to the base group, which are those with incomplete high school or lower education level.

For workers with complete post-grad degree, the increase in the median hourly wage, compared to the base group, was 600.83% in the cluster in Ilhéus-Itabuna and 424.8% in Pouso Alegre. These were the clusters that presented the highest values for the dummy regarding graduate education level. Thus, workers with a master's degree or PhD had a median hourly wage more than four times the hourly wage of workers who did not complete high school. For the group with a degree, the median hourly wage increase was approximately 157%, compared to the base group, ranging from 122.95% (São Carlos) to 189.37% (Florianópolis).

For the group with high school and incomplete higher education, the wage variation was subtler. For those with incomplete higher education, the increase varied between 35.70% (São Carlos) and 72.52% (Belo Horizonte). For those who completed high school, the median hourly wage increase was 21.35% over the base group.

B. Analysis of the STEM Wage Premium

The coefficient $\beta_8$resulting from data adjusted to model 01 appears in Table C.1 as "STEM". In fact, this coefficient indicates the difference between the medians of wages for STEM and non-STEM workers, a difference that the explanatory variables - age, education, and experience - did not explain. Thus, accepting the hypothesis that there were no other variables that influenced wage differences, the estimated coefficients indicated an "advantage" attributed to the worker's occupation.

One possible reason for the STEM wage premium was the connection of this particular workforce with technological innovation. Also, the selected technology clusters are known as places of developed industries that ensure an environment conducive to innovation and offer the benefits of external economies of scale.

Fig. 1 highlights the coefficients of the STEM variable in each of the clusters. It shows the percentage of the difference between the median hourly wage of STEM and non-STEM workers.

The most striking result is that every cluster exhibits STEM wage advantage well above higher than the observed by [7] for the US economy in 2010, which uses the same criteria to define STEM occupations as the one in the present research. Another interesting result relates to the three states in the southernmost region, which is the economically most homogenous region. These three clusters seem to harbor both, the highest and the lowest STEM wage differences. On one hand, for Porto Alegre, the southernmost cluster, presents the highest STEM wage advantage, as the estimated regression coefficient implies that the median hourly wage of the STEM workers is 66.1% higher than the median for non-STEM workers, when the productivity variables are controlled. On the other hand, Florianópolis and Curitiba, which are also southern clusters, present the lowest STEM wage advantage, being, respectively, 39.2% and 34.7%. Similarly, Pouso Alegre shows the second highest STEM wage advantage – 64% - while Belo Horizonte, also located in Minas Gerais, presented the third lowest STEM wage advantage, being estimated on 48%.

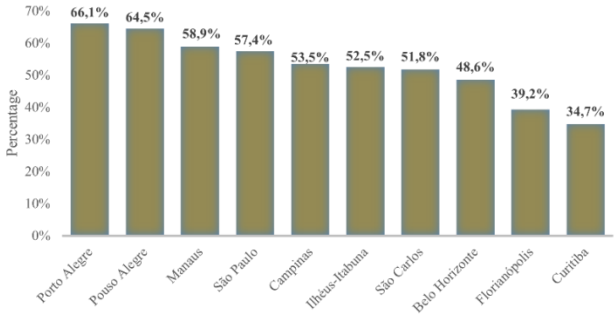


Fig. 1. Estimated STEM wage premium at the technology clusters.

These results should be connected to the descriptive analysis illustrated by Figure (b) in the Appendix C. As for the clusters in Ilhéus-Itabuna and Porto Alegre, they presented the highest proportions of STEM workers with high school diplomas, with 9% and 7.9%, respectively. This finding suggests that these clusters offered a higher proportion of technical jobs in comparison to other clusters analyzed.

Another important result is that seven of the ten considered clusters presented STEM premium above 50%. Ilhéus-Itabuna, which is located in the northeast state of Bahia, presents a STEM wage premium close to Campinas and São Carlos, which are located in São Paulo state. Similarly, Manaus and São Paulo, located in very different geographic regions present similar STEM wage premium of respectively, 58.9 e 54.5%. It is noteworthy that the these were the most similar regarding the education of the STEM workers: in both clusters, 85.9% of employees had a degree, and 6% had completed high school – Figure (a).

The STEM wage premium varied substantially among the clusters, despite being geographically close, in a way that it was not possible to observe a regional pattern. The two most significant premiums were in the Brazilian Regions of North and South, which are quite different in terms of economic characteristics. The STEM premium of Ilhéus-Itabuna and Porto Alegre, also located in economically distinct regions, were roughly the same, and similar to the two most substantial STEM wage premium. The Pouso Alegre and Belo Horizonte clusters located in the same state of Minas Gerais presented distinct STEM wage premium. In this case, the difference between them could be associated with location since Belo Horizonte is in a metropolitan region. However, Campinas is also in a metropolitan region (although smaller than Belo Horizonte), and shows one of the

lowest STEM wage premia.

Thus, the disparities observed in the STEM premium seem to be intricately linked to each cluster's particularities, that go beyond regional development conditions. As [8] argues, the fact that the STEM wage premium varies widely across the US, and is virtually disappearing in some states, must be explained by the demand for qualified workers, which occurs heterogeneously throughout the regions of the country. Indeed, the STEM premium seems to be associated to the demand and supply of skilled labor in the cluster. In Florianopolis, for example, the nucleus of the technology cluster is the Federal University of Santa Catarina (UFSC) with 40% of its student are in STEM courses [6].

V. Final Considerations

This article presented a study on the wage difference of STEM occupations in ten Brazilian technology clusters (Manaus, Ilhéus-Itabuna, Belo Horizonte, Pouso Alegre, Curitiba, Porto Alegre, Florianópolis, Campinas, São Carlos, and São Paulo), based on microdata from [12].

The regression analysis confirmed the existence of higher average wages for STEM workers in all ten clusters. The cluster with the highest STEM wage premium was Porto Alegre, where the median hourly wage of the STEM workers was 66.1% higher than the base group (non-STEM workers). Pouso Alegre was the cluster presenting the second-highest difference (64.5%), followed by Manaus and São Paulo (58.9% and 57.4%). Florianópolis and Curitiba were the technology clusters that had the lowest difference, with 37.3% and Curitiba, respectively.

Finally, it is possible to say that the study achieved the objective of identifying the differences in the STEM wage premium in Brazil based on the sample of technology clusters. The results based on the analyzed data confirmed the initial assumption that STEM occupations pay a STEM wage premium.

Appendix

A. Appendix A: Technology Clusters

TABLE A.I: Municipalities and Characteristics of the Technology Clusters

Main cities (and surrounding municipalities)	Main Universities, Institutions, and incubators	Characteristics of the cluster
Manaus	UniNorte (Centro Universitário do Norte), Incubator "UniNorte Empreende"	It includes the Manaus Free Trade Zone. Specialized in consumer electronics production.
Ilhéus-Itabuna	FTC (Faculty of Technology and Science of Itabuna)	Large number of SMEs in the computing sector.
Belo-Horizonte (Contagem and Betim)	UFMG (Federal University of Minas Gerais)	Concentrates companies operating in the segment of energy and automation
Pouso Alegre (Santa Rita do Sapucaí, Ouro Fino, Extrema, and Cambuí)	Inatel (National Institute of Telecommunication)	Specialized in producing electronic components and computing equipment.
Curitiba (Araucária)	UTFPR (Federal University of Technology – Paraná), UFPR (Federal University of Paraná), PUC PR (Pontifical Catholic University of Paraná), Lactec Institute.	The cluster includes universities and is specialized in telephones and telecommunication. Tendency to specialize in computing.
Porto Alegre (Gravataí, Canoas)	UFRGS (Federal University of Rio Grande do Sul), PUC RS (Pontifical Catholic University of Rio Grande do Sul), Tecnopuc (PUC RS Scientific and Technological Park)	Tendency to specialize in the segment of energy and automation.
Florianópolis (Palhoça e Biguaçu)	UFSC (Federal University of Santa Catarina), CERTI Foundation, Incubator "Celta."	Specialized in electronics and in the segment of telecommunication.
Campinas (Paulínia, Americana, Sumaré, Indaiatuba)	Unicamp (University of Campinas), CPqD (Center of Research and Development in Telecommunication), CTI (Center of Information Technology Renato Archer), Research Center Von Braun, Eldorado Institute.	The presence of Unicamp strengthens business-academia interaction. Tendency to specialize in the segment of telecommunication.
São Carlos (Porto Ferreira, Descalvado, Pirassununga, Santa Rita do Passa Quatro)	USP (University of São Paulo), UFSCar (Federal University of São Carlos)	The segment of medical equipment has gained prominence.
São Paulo (São Bernardo do Campo)	USP (University of São Paulo), Unesp (São Paulo State University)	More companies and professionals in the segment of ICT

Source: Elaborated by the authors.

B. Appendix B: Results of Regressions for Robust Estimation of Stem Wage Premium in Technology Clusters

TABLE B.I: INTERPRETATION OF THE ESTIMATED REGRESSION COEFFICIENTS

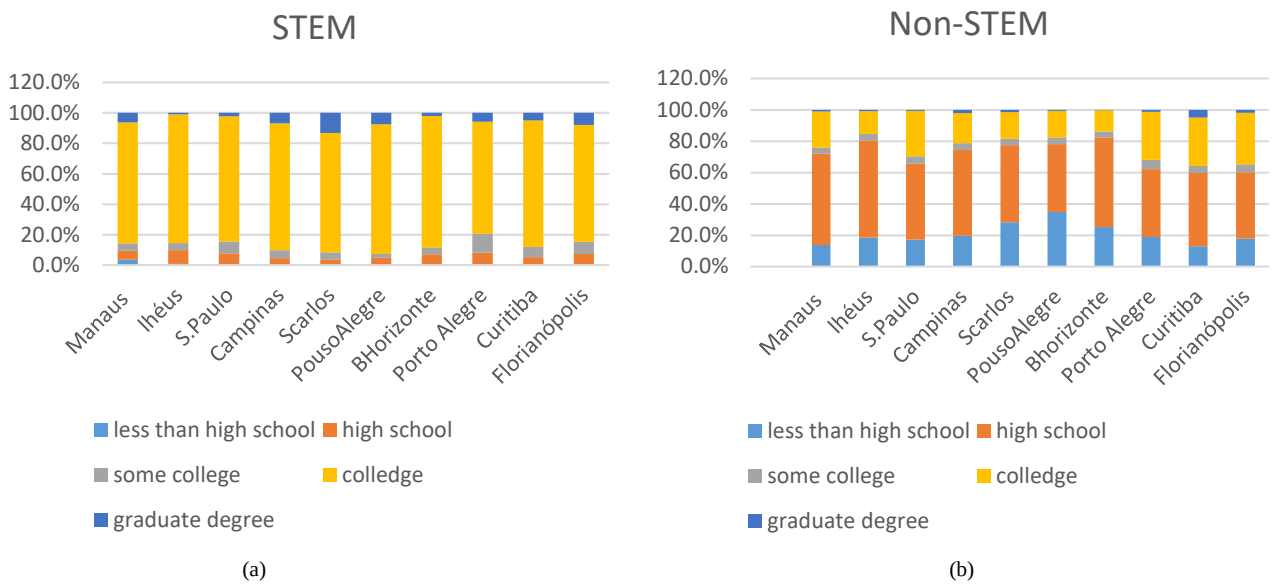
Cluster	Porto Alegre	Pouso Alegre	Manaus	São Paulo	Campinas	Ilhéus-Itabuna	São Carlos	Belo Horizonte	Florianópolis	Curitiba
Age[1]	4.2%	3.5%	5.1%	4.9%	4.7%	1.3%	3.7%	5.7%	3.0%	4.1%
(Age[2])	-0.05%	-0.04%	-0.06%	0.06%	-0.05%	-0.01%	-0.04%	-0.06%	-0.03%	-0.04%
Experience in the last job[2]	0.3%	0.3%	0.4%	0.3%	0.3%	0.3%	0.3%	0.4%	0.3%	0.4%
High School[3]†	20.8%	24.9%	24.1%	18.7%	23.0%	16.6%	16.9%	25.9%	20.73%	24.88%
Incomplete higher education[3]†	55.4%	56.5%	63.4%	63.8%	61.0%	43.2%	35.7%	72.5%	47.92%	62.00%
Higher education[3]†	139.9%	145.1%	167.0%	163.7%	146.9%	135.9%	122.9%	171.1%	189.37%	183.13%
Pos-Grad degree[3]†	271.1%	424.8%	283.1%	411.5%	343.7%	600.8%	334.0%	359.1%	418.87%	346.39%
STEM [4]†	66.1%	64.5%	58.9%	57.4%	53.5%	52.5%	51.8%	48.6%	39.23%	34.69%
Observations	729,884	11,534	438,928	4,676,606	468,287	60,670	103,985	1,377,331	389,080	941,159
R^2	46.58%	54.43%	48.45%	49.15%	52.38%	52.34%	52.48%	56.14%	63.21%	62.21%

1. Estimated increase of the median wage percentage for each year of age.
2. Estimated increase of the median wage percentage for each additional month in the duration of employment in the previous job.
3. Estimated increase of the median wage percentage for the education level incomplete high school.
4. Estimated STEM wage premium: percentage in which the median of STEM workers' wage is higher than the median of non-STEM workers.

† For these categorical variables, the unit to get to the value presented is subtracted from the antilog of the estimated coefficient.

Source: Elaborated by the authors.

C. Appendix C: Description of the Explanatory Variables



(a) (b)

Fig. C.I. (a) STEM; (b) Non-STEM.

TABLE C.I: AVERAGE AGE AND AVERAGE DURATION OF EMPLOYMENT IN THE LAST JOB, PER CLUSTER, PER GROUP

Technology cluster	Age (years)		Duration of employment (previous job) (months)	
	STEM	Non-STEM	STEM	Non-STEM
Manaus	38.6	37.85	89.8	77.15
Ilhéus-Itabuna	39.73	38.67	85.7	73.4
Belo Horizonte	37.5	36.86	78.9	76.9
Pouso Alegre	31.92	36.79	54.6	57.2
Curitiba	37.55	38.25	91.2	71.7
Porto Alegre	37.84	39.04	81.4	83.6
Florianópolis	36.92	37.66	75.8	69.3
Campinas	36.2	37.28	75.6	63.5
São Carlos	37.24	37.45	94.3	74.8

São Paulo	36.64	37.99	72.3	72.2
Total average	36.55	36.56	79.6	71.9

Source: Elaborated by the authors using RAIS (2019).

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Carolina downloaded and dealt with the dataset and the presentation of the relevant information for the research. The research proposal stems from earlier research conducted by Bonini´s previous research project, so the structure of the article and literature review were built up by Bonini. Both authors contributed to write the paper had approved it´s final version.

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