Determinants of Economists' Salary Levels in the Cities of Bogotá, Bucaramanga, Medellín, and Cali, Before and After the COVID-19 Pandemic*

[English version]

Determinantes del nivel de salario de los economistas en las ciudades de Bogotá, Bucaramanga, Medellín y Cali, antes y después de la pandemia Covid-19

Determinantes do nível salarial dos economistas nas cidades de Bogotá, Bucaramanga, Medellín e Cali, antes e depois da pandemia Covid-19

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Abstract

Objective: This study investigates the determinants of economists' salaries in Bogotá, Bucaramanga, Medellín, and Cali, before and after the COVID-19 pandemic. **Methodology**: Data from 1,480 job offers for economists from the pre-pandemic (2018-2019) and post-pandemic (2021-2024) periods were analyzed. A Multinomial Logit model was constructed to assess the salary levels offered in the analyzed job postings. The covariates considered were educational level, years of experience, English proficiency, and computer skills, controlling for city and sector of the offering company. **Results**: Before the pandemic, English proficiency, educational level, and previous experience were significant factors influencing economists' salaries. After the pandemic, the importance of English proficiency decreased, while specialized computer skills gained prominence. **Conclusions**: This study highlights the need for continuous adaptation of economists and economics curricula to the changing demands of the post-pandemic labor market.

Keywords: economists; labor market statistics; Logit model; overeducation; salary determinants (obtained from the STW English thesaurus for economics).

Resumen

Objetivo: en este estudio se investigan los determinantes del salario de los economistas en Bogotá, Bucaramanga, Medellín y Cali, antes y después de la pandemia COVID-19. **Metodología**: se analizaron datos de 1480 ofertas de trabajo para economistas de los períodos pre-pandémicos (2018-2019) y post-pandémicos (2021-2024). Se construyó un modelo Logístico Multinomial para el nivel de salario ofrecido en las convocatorias analizadas. Como covariable se consideraron el nivel educativo, los años de experiencia,

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el nivel de inglés y las habilidades computacionales, controlando por ciudad y sector de la empresa ofertante. **Resultados**: antes de la pandemia, la competencia en inglés, el nivel educativo y la experiencia previa eran factores significativos en los salarios de los economistas. Después de la pandemia, la importancia del inglés disminuyó, mientras que las habilidades especializadas computacionales ganaron protagonismo. **Conclusiones**: este estudio subraya la necesidad de adaptación continua de los economistas y los planes de estudio en economía a las cambiantes demandas del mercado laboral post-pandemia.

Palabras clave: economistas; estadísticas del mercado laboral; modelo logístico; sobreeducación; determinantes salariales (obtenidos del tesauro en inglés para economía STW).

Resumo

Objetivo: este estudo investiga os determinantes do salário dos economistas em Bogotá, Bucaramanga, Medellín e Cali, antes e depois da pandemia COVID-19. **Metodologia**: foram analisados dados de 1480 ofertas de trabalho para economistas dos períodos pré-pandêmicos (2018-2019) e pós-pandêmicos (2021-2024). Foi construído um modelo Logístico Multinomial para o nível de salário oferecido nas vagas analisadas. Como covariáveis foram considerados o nível educacional, os anos de experiência, o nível de inglês e as habilidades computacionais, controlando por cidade e setor da empresa ofertante. **Resultados**: antes da pandemia, a competência em inglês, o nível educacional e a experiência prévia eram fatores significativos nos salários dos economistas. Após a pandemia, a importância do inglês diminuiu, enquanto as habilidades especializadas em computação ganharam destaque. **Conclusões**: este estudo sublinha a necessidade de adaptação contínua dos economistas e dos currículos em economia às demandas em mudança do mercado de trabalho pós-pandemia.

Palavras-chave: economistas; Estatísticas do Mercado de Trabalho; Modelo Logístico; sobreeducação; determinantes salariais (obtidos do tesauro em inglês para economia STW).

Introduction

The training of economists in Colombia traces back to the law schools of the 1930s and 1940s. However, it was not until 1945 that formal economics education began, with the establishment of the Institute of Economic Sciences at the Universidad Nacional (Sarmiento & Silva, 2014). Currently, according to the National Professional Council of Economics, the economics degree is offered in 94 universities in the country (CONALPE, 2024). These institutions are responsible for developing the skills necessary for the labor market, equipping students with the fundamental tools for their professional integration.

On the one hand, there is a discrepancy between the skills economists acquire during their training and those demanded by the labor market. In Colombian universities, emphasis is placed on specific competencies such as microeconomic and macroeconomic analysis, project formulation, model design, and statistical and econometric analysis (Bautista et al., 2012; Sarmiento & Silva, 2014). On the other hand, the labor market increasingly demands broader skills, including language proficiency, commitment, integrity, multidisciplinary abilities, teamwork, process management, ICT knowledge, oral communication, and problem-solving skills (Periáñez et al., 2010; ANECA, 2009)

In this context, it is emphasized that the skills required by the labor market can be acquired by both students and professionals in fields related to economics. This increases the complexity in defining the unique competencies of economists and heightens competition in the labor market, as there are fewer positions available than qualified candidates. This dynamic results in overeducation and contributes to a heterogeneous labor market, where the skills offered by economists often diverge from those demanded (Mora, 2008).

Likewise, in the labor market, geographical location is an important variable that has an impact on labor income. According to Posso (2010a), cities such as Bogotá, Medellín, Bucaramanga, and Cali offer higher labor incomes in Colombia, indicating a higher quality of employment in these regions. In this context, there is not only a discrepancy between the labor market for which economists are trained and the one they actually encounter, but also variations in employment quality—measured by labor income—and the perceived importance of their profession, which may differ by geographic region.

Given these considerations, it is essential to understand the realities economists face in the labor market and the conditions that influence the quality of their employment, particularly concerning their labor income. To achieve this objective, job vacancies in Bogotá, Bucaramanga, Cali, and Medellín were monitored through various sources, including "*Elempleo,*" "*Computrabajo,*" and "LinkedIn." Using the

collected data, a descriptive statistical analysis was conducted, followed by the development of two multinomial logistic models. These models were designed to explore the relationship between the salary levels offered and the skills requested. Finally, the results were analyzed to draw relevant conclusions regarding the demand for economists and their working conditions in these cities.

State of the Art

The Latin American and Caribbean region faces a critical challenge regarding job quality, particularly for young people. This demography experiences higher rates of unemployment, informality, and job turnover compared to other population groups (Busso et al., 2012). Although many young people pursue additional education to enhance their skills, this does not always result in improved job quality. Companies in the region often struggle to align with workers' skills, leading to imbalances in the labor market (Pagés et al., 2009).

The COVID-19 pandemic has exacerbated these vulnerabilities, particularly for young people. This context has accelerated the need for digital tools, impacting the skills required in the post-pandemic labor market (IDB, 2021). This situation has placed significant pressure on universities, compelling them to equip students with the skills necessary to enhance their employability.

In Colombia, several studies have highlighted issues such as the low quality of the labor market and significant income inequality. In this context, education has been recognized as a crucial factor in enhancing employment conditions and access to the labor market (Farné, 2003; Galvis-Aponte & Pérez-Valbuena, 2015; García-Blanco & Cárdenas, 2015; Gil-León et al., 2020; Mora, 2003; Ortiz et al., 2007; Serna-Gómez et al., 2019). Posso (2010a) highlights that inequality in the Colombian labor market is linked to the distribution of wage earners' characteristics, particularly education and geographical location. Additionally, the disparity in returns on educational investment among the most educated individuals is attributed to factors such as overeducation and the quality of education.

As for other wage determinants, Ortiz et al. (2007) and Posso (2010b) agree on several important points. First, they note that the cities with the highest incomes are Bogotá, Bucaramanga, Medellín, and Cali. Second, they note that labor income generally increases with higher levels of education; however, this effect can vary depending on the specific level of education attained. Finally, they identify that work experience, the type of contract, and the formality of the company are key factors influencing salary levels. Other studies (Forero & Ramírez, 2008) have identified additional variables affecting income, including age, gender, parental education, institutional characteristics, field of study, and

economic activity. Additionally, they highlight that careers in Administration, Economics, Accounting, and Finance offer the best working conditions regarding income and unemployment rates.

Mora (2008) delves into the problem of overeducation and the imbalances it generates in the labor market. This phenomenon occurs when employees possess a higher level of education than the average of other employees in similar positions. Their results indicate that salary recognition for individuals with postgraduate, master's, and doctoral degrees is limited within the Colombian labor market. Additionally, it highlights that overeducation also impacts individuals with undergraduate degrees, due to a mismatch between the skills imparted by educational institutions and the requirements of the labor market.

Conceptual Framework

Quality of Employment

Job quality is a multidimensional concept that transcends static definitions, as its perception is influenced by individual needs and preferences. According to the United Nations (2000), 'quality' refers to the set of characteristics that enable workers to meet their basic needs. According to the ILO (2022), quality employment encompasses fair income, workplace safety, social protection, opportunities for personal development, and social integration, among other factors.

Quality assessment employs qualitative and quantitative approaches. On the one hand, from a qualitative perspective, aspects such as labor rights, adherence to international standards, employment opportunities, and social security are considered (UNECE, 2010). On the other hand, the quantitative approach employs estimates and models to focus on variables such as income levels or remuneration received by workers (Arranz et al., 2018; Burgess & Campbell, 1998; Johnson & Corcoran, 2003; Sehnbruch, 2004). The International Labour Organization (ILO) utilizes the Employment Quality Index (EQI), which encompasses dimensions such as income, working hours, employment type, and social security. An adaptation of this index for Colombia was developed by Farné (2003), Posso (2010), Mora & Ulloa (2011) and Farné & Vergara (2015).

In standard economic theory, job quality is typically perceived to be positively related to income and negatively related to hours worked. In the Colombian context, labor income is a crucial element in the definition of quality. Studies by Bustamante and Arroyo (2008), Farné (2003), and Farné & Vergara (2006)

indicate that labor income accounts for at least 40% of the overall result in the employment quality index. Additionally, it is one of the most significant factors for Colombians when assessing their job satisfaction (Farné & Vergara, 2007).

Employment Income Determinants

Disparities in labor income among workers arise from a variety of working conditions and are influenced by the valuation of working hours, which is based on specific individual characteristics. Several authors have examined the relationship between factors such as age (Gallo, 2009), type of employment (Rodríguez, 2013), gender disparities (Colacce, 2018), and various socioeconomic characteristics with the labor income perceived by individuals. From the perspective of human capital theory, educational level emerges as one of the most significant variables. A higher level of education is expected to imply a higher wage, especially in the case of salaried workers (Mora & Ulloa, 2011).

In Colombia, disparities in labor income are closely associated with factors such as educational level, work experience, region, and the type of contract signed (Posso, 2010a; Ortiz et al., 2007). The authors acknowledge that among the variables identified, the most significant contributors to income inequality are the returns to education and geographical location.

Overeducation and Returns to Education

Education plays a fundamental role in income differences in the Colombian labor market. An important phenomenon is overeducation, which occurs when individuals possess a higher level of education than is required by their employers (Domínguez, 2009).

Over-education has several consequences, including creating an imbalance between the supply and demand for skills in the labor market. This imbalance results in frequent job changes, less accumulation of work experience, a higher likelihood of obtaining indefinite-term contracts with lower economic returns, and increased labor market inequality. Additionally, it leads to a decrease in the returns on education (Castillo, 2007; Posso, 2010b).

Although education is valued in the Colombian labor market, the returns on higher educational levels are diminishing. These individuals are often placed in positions that require fewer skills or where their education is not appropriately valued. This phenomenon is attributed to the heterogeneity in training and skills required, as well as the regional diversity in which individuals are located. As a

result, individuals with the same degree may receive different incomes (Mora & Ulloa, 2011; Forero & Ramírez, 2008; Romero, 2008).

Methodological Framework

This study uses data from three job search platforms in Colombia: "*Elempleo*", "*Computrabajo*" and "LinkedIn". These platforms are used by a wide range of companies and institutions, such as Banco de la República, Ecopetrol, Grupo Éxito and Colpatria, as well as by renowned universities. Although "voice-to-voice" communication and social networks such as Twitter and Facebook are also important in job searching for economists, job platforms offer a comprehensive view of the labor market and help in understanding its trends and dynamics.

The search for job postings was conducted using the keyword "economist" in Bogotá, Bucaramanga, Cali, and Medellín across two distinct periods: From April 2018 to June 2019 and from February 2021 to February 2024. The goal was to compare changes in the labor market due to the COVID-19 pandemic.

Initially, the investigation was planned for the period from April 2018 to June 2019. However, due to the COVID-19 pandemic, it became necessary to extend the research to capture changes in the characteristics demanded of economists. This extension began in early 2021, coinciding with the economic reactivation. Pre-pandemic data were collected daily by the authors and collaborators, reaching 1020 calls. The post-pandemic data were collected monthly by the Santander Socioeconomic Observatory of Santo Tomás University in Bucaramanga, totaling 460 job postings. This decrease in the number of job postings is attributed to the economic slowdown and changes in the frequency of data collection, as some listings were removed from employment platforms within a few days of their publication.

During data collection, repeated job postings were excluded, as it is common for the same profile to be published multiple times if the vacancy remains unfilled. For this study, only employment contracts other than "Order for Provision of Services" (OPS) were considered. OPS contracts often involve higher fees to compensate for the lack of health, pension, vacation, layoff, and parafiscal benefits provided by the company, which could distort the actual salary data. When a job listing did not specify the type of hiring, it was automatically assumed to be an employment contract rather than an OPS.

Each job offer included an overview of the requirements, the sector of the hiring company, the type of contract, and the number of available vacancies. These data were processed according to expert criteria to construct a standardized data table, creating variables related to salary based on the reviewed literature.

Categorization of Variables

Dependent Variable (Salary).

Job offers typically present salary as an interval rather than a specific point value. Additionally, it is common for job postings to omit salary information altogether. Therefore, it was decided to treat the "salary" variable as categorical. This approach allows for the analysis of different salary levels and includes a separate category for unspecified salaries (either to be agreed upon or not reported).

The salary ranges were determined at expert discretion, using the 2018 Legal Minimum Wage (SMLV) for Colombia as a reference. These ranges were subsequently adjusted according to annual inflation rates up to December of 2019, 2021, 2022, 2023, and 2024, based on data provided by Banco de la República. Table 1 shows the ranges in Colombian pesos (COP) and its equivalent in US dollars (USD). The conversion to USD was performed using the average Market Representative Rate provided by Banco de la República for the corresponding analysis period.

Table 1. *Categorization of the Variable "Salaries".* [1]

Salary Category	2018	2019	2021	2022	2023	2024
0	Salary not specified or to be agreed					
1	< 2	< 2,08	< 2,11	< 2,23	< 2,52	< 2,75
	<669	<679	<690	<729	<825	<901

1 The first row in each salary category corresponds to millions of Colombian pesos (COP), and the second is its equivalent in US dollars (USD).

Salary Category	2018	2019	2021	2022	2023	2024
2	[2 – 6)	[2,08 – 6,23)	[2,11 – 6,33)	[2,23 – 6,68)	[2,52 – 7,56)	[2,75 – 8,26)
	[669 a 2007)	[679 a 2038)	[690 a 2071)	[729 a 2188)	[825 a 2475)	[901 a 2704)
3	≥6	≥6,23	≥6,33	≥6,68	≥7,56	≥8,26
	≥ 2007	≥2038	≥2071	≥2188	≥2475	≥2704

Covariates.

The covariates analyzed were extracted from the job advertisements and subsequently tabulated. The city of work and the sector or area of the contracting company were included as control variables. In cases where the sector of the company was not specified, the sector of the job offer was assumed. The explanatory variables of interest included those related to the worker's human capital, such as educational level and work experience. Additionally, hard skills, such as English proficiency and knowledge of computational tools, as well as specific expertise, were considered. Soft skills were not included due to their low variability (most offers mentioned skills such as responsibility and teamwork). Although these may be important in the hiring process, they do not appear to significantly influence salary determination for economists. The standardization process is presented in Table 2.

Table 2. *Model Explanatory Variables.*

Variable	Information
City	If the vacancy belongs to Bogotá, Medellín, Bucaramanga or Cali.
Area of the contracting company (A)	1) Administrative, human resources, audit, financial and management; 2) Commercial, sales and customer service; 3) Teaching, consulting and R&D; 4) Purchase of inventories and international trade; 5) Operations and processes; and 6) Others (advertising, marketing, technology, services, etc.).

Variable	Information
Minimum Required Education Level (EL)	1: High School, or Associate degrees; 2: Bachelor's degree; 3: Postgraduate.
Years of Experience (Exp)	Number of Years of Experience Required.
Programming Languages (PL)	It takes the value of 1 if the company required some knowledge of C, C++, *Java, JavaScript*, PL SQL, *Octave*, R, *phyton* or *Visual Basic*, 0 if not.
Data Storage Tools (ST)	It takes the value of 1 if the company required some knowledge of *Hadoop*, *Google Analytics*, *Site Catalyst*, *Coremetrics*, Oracle, *Access*, AWS, *Azure*, Databases, *Data lakes*, *IBM Cloud* or another storage tool, or 0 if not.
Accounting Tools or *Business* Type (AT)	It takes the value of 1 if the company required some knowledge of *Kactus* ,Siigo, ERP, as400, BPM, CRM, SAP, AWS, PMI, IAXIS, MRP or *Qlik View*, 0 if not.
Information Visualization and Processing Tools (VPT)	It takes the value of 1 if the company required some knowledge of *PowerBI*, *Tableau*, SPSS, STATA, SAS, *Alteryx* or *DataStudio*, 0 if not.
Office Tools (OT)	It takes the value of 1 if the company required some knowledge *ofKynote*, *Power Point*, Office Package, Excel, Word and 0 if not.
Specific Skills (SS)	It takes the value of 1 if the company required some area-specific skill (invoicing, purchasing, risk management, etc.) and 0 if not.
English	Level of English required by the company. It is measured in A (basic), B (intermediate), C (advanced) or does not require/not specified.

It is noted that the required level of education might vary from a degree in economics. Some vacancies accepted various profiles, including high school or associate degrees; bachelor's degree; master's degrees, and doctoral degrees. Additionally, different professions were considered, such as economists, industrial engineers, administrators, and others. The only criterion for inclusion in this study was that the job posting explicitly accepted the profile of a "qualified economist," regardless of whether it also accepted other profiles or academic levels.

Statistical Model.

Given that the dependent variable is categorical and not ordinal, a multinomial model was chosen over an ordinal response model. This choice is based on the fact that a multinomial model allows for the analysis of category 0 (salary to be agreed) without assuming a specific order for this category. Unlike ordinal response models, the multinomial model does not assume a preset order between categories (Best & Wolf, 2014). Model estimation was carried out using the *nnet* package in R. The estimated model is as follows.

$$\frac{\Pi_j(X)}{\Pi_3(X)} = \alpha_j + \beta X,$$

where $\prod_j (X)$ represents the probability that a call is in the category $j=\{0,1,2\}$ given a set of characteristics X; α_j *y* B they are parameters of the model and X is the matrix of covariates. It is important to note that the comparison category $\prod_3 (X)$ is the level of wages corresponding to category 3.

To assess potential changes in the characteristics demanded of economists, the same analytical procedure was applied to data collected before and after the pandemic. To determine the optimal model, we initially estimated the "Saturated Model" and then selected the best model using the *Stepwise* algorithm integrated into the *mass* library. This process assisted in selecting the optimal model by including and excluding covariates and assessing their impact on the *Akaike Information Criterion* (AIC).

To evaluate model fit and ensure unbiased coefficient signs, the dataset was randomly divided into training (80%) and test (20%) sets. This division was repeated 1000 times to cross-validate the results and minimize potential biases associated with a single database partition.

The minimum, maximum, and average values of the 1000 partitions were calculated for the Akaike Information Criterion (AIC), the *deviance*, and the percentage of correct classifications to assess the goodness of fit of the model. The interpretation of the effects of the coefficients was based on the averages of the coefficients and their *p-values* from each model.

Results

Descriptive Statistics

During the first period, a total of 1,020 vacancies were analyzed, whereas in the second period, 460 vacancies were evaluated. Most of the offers were located in the city of Bogotá, as shown in Table 3.

Table 3. *Distribution of Job Vacancies by City.*

	Study Period	
City	2018-2019	2021-2024
Bogotá	46,5%	65,22%
Bucaramanga	28,3%	10,22%
Cali	9,0%	8,70%
Medellín	16,2%	15,87%

Figure 1 illustrates the distribution of vacancies by salary category for the two time periods analyzed. It is noted that, in the first period, most of the vacancies did not specify salary information. Although in the 2021-2024 period this category is no longer the most frequent, it remains in the second position. This salary category poses a problem, as it can encompass two scenarios: first, high salaries that are kept confidential by companies to avoid revealing their salary structure; and second, cases where the information is not disclosed because the salaries are low and not competitive compared to other offers. This hypothesis is discussed below. Another relevant category in both periods is Category 2, which represented vacancies with salaries ranging from 2 to 6 million pesos in 2018, and from approximately 2.75 to 8.26 million pesos in 2024.

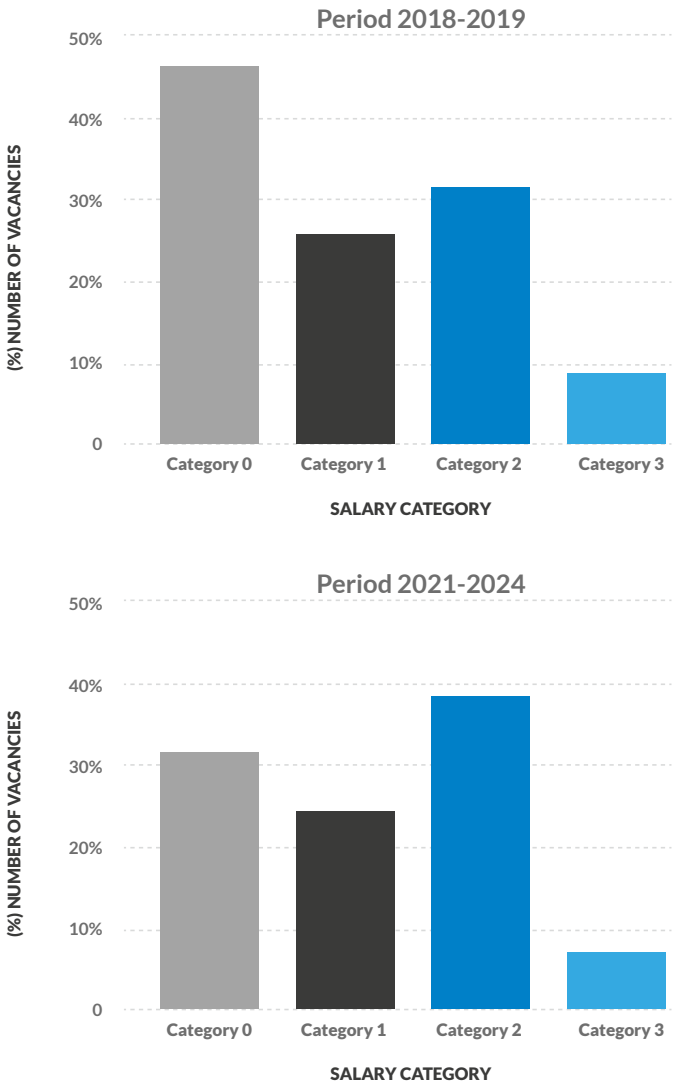
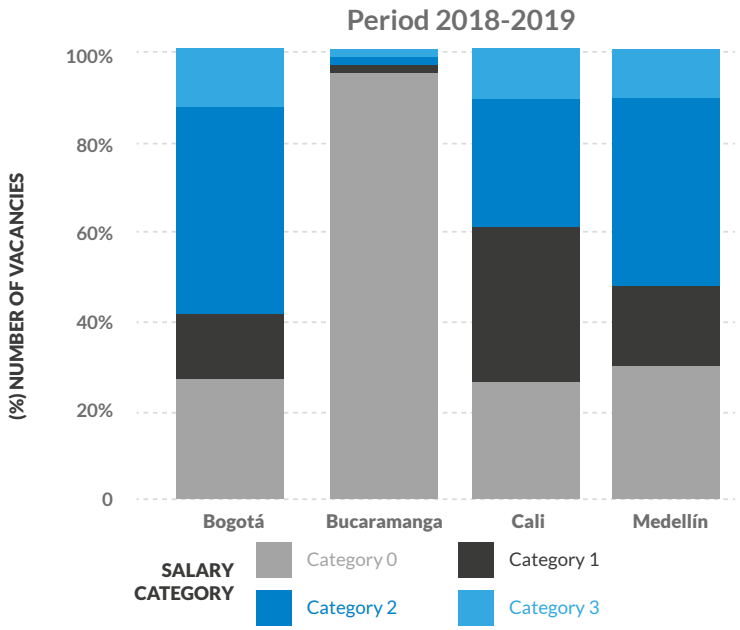


Figure 1. *Distribution of Vacancies According to Salary Categories.*

Figure 2 presents the distribution of vacancies at each salary level for each city. It is observed that, during the first study period, Bucaramanga is the city offering the most vacancies for economists without providing salary information, with 95%. This trend in Bucaramanga changes in the second study period, where there is an increase in vacancies with salaries categorized as 1 and 2.

On the one hand, in Bogotá and Medellín the most relevant salary category in both periods is 2. However, after the pandemic, there is evidence in Bogotá of a reduction in higher wages, represented by category 3, and an increase in lower wages, represented by category 1. On the other hand, in Medellín, there is a decrease in the number of vacancies without salary information (category 0) and an increase in vacancies falling into categories 1 and 2. In Cali, the main salary category in the first period was 1, while in the second period it was reduced, giving a greater share to category 2.

Considering salaries exclusively, it could be interpreted that, after the pandemic, job postings in the cities —except Bogotá— readjusted their salary categories, often moving towards higher salary ranges. In the first period, categories 0 and 3 represented 46.8% and 8.9% of total calls. In the second period, there was a decrease in the participation of these categories, with 30.9% and 7%. Meanwhile, categories 2 and 1 experienced an increase in their participation, from 13.3% and 31.4% to 24.1% and 38%, respectively. However, it is important to note that this interpretation should be approached with caution, as the nature of category 0 —where salary information is unspecified— means that its implications are not entirely clear.



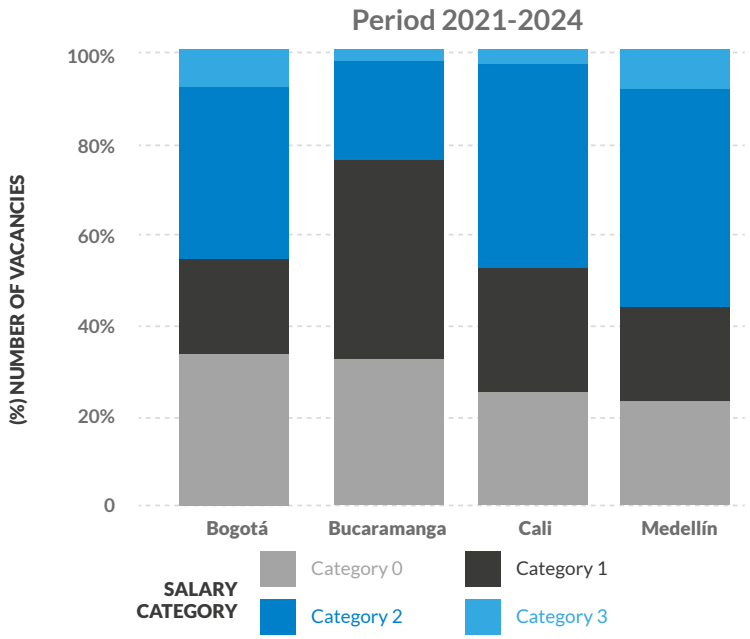


Figure 2. *Distribution by City of Vacancies According to Salary Level.*

Figure 3 illustrates the relationship between years of experience and the salary offered in the job vacancies. In the first period, job categories 0, 1, and 2 each have a median of 2 years of experience, but they differ in their dispersion. Category 0 exhibits a wider variation, supporting the idea that this category can hide two different types of employment and salary.

Most category 1 vacancies are below the median, suggesting that these positions typically require little or no experience. This facilitates the entry of newly graduated economists into the labor market in exchange for lower wages. In contrast, category 2 shows the majority of wages above their median. Category 3 exhibits a considerable dispersion in their salaries, requires a minimum level of experience of 2.5 years and presents a median of 5 years.

In the second period, categories 0 and 2 maintain a median of 2 years of experience. However, for category 0, the dispersion increases further compared to the previous period. Category 1 reduces its median to one year of experience, while category 3 increases its median slightly to 5.5 years.

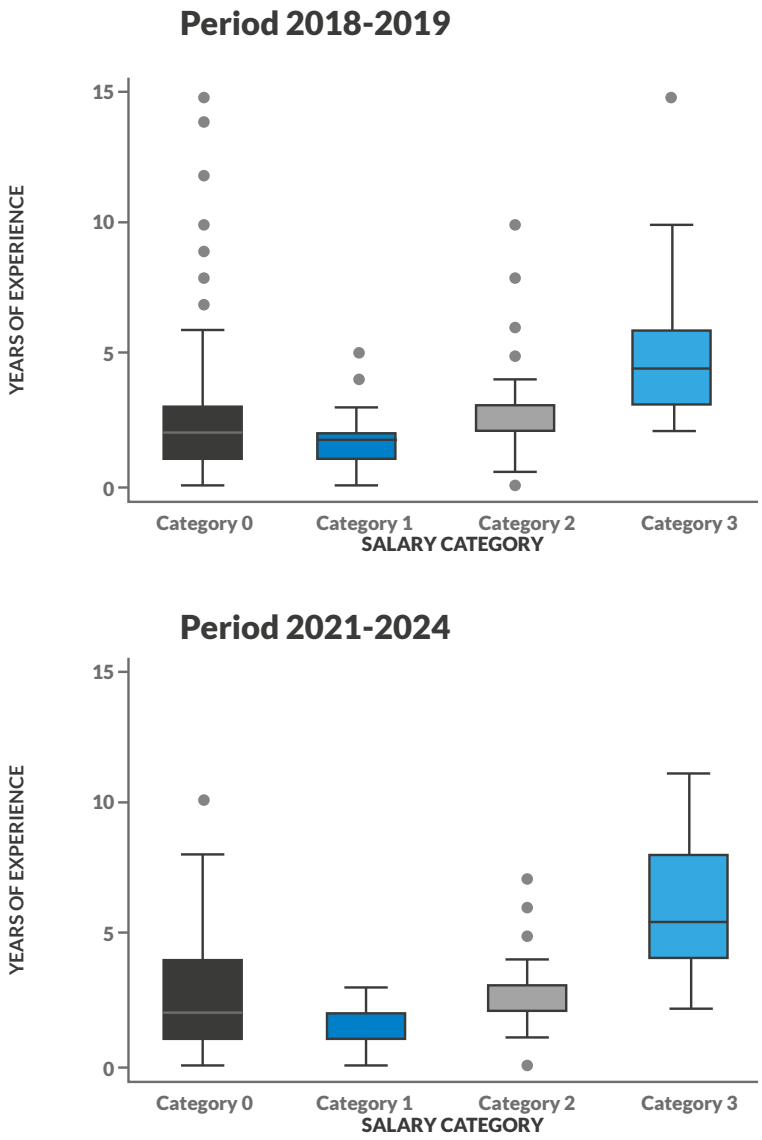
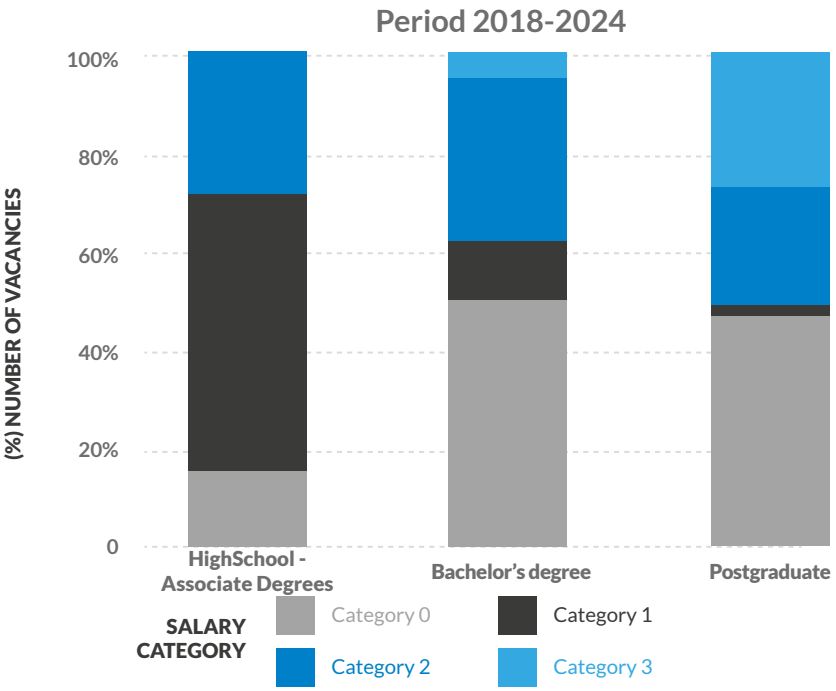


Figure 3. *Relationship Between Experience and Salary Category.*

Figure 4 shows the relationship between education level and salary category. As expected, Bachelor's degrees with postgraduate degrees tend to receive more offers in the higher salary categories, particularly in category 3. For

their part, those with undergraduate degrees show a different distribution of salary categories. For this group, the predominant salary categories are 0 and 2, indicating a wider range in the wages offered—from unspecified amounts to moderately high wages. In contrast, profiles with technical degrees show a significant concentration in the lower salary categories, particularly in category 1. This clearly indicates a symptom of overeducation, where the offered salary is relatively low compared to the level of technical or technological training required, yet the job vacancy extends to profiles with a higher qualification, such as a graduate economist.



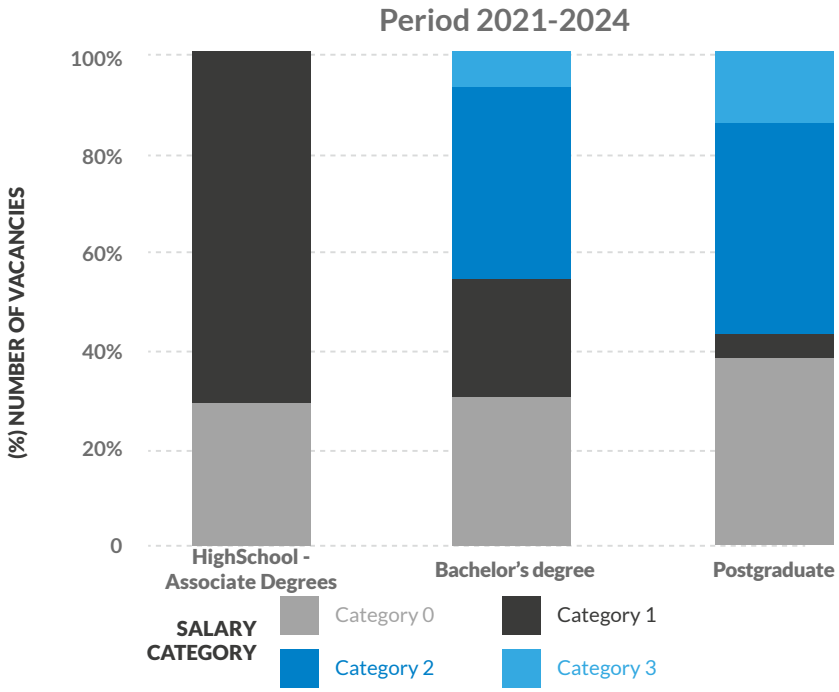


Figure 4. *Relationship Between Level of Education and Salary Category.*

Other variables of interest include computational skills related to data management and analysis, such as proficiency in programming languages, data storage tools, accounting software, data visualization tools, office software, and specific knowledge areas. Table 4 illustrates these skills, which should be interpreted by columns, as many vacancies required multiple hard skills.

In both the first and second periods, the most demanded skills are specific knowledge and the use of office tools. This could suggest that the economist profile sought on these job boards may not always require expertise in programming languages or data visualization tools. On the other hand, skills related to office tools are more valued, which are not exclusive to economists and can be acquired through various levels of study and areas of knowledge. This demand could explain the low wage levels; however, after the pandemic, there is evidence of a relative increase in demand for data visualization tools and programming languages compared to the pre-pandemic period.

Table 4. *List of Vacancies that Require Some Type of Knowledge with the Salary Offered.*

Term 2018 – 2019						
Vacancies that require knowledge in:						
Salary Category	Programming Languages	Storage Tools	Accounting Tools	Data Visualization Tools	Office Tools	Specific Skills
0	15	206	18	8	45	275
1	2	10	5	2	37	64
2	18	27	21	15	94	194
3	3	5	10	3	16	56
Total	38	248	54	28	196	589
Term: 2021-2024						
Vacancies that require knowledge in:						
Salary Category	Programming Languages	Storage Tools	Accounting Tools	Data Visualization Tools	Office Tools	Specific Skills
0	22	8	5	20	57	88
1	7	1	4	4	32	38
2	37	13	18	29	89	134
3	24	9	3	13	21	29
Total	90	31	30	66	199	289

Regarding the variable of English language proficiency, Figure 5 provides information on the linguistic requirements demanded in the job offers. It should be noted that, in most of the calls, no specific skill level in English is mentioned. However, the demand for English proficiency increases as you move up in the salary categories. In the lower salary categories, it is less common to find requirements for intermediate or advanced English proficiency; however, in the higher categories, the proportion of job vacancies requesting advanced English skills increases.

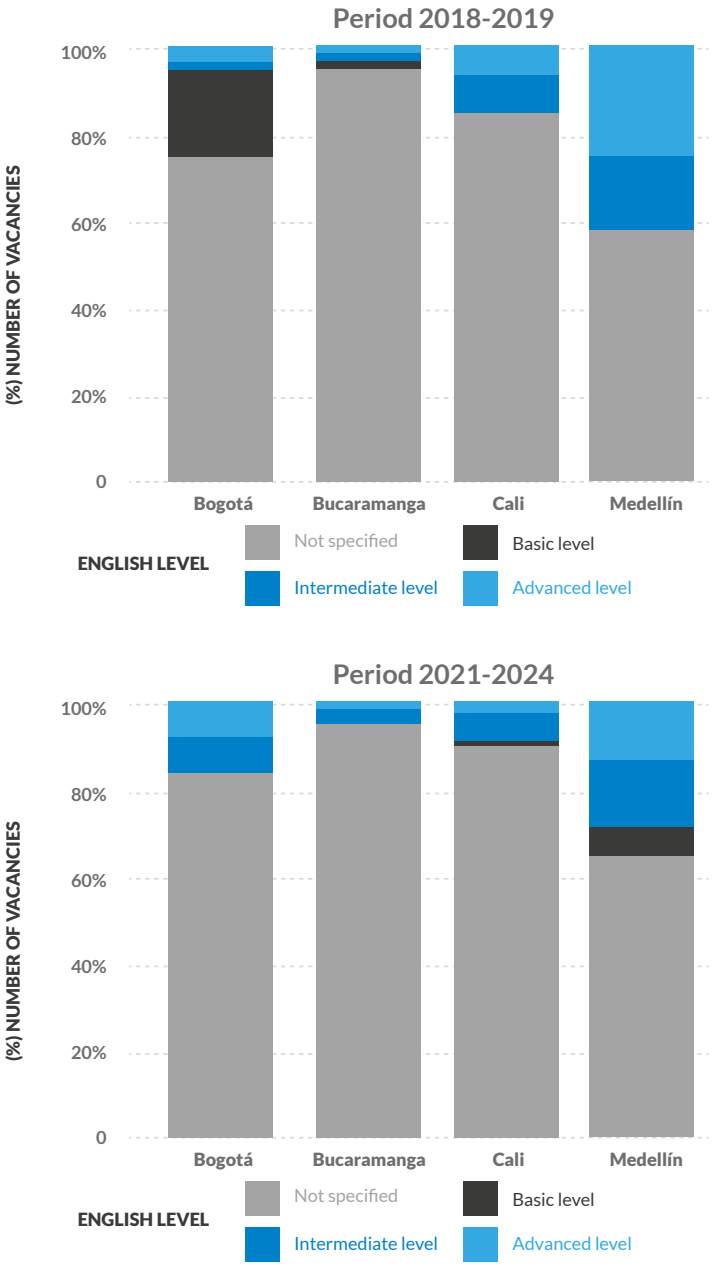


Figure 5. *Relationship Between Salary Offered and Level of English.*

Multinomial Model 2018-2019

The "saturated model" for the periods before and after the pandemic uses grouped salary as the dependent variable. The covariates include those listed in Table 2, along with their transformations *Exp^2* and interactions *Exp*PL;Exp*ST;Exp*AT;Exp*VPT;Exp*OTy Exp*SS*. Below are the adjustment criteria for the "Saturated" model and the best model, as determined by the *Stepwise algorithm*, for both pre-pandemic and post-pandemic data.

Table 5. *Adjustment Criteria of the Proposed Models.*

	Average, Minimum, and Maximum Values of the 1000 Random Partitions		
Model	**Success**	**AIC**	***Deviance***
Saturated model 2018-2019	0.59 (0.44-0.75)	1311 (1216-1398)	1149 (1054-1236)
Adapted *Stepwise* Model 2018-2019	0.61 (0.44-0.76)	1287(1190-1364)	1197 (1100-1274)
Saturated Model 2021-2024	0.54 (0.16-0.73)	730 (665-789)	599 (533-657)
Adapted *Stepwise* Model 2021-2024	0.56 (0.34-0.77)	713 (645-772)	635(567-695)

Table 5 concludes that the models proposed by the *Stepwise* algorithm exhibit better indicators in terms of the Akaike Information Criterion (AIC) and the percentage of correct classifications, while the deviance values are close to *those* of the saturated model. In this way, the model proposed by the *Stepwise* method is a parsimonious model, achieving indicators that are either higher or comparable to those of the saturated model, but with a lower number of covariates.

Below are the best models for the two periods analyzed:

Best Adapted Stepwise Model 2018-2019

$$log\ \frac{\Pi_j(x)}{\Pi_3(x)} = \alpha_j + \beta_{1j}\ City_i + \beta_{2j}EL_i + \beta_{3j}Exp_i + \beta_{4j}Exp_i^2 + \beta_{5j}PL_i + \beta_{6j}(Exp_i * PL_i) + \beta_{7j}AT_i + \beta_{8j}(Exp_i * AT_i) + \beta_{7j}English_i + \epsilon i.$$

The model for the years 2018-2019 included the AT variable to maintain the hierarchy of the Exp*AT. interaction. The remaining variables were included by the algorithm automatically.

Table 6 presents the model results. For proper interpretation, it should be noted that salary category 3 serves as a benchmark. In addition, the base categories of the polytomous covariates used must be considered, such as the city (Bogotá), the level of education (undergraduate), and the level of English (no requirement).

Table 6. *Average Coefficients and Average p-values of the Nominal Model 2018-2019.*[2]

	Coefficients			P Values		
	0	1	2	0	1	2
Intercept	34,47	38,15	8,45	0,00*	0,00*	0,00*
Bucaramanga	2,23	-2,37	-2,20	0,00*	0,00*	0,00*
Cali	0,40	0,54	-0,29	0,40	0,33	0,56
Medellín	0,84	0,20	0,56	0,03*	0,68	0,15
EL 1	30.32	33.21	31.76	0,00*	0,00*	0,00*
EL 3	-0.69	-1.48	-0.217	0,08	0,04*	0,59
Exp	-0,60	-1,06	-0,25	0,00*	0,03*	0,39
Exp2	0,04	-0,07	-0,05	0,00*	0,49	0,15
PL	67,66	64,79	68,42	0,00*	0,00*	0,00*
PL*Exp	-13,43	-13,19	-14,02	0,00*	0,00*	0,00*
AT	2,34	0,90	3,31	0,17	0,68	0,09
AT*Exp	-0,56	-0,02	-1,08	0,10	0,98	0,02*
English A	21.38	20.86	-10.50	0,00*	0,00*	0,00*
English B	-1.12	-29.17	-0.934	0,02*	0,00*	0,05*
English C	-1.23	-2.69	-0.94	0,00*	0,00*	0,00*

2 * Statistical significance of at least 5%.

By analyzing the coefficients (log odds ratios) of the variable EL 3 (Postgraduate), it is interpreted that a job posting requiring a postgraduate level of education will be associated with a higher likelihood of offering a salary in category 3, compared to a posting that requires only an undergraduate level of education. However, this association is statistically significant only for salary category 1, not for categories 0 and 2 (*ceteris paribus*).

It is essential to consider that the magnitude of the effect of the covariates is not directly represented by the coefficient, as the multinomial model is not linear in its parameters. Therefore, for a more streamlined presentation of the results, the focus should be on the significance and direction of the coefficients. The calculation of marginal effects and the discussion of the base categories of the polytomous covariates are omitted.

However, the most significant factors explaining the salary categories for the years 2018-2019 were knowledge of programming languages, use of *business* and accounting tools, years of experience, educational level, and proficiency in English.

Regarding the effects, it was found that postgraduate education, years of experience, and proficiency in English (levels B or C) are negatively associated with the probability of receiving lower salary levels. However, in category 0, the effect of years of experience diminishes at increasing rates, as evidenced by the positive and significant coefficient exp^2. This indicates that an increase in years of experience is associated with a decreased probability of a job offer being classified in salary category 0. However, this effect is met to a certain extent, where a high level of experience increases the probability of belonging to category 0. It is important to remember the hypothesis that this wage category could include both very low wages and very high wages.

Conversely, job offers that require programming languages, accounting tools, and educational qualifications below the professional level are more likely to be associated with salary categories 0, 1, and 2, as opposed to higher salary categories. However, interactions between high levels of experience *Exp*LP* and *Exp*AT* the simultaneous requirement of programming languages or accounting tools reveal a reversed relationship, favoring the presentation of salary category 3.

Some variables showed combined effects. For example, the basic level of English has a negative relationship with wages in category 2, but a positive relationship with wages in categories 0 and 1. Regarding the control variable, "city" it was found that job calls for Bucaramanga are more likely to offer category 0 salaries and less category 1 and 2 salaries. In the case of Medellín, it was found more likely to offer a category 0 salary compared to category 3.

Adapted Stepwise Model 2021-2024

$$log\ \frac{\Pi_j(x)}{\Pi_3(x)}$$
$$= \alpha_j + \beta_{1j}\ City_i + \beta_{2j}EL_i + \beta_{3j}Exp_i + \beta_{4j}Exp_i^2 + + \beta_{5j}SS_i + \beta_{6j}PL_i + \beta_{7j}ST_i$$
$$+ \beta_{8j}(Exp_i * ST_i) + \epsilon i.$$

The model for the years 2021-2024 underwent two modifications from the original model proposed by the *Stepwise algorithm*: the elimination of OT and AT due to their lack of 5% significance, and the inclusion of ST to preserve the hierarchy of interaction Exp*ST. The remaining exogenous variables were included by the algorithm.

Table 7 illustrates significant changes in the structure of profiles required for economists and their correlation with wage levels. The most notable change is the output of the variables "English level" and "management of accounting tools"; and the inclusion of "storage tools" and "specific skills" in the final model.

Table 7. *Average Coefficients and Average p-values of the Nominal Model 2021-2024.*[3]

	Coefficients			P Values		
	0	1	2	0	1	2
Intercept	77,77	79,62	26,77	0,00*	0,00*	0,16
Bucaramanga	7,52	8,16	6,86	0,69	0,48	0,78
Cali	76,50	76,53	77,11	0,00*	0,00*	0,00*
Medellin	-1,10	-1,01	-0,50	0,24	0,31	0,55
EL1	4.00	4.68	-10.30	0.00*	0,00*	0,00*
EL3	7.04	6.74	6.71	0,03*	0,02*	0,03*
Exp	-2,88	-2,98	-2,01	0,00*	0,00*	0,02*
Exp2	0,21	0,03	0,06	0,00*	0,78	0,41
SS	-57,11	-57,94	-56,19	0,07	0,049*	0,12
PL	-6,82	-9,33	-6,82	0,01*	0,00*	0,01*
ST	44,35	31,56	45,07	0,43	0,00*	0,33
Exp*ST	-23,20	-28,85	-23,29	0,03*	0,00*	0,02*

3 * Statistical significance of at least 5%.

Variables such as "years of experience" and "knowledge of programming languages" are negatively related to wages in categories 0, 1 and 2. This indicates an increased likelihood that job postings requiring more years of experience or knowledge of programming languages will offer salaries in category 3. Additionally, the quadratic effect of years of experience on category 0 mirrors the findings from before the pandemic, further reinforcing the hypothesis that category 0 encompasses two distinct types of profiles.

When the call requests at least one specific skill, the probability that the offer presents category 1 salaries (the lowest) is reduced. Regarding storage tools, it is observed that their requirement increases the probability of receiving salaries in the lowest category. However, when these tools are requested alongside a higher level of experience, the likelihood of receiving a category 3 salary— the highest category— increases.

On one hand, the postgraduate educational level yields unexpected results in the post-pandemic period, as it shows a positive coefficient for categories 0, 1, and 2. This indicates that a postgraduate requirement is more likely to be associated with these salary levels, which may highlight issues of over-education. Conversely, the level of basic education retains the behavior observed before the pandemic. It remains unlikely to be associated with salaries in category 2 and more likely to be associated with salaries in categories 1 and 0.

Regarding the control variable "city", it shows significant effects for Cali with a higher probability of having salary categories 0, 1 and 2 compared to Bogotá. In the cases of Bucaramanga and Medellín, no significant effects were found.

Finally, the model's pre-pandemic and post-pandemic intercepts do not reflect major changes. Subsequently, job postings in Bogotá requiring an undergraduate education level have a higher probability of falling into salary categories 0 and 1 compared to category 3. Prior to the pandemic, intercepts also considered unspecified English level and category 2.

Conclusions

This research enhances the understanding of labor market dynamics for economists in Colombia, with a focus on four major cities, both before and after the pandemic. The primary objective was to identify, in both periods, the most significant characteristics that explain the various salary categories. This was

done to understand which attributes are most in demand and valued in the labor market.

Descriptive statistics reveal that Bogotá dominates the labor market for economists in Colombia, as it is the city with the highest number of job openings both before and after the pandemic. Category 0 was prominent in both periods, accounting for over 35% of the total job openings, highlighting the need to understand its determinants. After the pandemic, there was an increase in the demand for skills such as office tools, programming languages, and data visualization tools, indicating a heightened emphasis on these competencies in the labor market for economists.

Before the pandemic, factors such as English proficiency, education level, prior experience, and the use of programming languages were critical in determining salaries for economists. Additionally, non-traditional skills in economic training, such as proficiency in accounting and administrative tools, showed significant influence. Thus, job postings frequently required skills that deviated from the classical training of an undergraduate economist.

In the post-pandemic scenario, education, experience, and programming languages remain relevant. Additionally, the use of storage tools has emerged as a significant explanatory factor. Surprisingly, English proficiency has lost relevance in this new scenario. This shift in wage determinants may reflect an adjustment in labor market priorities. There is now a greater emphasis on advanced technical skills and the use of specialized storage and programming tools. This could be indicative of an evolution and increased specialization within the labor market for economists in Colombia.

The research also uncovered intriguing trends regarding postgraduate education in the post-pandemic wage landscape. It was found that postgraduate qualifications were associated with lower salary categories (1 and 2), highlighting an issue of overeducation. This phenomenon could be linked to the widespread decrease in wages during the pandemic, a period in which many professionals had to accept lower salaries to remain in the labor market.

The results of the model, in both periods analyzed, confirm the hypothesis of the ambiguity of the unspecified salary category (category 0). On one hand, some job postings were associated with high levels of compensation and required advanced academic qualifications, extensive experience, and specialized technical skills. On the other hand, other offers shared similarities with the typical characteristics of lower salary calls.

The model highlighted the relevance of 'experience' variable interactions in the pay structure. It was found that the use of programming tools and storage systems, when coupled with considerable experience, significantly increases the likelihood of securing a higher salary. Also, through the variable "experience"

the idea of duality within category 0 is reinforced. The data suggest that an increase in years of experience generally decreases the likelihood that a job offer will fall into the 0 salary category. However, there is a threshold beyond which a particularly high level of experience again increases the probability of classification in this ambiguous category.

These findings are valuable for Colombian universities offering economics programs, as they provide insights for adjusting and aligning curricula with current labor market demands. Future research could deepen the analysis of additional categories that contemplate a broader spectrum of competencies. Additionally, increasing the sample size would enable a more detailed differentiation among postgraduate categories, distinguishing between specializations, master's degrees, and doctoral levels. A more detailed segmentation by business areas is also recommended, overcoming the current limitations imposed by the low number of calls.

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