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The Role of Company Size in Career Progression: Analysis of Wage Dynamics and Job Stability Among Recent Graduates

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Gonçalo José Eira Antunes da Silva

Dissertation

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Pedro Luís Silva

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Abstract

This thesis investigates how the size of a graduate's first employer influences early career outcomes in the Portuguese labour market. Using linked employer–employee administrative data, it examines the effects of firm size on entry wages, wage growth, and job stability among recent higher education graduates. The study also explores the trade-offs between job mobility and firm-specific tenure, and assesses how these patterns vary across fields of study. The empirical approach relies on OLS regressions estimated on both cross-sectional and panel data, with robust controls for demographic, job, and firm-level characteristics.

The results show that starting in a large or medium-sized firm is associated with a wage premium at entry and steeper wage growth over the first decade. Field of study also plays a decisive role: STEM graduates earn significantly more than their non-STEM peers at entry, and this advantage widens over time, even after controlling for observable characteristics. Moderate mobility early in the career yields wage gains, particularly for STEM graduates, while excessive job switching erodes the benefits of both tenure and mobility. Firm tenure, in turn, provides positive returns only when supported by stable employment. Overall, the findings underscore the importance of initial job placement, strategic timing of career moves, and educational background in shaping long-term labour market outcomes.

Key Words

Career progression; Company size; Employer; Employee; Firm size; Job mobility; Job stability; Labour market; Recent graduates; STEM; Tenure; Wage dynamics; Wage growth

Resumo

Esta dissertação investiga de que forma a dimensão do primeiro empregador influencia os resultados iniciais de carreira no mercado de trabalho português. Utilizando dados administrativos emparelhados entre empregadores e trabalhadores, analisa-se o impacto da dimensão da empresa nos salários de entrada, na progressão salarial e na estabilidade do emprego entre recém-licenciados do ensino superior. O estudo explora ainda os trade-offs entre mobilidade laboral e antiguidade na empresa, avaliando como estes padrões variam consoante a área de formação. A estratégia empírica baseia-se em modelos de regressão OLS aplicados a dados em corte transversal e em painel, com controlos robustos para características demográficas, contratuais e da empresa.

Os resultados mostram que começar a carreira numa empresa de grande ou média dimensão está associado a um prémio salarial à entrada e a uma progressão salarial mais acentuada na primeira década. A área de formação também desempenha um papel determinante: os diplomados em áreas STEM auferem salários significativamente superiores face aos colegas de outras áreas logo no início da carreira, e esta diferença tende a aumentar ao longo do tempo, mesmo após controlar por características observáveis. A mobilidade moderada nos primeiros anos está associada a ganhos salariais, sobretudo entre licenciados em STEM, ao passo que mudanças frequentes de emprego reduzem os benefícios tanto da antiguidade como da mobilidade. A antiguidade na empresa, por sua vez, só gera retornos positivos quando sustentada por continuidade no emprego. Em conjunto, os resultados destacam a importância da colocação inicial, do timing das decisões de carreira e da formação académica na definição dos trajetos salariais a longo prazo.

Palavras-chave

Antiguidade; Crescimento salarial; Dinâmica salarial; Dimensão da empresa; Empregador; Estabilidade no emprego; Mercado de trabalho; Mobilidade laboral; Progressão na carreira; Recém-licenciados; STEM; Tamanho da empresa; Trabalhador

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1. Introduction

Entering the labour market marks a pivotal moment for recent graduates, as early career choices can significantly shape long-term trajectories (Arellano-Bover, 2022). One often-overlooked determinant of career advancement is the size of the company where a graduate begins their professional journey. Larger firms typically offer structured career pathways, higher starting salaries, and robust training programs, while smaller firms may provide broader responsibilities, greater autonomy, and faster skill acquisition (Arellano-Bover, 2022). This presents critical trade-offs that graduates must navigate, especially in contexts like the Portuguese labour market, where firm size distribution skews smaller compared to other European countries (Braguinsky et al., 2011).

However, graduates' career choices reflect broader labour market dynamics and shifting employment trends. Aligning workforce skills with employer needs is crucial for sustainable employment outcomes (OECD, 2024), as mismatches can hinder wage growth, job stability, and career progression. While large firms have traditionally been favoured for career stability, young workers are increasingly drawn to smaller firms and startups, valuing autonomy, flexibility, and innovation (Roach & Sauermann, 2023). Recent data from Handshake, a leading U.S.-based career platform widely used by Gen Z graduates, indicates that between September 2023 and September 2024, 39% of all job applications on the platform were directed to small businesses (those with fewer than 250 employees), up from 32% the previous year and 27% the year before that. Notably, the average number of applications per small business role quadrupled between 2021 and 2024. This trend is particularly evident among Computer Science students, whose applications to small businesses have grown by 68% since the 2021/22 academic year (Pasette, 2024).

Understanding how company size shapes career outcomes is key to developing effective employment strategies. Employers need evidence-based strategies to attract and retain talent, while policymakers must design labour market conditions that support productive career development (OECD, 2024). Graduates, as key participants in the labour market, stand to benefit from greater clarity about the long-term implications of their first employment decisions.

This study sets out to examine how the size of the first employer influences early career wage dynamics among recent higher education graduates in Portugal. The core research questions are fourfold: (i) Does starting a career in a larger firm lead to higher initial wages? (ii) Does the size of the first employer have a persistent effect on wage growth over time? (iii) How do job mobility and firm tenure interact in shaping wage trajectories? (iv) To what extent does the worker's field of study contribute to wage differentials? To address these questions, I exploit rich longitudinal administrative matched employer–employee data from the Quadros de Pessoal (QP), covering the period from 2010 to 2022 and focusing on individuals entering the labour market for the first time. The empirical strategy relies on ordinary least squares (OLS) regressions estimated on repeated cross-sections and individual-level panels, controlling for a broad set of observed characteristics such as gender, education, age, nationality, sector, and year effects. While the approach does not account for unobserved individual heterogeneity, it enables the identification of both level and trend effects associated with firm size, job mobility, and employment tenure over the course of early career development.

The empirical results reveal that initial firm size plays a decisive role in shaping early career outcomes. Graduates who begin their careers in medium-to-large firms benefit from both a wage premium at entry and steeper wage growth over time. Field of study also matters substantially: STEM graduates earn significantly more than non-STEM peers, and this gap widens over time. Moderate job mobility early in the career is associated with higher wages, particularly among STEM graduates, but excessive switching reduces the benefits of both tenure and mobility. Firm-specific tenure yields positive returns only when supported by employment continuity. These findings underscore the importance of consistent and well-timed career strategies, particularly in the early years of employment.

The remainder of this thesis is structured as follows. Section 2 reviews the relevant literature on wage dynamics, firm size, job mobility, and field of study. Section 3 presents the data and descriptive statistics, including details on the administrative sources and key variables. Section 4 outlines the empirical strategy and econometric models. Section 5 presents the main findings across four dimensions: entry wages by firm size, wage progression over time, the trade-off between job mobility and tenure, and heterogeneity by field of study. Section 6 discusses the results in relation to the literature and highlights policy implications. Section 7 concludes.

2. Literature Review

Wages in the early stages of a career are shaped by educational attainment, economic conditions, and the characteristics of the first employer. Graduates with advanced qualifications often secure higher starting salaries, reflecting the premium placed on education (Murphy & Welch, 1992). However, the timing of labour market entry also matters, since economic downturns can suppress entry-level wages and lead to prolonged earnings disadvantages (Kahn, 2009; Oreopoulos et al., 2012). The choice of field and industry further influences wage trajectories. Careers in STEM fields yield higher earnings due to strong demand for technical skills and technology-driven innovation (Altonji et al., 2012). Technology sectors in particular offer substantial wage premiums, underscoring the importance of occupational choice in shaping long-term financial stability (Deming & Noray, 2020). However, further evidence by Deming & Noray (2020) shows that while STEM graduates initially benefit from high earnings, their wage trajectories may flatten over time due to rapid skill obsolescence in fast-changing occupations, leading many to sort into slower-changing roles as they gain experience.

Beyond individual credentials, and even before employment begins, firm size influences career outcomes. Larger firms tend to screen workers with less accuracy due to the higher costs of acquiring detailed information about applicants (Barron et al., 1989). As a result, they implement different compensation schemes than smaller firms, which can lead to a wage structure that favours individuals with more schooling who self-select into larger firms (Garen, 1985). These initial differences in selection and compensation are further amplified as career trajectories unfold.

Larger firms typically provide structured salary progression and training opportunities, whereas smaller firms often offer early responsibility but with less predictable wage trajectories. Employees in larger firms benefit from defined promotion paths and specialized skill development programs, contributing to consistent salary growth (Brown & Medoff, 1989; Oi & Idson, 1999). Structured career ladders in these organizations often lead to more predictable wage growth, as employees follow defined promotion pathways that ensure steady salary increments (Baker et al., 1994). By contrast, smaller firms, particularly in dynamic industries, may offer faster promotions and diverse experiences, albeit with greater risk and variability. While they often provide lower initial wages, they can compensate

through dynamic growth opportunities and broader roles, allowing employees to rapidly develop a diverse skill set and take on more responsibilities early in their careers (Autor et al., 2020; Burton et al., 2017). This effect is particularly pronounced for high performers, who may experience rapid wage increases due to the flexibility and agility of smaller organizations (Nyberg & Wright, 2015).

Hiring standards and firm size play a fundamental role in shaping employment conditions, as they help establish a clear link between workforce stability and long-term career development (Weiss & Landau, 1984). Larger firms, facing greater monitoring costs and higher stakes in workforce management, invest in more structured hiring and training programs to optimize productivity. These structured approaches not only enhance skill acquisition but also promote long-term employment stability, offering workers clearer career progression and reducing turnover (Barron et al., 1987).

As careers progress, job stability, encompassing employment duration and security, becomes a critical pillar of professional development. While job mobility is common among young workers and can serve as a strategy for upward wage adjustment (Topel & Ward, 1992), long-term stability has its advantages. Greater job security has been shown to enhance wage growth, particularly in roles offering sustained employment and career progression (Gittleman & Wolff, 1993). Larger firms, with their structured career paths and extensive resources, provide greater job stability and lower turnover rates, improving employee retention (Rebitzer & Taylor, 1995; Burgess et al., 2000). However, smaller firms in niche or high-growth sectors can achieve comparable stability by fostering specialized roles and strong employee engagement, creating alternative paths for long-term career development (Matsa & Miller, 2011).

The organizational structure of a firm also plays a significant role in shaping career outcomes. Flat structures, which are more common in smaller firms, allow for greater flexibility and direct engagement with decision-makers. This fosters innovation and accelerates skill development, making such environments appealing to younger employees (Mintzberg, 1989; Malmendier, 2021). On the contrary, hierarchical structures in larger firms offer stability and clear career pathways, which can be attractive for individuals seeking defined roles and steady growth (Ouchi, 1980; Lazear & Shaw, 2009). While hierarchical structures promote job security and specialization, they may also limit the autonomy and fast-paced advancement available in flatter organizations.

Although wage dynamics, job stability, and firm size have been widely studied - including recent work by Arellano-Bover (2024), which finds that starting a career in a larger firm is associated with higher initial wages and steeper wage growth - important gaps remain in understanding how these patterns evolve throughout the early career. In particular, few studies follow individuals longitudinally to assess whether the characteristics of the first employer, such as firm size, have persistent effects beyond entry wages and into mid-career wage trajectories. Moreover, most existing evidence comes from large economies or cross-country studies, with limited attention given to small, SME-dominated labour markets such as Portugal.

This study addresses these gaps by leveraging linked employer-employee data specific to Portugal to examine how the size of the first employer shapes both entry wages and wage progression across the first decade of professional experience. It also investigates the trade-offs between job stability and mobility: whether workers benefit more from remaining in the same firm (accumulating tenure) or from switching jobs (each mobility acting as a potential wage jump). By combining theoretical insights with empirical analysis, this research aims to enrich the broader literature on labour economics while providing practical recommendations for graduates, employers, and policymakers navigating a rapidly evolving labour market.

3. Data and Descriptives

3.1. Data Source and Structure

This study utilizes detailed administrative matched employer–employee data from the Quadros de Pessoal (QP), a dataset maintained by the Instituto Nacional de Estatística (INE) in Portugal. The QP is an annual census-like survey that comprehensively covers private-sector establishments with wage earners in Portugal, excluding public administration and domestic services, thereby covering a near-universe of private sector employment relationships. It provides a rich and longitudinal view of the labour market, including individual-level information on demographic characteristics (such as age, sex, nationality, and education level), contractual arrangements (type of contract, job tenure), working conditions (hours worked, occupation), and remuneration (base salary, total earnings, bonuses). At the firm level, the dataset captures sector, size, location, and ownership structure, making it highly suitable for analysing employer effects on individual labour market outcomes over time. This study uses QP data from 2010 to 2022.

The analysis uses two core components of the QP database: the worker-level file (commonly referred to as TRB), which contains detailed information on individual employment contracts; and the firm-level file (EMP), which includes establishment and firm characteristics. The worker-level component (TRB) includes variables such as the worker's sex, age, nationality, education level, occupational classification, type of contract, working hours, and various remuneration components including base wage, total wage, regular and irregular bonuses. Employment tenure with the current employer is also recorded annually, allowing for the construction of employment histories and the analysis of wage progression over time. Additionally, each observation includes anonymised identifiers that allow linkage to firm-level information and tracking of workers across different employers and years.

The firm-level component (EMP) includes data on firms, such as their legal status, capital structure, founding year, location (NUTS I and II), sector of activity (classified by CAE codes), number of employees, number of establishments, and volume of business. Both TRB and EMP are part of the QP database and are linkable via consistent firm and year identifiers, enabling the construction of a longitudinal panel that captures the employment context of each worker within the Portuguese private sector.

The analysis focuses on recent higher education graduates entering the labour market for the first time. To construct the sample, a series of steps were undertaken to ensure that only true labour market entrants with complete and clean information were retained. First, individuals were retained only if they were aged between 16 and 50 and had attained a higher education degree, corresponding to a bachelor's degree or higher. Subsequently, all monetary values were converted from nominal to real euros using the Portuguese Consumer Price Index (IPC), standardizing to 2012 prices. This adjustment accounts for inflation and ensures wage comparability across years. The real salary was calculated by multiplying the reported earnings by the year's deflator (IPC base 2012), thereby allowing consistent analysis of wage dynamics in real terms over the full period of observation. Hourly wages were derived by dividing monthly real wages by the reported normal monthly working hours. Observations with zero or missing hours were excluded. To address skewness and facilitate interpretation, the dependent variable in regression analysis is the natural logarithm of the real hourly wage.

To ensure comparability of worker characteristics, a set of control variables was constructed. These include binary indicators for gender, foreign nationality, and postgraduate education (master's degree or higher). A quadratic term in age was also added to capture non-linear age effects. Labour market entry was determined by identifying the first year in which each individual appeared in the dataset, allowing the construction of an entry indicator.

The target population comprises recent graduates who entered the labour market shortly after completing their studies. To capture this group, the final sample includes only individuals who met three conditions in their first year of observation: being younger than 30 years old, having zero firm tenure, and being flagged as entering the dataset for the first time. This definition minimises contamination from workers with long employment histories predating graduation.

To further ensure that the sample includes only new entrants from 2010 onwards, individuals whose anonymised identifiers appeared in earlier years of the database (covering 2002-2009) were excluded. Additionally, to preserve sample consistency across the 2010-2022 period, two filters were applied: (i) firm tenure must not exceed 12 years, and (ii) individuals must be aged 41 or less by 2022, aligning with someone entering at age 29 in 2010.

To study wage trajectories over time, an individual-level variable was constructed measuring the average real hourly wage across all observed years. To analyse the role of job changes, a

binary indicator of job mobility was defined, taking the value of 1 if an individual switched employer after labour market entry (i.e. observed with zero firm tenure in a subsequent year after entry). This variable allows identification of job transitions and the study of their association with wage dynamics.

Finally, a detailed data cleaning process was implemented to remove observations that were logically inconsistent or exhibited extreme values. Three preliminary filters were applied to correct inconsistencies between tenure and market experience, removing observations where firm tenure exceeded total labour market experience (1.03%), where total experience was outside the valid 0-12-year range (0.11%), and a very small set of early inconsistent entries. Subsequently, observations with missing or zero wages (5.36%) and those in the bottom 1st percentile of the wage distribution (1.00%) were also excluded. Additional filters targeted inconsistencies in working hours: observations with mismatched reported and computed monthly hours (0.12%) and those with implausibly low working hours in the bottom 1st percentile (1.00%) were removed. These steps improved the logical coherence of the dataset and ensured a consistent basis for analysing wage dynamics among recent labour market entrants.

3.2. Descriptive Statistics

A natural starting point for understanding early career wage dynamics is the relationship between the size of the first employer and average earnings over the initial years in the labour market. Figure 1 presents a binned scatterplot of the log average real hourly wage across an individual's observed career, plotted against the logarithm of the size of their first employer. The relationship is clearly non-linear. The steepest gains are observed between log firm sizes of 4 and 7 (approximately 50 to 1000 employees), suggesting that starting in medium-to-large firms is particularly beneficial for long-term wage trajectories. Interestingly, the curve reaches its peak around this interval and declines for very large firms, indicating that entering extremely large organizations (with over 1000 employees) may not confer additional long-term wage benefits, and may even be associated with lower average wages compared to mid-sized firms. At the lower end of the distribution, graduates who begin their careers in very small firms tend to earn significantly less on average across their early career.

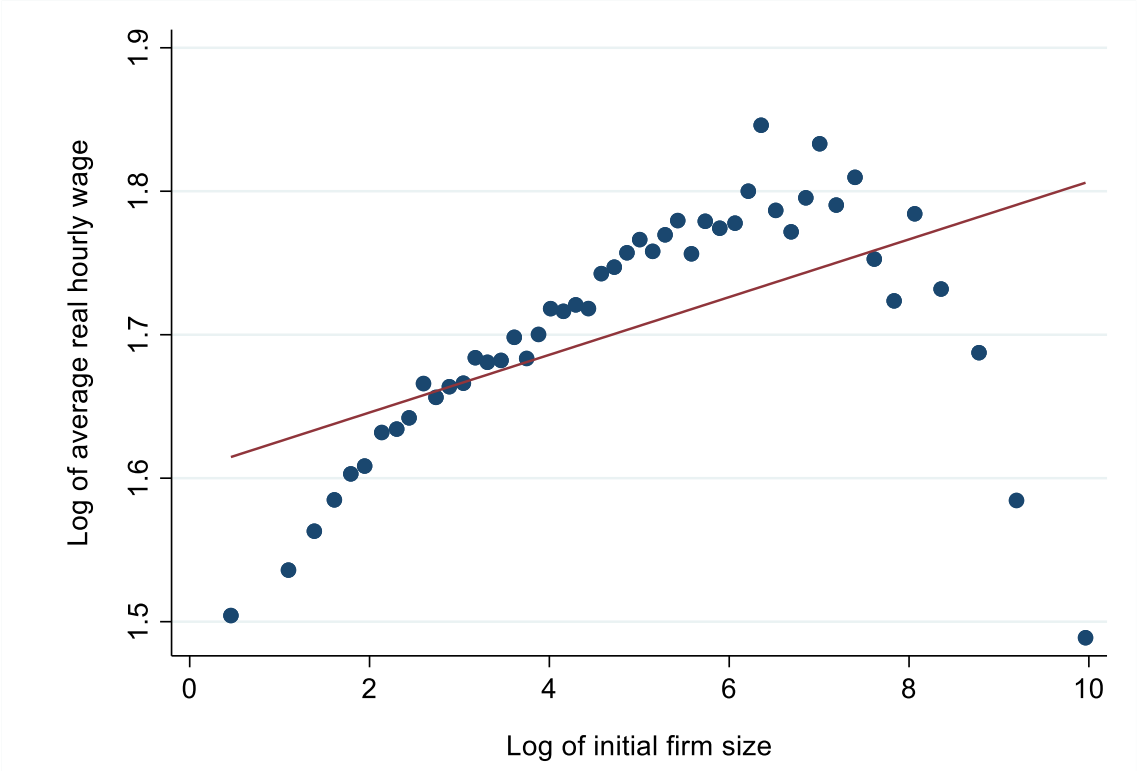

Figure 1. Average real hourly wage over the career by size of the first employer

Notes: This figure presents a binned scatterplot of the log average real hourly wage over the observed career span (2010-2022) against the log of initial firm size. Each dot represents a bin of graduates grouped by the log of the number of employees at their first employer. Wages are averaged at the individual level across all years with valid wage observations. The sample includes only recent graduates at labour market entry. A linear fit line is included to illustrate the general trend. Source: Quadros de Pessoal, own calculations.

These differences in average wages by initial firm size are mirrored by disparities across individual characteristics. At labour market entry, men earn approximately €6.22 per hour on average, compared to €5.60 for women, a gender pay gap of over 10% that persists across the wage distribution. A similar pattern is observed for nationality, as foreign-born graduates earn an average of €6.72 per hour, significantly more than their Portuguese counterparts (€5.78), although their standard deviation is significantly larger, indicating much greater dispersion and pointing to a bimodal structure likely driven by both high-skilled expatriates and low-paid migrant workers. Field of study also emerges as a key determinant of early earnings. Graduates in STEM fields start their careers with an average hourly wage of €6.31, compared to €5.71 for non-STEM graduates. The gap is particularly pronounced in the upper quartiles of the distribution, where STEM graduates earn nearly €0.70 more per hour, reflecting a premium for technical qualifications and stronger demand in high-productivity sectors.

Table 1. Entry hourly wages by gender, nationality and field

	Mean	SD	P25	P50	P75
Gender					
Male	6.22	3.96	4.52	5.51	7.23
Female	5.60	2.21	4.21	5.01	6.50
Nationality					
Portuguese	5.78	2.33	4.34	5.18	6.76
Foreigner	6.72	7.53	4.26	5.30	7.44
Field of study					
Non-STEM	5.71	3.13	4.23	5.05	6.61
STEM	6.31	2.72	4.65	5.73	7.30
Total	5.85	3.05	4.34	5.19	6.80

Notes: This table presents the distribution of real hourly wages at labour market entry by gender, nationality, and field of study. The statistics are calculated using the first observation for each individual in the sample of recent graduates. Wages are expressed in 2012 euros and correspond to monthly real wage divided by normal working hours. Reported values include the mean, standard deviation (SD), and the 25th (P25), 50th (P50), and 75th (P75) percentiles. Source: Quadros de Pessoal, own calculations.

This heterogeneity in wages is closely linked to the distribution of graduates across firm size categories at market entry. While literature shows that small and medium-sized enterprises dominate the Portuguese economy, the data shows that the majority of graduates do in fact begin their careers in these firms: according to Table 2, 17.0% enter microenterprises with fewer than 10 employees, 22.1% start in small firms (10–49 workers), and 22.8% are employed in medium-sized firms with 50–249 employees. Together, these groups account for 61.8% of the sample. Nevertheless, access to large employers is not limited to a small elite, as over one in five graduates (20.7%) secure entry positions in firms with more than 1,000 employees. By contrast, only around 17% start in firms with 250–999 workers, suggesting that mid-to-large-sized companies are less accessible. This bimodal distribution, with high shares at both ends of the firm size spectrum, reflects the structural composition of the Portuguese economy, which is heavily skewed toward microenterprises but also includes a small number of dominant large firms. These patterns have important implications for wage trajectories and career development paths, as explored in the following sections.

Table 2. Distribution of graduates by initial firm size

	Percent	Cum.
Firm size category		
1 - 9 people	17.01%	17.01%
10 - 49 people	22.13%	39.14%
50 – 249 people	22.81%	61.96%
250 – 499 people	8.79%	70.75%
500 – 999 people	8.59%	79.34%
1000+ people	20.66%	100.00%
Observations	380,950	

Notes: This table shows the distribution of recent graduates by the size category of their first employer, measured by the number of employees in the firm at the time of labour market entry. Both the percentage and cumulative percentage are reported for each group, based on the cleaned sample of market entry only used throughout the analysis. Source: Quadros de Pessoal, own calculations.

Regarding demographic characteristics at labour market entry, as shown in Table 3, the sample is relatively homogeneous in age, with an average of 24.9 years and most individuals

entering the labour market between 23 and 27. The majority are female and Portuguese. Most do not hold a postgraduate degree at entry and a substantial share graduated from non-STEM fields. Wage levels at entry, however, are more dispersed. The mean real hourly wage is €5.85, with an interquartile range from €4.34 to €6.80, and monthly real wages average €913. This variation reflects substantial heterogeneity in early job quality and firm placement. The size of the first employer is also highly skewed. Although the mean number of employees is 1210, the median is just 104, and the 75th percentile is 677, indicating that while some graduates enter very large firms, most begin their careers in small or medium-sized enterprises.

Table 3. Summary statistics for entry characteristics and early career outcomes

	Mean	St dev	P25	P50	P75
Individual characteristic					
Age	24.93	2.18	23	25	27
Gender	Female				
Nationality	Portuguese				
Postgraduation	No				
STEM	No				
First job / market entry					
Real wage	913.18	516.92	666.88	839.15	1111.66
Real hourly wage	5.85	3.05	4.34	5.19	6.80
Log real hourly wage	1.70	0.34	1.47	1.65	1.92
First employer size	1209.68	3445.84	17	104	677
Log first employer size	4.74	2.36	2.83	4.64	6.52
Career progression					
Average real hourly wage	6.81	3.66	4.78	6.08	8.01
Log average real hourly wage	1.84	0.37	1.57	1.80	2.08

Notes: This table presents descriptive statistics for key individual characteristics at labour market entry and career outcomes over time. For continuous variables, the mean, standard deviation, and percentiles (P25, P50, P75) are shown. Variables refer to age at entry, wages (monthly and hourly, in real 2012 euros), and firm size. Logarithmic transformations are applied to wage and firm size variables for comparability. Source: Quadros de Pessoal, own calculations.

As careers progress, wage growth is evident. The average real hourly wage over the period rises to €6.81, confirming an upward earnings trajectory for the majority of workers, consistent with human capital accumulation and job matching processes. However, as earlier evidence suggests, this growth is far from uniform across initial employment conditions.

Figure 2 illustrates the evolution of log hourly wages over the first 12 years in the labour market, segmented by the size category of the graduate's initial employer.

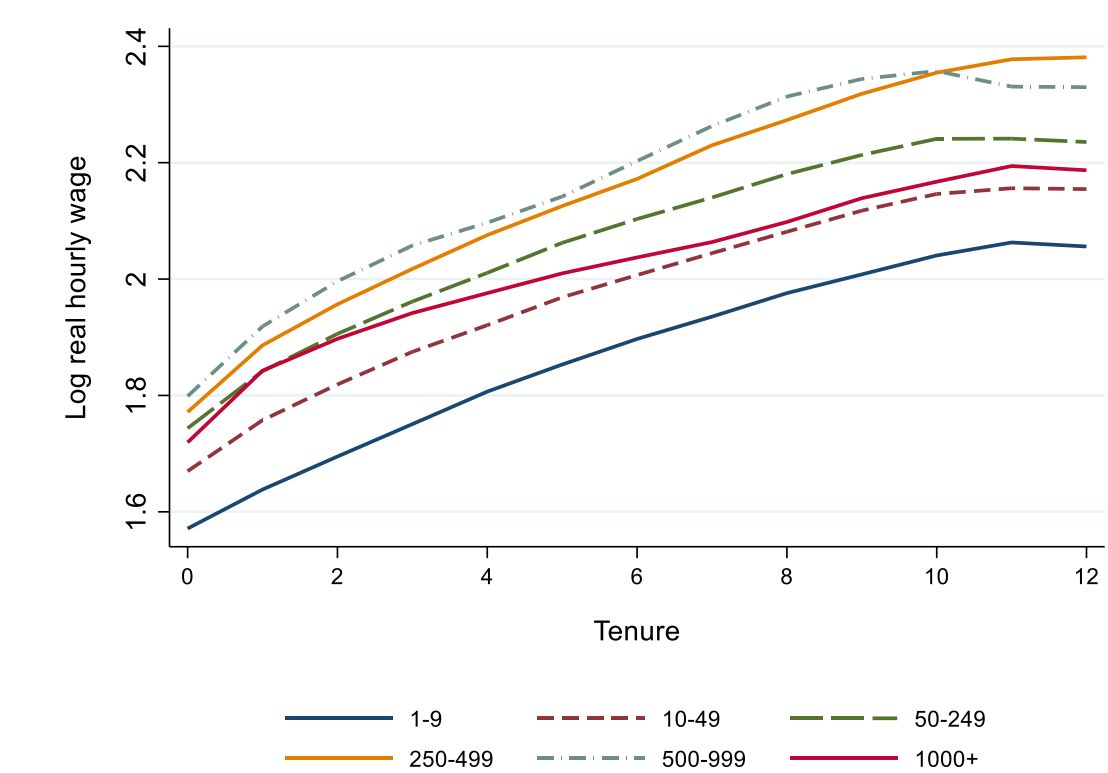

Figure 2. Wage progression by initial firm size

Notes: This figure shows the evolution of the log real hourly wage during the first 12 years of observed tenure, grouped by the size category of the graduate's initial employer. Each line represents a different firm size bracket, defined by the number of employees in the first year of employment. The wage values are calculated as annual means and plotted against tenure in the labour market. Sample restricted to recent graduates employed in the private sector. Source: Quadros de Pessoal, own calculations.

The figure reveals a strong and persistent association between initial firm size and wage progression over time. Graduates who start in firms with 250-499 employees experience the steepest wage growth, while the ones in firms with 500-999 ultimately attain the highest wages across the early career. Interestingly, while workers in the largest firms (1000+ employees) begin with relatively high wages, their earnings grow more slowly over time,

suggesting that very large employers may offer strong starting pay but more rigid or flatter advancement structures. Conversely, individuals who begin in microenterprises (1-9 employees) start at the bottom of the wage distribution and follow the flattest progression path. Wage trajectories for those employed in firms with 10-49 or 50-249 workers lie between these extremes, showing moderate but steady increases.

This non-linear pattern suggests that the most favourable wage trajectories are not necessarily found in the largest firms, but rather in medium-to-large enterprises that offer a balance of attractive entry wages and dynamic internal progression. These descriptive results reinforce the relevance of firm size not only for labour market entry but also for subsequent wage growth, a question that is examined more formally in the econometric sections that follow.

To complement the descriptive analysis and further illustrate the role of individual characteristics in shaping early wage growth, I include the figure below, which shows the average log real hourly wage over time by field of study (STEM vs. non-STEM).

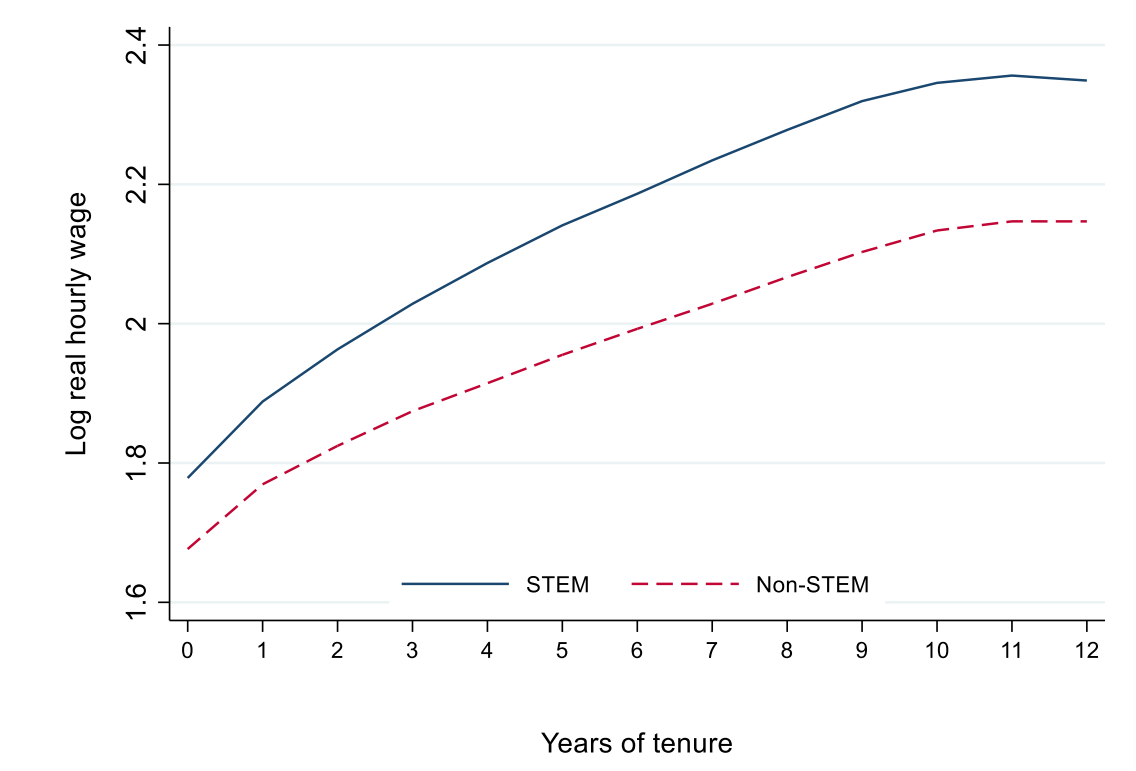

Figure 3. Wage trajectories by field of study: STEM vs non-STEM

Notes: This figure plots the log real hourly wage over the first 12 years of observed tenure, separately for STEM and non-STEM graduates. The field of study is defined using educational classification codes, with STEM covering science, technology, engineering, and mathematics degrees. Wages are computed as annual means by year of tenure for each group. Classification into STEM vs. non-STEM is based on field of study, not current occupation. The figure captures wage patterns by educational background, regardless of the job performed. Source: Quadros de Pessoal, own calculations.

The figure shows that STEM graduates not only start their careers with higher wages but also experience steeper wage growth throughout the early years of employment. Over the first 10 to 12 years in the labour market, the wage gap between STEM and non-STEM graduates widens progressively, suggesting that the economic returns to STEM education are not static but dynamic and cumulative. This pattern supports the view that field of study influences both initial placement and long-term wage growth, with STEM degrees offering more favourable trajectories.

4. Empirical Strategy

The empirical analysis aims to examine how the size of the first employer influences both entry wages and wage progression during the early stages of graduates' careers. The dependent variable in all models is the natural logarithm of the real hourly wage, measured annually at the individual level.

The first part of the analysis focuses on the effect of firm size on entry wages, using a cross-sectional specification that retains only the first observed job for each graduate. The size of the employer at entry is measured as the natural logarithm of the number of employees in the firm in the year of labour market entry. The model is estimated using ordinary least squares (OLS), with robust standard errors to account for heteroskedasticity. Since each individual appears only once, there is no need to cluster standard errors. The regression specification is as follows:

$$\ln(\text{Wage}_i) = \beta_0 + \beta_1 \ln(\text{Firm Size}_i) + X_i\beta + \delta_s + \delta_t + \varepsilon_i \quad (1)$$

where $\ln(\text{Firm Size}_i)$ is the natural logarithm of the number of employees at the graduate's first employer, observed at labour market entry; X_i includes controls for gender, nationality, postgraduate education, age and age squared, part-time status at entry, and field of study; δ_s and δ_t denote sector and year fixed effects, respectively; and ε_i is the error term.

To study how the influence of firm size evolves over time, a second model uses the full panel of individual-year observations between 2010 and 2022. In this specification, firm size is measured by the size of the first employer and held fixed over time, allowing the model to isolate dynamic effects associated with early job placement. The estimation is performed using pooled OLS, with standard errors clustered at the individual level, and includes time-varying regressors to capture the role of job tenure and mobility over the career. The panel regression is given by:

$$\ln(\text{Wage}_{it}) = \beta_0 + \beta_1 \ln(\text{Initial Firm Size}_i) + X_{it}\beta + \delta_s + \delta_t + \varepsilon_{it} \quad (2)$$

where $\ln(\text{Initial Firm Size}_i)$ is the same measure as in the cross-sectional model but held constant for each individual across time to reflect the size of their first employer; X_{it} includes the same controls as in the cross-sectional model, updated annually where applicable, and in addition time-varying measures of tenure, firm tenure and its square and cumulative job mobility and its square, to capture dynamic effects on wage progression; δ_s and δ_t denote sector and year fixed effects; and ε_{it} is the error term.

Another central aspect of the analysis is the potential trade-off between remaining with the same employer and switching jobs in pursuit of wage growth. The variable measuring firm tenure captures the returns to employment continuity within a single firm, while cumulative job mobility captures wage changes associated with transitions between employers. Comparing the marginal effects of these variables sheds light on whether early career wage progression is primarily driven by internal advancement or by external opportunities. This distinction is especially salient in the initial years of a career, when job changes reset firm-specific tenure but may also offer better matching or faster progression.

The analysis also investigates how field of study influences both entry wages and subsequent wage dynamics. A binary STEM indicator, derived from educational classification codes, is included in all specifications to compare wage trajectories between STEM and non-STEM graduates. Interaction terms with firm size and tenure allow the models to capture potential heterogeneity in career progression across fields, reflecting differences in labour market demand, occupational structures, and skill returns.

Overall, this modelling framework captures both static effects at entry and dynamic effects over time. It allows for a detailed assessment of how firm size, job mobility, tenure, and field of study shape wage outcomes during the first decade in the labour market. The inclusion of squared terms permits the identification of non-linearities, such as diminishing returns to tenure or mobility, while interaction terms reveal heterogeneous patterns across educational backgrounds. Although individual fixed effects are not included, the use of rich longitudinal administrative data, robust standard errors, and comprehensive control variables enhances the credibility of the results. Macroeconomic variations are controlled by the inclusion of year fixed effects.

5. Results

5.1. First Employer Size and Entry Wages

To assess the robustness of the firm-size wage premium, I estimate a sequence of five OLS models (Table 4) where the dependent variable is the logarithm of the real hourly wage at labour market entry, and the key explanatory variable is the logarithm of the number of employees in the firm at entry. This log-log specification allows for an elasticity-based interpretation, in which a coefficient of 0.027 in the fully specified model implies that a 10% increase in firm size is associated with a 0.27% increase in hourly wages, while doubling firm size corresponds to a 2.7% wage premium, holding all else constant.

Table 4. OLS estimates of the effect of initial firm size on entry wages

	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Log (Firm size)	0.0201***	0.0201***	0.0201***	0.0252***	0.0272***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Postgraduate	No	Yes	Yes	Yes	Yes
Female	No	No	Yes	Yes	Yes
Foreign	No	No	Yes	Yes	Yes
Age	No	No	Yes	Yes	Yes
Part-time	No	No	No	No	Yes
Field of study	No	No	No	No	Yes
Sector FE	No	No	No	Yes	Yes
Year FE	No	No	No	Yes	Yes
Observations	380,950	380,950	380,950	380,950	380,950
R^2	0.0191	0.0501	0.0704	0.2404	0.2786

Notes: Estimates based on cross-sectional OLS regressions using the first job observation for each individual. Robust standard errors are reported in parentheses. *** $p < 0.01$. No clustering is required as each individual appears only once. Sector fixed effects refer to one-letter CAE codes. Field of study refers to narrow ISCED categories constructed from education codes in the Quadros de Pessoal, using a conversion developed by Ana Rute Cardoso and Pedro Luís Silva.

The baseline model (column 1) includes no controls and yields a coefficient of 0.020, suggesting a 0.20% wage increase for every 10% increase in firm size. As additional covariates are progressively introduced, the coefficient on firm size not only remains statistically significant but also increases slightly. Column 2 introduces a control for postgraduate education; column 3 adds demographic controls such as gender, nationality and age. Column 4 incorporates fixed effects for sector and entry year, accounting for industry wage structures and macroeconomic conditions at the time of labour market entry. The final specification (column 5) adds part-time status and field of study indicators.

The explanatory power of the model increases substantially as controls are added, with the R^2 rising from 0.019 in the baseline specification to 0.279 in the fully saturated model. The largest gain occurs between models (3) and (4), where the inclusion of sector and year fixed effects raises the R^2 from 0.070 to 0.240, indicating that industry-specific wage structures and macroeconomic entry conditions explain a significant portion of wage variation. Still, the coefficient on firm size remains highly significant and stable across all specifications, and even increases slightly as controls are added. This pattern reinforces the interpretation that firm size independently contributes to wage setting, beyond what is explained by demographics, education, or contract type.

To explore potential non-linearities in the firm-size wage premium, I re-estimate the model using categorical dummies for firm size brackets instead of a continuous log specification. the estimated coefficients approximate semi-elasticities. To obtain exact percentage effects, coefficients should be transformed using $e^{\beta} - 1$. The results, presented in Table 5, reveal a clear and monotonic wage gradient across firm size categories. Graduates entering firms with 10-49 employees earn approximately 9.3% more than those in micro firms, while those in firms with 50-249 or 250-499 workers earn 15.9% and 18.4% more, respectively. The wage premium peaks at 21.0% in firms with 500-999 employees and slightly declines to 18.7% for firms with 1,000 or more workers, a pattern consistent with the earlier binned scatterplot. The magnitude of these premiums aligns closely with the elasticity-based estimates from the log-linear specification, reinforcing the conclusion that larger firms offer systematically higher pay at the point of labour market entry. Most of the premium is concentrated in the transition from small to medium-sized employers, suggesting that structural firm characteristics such as productivity, internal wage-setting policies, or bargaining environments play a central role.

Table 5. OLS estimates of the effect of first employer size (categories) on entry wages

Firm size category	Coefficient (Robust std. err.)
10 – 49 people	0.0933***
	(0.0015)
50 – 249 people	0.1586***
	(0.0016)
250 – 499 people	0.1842***
	(0.0021)
500 – 999 people	0.2104***
	(0.0020)
1000+ people	0.1874***
	(0.0017)
Observations	380,950
R^2	0.2867

Notes: Estimates based on cross-sectional OLS regressions using categorical dummies for initial firm size brackets. The dependent variable is the log of real hourly wage at entry. Microenterprises (1-9 employees) serve as the reference group. To obtain exact percentage effects relative to the reference group, apply the transformation $e^{\beta}-1$ to the reported coefficients. Robust standard errors are reported in parentheses. *** $p < 0.01$. The same set of control variables used in Column (5) of Table 4 is included here (gender, age, nationality, education, part-time status, sector and year fixed effects). No clustering is required as each individual appears only once in the sample.

Overall, both specifications converge on a common result: firm size at entry is a key determinant of starting wages. The next sections turn to the question of whether this initial advantage also influences longer-term outcomes, including wage growth and job stability.

5.2. Firm Size and Wage Progression

While firm size is strongly associated with wage levels at labour market entry, an important question is whether this advantage persists throughout the early stages of a graduate's career. Specifically, do workers who start in larger firms continue to earn more as they accumulate experience, or is the observed wage premium merely a reflection of initial sorting into better-paying jobs? To address this question, I extend the analysis beyond the entry point and investigate the relationship between the size of the first employer and wages over time.

The empirical strategy involves estimating pooled OLS regressions using panel data for the years 2010 to 2022, covering up to 12 years of observed wages per individual. The dependent variable is the log of the real hourly wage, measured annually, and the key explanatory variable remains the log of the number of employees in the individual's first employer, which is constant over time and captures long-run effects of firm size at entry. By including multiple wage observations for each individual, this approach allows me to examine whether the firm-size premium observed at entry is also reflected in earnings trajectories across the career.

Once again, the regressions include a sequence of models with progressively richer sets of control variables, following a similar structure to the analysis in the previous section. As before, the baseline specification includes only the log of initial firm size, while additional models incrementally introduce further covariates. However, in contrast to the entry wage regressions, this specification also incorporates dynamic career variables such as overall tenure, firm-specific tenure, and the cumulative number of job changes observed during the period. Other controls include age, gender, nationality, postgraduate education, part-time status, and field of study. In the final model, sector and year fixed effects are added to account for industry wage structures and macroeconomic fluctuations. This modelling strategy enables a stepwise assessment of how robust the firm-size effect remains as increasingly detailed information is incorporated, while also allowing for the role of employment dynamics in shaping wage trajectories to be explicitly considered.

The results, presented in Table 6, indicate that the wage premium associated with initial firm size does in fact persist throughout the early career. In the fully specified model, the coefficient on the log of firm size is 0.023 and statistically significant at the 1% level. This implies that a 10% increase in the size of the first employer is associated with a 0.23% increase in real hourly wages on average across the observed period, while a doubling of firm

size corresponds to a 2.33% wage premium. The coefficient remains relatively stable across specifications, despite the inclusion of detailed controls for human capital, job characteristics, and sector-year heterogeneity.

Table 6. OLS estimates of the effect of initial firm size on wages over the early career

	(1)	(2)	(3)	(4)	(5)
Log (Firm size)	0.0238***	0.0260***	0.0245***	0.0229***	0.0233***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Tenure	No	Yes	Yes	Yes	Yes
Age	No	Yes	Yes	Yes	Yes
Postgraduate	No	No	Yes	Yes	Yes
Female	No	No	Yes	Yes	Yes
Foreign	No	No	Yes	Yes	Yes
Number of job changes	No	No	No	Yes	Yes
Firm tenure	No	No	No	Yes	Yes
Part-time	No	No	No	No	Yes
Field of study	No	No	No	No	Yes
Sector fixed effects	No	No	No	Yes	Yes
Year fixed effects	No	No	No	Yes	Yes
Observations	1,748,128	1,748,128	1,748,128	1,748,128	1,748,128
R^2	0.0178	0.1510	0.2212	0.3045	0.3359

Notes: Estimates based on pooled OLS regressions using individual-year observations from 2010 to 2022. The dependent variable is the log of real hourly wage. The main explanatory variable is the log of the number of employees in the graduate's first employer, which remains fixed across time. Robust standard errors clustered at the individual level are reported in parentheses. *** $p < 0.01$. Models include the same control variables as in Table 4. Additional controls introduced include overall tenure, years of tenure within the current firm, the cumulative number of job changes since entry, and their squared terms to allow for non-linear effects. Full sample includes workers with up to 12 years of observed tenure.

Although the estimated effect of firm size is smaller in the longitudinal model than in the cross-sectional regression using entry wages only, this difference is both expected and informative. In the cross-sectional model, the coefficient captures the immediate wage premium at the point of labour market entry, which may include not only long-term firm-specific advantages but also initial sorting effects, such as higher-paying contracts or better-matched jobs in larger firms. In contrast, the pooled OLS model averages wages over multiple years of each individual's career, smoothing out transitory wage fluctuations and capturing the persistent component of the firm-size effect.

Moreover, the longitudinal specification introduces controls for career dynamics such as total tenure, firm-specific tenure, and job mobility, which partially mediate the relationship between initial firm size and subsequent wages. For example, workers who start in larger firms may accumulate more relevant experience or progress through more structured promotion ladders, which in turn influence their earnings independently of initial firm size. By including these variables, the model isolates the residual long-term wage premium attributable specifically to the size of the first employer, net of endogenous career developments.

As additional covariates related to career dynamics are introduced, such as job tenure, firm-specific tenure, and job mobility, the model captures more variation in wages and provides a more nuanced account of long-term wage determinants. These additions help clarify how dynamic employment characteristics shape wage trajectories over time, while the wage premium associated with initial firm size remains robust and statistically significant. The overall model fit improves considerably, with the R^2 increasing from 0.018 in the baseline specification to 0.336 in the fully specified model, indicating that a larger portion of the variance in wages is accounted for once these controls are included.

Overall, these findings suggest that the wage advantage associated with larger initial employers is not simply transitory. Rather, it reflects persistent differences in earnings trajectories, potentially driven by factors such as early training quality, career ladders, signalling effects in the labour market, or access to better job networks. The next section explores these dynamics more closely by focusing explicitly on the role of job mobility and firm tenure in shaping wage growth.

5.3. Trade-Off Between Job Mobility and Firm Tenure

This section examines the trade-off between tenure and job mobility in shaping early career wage trajectories. Specifically, it asks: Is it more beneficial to remain in the same firm or to switch jobs frequently in the first decade after labour market entry? To address this, three progressively richer linear regressions are estimated, presented in Table 7.

Table 7. OLS estimates of the effect of job mobility and firm tenure on hourly wages

	(1)	**(2)**	**(3)**
Number of job changes	0.0879***	0.0070***	0.0132***
	(0.0007)	(0.0010)	(0.0010)
Firm tenure	0.0506***	0.0082***	0.0104***
	(0.0002)	(0.0004)	(0.0005)
Interaction			-0.0038***
			(0.0003)
Full Model	No	Yes	Yes
Interaction	No	No	Yes
Observations	1,751,998	1,748,128	1,748,128
R^2	0.1076	0.3342	0.3345

Notes: Estimates based on OLS regressions using individual-year data from 2010 to 2022. The dependent variable is the log of real hourly wage. The number of job changes is measured cumulatively up to each year of observation, meaning that individuals with longer labour market exposure may accumulate more transitions simply due to being observed over a longer period. To obtain exact percentage effects, apply the transformation $e^{\beta} - 1$ to the reported coefficients. The full specification in Columns (2) and (3) replicates the controls used in Column (5) of Table 6. The interaction term corresponds to the product of the number of job changes and firm tenure, allowing the wage return to mobility to vary with the length of time spent within the same firm. Robust standard errors clustered at the individual level are reported in parentheses. *** $p < 0.01$.

The baseline model includes two predictors: the cumulative number of job changes and total firm-specific tenure. Both coefficients are highly statistically significant and positive. A single job switch is associated with an 8.8% increase in hourly wage, while an additional year of tenure contributes approximately 5.1%. These results suggest that, in the absence of controls,

both mobility and tenure appear to positively influence earnings, with job mobility exerting the stronger effect. However, this reflects a mechanical correlation: since the number of job changes is measured cumulatively up to each year of observation, workers with longer labour market exposure mechanically accumulate more transitions. These workers tend to have higher wages due to experience effects and wage growth over time. Therefore, the observed coefficient in the baseline model partly captures this time-exposure effect.

The second model introduces a rich set of control variables, including educational attainment, gender, nationality, age, sector, year fixed effects, and the log size of the first employer. Once these factors are taken into account, the estimated effects of both job mobility and firm tenure decrease substantially. The return to job switching falls sharply to 0.70% per move, and the return to tenure drops to 0.82% per year. These attenuations suggest that a large portion of the apparent wage benefits associated with both strategies in the baseline model were driven by underlying experience and exposure time, as well as other correlated factors, such as differences in education, sectoral wage structures, or the type of firms where mobile or stable workers are employed. Importantly, the fact that both effects remain statistically significant even after extensive controls implies that mobility and tenure still contribute positively to wage growth, but to a much lesser extent than initially estimated.

The third model introduces an interaction term between job mobility and firm-specific tenure to allow for differential returns depending on the combination of both strategies. The coefficient on the interaction term is negative and statistically significant ($\beta = -0.0038$, $p < 0.01$), indicating that the wage returns to mobility and tenure are not independent. Instead, there is evidence of diminishing marginal returns, meaning that frequent job changes reduce the wage benefits typically associated with longer tenure, and conversely, extended firm tenure lowers the marginal gain from additional job switches.

Interestingly, the main coefficients on job mobility and tenure increase in magnitude relative to the previous model, reaching 1.32% per move and 1.04% per year respectively. This does not imply stronger effects overall. In models with interactions, these coefficients represent conditional effects, specifically, the effect of job mobility when tenure equals zero, and vice versa. Since few individuals in the sample have zero tenure or zero job changes, these values are not representative of average workers. The overall wage effect for most individuals must account for the interaction term. Because the interaction is negative, the marginal effects of each variable decrease as the other increases.

Overall, the results reveal a non-linear trade-off between job mobility and stability. Both strategies can support wage growth, since workers who remain with the same employer accumulate firm-specific capital that pays off over time, while those who switch jobs more frequently may benefit from broader experience and better matching. However, when both are pursued simultaneously (e.g., frequent moves with medium tenure) the returns are significantly reduced. This suggests that early career wage growth is best supported by a coherent employment strategy. Rather than one approach being universally superior, the effectiveness of mobility or stability depends on how they interact and are applied over time.

To complement the regression results and better illustrate the interaction between job mobility and tenure, I plot the estimated marginal effects. While the coefficients from the interaction model reveal an average negative relationship between the two strategies, they do not show how the marginal returns evolve across different values of tenure or mobility. The following figures provide a more intuitive view by visualising how the effect of one variable changes across the distribution of the other and reveal the extent to which stability and mobility are substitutes, or potentially even conflicting strategies in shaping wage growth.

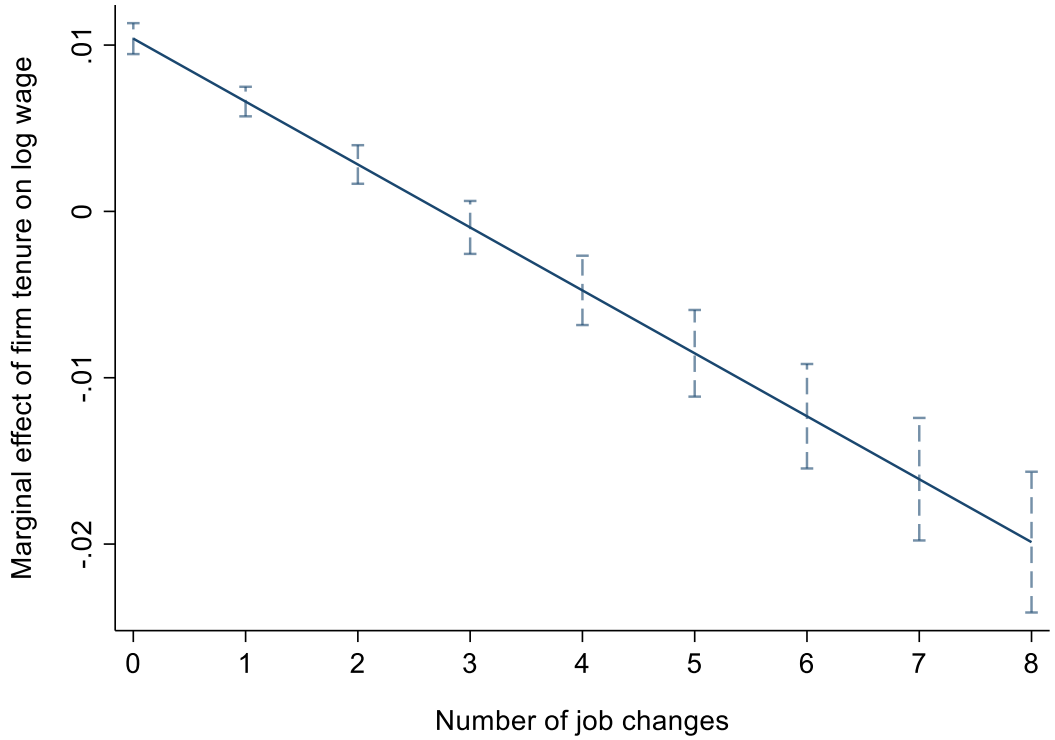

Figure 4. Marginal effect of firm tenure by job mobility

Notes: Marginal effects computed from the full specification of Table 7, Column (3). The graph displays how the marginal return to firm tenure varies across different levels of cumulative job mobility. Vertical bars represent 95% confidence intervals based on robust standard errors clustered at the individual level.

This figure (Figure 4) shows how the marginal return to one additional year of firm-specific tenure varies across different levels of job mobility. For workers with no job changes, the marginal effect of tenure is close to 0.01 log points, equivalent to a 1% increase in real hourly wages. While modest, this return reflects the accumulation of firm-specific experience and the potential for salary progression within stable employment relationships.

As the number of job changes increases, the wage return to tenure declines steadily. By the time a worker has switched jobs two times, the marginal return to tenure approaches zero, and becomes negative beyond three transitions, suggesting that tenure no longer translates into wage gains for highly mobile individuals. This decline may reflect the inability to accumulate seniority benefits or progress within firms when employment spells are short.

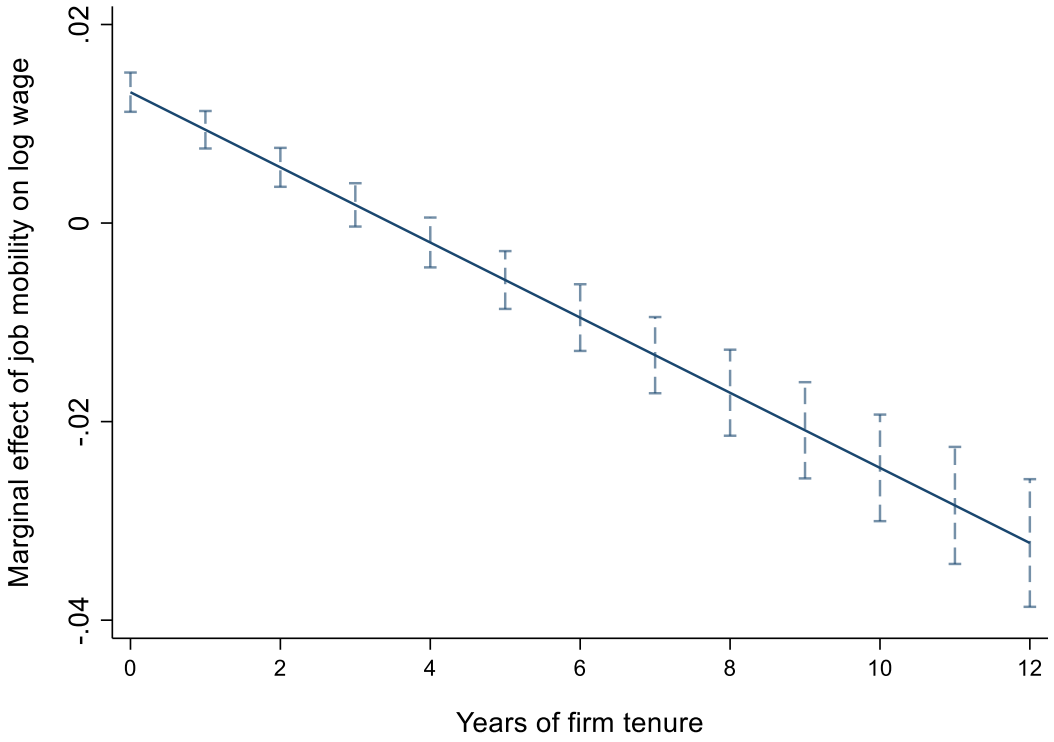

Figure 5. Marginal effect of job mobility by firm tenure

Notes: Marginal effects derived from the full model in Table 7, Column (3), incorporating an interaction term between firm tenure and the number of job changes. This graph illustrates how the marginal effect of job mobility on wages varies according to years of tenure within the same firm. Vertical bars represent 95% confidence intervals based on robust standard errors clustered at the individual level.

Figure 5 reverses the relationship, illustrating the marginal effect of job mobility at different levels of firm-specific tenure, that is, the number of years an individual has spent in their current firm, irrespective of overall experience in the labour market. The figure shows that

the return to switching jobs is slightly positive when tenure is very low, particularly in the first year at a firm. This suggests that early exits, potentially driven by poor initial matches or access to better opportunities, can yield modest wage improvements. However, the return to mobility declines steadily as tenure within the same firm increases. Once a worker has spent several years in a firm, the wage penalty for switching employers becomes increasingly pronounced. By the time tenure reaches 10 to 12 years, the marginal effect of changing jobs is negative, with wage losses exceeding 3.5%.

This pattern likely reflects the loss of firm-specific capital, seniority benefits, or promotion prospects that accumulate with time spent in one organization. Additionally, changing jobs after a long period with the same employer may be perceived as a negative signal by potential new employers, especially if not accompanied by a clearly upward transition. Thus, job mobility appears most beneficial during the early stages of a given employment spell, whereas long-term attachments to a firm make subsequent exits costlier in terms of earnings.

These results highlight a dynamic trade-off between mobility and stability in shaping early career wage growth. Firm-specific tenure yields returns primarily when supported by employment continuity, allowing workers to accumulate internal capital and progress within organisational hierarchies. Conversely, job mobility offers the greatest benefits at the beginning of a firm spell, when opportunities for upward transitions or better matches are most abundant. As tenure increases, the wage advantage of switching diminishes and eventually becomes negative, highlighting the costs of abandoning accumulated seniority or signalling instability.

Overall, the evidence suggests that the effectiveness of wage-enhancing strategies depends not just on whether individuals stay or move, but on the sequencing and timing of those choices. Mobility and stability act as substitutes: combining them too frequently erodes the benefits of each. Strategic coherence, whether through early mobility followed by consolidation, or long-term tenure in a growth-oriented firm, emerges as key to sustained wage progression.

5.4. Field of Study and Wage Differences

Educational background is one of the most prominent predictors of labour market outcomes, particularly at the point of entry. STEM (Science, Technology, Engineering, and Mathematics) fields, in particular, are often associated with higher earnings potential due to their technical nature and strong demand in the labour market. To quantify the extent of these differences, I examine whether graduates from STEM fields earn systematically higher wages than their non-STEM counterparts upon entering the workforce.

Using a cross-sectional specification restricted to the first job observation per individual, the results reveal a clear and statistically significant wage premium for STEM graduates. In the baseline model without controls, those with a STEM degree earn on average 10.2% more than graduates from other fields. Introducing controls for firm size, age, postgraduate education, gender, nationality, and sector reduces the estimated premium to 5.5%, yet the coefficient remains highly significant.

Table 8. OLS estimates of STEM wage premium at labour market entry

	(1)	**(2)**
STEM	0.1022***	0.0547***
	(0.0013)	(0.0013)
Full Model	No	Yes
Observations	380,950	380,950
R^2	0.0159	0.2525

Notes: Estimates based on cross-sectional OLS regressions using the first job observation for each individual. The dependent variable is the log of real hourly wage, and the key explanatory variable is a binary indicator for whether the graduate's degree falls within a STEM field, based on the same conversion from QP educational codes explained before. To obtain exact percentage effects, apply the transformation $e^{\beta} - 1$ to the reported coefficients. Column (2) includes the full set of controls from Table 4, including age and age squared, gender, nationality, postgraduate education, part-time status, sector fixed effects, and year fixed effects. Robust standard errors are reported in parentheses. *** $p < 0.01$.

These findings suggest that part of the observed advantage reflects favourable sorting into higher-paying firms or sectors, such as large employers or high-wage industries, but a

substantial portion of the premium persists even after controlling for these factors. This supports the interpretation that STEM education is associated with higher productivity or market valuation of skills, conferring a direct wage advantage at labour market entry.

To evaluate whether the wage premium for STEM graduates persists or evolves over time, I extend the analysis to a panel setting covering the early career years. The results suggest that the advantage is not only sustained but amplifies with experience. In the pooled regression without controls (column 1), STEM graduates earn on average 16% more than non-STEM graduates across the observed period. Even after accounting for firm size, education, demographics, and sector and year fixed effects (column 2), the premium remains substantial at 7.1%, exceeding the controlled premium observed at entry.

Table 9. OLS estimates of STEM wage premium over the early career

	(1)	**(2)**
STEM	0.1597***	0.0705***
	(0.0015)	(0.0015)
Full Model	No	Yes
Observations	1,751,998	1,751,998
R^2	0.0285	0.3124

Notes: Estimates based on pooled OLS regressions using individual-year observations from 2010 to 2022. The dependent variable is the log of real hourly wage, and the key explanatory variable is a binary indicator for whether the graduate's degree falls within a STEM field, based on the conversion from QP educational codes. To obtain exact percentage effects, apply the transformation $e^{\beta} - 1$ to the reported coefficients. Column (2) includes the full set of controls described in Table 6, with robust standard errors clustered at the individual level. *** $p < 0.01$.

This pattern indicates that the returns to STEM education are dynamic, accumulating over time rather than being limited to initial labour market sorting. While part of the early differential can be attributed to favourable matching into higher-paying firms or sectors, the growing premium suggests that STEM graduates benefit from faster wage progression, more efficient job matching, or better access to career ladders over time. The contrast between entry-level and longitudinal estimates reinforces the idea that technical fields confer enduring advantages, with the labour market consistently rewarding STEM skills as careers advance.

To deepen the analysis of how wage trajectories differ by field of study, I now turn to predicted wage paths over the early career. Building on the regression estimates discussed above, Figure 6 illustrates the model-adjusted evolution of log real hourly wages for STEM and non-STEM graduates during the first 12 years in the labour market. The underlying specification includes an interaction between years since entry and a STEM dummy, while controlling for the same wide set of covariates.

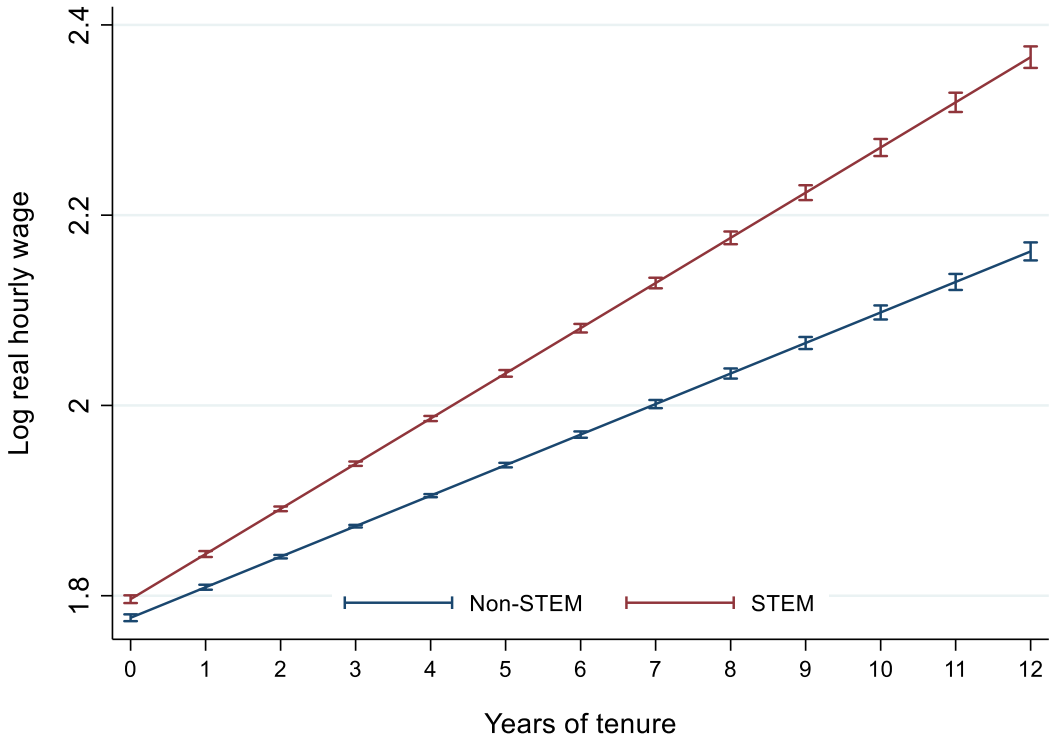

Figure 6. Adjusted wage trajectories by field of study: STEM vs non-STEM

Notes: Predicted values from a pooled OLS regression including an interaction between a STEM dummy and years of tenure, along with controls for firm size at entry, age, gender, nationality, postgraduate education, part-time status, number of job changes, and sector and year fixed effects. The graph shows adjusted wage trajectories over the first 12 years in the labour market, separately for STEM and non-STEM graduates. Vertical bars represent 95% confidence intervals.

The figure reveals a clear and growing divergence in earnings. STEM graduates begin their careers with a modest wage advantage, but the gap widens steadily over time, indicating faster wage growth relative to their non-STEM peers. By year 12, the accumulated difference becomes substantial, reflecting dynamic and compounding returns to STEM education. Importantly, this pattern persists even after adjusting for observable characteristics, suggesting that the advantage is not merely a product of selection into higher-paying jobs or sectors. Instead, the results are consistent with mechanisms such as better job matching,

stronger wage ladders in technical fields, or higher demand in growth-oriented industries, all of which help explain the steeper wage progression observed among STEM graduates.

Deepening the understanding of how early career mobility interacts with field of study, the next figure disaggregates wage paths by number of job changes for STEM and non-STEM graduates, allowing us to observe whether both groups benefit equally from switching jobs, or if mobility yields asymmetric returns depending on educational background.

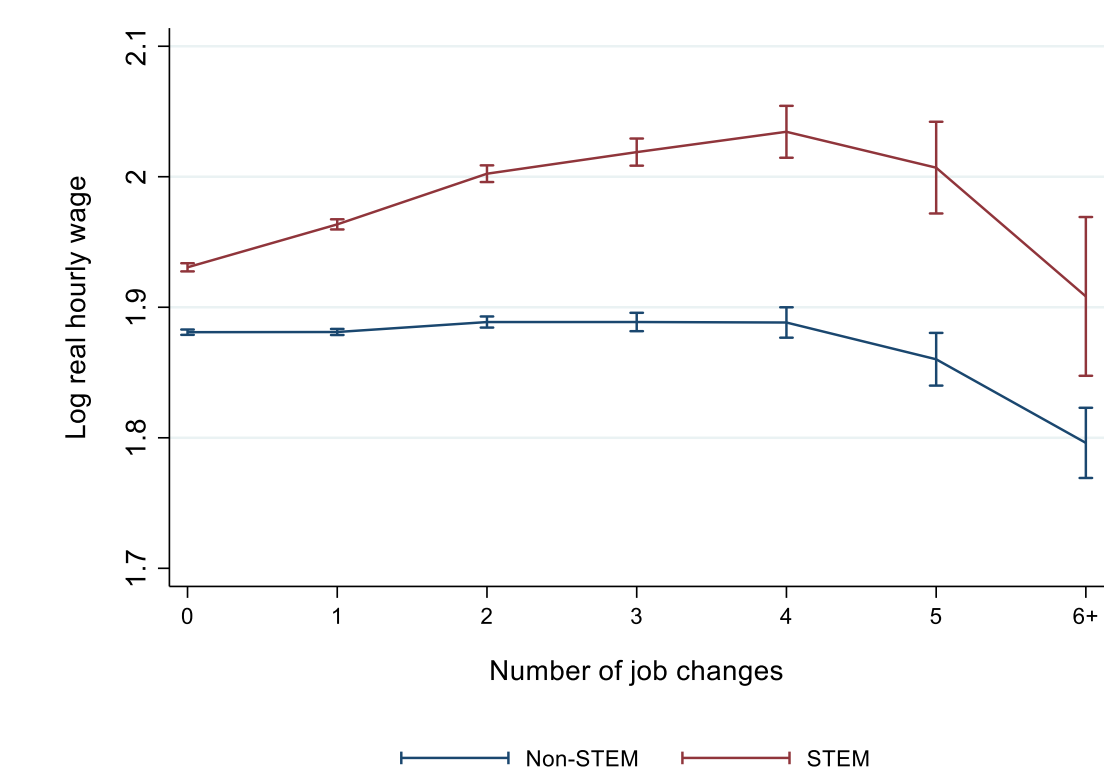

Figure 7. Wage by number of job changes: STEM vs non-STEM

Notes: Predicted log hourly wages from a pooled OLS regression including an interaction between a STEM dummy and the number of job changes (categorical). The model controls for firm size at entry, age, gender, nationality, postgraduate education, part-time status, tenure, and includes sector and year fixed effects. Confidence intervals at the 95% level are shown for each point.

The results reveal sharply contrasting patterns. For STEM graduates, wages rise steadily with job changes up to a peak around four transitions, suggesting that moderate mobility helps capitalize on external opportunities, potentially via better job matching, faster skill acquisition, or stronger bargaining leverage. However, beyond this point, the returns to further mobility turn negative, indicating that excessive switching may erode earlier gains. This pattern suggests that four job changes may represent an optimal adjustment process for STEM workers during the first 12 years of their careers. Past this threshold, the wage decline

could reflect a subgroup of workers who struggle to adapt to new environments or fail to secure higher-quality jobs, despite frequent transitions.

In contrast, non-STEM graduates exhibit a flatter trajectory throughout: wage levels remain largely constant for low to moderate mobility and eventually decline after frequent moves. This muted responsiveness points to limited outside options or weaker demand for non-STEM skills in the external market. Together, these results suggest that moderate mobility is an effective strategy for wage growth, particularly for STEM graduates, but that excessive mobility leads to wage penalties. The flat early trajectory for non-STEM workers reinforces the idea that returns to mobility are not uniform, but instead shaped by the market value of one's skills. Field of study plays a critical role in shaping how graduates convert career decisions into wage outcomes.

Finally, I explore how wage growth within firms differs by field of study. By plotting predicted wages over increasing years of firm tenure, separately for STEM and non-STEM graduates, it becomes possible to assess whether the returns to staying with the same employer diverge depending on educational background.

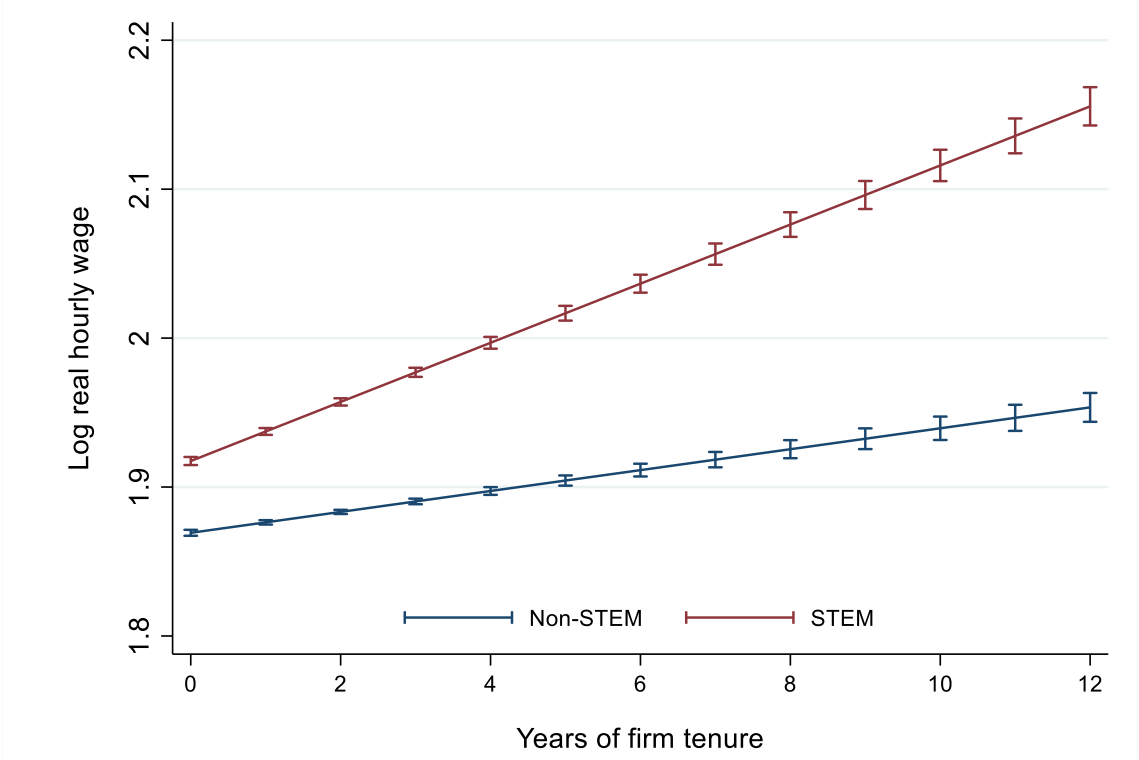

Figure 8. Wage by firm tenure: STEM vs non-STEM

Notes: Predicted log hourly wages from a pooled OLS regression including an interaction between a STEM dummy and firm tenure (in years). The model controls for initial firm size, age, gender, nationality, postgraduate education, part-time status, number of job changes, and includes sector and year fixed effects. Confidence intervals at the 95% level are shown.

The results, once again, show a clear divergence. STEM graduates begin with higher wages and see steeper growth in earnings with each additional year of tenure at the same firm. The wage trajectory is almost linear, suggesting that STEM skills are consistently rewarded within firms over time, possibly through internal promotions, skill deepening, or performance-based increases. In contrast, non-STEM graduates follow a flatter path, with more modest returns to tenure. This gap widens over time, indicating that firm-specific experience generates more value when paired with technical qualifications. The findings reinforce the notion that both mobility and stability yield greater returns for STEM graduates, while non-STEM workers face more constrained wage progression regardless of strategy.

6. Discussion

This study has analysed how early career wage dynamics for recent graduates are shaped by initial firm size, job mobility, tenure, and field of study, using rich matched employer–employee administrative data from Portugal. The results reveal that early labour market experiences, particularly the characteristics of the first job, have long-lasting effects on wage trajectories.

Graduates who start their careers in larger firms earn significantly higher wages at entry, and this advantage tends to persist and even widen over time. These findings reinforce the employer size wage premium documented in earlier literature (Brown & Medoff, 1989; Oi & Idson, 1999), and extend it by showing that large and medium-sized firms are also associated with steeper wage growth. This likely reflects more structured career ladders, the presence of internal labour markets, or greater training capacity (Baker et al., 1994; Autor et al., 2020). The institutional features of firms, therefore, play a central role not only in initial sorting but also in shaping long-term career development.

Job mobility and tenure also prove to be key drivers of wage progression. However, their interaction reveals a complex trade-off. Moderate mobility appears to enhance wage growth, especially among STEM graduates, yet frequent switching reduces the cumulative benefits of tenure, while prolonged tenure erodes the marginal gains from mobility. These dynamics are consistent with the declining returns to mobility identified by Topel & Ward (1992), and they echo the broader theories of firm-specific human capital and the importance of coherent career paths (Barron et al., 1987; Rebitzer & Taylor, 1995).

Field of study introduces a further layer of differentiation. STEM graduates not only begin their careers with higher wages but also see faster wage growth relative to their non-STEM counterparts. This premium remains significant after accounting for individual and firm characteristics, indicating dynamic, compounding returns to technical degrees. The results are aligned with the findings of Deming & Noray (2020) and Altonji et al. (2012), who argue that technical skills are increasingly rewarded in a changing labour market, offering better matching and mobility options.

The interaction between job strategies and field of study is particularly noteworthy. STEM graduates benefit more from both job mobility and firm-specific tenure, suggesting they are

better positioned to take advantage of both external opportunities and internal advancement. In contrast, non-STEM graduates show flatter wage responses to mobility, potentially due to weaker outside options or less structured career ladders. These findings align with Garen (1985) and Weiss & Landau (1984), reinforcing the view that early career strategies are not universally effective but depend on the market value of one's skillset.

From a policy and practical perspective, these results carry relevant implications. For students and graduates, securing a good initial match, especially in larger firms or technical roles, can offer a strong foundation for long-term wage growth. For employers, especially SMEs, investing in structured progression systems may help attract and retain talent. For policymakers, the findings support policies that improve labour market transparency, enhance early career guidance, and assist SMEs in offering competitive employment conditions.

Finally, the study's limitations should be acknowledged. The administrative data, while comprehensive, do not capture soft skills, motivation, or career preferences, which may also influence wage outcomes. Furthermore, unobserved individual heterogeneity, such as innate ability or social networks, may affect both initial job sorting and wage progression. Nevertheless, the consistency of results across specifications and the alignment with existing literature offer confidence in the robustness and relevance of the conclusions drawn.

7. Conclusion

This thesis provides clear evidence that early career decisions, particularly regarding firm size, mobility, tenure, and field of study, play a critical role in shaping long-term wage trajectories among recent graduates in Portugal.

The results show that starting in a large or medium-sized firm, pursuing moderate job mobility, and holding a STEM degree are each independently associated with higher earnings over the first decade of employment. These patterns suggest that early career advantages are shaped by more than individual characteristics - they reflect structural differences in how firms and sectors support or limit wage progression.

In addition to contributing to the academic literature on labour economics and early career development, the findings have concrete implications for graduates, employers, and policymakers. Supporting better job matching, investing in career progression pathways within firms, and enhancing early career guidance are all key to improving youth labour market outcomes.

While the analysis cannot fully address unobserved heterogeneity or qualitative dimensions of job content, it lays a strong empirical foundation for future research. Extensions could include causal designs or sector-specific studies to better understand heterogeneity across industries or regions.

In sum, the study underscores the importance of initial job placement and coherent career strategies in the years following graduation. Decisions made at labour market entry resonate far beyond the first paycheck, shaping wage paths for years to come.

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