The returns of vocational education in Portugal*

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Abstract

This paper examines the wage returns to general and vocational secondary education throughout the life cycle in Portugal. Using a rich combination of administrative matched employer-employee data we show that the returns of secondary education depend on the type of skills acquired. Consistent with human capital theory, we find that the initial advantage in wages given by the specific skills acquired by vocational graduates fades with age. Our results also suggest that the vocational wage gap is sightly larger for men then for women. Our results shed new light on the wage gap differences.

Keywords: VET, Education, Portugal

Contents

List of Tables

List of Figures

1 Introduction

Vocational education has become more and more relevant in policy discussion. On the one hand, proponents argue that it may be used to address rapid changes in labor demand, tackle skill mismatches, and youth unemployment (CEDEFOP, 2020). On the other hand, opponents fear the implicit trade-off in vocational education: since specialized skills may deteriorate more quickly than generic ones, vocational education graduates may have different trajectories in terms of salary, career progression, and employability. Quantifying the actual impact of vocational education on labor market outcomes is key for efficient allocation of resources and effective design of education policies.

In this article we investigate the ex-post returns of different types of secondary education in Portugal. In particular, we investigate the different returns to general education and vocational education over the life cycle. Throughout the paper we decompose the further trough time considering the effect in different generations. Such approach account for labor market conditions and institutional settings particular to each generation. Consequently, we are able to describe the evolution of the labor income earnings unbalances across time, and its evolution within and between generations. Our analysis relies on a unique data set that allow us to observe the individual careers and wage path of Portuguese workers in the manufacturing and services sector. We also explore further questions related to recent policy relevant questions, as gender.

This paper contributes to the literature and policy debate by studying the returns of secondary education in Portugal. Our analysis documents the labor earning differences between the two types of secondary education existing in Portugal: general and vocational education. While general education provide student with general skills that lay the groundwork for additional life long learning, vocational education provides the required skills for specific occupations. Although vocational education could speed up the transfer into the workforce, the skills developed through vocational education might also become outdated more quickly (Hanushek et al., 2017). This difference makes that the *Hump-Shaped Wage Profile*[1] —the fact that wages typically do not fall (if they fall at all) until individuals are close to retirement, but hours decrease rapidly after 50 —has a different shape for each type of secondary education, resulting in very different earnings profiles throughout the life cycle. We expect that students that finish vocational education have an advantage in the first years after entering the labor market, but that the depreciation of skills penalize wages at a faster rate.

In Portugal, secondary education is the second most heterogeneous group when considering wages distribution (Cardoso et al., 2018). In this study we intend to unveil the expected

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[1]See Rupert and Zanella (2015) for a detailed characterization on wages and hours trough the life cycle.

difference depending on the path chosen by the secondary education student. A recent paper by Hartog et al. (2022) finds that wage profile is *Hump-Shaped* when considering within and between cohorts. We use administrative matched employer-employee data on Portuguese workers with secondary education and no post-secondary degree. Our data allow us to compare earnings between the general and vocational track while accounting for the different labor market conditions trough time. When we analyze gender, the gender wage gap increases with age, and slightly decreases close to retirement. Overall, the vocational wage gap is slightly larger for men than for women.

Skills are on the center of recent policy debate. Skills are a fundamental component when analyzing the labor market (Deming and Kahn, 2018; Deming, 2017; Lindenlaub and Postel-Vinay, 2016; Guvenen et al., 2020; Lise and Robin, 2017; Lise and Postel-Vinay, 2015; Tan, 2017). It is common now to think of the labor market in terms of skills, in which individuals possess different levels of each skill, and each job can require a different combination of skills and in different amounts (Lazear, 2009). The types of skills supplied to the economy impact not only the wage profiles of workers, but also firms and overall productivity, unemployment levels, and could hamper innovation and growth (Brunello and Wruuck, 2019). This makes that governments have to strategically plan the supply of skills, considering its type, cost and employability. This paper provides quantitative and reliable estimates to assess the return of secondary education in Portugal, considering the effect across different demographic groups.

Our empirical analysis proceeds as follows: In the first stage, we provide unconditional estimates of the gap between vocational and general education across age and cohorts. In the second step, following Hartog et al. (2022) we inquire on the conditional estimates of the difference in earning between general and vocational education. From our first step, we find that *Hump-Shaped Wage Profile* has flattened between generations, and across ages within each cohort. This is consistent with previous findings (Hartog et al., 2022; Rupert and Zanella, 2015; Hanushek et al., 2017). From our second step analysis we find that the wage gap persist at all levels, but on average inside the firm, workers that have vocational education training have a wage premium. Taken together, our findings have important implications for policymakers interested in the design and supply planning of secondary education. In both stages we provide different results for men and women. Overall our result is consistent with previous findings but we point out that the vocational wage gap is slightly larger for men. This hints at the different structure of the occupational composition of employment.

One limitation of our analysis is that the choice of the education path is highly endogenous, and might be driven by ability Altonji et al. (2012), a variable that is not observed in our data. Our specification controls for age and tenure and the type of

firm to account for such limitation. Another limitation is that we do not consider the type of labor market faced by the worker, and the theory points out that the choice of track can be tied to how competitive the labor market is (Wasmer, 2006). In more competitive environments (high worker mobility and high finding rate) workers would prefer to specialize in general skills. The available data does not allow us to control at this level of detail.

Our research is related to three strands of the literature. The first is the literature investigating the returns to secondary education along the life cycle. There is also evidence that different institution affect the labor market outcomes, both in term of employment and wages (Hartog et al., 2022; Machin et al., 2020; Kirkeboen et al., 2016; Brunello and Rocco, 2017). Following Hanushek et al. (2017), such difference also occur between countries. The second strand is the recent literature that test theoretical advantages that vocational education has at entry, and how they become disadvantages as workers age. Different authors (Hanushek et al., 2017; Hampf and Woessmann, 2017; Krueger and Kumar, 2004) provide evidence of such trade-off. This is backed by other country studies using administrative data (Silliman and Virtanen, 2022; Hartog et al., 2022; Berge, 2018). Lastly, recent literature has pointed out that one of the sources of heterogeneity of labor income is the date of entry to the labor market (Oreopoulos et al., 2012; Berge, 2018). Even if our empirical strategy does not address this issue in detail, the division in cohorts capture some of the heterogeneity capture by earnings.

The remainder of the paper is organized as follows. Section 2 lays down a conceptual framework as a motivation for our empirical analysis. Section 3 describes the particular institutional background that frames our analysis. Section 4 presents the data sources and the descriptive statistics of the sample considered. Section 5 provides the empirical strategy to identify the returns to education, and presents the results. Section 6 concludes.

2 Conceptual Framework

How does vocational education differ from general education? Mainly, they differ in purpose: vocational education prepares students to perform certain jobs through a *hands-on* learning process where the specific skill needed for the occupations is acquired. In vocational education, therefore, there are technical craft-type courses, professional courses and art specialized courses. The aim is to prepare students to perform 'professional' jobs: electrician, programmer etc. In general education, on the other hand, the focus are abstract skills not necessarily related to any particular job or occupation. This difference is key to determine later labor market outcomes since these skills - specific or abstract - translate into very different consequences for firms.

When transitioning from school to a the labor market, a worker with general education will need more on-the-job training, leading to higher costs for the employer, and lower expected starting wages. However, general education, by its broad scope, prepares workers better for future learning and to adapt to different jobs. Because the demand for occupations changes throughout time, the higher flexibility of workers with a general education will yield a higher wage growth. As a result, the key hypothesis, as in Becker (1994), is that the initial wage benefit of vocational over general education diminishes with age. Figure 1 illustrates this mechanism with crossing wage profiles.

Figure 1: Theoretical Returns to Vocational and General Education
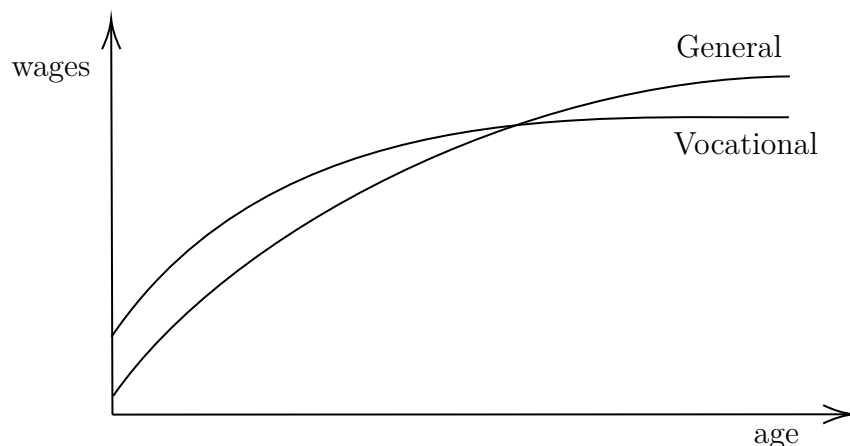
Notes: This Figure illustrates the theorical returns of general vs. vocational education as predicted by Human Capital theory (Becker, 1994).

Although Human Capital theory predicts that the slope for the wage trajectory of vocational graduates is lower than for general graduates, the age at which these two trajectories cross (or the existing of this intersection) is heavily reliant on the quality of skills acquired and the economic context. These are the main reasons why the wage gap is not uniform across countries. In fact, evidence shows that returns to vocational education are higher in countries with well-developed and established apprenticeship systems as opposed to countries where it is not so widespread (Acemoglu and Pischke, 1999). Furthermore, the velocity at which specific skills depreciate over the life cycle depends on the dynamism of the economy, innovation, and the stability of jobs. Again, the data suggests that the returns to vocational education are higher in slower growing countries, such as Switzerland, but lower in more rapidly growing states, such as Denmark and Germany (Hanushek et al., 2017).

The goal of this paper is to estimate the wage gap between general and vocational graduates over the life cycle for Portugal. To do so, we will compare the wage trajectories of workers with the same education level but different types of education. However, we

must note that this is not the usual Mincer (1974) framework where the goal is to detect the returns of schooling. Rather, we aim at studying the difference in returns from these two tracks.

At the end, we cannot disregard that the decision of whether to pursue general or vocational education is the decision of a rational economic agent, and a function of multiple variables. First, as with any decision, it depends largely on preferences: both regarding schooling itself, where some agents will simply derive higher utility from pursuing a given type of education than others, but also the perception over job stability and risk aversion. Even if not affected by external factors and with access to complete information, different people will attach different utilities to the labor market outcomes of these tracks. For a risk averse individual for whom uncertainty represents a big utility cost, acquiring specific skills may seem too risky of an investment. On the other hand, for someone with a high discount rate over life-long earnings, the expectation of larger initial wages may compensate for later lower average earnings.

Second, this decision depends on individual characteristics and family background. As the decision of whether to pursue further studies is largely impacted by parent's education level, also the decision on which track to choose will be affected by parent's background and their jobs, as well as by friends' career choices and the socioeconomic conditions. Moreover, the cognitive skills of a student will largely affect the costs that she attaches to each type of education. This is the source of the so-called *ability bias*: it is believed that high ability students are more likely to end up in general education. In section **??**, we explore this issue further, as well as the implications for the estimations in this paper.

Lastly, the choice of the education system is most affected by the education policy in the country. Currently, the ongoing debate on the trade-off between short-term gains and long-term costs of vocational schooling is reflected into very different education policies across countries. While, for instance, the US has practically abolished vocational education in secondary school, many European countries provide extensive vocational education and training at this school level, complemented by apprenticeship programs in firms (Hanushek et al., 2017). For that reason, understanding the policy and institutional context is key. With this in mind, we devote the next section to an overview of the educational system in Portugal.

3   Institutional background

Labor market outcomes are largely shaped by the institutional context of each country, to a large extent through the design of the educational system, which will be different

depending on the productive structure of the country, its growth policy, and its needs.

Although the educational structure of OECD countries is relatively similar (and even more so for European countries), important differences still persist, especially with regards to secondary education. For this level of education, the division between general and vocation education is one of the largest differences across European countries, as illustrated by Figure 2.

Figure 2: Enrollment in Vocational and General Secondary Education
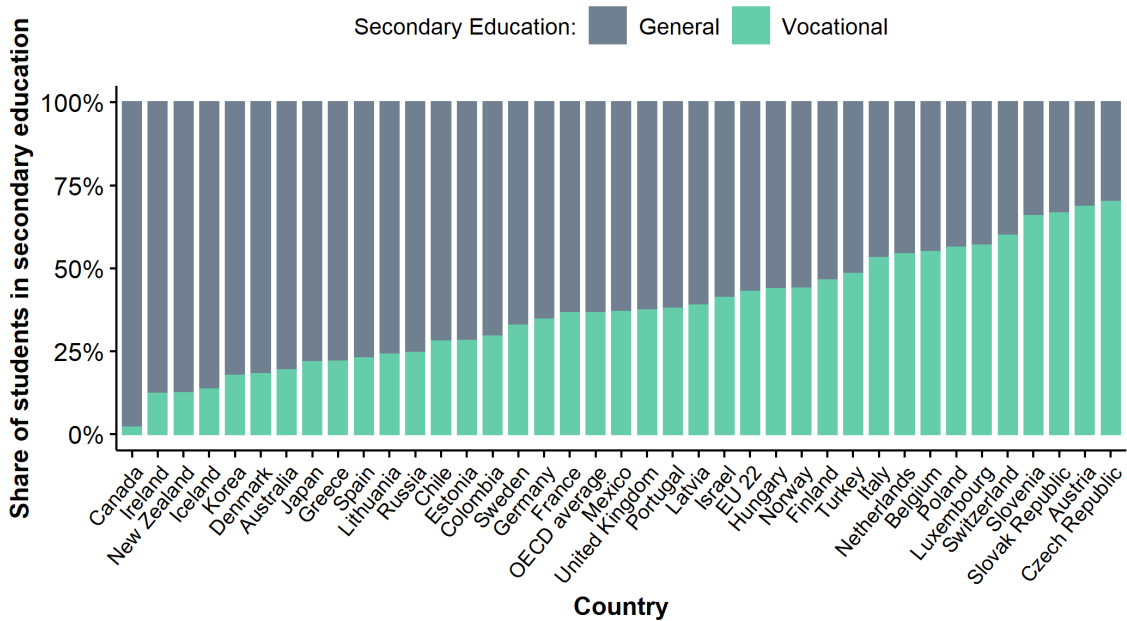
Source: Online Education Database (OECD, 2021)
Notes: This Figure shows the share of students enrolled in vocationl or general secondary education from students enrolled in secondary education between the age of 15 and 19, in the year 2021, for OECD countries. We removed the United States because its different system disallows any comparison. EU 22 is the average for the OECD countries which are also in the European Union.

In Portugal, children enter the educational system at the age of 6, when they start primary school, and complete secondary education at the age of 18. This translates into 12 years of mandatory education, from which the first 9 are common to all students. Starting from 10th grade, there are two paths available: vocational and general education.

The path chosen for secondary education impacts future labor market outcomes directly, for the difference in skills acquired, and indirectly, by impacting the access to tertiary education. While it is possible for vocational students to continue to the university after completing their formation, this rarely happens: In fact, the large majority of VET students enters the labor market just after finishing their studies. Therefore, the

wage profile, career progression and the sector of employment are closely tied to such choice. This is especially important given that these choice is not depending only on preferences or family background, but is often largely influenced by student ability.

Besides the differences in content and purpose of the to education tracks, general vocational education also differs from general education in the way that the curriculum is defined and the learning is performed: There is little overlap of courses between the two systems (only Portuguese and Mathematics are common to both) and, while the curricula for general educational is relatively homogeneous across all fields, it is quite heterogeneous in the case of vocational education. Moreover, the teaching method is completely different: While the learning of general education occurs in the classroom, the structure of vocational education is practical, and follows the *dual* system, in which half of learning is done in the class, and half of the learning is done in practice, generally within a firm, accompanied by internships.

Such differences result in very heterogeneous expected outcomes. Considering only graduates who do not advance to tertiary education in a relatively homogeneous population, human capital theory predicts an earnings advantage at the start for vocational graduates, since they need less on-the-job investment, and a lower starting wage for general graduates, given the higher on-the-job required training and presumably higher investment costs charged to the employee. Even so, human capital predicts that graduates from general education will catch up the vocational graduates over the life cycle earnings profile as their on-the-job investment pays off leading to an equal lifetime earnings. This crossing argument is strengthened by the usual assumption that general education graduates have a greater adaptability to changes in the labor market dynamics being easier for them to adapt to newly emerging technologies.

Vocational education has been gaining ground in the policy debate. On the one hand, it can be used as a measure to tackle skill mismatch and young population unemployment. On the other hand, there is a trade-off in vocational education, since specific skills might depreciate at a higher rate than general skills, impacting both employability and compensation in the long-run. Therefore, understanding exactly he interplay between these two forces across the life cycle of the worker and their real implications in terms of wages and employability is key for effective policy design.

Nonetheless, gathering evidence on the advantages of vocational or general education for the case of Portugal is difficult for the fact that the country has experienced substantial changes in the division between vocational and general education at the secondary level, in addition to other reforms in the rest of the education system. For the purposes of our analysis, the education system attended by children born before 1951 is not considered,

since it did not comprise the same number of school years for vocational and general programs. Thus, because our analysis relies on the comparison between vocational and general education graduates, it must be that the years of schooling are the same across both groups such that differences between the two stem solely from the type of education and not its quantity. It is possible to distinguish between three stages regarding the organization of the Portuguese education system for children born after 1951:

1. **The traditional period**, until 1977 and for birth cohort born between 1951 and 1961; During this period, children start school at age 7, attend 6 years of basic education common to all, followed by 5 years of either vocational or general education. Both general and vocational education are highly selective, with separate admission exams and share the curricula for reading and math. Vocational schools are typically local schools, with strong ties to local industry (agricultural, commercial and crafts training), whereas general education is mostly provided in cities, including public, private and church-owned schools.

2. **The fuzzy period**, from 1978 until 1982, for birth cohorts born between 1962 and 1967; Following the Carnation revolution, and the belief that vocational and general education split students according to one's socioeconomic status, vocational education is abolished. A unified system is created and schools are free to organize their curriculum. This means that some schools kept their vocational programs informally.

3. **The modern period**, from 1983 onward and for individual born after 1968; In 1983, there is a return to the dual system with 9 years of basic education, common to all, followed by 3 years of either vocational or general education. This return to the dual system is also a product of a push by the international community. In 1983, the World Bank subsidizes the creation of 43 technical high schools in Portugal focused solely on vocational education. Mandatory education also suffered some changes for this later cohort. Individuals born until 1979 face 8 years of mandatory schooling; whereas individuals born between 1980 and 1995 face 9 years, and individuals born from 1996 onward face 12 years of mandatory schooling (the latter is the reason why we split this last cohort into two groups for the analysis in this paper).

In order to estimate precisely the returns to vocational education, we consider the effects of policy changes over time. In the following sections, we perform the analysis by cohort to account for how distinct policies might end up in different labor market outputs.

10

4 Data and Descriptive Statistics

This paper's empirical analysis uses Quadros de Pessoal (QP), a linked-employer-employee-dataset annually collected by the Ministry of Labor, Solidarity and Social Security, with a census to all private firms with at least one dependent employee in Portugal. QP assembles information at the establishment, firm and worker level, with a fictitious ID for each of them. Its legally mandatory nature ensures high response rates. Additionally, the Ministry's inspectors ensure adherence to the MW and collective agreements. Nowadays, QP collects information of more than 300 thousand firms and almost 3 million workers. QP includes year-by-year information on firm's characteristics, sector, establishment, collective agreement and on each worker's monthly wage, weekly hours worked, tenure, education, occupation, and gender. The education variable. This data have been recently used by Carneiro et al. (2012), Card et al. (2016), Card and Cardoso (2021), Raposo et al. (2021), and Carneiro et al. (2022).

Table 1: Descriptive Statistics for the Entire Sample

	General		Vocational		Difference
	mean	sd	mean	sd	
	(1)	(2)	(3)	(4)	(5) = (1) - (3)
Age (years)	35.58	(9.48)	34.75	(9.60)	70.33***
Hourly 2age (log)	0.56	(0.54)	0.53	(0.52)	1.09***
Tenure (months)	90.31	(93.01)	81.72	(87.85)	172.03***
Firm Size (log)	4.76	(2.61)	4.03	(2.27)	8.79***
Hours worked (monthly)	168.63	(9.18)	169.22	(8.88)	337.85***
Observations per worker	11.42	(5.64)	9.80	(5.59)	21.22***
N	5 290 992		2 323 054		
Workers in the services sector (%)	88.5		84.4		
Workers in the manufacturing sector (%)	11.5		15.6		

This table compares descriptive statistics of vocational and general education, from workers who have completed secondary education and hold no college degree. Columns (1) and (2) report the mean and standard deviation for workers with general secondary education, and column (3) and (4) do the same for workers with vocational secondary education. Columns (5) shows the difference between columns (1) and (3), where *** means the p-value of the difference is < 0.001. The data from Quadros de Pessoal excludes the primary sector, and only includes workers who are employed dependently and whose age is between 17 and 65 years old.

Table 2 and Table 1 display descriptive statistics for selected variables and indicators. The sample contains data on individual workers whose age is between 17 and 65 years old, and have complete no more nor no less than secondary education. Table 2 reports general differences between workers with vocational education and workers with general education. Table 1 breaks those differences down by cohort of educational system.

Table 2: Descriptive Statistics by Cohort

	Traditional Cohort (1951-1961)		Fuzzy Cohort (1962-1967)		Modern Cohort (1968-1995)		Modern+ Cohort (1996-2001)	
	General (1)	Vocational (2)	General (3)	Vocational (4)	General (5)	Vocational (6)	General (7)	Vocational (8)
N	440982	336041	679818	304105	4067639	1643696	102553	39212
Age (years)	49.84	46.50	44.15	40.54	32.98	31.61	20.74	20.70
Hourly wage (log)	0.91	0.83	0.81	0.65	0.49	0.45	0.26	0.27
Tenure (months)	185.30	156.81	146.24	107.95	72.63	63.15	11.96	13.31
Firm size (log)	5.15	4.41	4.99	3.95	4.68	3.96	4.73	4.46
Hours worked (monthly)	165.20	166.66	166.15	168.25	169.38	169.87	170.18	171.29
Observations per worker	15.33	10.94	15.19	11.23	10.61	9.48	2.21	2.42
In the services sector (%)	87.2	79.7	88.7	86.5	88.7	85.1	86.1	76.3

This table compares descriptive statistics of vocational and general education by cohort of education system, from workers who have completed secondary education and hold no college degree. The year intervals below the cohort name are the workers' birth years which correspond to having completed secondary school in the respective educational system. The data from Quadros de Pessoal excludes the primary sector and only includes workers who are employed dependently, have no more nor less than secondary education and whose age is between 17 and 65 years old.

5 The vocational wage gap

5.1 The raw wage gap

In this section we analyzes the wage gap between vocational and general education graduates, across and within cohorts.

We start by analyzing the raw wage gap between general and vocational high school graduates in the 3 different stages of the educational system. To do so, we compute the average logarithm of real hourly wages for each education system cohort over the life cycle. Figure 3 displays the result of this exercise. The blue line represents the wage of general high school graduates, whereas the red line represents the wage for vocational high school graduates.

The two wage lines are relatively close to each other until the age of 40 for the first cohort and 30 for the remaining. For the traditional education system cohort, depicted in panel (a), general high school graduates have slightly higher wages during most of this period. For the modern cohort in panel (c), however, vocational high school graduates seem to have a slight advantage at the start. This distinction is not so clear for the cohort in the fuzzy education system.

After this early stage, and for all cohorts, the average real hourly wages of general high school graduates is higher than for vocational high school graduates. For the first two cohorts, displayed in panels (a) and (b), real hourly wages of vocational high school graduates seem to either plateau earlier or slightly decrease compared to real hourly wages of general high school graduates. For the most recent cohort, in panel (c), the effect seems to stem more clearly from a deceleration in growth. For the earlier two

education system cohorts, real hourly wages seem to plateau at around age 40. This effect is more pronounced for the fuzzy education system cohort. On the other hand, for the traditional education system cohort, the wage line has a more approximate U-shape. For the earlier cohort, the wage lines keep on increasing, although at at a slower rate.

The analysis of the raw data on wages allows us to draw some stylized facts on the wage gap both over the life cycle and across cohorts. First, the initial differences in wages between general and vocational high school graduates in Portugal seem to be small at the start of the labour market career. Moreover, for younger cohorts, who attended school during the current education system, there seems to be a slight initial advantage for vocational graduates compared to general graduates. Over time, however, this initial advantage seems to fade away and even be reversed. Lastly, wage trajectories of older cohort show a more pronounced inverted U-shape. Given that we can only observe the modern cohort up to the age of 50, we cannot confirm or refute this pattern for the latest educational system.

5.2   Returns to vocational education

Looking only at the comparison between the raw average wages across cohorts and throughout the life cycle of general and vocational graduates is not enough to conclude on the difference between returns to these two tracks for several reasons. First, students are not randomly allocated to general or vocational education. This gives rise to the so-called *selectivity bias*: If high-ability students are systematically more likely to end up in general education (even if they do not pursue to tertiary education), as it is commonly assumed, then we would overestimate the wage returns to this track by not accounting for differences in student ability. The data used in this paper does not allow for correcting for this bias, given that it does not include test scores or any other proxy for ability. Nevertheless, previous studies for Portugal (see, for instance Hartog et al. (2022)) have looked at a set of proxies for ability (such as reading and math scores and retention rates) and concluded that, at least in the past, the difference in school performance between general and vocational education graduates is not significant. Therefore, the authors conclude that a significant ability selection bias is not likely in the past.

Second, even if there are no systematic differences in ability between general and vocational graduates, wages are itself a function of several variables, which may be indirectly impacted by the choice of education track. For instance, Table 2 seems to point that general graduates have higher average tenure, on average. If wages are somehow conditional on tenure, then our estimates of the returns to education will change depending on whether we account for this difference or not. Since we are interested in
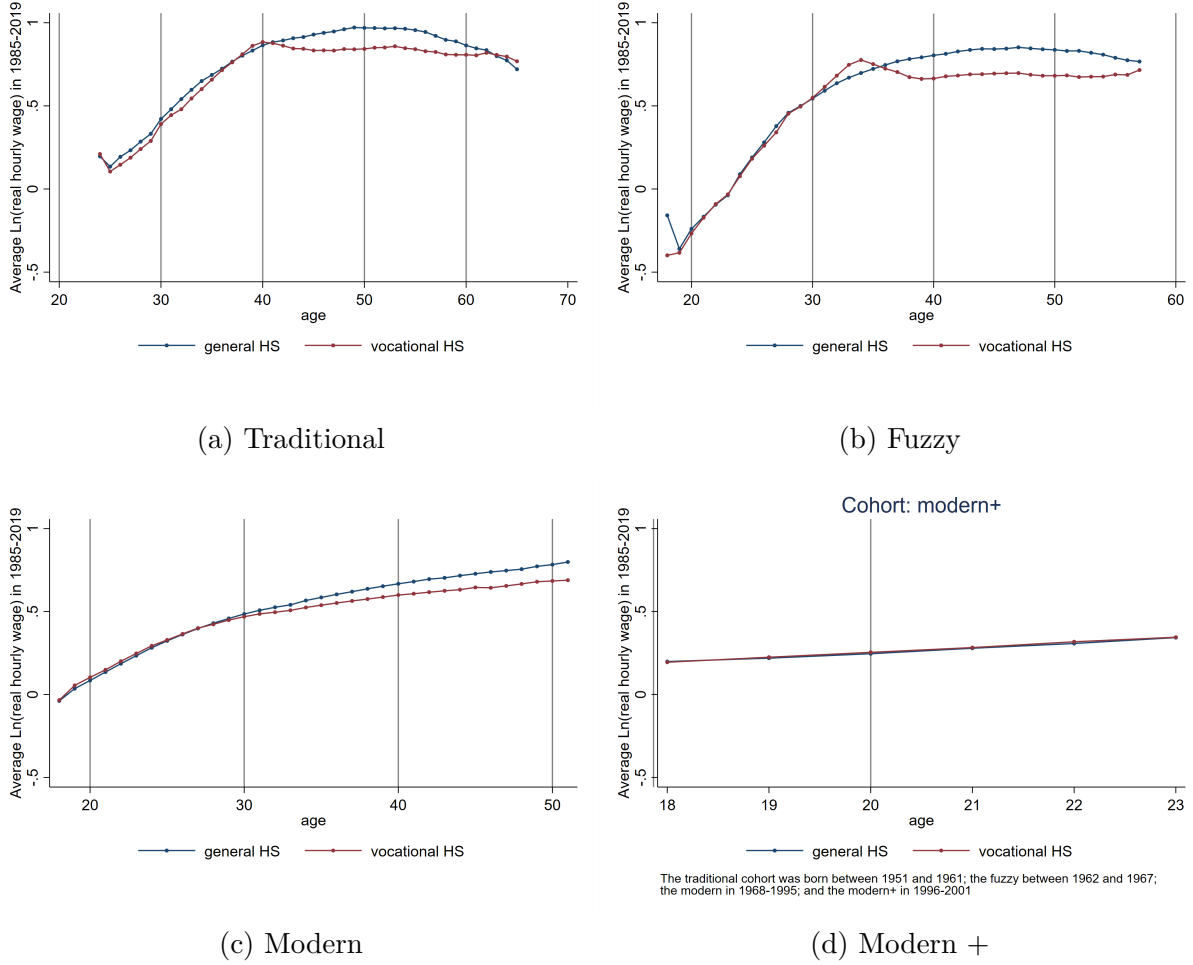
13

(a) Traditional

(b) Fuzzy

(c) Modern

(d) Modern +

Note: the traditional cohort was born between 1951 and 1961; the fuzzy cohort between 1962 and 1967; the modern cohort from 1968 to 1996, and the modern + cohort from 1996 onwards.

looking both at the unconditional (raw) wage gap and at the impact of the heterogeneity in characteristics of workers, and firms, in the wage gap, we deploy a regression model, based on the specification in Equation 3:

$$
\begin{aligned}
ln(wage_{i,t}) = & \beta_0 + \beta_1 vocational_i + \beta_2 X_{i,t} + \\
& + \beta_3 Z_{j,t} + \delta_t + u_{i,t}
\end{aligned}
\tag{1}
$$

The dependent variable in Equation 3 is the natural logarithm of the real hourly wage (in 1986 prices) of worker i in year t. The main independent variable, $vocational_i$, is a dummy variable that takes the value of one for workers with vocational education (high school graduates), and zero otherwise. The vector $X_{i,t}$ includes worker characteristics (gender, age, tenure and their quadratic forms), whereas $Z_{j,t}$ is a vector of firm controls (natural log of firm size captured by the number of workers, firm fixed effects). Finally,

δ_t is a vector of year dummies. Standard errors are clustered at the worker-level.

Table 3 shows the point estimates for the independent variable of interest in Equation 3, along with their standard deviations. Column 1 reports unconditional results, only controlling for the type of high school. Column 2 includes year effects. Column 3 adds individual characteristics, namely gender, age, tenure and the quadratic form of the former. Column 4 adds the log size of the firm captured by the number of workers on October 31st of each year; whereas column 5 drops this control to include firm fixed effects.

As shown by Table 3, and consistent with figure 3, the unconditional vocational wage gap is negative, and close to 3%, meaning, on average, a vocational graduate has a 3% lower wage than a general graduate. the gap remains negative when we include year fixed effects (column 2) and individual characteristics (column 3). However, when we control for firm characteristics, the vocational wage turns positive. This suggests that, in equally sized firms (column 4), the wage of vocational high school graduates is higher than the wage of general high school graduates. There is evidence that bigger firms tend to pay higher wages than smaller firms. Therefore, this is according to the stylized fact that vocational education graduates tend to work in smaller firms, on average (see Table 2) Additionally, the wage gap becomes more pronounced when we control for firm unobserved heterogeneity in column 5: For workers employed in the same firm, real hourly wages of vocational high school graduates are 2.5 per cent higher than wages of general high school graduates. The adjusted R^2, a measure of goodness-of-fit of our model, also makes us prefer this more complete specification than any of the initial ones.

Table 3: Returns to vocational education

	(1)	(2)	(3)	(4)	(5)
	Dependent variable: $log(hourly\ wage)$				
vocational	-0.029***	-0.029***	-0.038***	0.007***	0.025***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Year FE	No	Yes	Yes	Yes	Yes
Worker-level controls	No	No	Yes	Yes	Yes
Control $log(firm\ size)$	No	No	No	Yes	Yes
Firm FE	No	No	No	No	Yes
Observations	6389103	6389103	6389103	6389103	6389103
Adjusted R^2	0.001	0.014	0.291	0.380	0.687

$^+$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: This table reports the vocational wage gap from 1994 to 2013. The dependent variable is the natural logarithm of real hourly wage (1986 prices). Column (1) reports the unconditional results, column (2) includes the year effects; column (3) includes individual characteristics: gender, and age and tenure in quadratic form; column (4) adds the log size of the firm (captured by the number of workers on October 31st of each year); and column (5) includes firm fixed-effects. Robust standard errors in parentheses.

Equation 3 and table 3 only give us an estimate of the average vocational wage gap for all cohorts across all periods. In order to study the cohort and education system effects, we estimate a more complete regression model, given by Equation 2. Moreover, we further split the 3 education system cohorts, according to changes in mandatory schooling laws.

$$
\begin{aligned}
ln(wage_{i,t}) = &\alpha_0 + \alpha_1 \times vocational_i + \\
&+ \sum_{k=1}^{4} \alpha_{1k} \times cohort_k + \\
&+ \sum_{k=1}^{4} \alpha_{3k} \times vocational_i \times cohort_k + \\
&+ \alpha_4 X_{i,t} + \alpha_5 Z_{j,t} + \delta_t + u_{i,t}
\end{aligned}
\tag{2}
$$

The variable $cohort_k$ takes value 1 for the workers who belong to cohort k (to differentiate the education systems). We make two additional distinctions within the modern period cohort to account for the extension of schooling length and changes in enter age, as

in Hartog et al. (2022). The baseline category in this regression are the workers who attended the traditional education system and were born between 1951 and 1956.

Table 4 shows point estimates of the coefficients of interest along with their standard errors. For this part of the analysis we focus on the estimates of the variable $vocational_i$, which captures the vocational wage gap for high school graduates in the first cohort, as well as its interaction terms with the remaining cohort variables. These terms represent how much the vocational wage gap changes across cohorts. The first column of Table 4 represents the unconditional wage gap, whereas the second controls for time dummies, worker characteristics and firm fixed effects.

Just as before, our preferred specification is the one in the last column and we will focus on this one to interpret our results. Figure ?? depicts the net wage gap by cohort corresponding to column 2 in Table 4. The results suggest that the vocational wage gap is positive for all cohort, except for the last one. As before, vocational high school graduates have higher real hourly wages on average, regardless of their education system and cohort, than general high school graduates (with the exception of the youngest cohort, who we only observe for 5 years in the labor market). Moreover, the vocational wage gap is also higher and in favor of the first cohort, having shrink since then. This suggests that the gap in wages between vocational and general education graduates has been shrinking over time and as the education system changes. As before, the analysis of the unconditional wage gap hides the mechanism through which vocational school graduates may have an advantage on the labour market: the possible match with better and/or bigger firms.

Table 4: The vocational wage gap – Cohort analysis

| | Dependent variable: | |
| | $log(hourly\,wage)$ | |
	(1)	(2)
Vocational	-0.041***	0.063***
	(0.002)	(0.002)
voc × cohort (1957,1961)	-0.040***	-0.027***
	(0.003)	(0.002)
voc × cohort (1962,1967)	-0.036***	-0.034***
	(0.003)	(0.002)
voc × cohort (1968,1970)	-0.017***	-0.035***
	(0.003)	(0.002)
voc × cohort (1971,1979)	0.008**	-0.040***
	(0.002)	(0.002)
voc × cohort (1980,1995)	0.056***	-0.056***
	(0.002)	(0.002)
voc × cohort (1996,2001)	0.045***	-0.080***
	(0.003)	(0.002)
Year FE	No	Yes
Worker-level controls	No	Yes
Firm FE	No	Yes
Observations	6389103	6389103
Adjusted R^2	0.096	0.689

[+] $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: This table reports the vocational wage gap from 1994 to 2013, by cohort. The dependent variable is the natural logarithm of the real hourly wage (1986 prices). Column (1) reports the unconditional results, column (2) includes the year effects, individual characteristics: gender, and firm fixed-effects. Robust standard errors in parentheses

5.3 Heterogeneity analysis

After studying the wage gap of vocational education graduates compared to high school education graduates over the different schooling systems, we now perform some heterogeneity analysis. Particularly, we what to understand whether the path of vocational

Figure 4: The vocational wage gap - cohort analysis
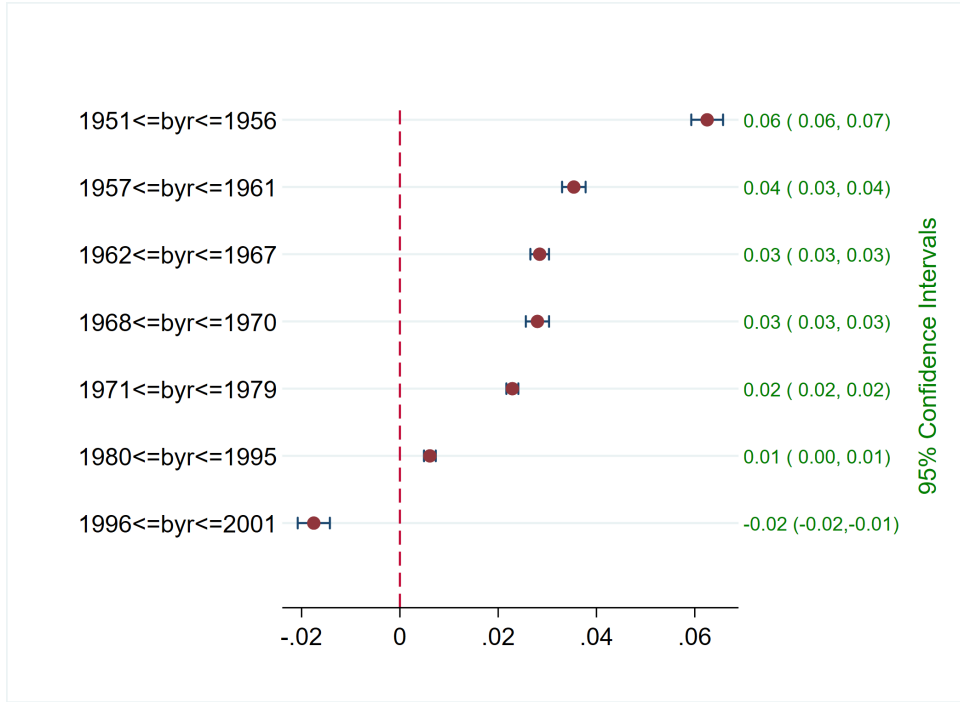
Note: This figure reports the estimated wage gap by cohort, based on the results in column 2 from Table 4

and general education wages over the life cycle differs for men and women, and whether the existing gap between wages differs significantly between genders. To do so, we estimate a variation of Equation 3, where we allow for the coefficient of vocational education to vary between genders.

$$ln(wage_{i,t}) = \beta_0 + \beta_1 vocational_i + + \beta_2 vocational_i \times male_i + \\ + \beta_3 X_{i,t} + \beta_4 Z_{j,t} + \delta_t + u_{i,t} \tag{3}$$

Figure 5 displays the results of this estimation. Across all cohorts, a gender wage gap persists, increasing with age, and then decreasing slightly close to retirement. The figures also suggest that the vocational wage gap is slightly larger for men than for women.

Figure 5: The raw wage gap
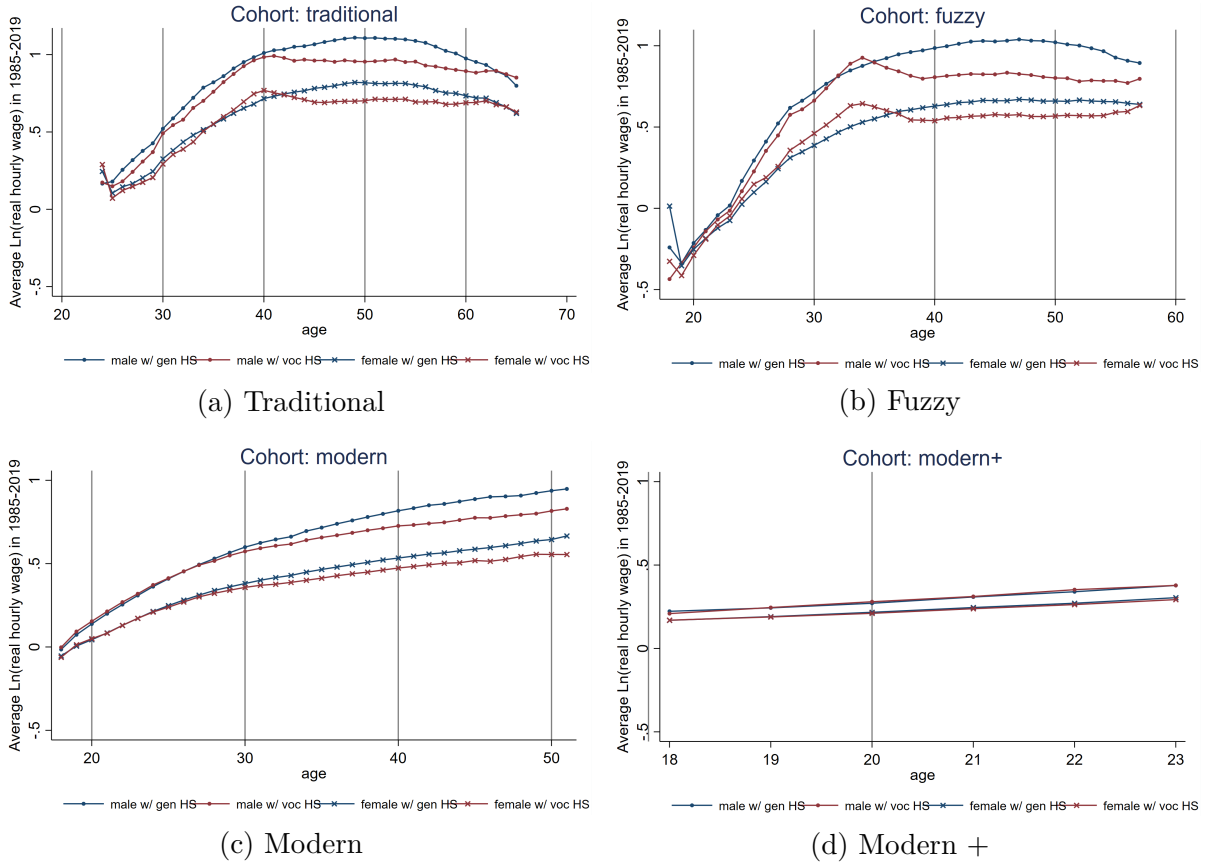
(a) Traditional

(b) Fuzzy

(c) Modern

(d) Modern +

Note: the traditional cohort was born between 1951 and 1961; the fuzzy cohort between 1962 and 1967; the modern cohort from 1968 to 1996, and the modern + cohort from 1996 onwards.

6 Conclusion

Using a rich combination of linked employer-employee administrative data for Portugal, we study the returns of the two types of secondary education in Portugal, general and vocational education. To do so, we compare the lifetime wage profiles of students that completed secondary education and hold no post-secondary degree, accounting for labor market conditions through time. Consistent with the existent literature, we find that there is a significant wage gap between vocational and general graduates, in benefit of the latter, but that this gap changes over the life cycle. Consistent with the theory, we find that the slight initial benefit of acquiring specific skills fades with experience, which then translates into relative lower salaries. Moreover, we find that, inside the same firm, the sign of the wage gap is actually reverted, which suggests that vocational workers are, on average, matched to lower-paying firms. Lastly, our results point out that the vocational wage gap is slightly larger for men than for women.

Our findings have important implications for policy design and implementation. Governments are searching for different tools to tackle a fast-paced changing environment, where

innovation creates specific skill demands. Vocational education offers a flexible solution to be customized for the industry's needs. The trade-off between employability and wage progression must be considered for optimal policy design without harming workers' wage profiles.

Finally, our results point relevant directions for future research. First, a further decomposition of the determinants of the wage gap between vocational and general graduates, considering the worker-firm match and worker mobility patterns. Second, the study of the impact of further training on workers with general education background, when compared to students who completed vocational education. This is not only crucial for policy design, but key to also validate the theory: if the growing wage gap is indeed mainly attributable to the depreciation or out-dating of the specific skills acquired by vocational graduates, then this gap may be at least partially recoverable through the promotion of on-the-job training programs.

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