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Risk and Heterogeneity in Benefits from Vocational versus General Secondary Education: Estimates for Early and Mature Career Stages in Portugal

Abstract

We estimate a dynamic model of individual labour market careers (turnover and search, wage development) on Portuguese panel data of graduates from vocational and general secondary education. We find that vocational graduates benefit more from the internal labour market than from the external market. This holds even more for mature than for young individuals. This hurts as among the mature, vocational has higher lay-off probability. To the common result that vocational education trades early employment advantage for later disadvantage we add a decomposition of employment status in its dynamic components. To the literature on wage effects we add a breakdown of variances in heterogeneity and risk.

JEL-Codes: J300, J640, D800, I260.

Keywords: risk, vocational education, search models.

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1 Introduction

Vocational education is meant to prepare students directly for job performance, as it teaches occupation specific skills, whereas general education teaches more general skills, yielding broader employability but also requiring more additional on-the-job training to acquire the job-specific skills. The consequence would be that graduates from a vocational education fare better in the early career stage, with easier access to jobs and higher earnings while graduates from a general education are better equipped to deal with labour market dynamics, as their broader skills have prepared them for a wider array of job opportunities and made them better able to adjust to new situations and new requirements. The benefits from vocational and general education have been compared in terms of wages and the probabilities of employment and unemployment, mostly separately.[1]

In terms of wages, there is support for a trade-off between initial advantage for vocational and later advantage for general education (Golsteyn and Stenberg (2017), Brunello and Rocco (2017), Hanushek et al. (2017)) but not unequivocally, and often differentiated by country-specific institutional details, such as well developed apprenticeship programs and the existence of dual systems for working and learning (Carneiro et al. (2010), Acemoglu and Pischke (1999), Heckman (2000)). From a cross-country analysis, Hampf and Woessmann (2017) conclude to a strong trade-off between early advantages and late disadvantages in employment for individuals with vocational education, but also stress the heterogeneity associated with the specific institutional structure of schooling and training. Zimmermann et al. (2013) survey the literature on the effect of vocational education on unemployment and find that countries with a substantial dual apprenticeship system exhibit a much smoother transition from school to work, with low youth unemployment and below average repeated unemployment spells. Eichhorst et al. (2015) also stress that the relative performance of vocational versus general education varies across countries and over time.

The effect of vocational education in Portugal has been analysed before. Pereira and Martins (2001) find that with a Mincer earnings function over the period 1982-1995, a lower secondary technical degree pays always more than its academic counterpart and that upper secondary vocational education paid better than general education in 1994 and 1995. Oliveira (2014) finds that between 1993 and 2009, workers with vocational

[1] General overviews of the economics of vocational education are given in Eichhorst et al. (2015) and in Carneiro et al. (2010).

education initially have a wage advantage over workers with general education, but that wages are higher for workers with general education after some eight years of experience. In our own work (Hartog et al. (2022)) we find, for cohorts born between 1951 and 1994, that vocational wages are always below wages for general education and that the vocational wage gap initially increased and then decreased. We relate this pattern to changes in worker-firm allocation, a change in assortative matching to the benefit of vocational graduates. The approach we take differs from the literature so far. At the heart of the argument is the claim that general education delivers more flexible workers, better able to cope with the inherent vagaries of the labour market. So, to test the hypothesis we think it's imperative to use a structural econometric model that fully recognises these vagaries. The model we use, developed by Liu (2019), is a dynamic programming model that tracks individuals' working life as a sequence of decisions on work and no-work in response to wage dynamics with several stochastic components. Switches in the labour market can be voluntary or involuntary. An employee always keeps an eye on the outside opportunities and may react to a favourable job offer. Or she may be forced to search as she is laid off. The model offers insight in the differential uncertainties that vocational and general graduates face and how they deal with the challenges and opportunities that these uncertainties offer. Attractive features of the model are the simultaneous modelling of wage and employment dynamics, the identification of wage shocks by source (general, individual and worker-firm match specific) and the explicit modelling of mobility response to wage shocks that would be underestimated if only the resulting wage profile would be considered.[2]

The testing ground we use is secondary education in Portugal, where secondary vocational education is virtually exclusively the students' final level and where we restrict the population of secondary general graduates to students that do not continue into tertiary education. We provide arguments that selectivity does not invalidate our core conclusion. We use longitudinal data from a large household survey in Portugal, a country that has a well developed system of vocational education but no integrated dual system of working and learning. A key finding of our estimates is that vocational graduates benefit more from internal labour markets, but also face increasing risk of being expelled from internal labour markets and then will be confronted with harsher conditions.

[2]For positioning the Liu model within the literature on wage and employment dynamics, see Hospido (2015).

2 Liu's (2019) Model

We start with a summary of Liu's model structure. When unemployed, an individual receives unemployment benefit. Unemployment can be involuntary (after an exogeneous lay-off, at rate ρ) or voluntary, when a wage offer is considered too low. The wage has two components, the personal and the match or firm component. When employed, an individual's wage grows annually with experience (at rate δ) and with tenure (at rate c). At the outset, individual productivity (the wage rate) has heterogeneity (at dispersion σ^2_{u0}), which increases randomly (at dispersion σ^2_ζ). When employed, the firm offers annual wage growth (on top of the tenure and experience effects) as a draw from a distribution with dispersion σ^2_η. There is an outside offer distribution, with dispersion σ^2_{a0}.

If an individual accepts an offer from this distribution, whether from employment or unemployment, the wage at the new employer starts at this wage offer and then develops as specified above for stayers. Optimally searching for a job offer leads to an endogenous job offer arrival rate λ; searching has cost function $\phi(\lambda)$, differentiated between the employed and the unemployed. The search process is formulated as expected utility maximisation up to the end of working life, with utility the expected value of log wage and log unemployment benefit. At the time of the decision on job offers, the individual knows the personal component in productivity, the match-specific productivity in the present job (if employed), the job offer and the distribution of the match-specific component of the wage. All wages have an intercept β_0 and are measured with error, at variance σ^2_v.

In detailed mathematical specification the model runs as follows. All individuals start out unemployed after leaving school. They search for job offers, at a cost that increases in search effort and they decide on accepting or rejecting an offer on the basis of maximising expected utility over remaining lifetime. Expected utility depends on earnings when employed and benefits when unemployed (probability weighted average of log wage and log unemployment benefit). As outsiders we observe the wage with measurement error v_{it}, independent of the firm, $E[v_{it}] = 0$, $E[variance(v_{it})] = \sigma^2_v$.

The wage process has an individual-specific component μ_{it} and a match-specific component a_{ijt}:

$$lnw_{ijt} = \beta_0 + \mu_{it} + a_{ijt}$$

The individual-specific component starts out from heterogeneity among individuals

when leaving school:

$$\mu_{i0} \sim \mathcal{N}(0, \sigma^2_{u0})$$

And develops according to

$$\mu_{it+1} - \mu_{it} = \delta + \zeta_{it+1} \quad with \quad \zeta_{it} \sim \mathcal{N}(0, \sigma^2_{\zeta}),$$

where μ_{it} represents the general productivity, with random growth independent of the firm.

The match-specific component differs between stayers and movers, building on the wage accepted in the first job. For a stayer it develops according to

$$a^l_{ijt+1} - a_{ijt} = c + \eta_{ijt+1} \quad with \quad \eta_{it} \sim \mathcal{N}(0, \sigma^2_{\eta}),$$

Hence, there is a common wage growth in all firms and stochastic match-specific wage growth that is drawn from the same distribution for all firms.

For movers, the new wage is equal to the accepted wage offer $a^0_{ij't}$, drawn from the same distribution for all firms:

$$a^0_{ij't} \sim \mathcal{N}(0, \sigma^2_{a0}),$$

Job offers are accepted or rejected based on comparing expected utility over remaining lifetime from staying or moving. As noted, at the time of the decision, the individual knows his general productivity μ_{it}, his match-specific productivity in the present job a^l_{ijt} and the job offer $a^o_{ij't}$, as well as the distribution of the match-specific component of the wage.

Job offers have to be solicited by search activity at intensity λ and search cost $\phi(\lambda)$, differentiated between search while employed (λ^e, $\phi^e(\lambda^e)$), and search while non-employed (λ^n, $\phi^n(\lambda^n)$).

Lay-offs are exogeneous at probability ρ. If a job offer is accepted, the wage process continues as described above, on the basis of the accepted job offer. After a bad shock of the firm match component, the worker may decide to quit and search for another job. Search costs for a job are exponential in job search intensity $\phi(\lambda) = K\lambda^{\gamma}, \gamma > 1$,and differentiated between employed and non-employed search (K_e and K_n), defined as the search cost needed to receive a job offer for sure[3]; a higher job offer rate requires progressively higher cost.

[3]K is in the metric of ln wage and ln unemployment benefit. See equations (9) and (10) in Liu (2019) (page 149 in Section II. B - The Model of Job Mobility and Employment). The value function is expressed in a weighted average of ln w and ln b, so the final term, $\phi(\lambda = K\lambda^{\gamma})$ must also be in logs of the monetary unit: the monetary value of the disutility of search activity.

Estimated parameters are the wage parameters $\beta_0, c, \delta, \sigma^2_{u0}, \sigma^2_{a0}, \sigma^2_\eta, \sigma^2_\zeta$, and σ^2_v, and the search parameters K_e, K_n, γ, and ρ.

More specifically, β_0, c, and δ are common wage development parameters, equal for all individuals: general wage level growth, individual specific wage level growth and mean growth of the wage offers for stayers. Search cost when employed and when unemployed, K_e and K_n are non-stochastic. Measurement error variance σ^2_v reflects the researcher's problem to observe wages perfectly and similarly, σ^2_{u0} reflects our inability to measure worker productivity precisely.

The worker faces four uncertainties: lay-off probability ρ, wage offer uncertainty σ^2_{a0}, match-specific wage growth uncertainty σ^2_η and individual specific wage growth uncertainty σ^2_ζ.

The parameters are estimated on longitudinal observations of wages, unemployment benefits and labour market status switches (employed, unemployed).

Briefly, Liu compares labour market careers for men with high school and with college education in the USA, in panel data based in 1996 and covering the ages 23-35.[4] He finds that high school graduates in this early career stage have higher lay-off probability and higher variance in their on-the-job wage growth, and that college graduates have higher values for the other risk and heterogeneity parameters (o.c., Table 4).

3 Setting and Data: Labour Force Survey

Collective bargaining plays a central role in the Portuguese labor market, as in several other continental European economies. Indeed, massive collective agreements, often covering an industry, are common in the economy. Firm level collective bargaining traditionally covers a low share of the workforce, less than 10%. Extension mechanisms are common, either by mandatory government regulation or on a voluntary basis, as employers automatically apply the contents of collective agreements to their non-unionized workforce.

Despite the relevance of collective bargaining, firms have always enjoyed some degree of freedom in wage setting. Cardoso and Portugal (2005) have documented that wage cushion (or wage drift, the difference between the actual wage level and the bargained wage level) promotes an alignment of wages with firm-level conditions. They show that once

[4] In Liu (2016) he compares results for men and women.

mandatory contract wages have been set, firm-specific arrangements stretch the returns to worker and firm attributes and shrink the returns to union power. The existence of wage cushion therefore leaves ample scope for firms to define distinct wage policies.

A national minimum wage is enforced in Portugal, defined as a monthly rate for full-time work. Currently, sub-minimum wage levels apply only to physically disabled workers and trainees, after all reductions based on age were abolished in 1999. The minimum wage develops rather smoothly over time, shares of covered vocational and general educated workers at entry ages 18-25 (where impact may be strongest) increase over time but are essentially constant from 1994 to 2008 and differ by almost 4 percentage points in the years 2009-2013 (27.0% for general and 23.3% for vocational). Over time, there have been changes in labour market institutions, but none aimed for differential impact on vocational and general graduates of secondary education.[5]

Our dataset is a CPS type household survey conducted by the Portuguese Official Office (INE - *Instituto Nacional de Estatística*). Every quarter the INE surveys around 45000 individuals to obtain information about their labour market position. The basic structure of the survey follows the instructions of Eurostat, making the definitions of the basic labour market indicators identical to those in other European countries (e.g., employment, unemployment, inactivity). The Labour Force Survey is a household survey with rich and detailed information on labour market characteristics such as participation, earnings, training and qualifications. Furthermore, this survey is used to compute the official unemployment rate in Portugal, and it is used to compute employment data of the national accounts. We are using the raw data from the survey, which comprises two periods 1998-2010 and 2011-2019 period. Each quarter, 1/6 of the sample is rotated out. Thus, each quarter, we can compute the labour market status of a worker in quarter t - 1 and t for 5/6 of the workers in the current sample, using a unique worker identifier. Using the same dataset, Blanchard and Portugal (2001) found negligible evidence of inconsistencies in the observed labour market transitions. The computation of the quarterly transitions of employment to unemployment, and unemployment to employment is conventional. For example, the flow of workers from employment to unemployment is equal to the number of workers reporting being employed in quarter t - 1 and reporting being unemployed in quarter t, divided by total employment at t - 1. We define a job-to-job transition as

[5]See Portugal and Cardoso (2006) and Bover and Portugal (2000) for further details on Portuguese labour market institutions.

a situation where: first, the worker was employed in the previous quarter; second, the reported tenure in the current job is less than or equal to 3 months; and third, the worker reports moving directly from another job. Unemployment benefits are not observed but fixed at 40% of the average wage in the sample (differentiated by education).

To compare full lifetime career experiences of vocational and general graduates, one would like to estimate a single model for the entire age span between leaving school and retirement, presumably allowing for changes in some parameters with age (e.g parameters of the wage offer distribution). This is simply not feasible with our dataset covering only 22 years. Our solution is to estimate on two career stages, ages 23-35 ("young") and ages 36-48 ("mature"), consecutive age groups, with the young covering the stage that begins with entry after leaving school and the mature covering the stage before exits from disability, voluntary and involuntary retirement become important.

We consider individuals with the same interval of birth years but observed in different calendar years. The young are observed in 1998-2010, the mature in 2011-2019; hence, the young and the mature data are drawn from the same population and the shift in window of observation matches the upward shift in individual ages. Unobserved differences in calendar time may confound our estimated differences among vocational and general. But unobserved differences among individuals may be assumed to be fairly constant among the mature and the young. In particular, we have restricted the sample with individuals born after 1971 that have been educated in the same school system - the new system (for details see Hartog et al. (2022).[6]

To investigate possible effects of changing labour market conditions over time, we also estimate the model for young individuals in the period when we observe the mature: Ages 23-35 observed in 2011-2019. We call this sample the "new young".

We define schooling by completed level, thus adopting the conventional procedure of ignoring possible time spent at university without graduating. Advancing to tertiary education after vocational secondary education is highly unusual. We exclude the self-employed. The distinction between general and vocational education is not exogenous. The variables available in our data do not allow for selectivity bias correction, but we do not believe this is significant for our results; we cannot test this claim as we can not think of a credible available exclusion restriction. We discussed the issue in our earlier paper

[6]The new system is characterized by 3 cycles (primary/basic) of 9 years of non-differentiated education followed by 3 years of secondary education of either general or vocational education.

(Hartog et al. (2022)). We stressed there that a commonly presumed ability difference among pupils in general and in vocational education rests mostly on the presumed higher ability of students in the general track who continue into tertiary education. As we report there, students in the general track who do not intend to continue to higher education score barely better on reading and math than students in the vocational track. In the Portuguese data we analysed, mother's education and reading score have significant effect on the likelihood of choosing general secondary education, but math score does not. With math generally considered the better measure of general intelligence or IQ, we take this result as an indication that ability basis may be quite modest but that preferences, as measured in reading ability and mother's education may be responsible for some selectivity bias.

Comparing basic data

In our prime analysis, in each quarter, the sample size of the young(mature) cohort includes 10049(8766) and 2274(1206) individuals for general and vocational education, respectively. Basic data for our samples are given in Table 1 (young) and Table 2 (mature). In Appendix A we provide mobility data and graphs on distributions of wage changes.

As Table 1 shows, for the young sample, the vocational and the general graduates are about the same average age, but among the vocationals there are more male and fewer married individuals. Vocationals have lower wages and higher employment rate, and move substantially more frequently between jobs. But they also loose their job more often and have slightly lower rate of returning to employment. In the end, they have lower average tenure than "generals".[7] This suggests, that vocationals have more portable human capital, which would indeed match the intention of training for a vocation, not for an employer, but on the other hand shows them more vulnerable in the churning through unemployment. Appendix Table A.1 shows that the higher job-to-job mobility among vocationals is concentrated in the first episodes of working life, whereas for generals it only tapers off towards the end of the interval we observe.[8]

Table 2 shows the summary statistics for the mature sample. Wages are still lower for vocational but now the employment rate is also lower. Job-to-job transition is lower,

[7] Obviously, we use "generals" as convenient shorthand, not for military personnel.

[8] We have followed Liu and checked the endogeneity of mobility in relation to the wage rate. We find that probability to move (job-to-job) is negatively but not statistically significant, related to wage growth within the present job and also negatively but now statistically significant related to the average wage rate within the job (averaged over individuals in the same job, i.e. the job wage). The magnitude of the estimated effect varies strongly with the estimation method.

Table 1: Summary Statistics - young (aged 23-35 between 1998 and 2010)

	Vocational		General	
	mean	sd	mean	sd
Labour Market Outcomes				
Log Wages (real)	1.037	0.311	1.043	0.312
Employment (%)	94.8	22.1	92.7	26.0
Not searching (% of Unemployment)	0.0	0.0	0.5	7.0
Job to job Transition (%)	0.9	9.6	0.6	7.4
Emp. to Unemp. transition (% of total Labour Force)	1.0	8.9	0.9	8.4
Emp. to Unemp. transition (% of Employment)	1.0	9.9	1.1	9.6
Tenure (in months)	62.21	45.32	68.90	48.22
Tenure (in quarters)	20.22	15.10	22.49	16.08
Unemp. to Emp. transition (% of total Labour Force)	0.7	7.6	0.9	9.4
Unemp. to Emp. transition (% of Unemployment)	14.9	35.7	14.8	35.5
Employment (% LF+NLF)	87.9	32.6	84.5	36.2
Unemployment (% LF+NLF)	7.6	26.5	9.4	29.2
Inactive (% LF+NLF)	4.5	20.7	6.1	23.9
Individual Characteristics				
Age	28.09	3.56	28.81	3.47
Male (%)	50.5	-	42.8	-
Married (%)	43.6	-	51.5	-

Notes: For the young cohort - aged 23-35, this table presents for both type of individuals, Vocational and General secondary graduates, the mean and the standard deviation of Labour market outcomes and individual attributes between 1998 and 2010. % LF + NLF stands for as a percentage of individuals in the Labour force and not in the Labour Force.

Table 2: Summary Statistics - mature (aged 36-48 between 2011 and 2019)

	Vocational		General	
	mean	sd	mean	sd
Labour Market Outcomes				
Log Wages (real)	1.174	0.297	1.199	0.432
Employment (%)	93.1	25.3	94.8	22.3
Not searching (% of Unemployment)	3.4	18.2	0.3	5.8
Job to job Transition (%)	0.5	6.8	0.8	8.8
Emp. to Unemp. transition (% of total Labour Force)	0.8	8.9	0.4	6.2
Emp. to Unemp. transition (% of Employment)	0.9	9.2	0.4	6.4
Tenure (in months)	146.6	85.1	148.0	88.3
Tenure (in quarters)	48.9	28.3	49.8	29-2
Unemp. to Emp. transition (% of total Labour Force)	1.9	13.7	0.7	8.1
Unemp. to Emp. transition (% of Unemployment)	27.8	44.8	12.6	33.2
Employment (% LF+NLF)	89.9	30.2	88.3	32.1
Unemployment (% LF+NLF)	7.3	26.0	6.7	25.1
Inactive (% LF+NLF)	2.8	16.6	5.0	21.7
Individual Characteristics				
Age	40.0	2.4	40.5	2.7
Male (%)	52.3	-	45.3	-
Married (%)	67.0	-	71.0	-

Notes: For the mature cohort - aged 36-48, this table presents for both type of individuals, Vocational and General secondary graduates, the mean and the standard deviation of Labour market outcomes and individual attributes between 2011 and 2019. % LF + NLF stands for as a percentage of individuals in the Labour force and not in the Labour Force.

transition to unemployment is much higher, but the rate of returning to employment is also much higher. In the end, job tenure is barely different. The churning process thus has changed character between cohorts. Among the young, it's much more job-to-job for vocationals, but among the mature, the vocationals experience much more forced mobility, with much easier return into employment than generals and mobility no longer concentrated among the inexperienced.

Over time, gaps between vocational and general move: initially, when young, vocationals have better employment rate, later, when mature, they have lower employment rate. Vocational wages are lower in both stages, but in the mature stage, vocationals are lagging further behind. Their transition rate from employment to unemployment is higher in both stages, but the gap has increased greatly. However, while the vocational transition rate from unemployment back into employments is lower for the young, it has become substantially higher for the mature. Thus, in terms of wages, employment and transition from employment, the position of vocational deteriorates relative to general, it improves in terms of probability to return to employment out of unemployment.

Appendix Figure A.1 presents wage growth distributions. Both for young and mature, wage growth distributions within jobs are more concentrated than between jos. Wage growth distributions for vocational are more concentrated than for general, modestly so for within job wage growth, more so for growth between jobs.

In Appendix B, we present data for the new young, ie young in the later period of observation and hence, not drawn from the same population as the mature. Wages for the young vocationals are still lower in the later period, at a much larger gap, but employment levels and employment dynamics show a number of sign reversals for vocational versus general. This shows the importance of comparing samples from the same population, as we do but it also suggests that vocationals and generals may be affected differently by a change in economic conditions. Proper investigation of the latter question however, would require observations in an interval beyond 2019.

4 Results

For each education group, the structural model of job mobility is estimated jointly with the wage process. The model is estimated by the method of simulated moments. In our setup, the decision period in the model corresponds to one wave (3 months) in the data.

We refer to Liu (2019) - Section IV. Identification and Estimation Strategy - for further details.

Parameter estimates for young and mature

Our estimation results are presented in Tables 3 (young) and 4 (mature). All estimated parameters differ from zero at high levels of statistical significance, except measurement error for the young. Consider the differences between vocational and general for the young (in all our comparisons, we take general as the reference to which vocational is related). The basic wage level β_0 is some 11% lower, the return to experience is 35% lower but the return to tenure is 16% higher. Heterogeneity when entering the labour market is about a quarter smaller. The lay-off probability is higher, at 1.24 and 0.98. Base search cost are much lower for vocational, while the elasticity of search cost to the job finding rate is somewhat higher. The wage risks differ among vocational and general, but not all in the same direction. The variance of the person specific wage growth shock is much higher for vocational, so vocationals are less certain about their own productivity development. Their wage risk on the job (match specific wage growth) is much smaller, but the dispersion in the wage offer distribution is much higher.

So, the comparison among the young does not bring us an unambiguous result. Graduating vocationals are initially less heterogenous, but their heterogeneity increases more. To some extent they have a relative advantage in the internal labour market: relative to generals, they have faster wage growth with tenure and lower growth with experience and the variance of their wage offer is lower, while the variance of outside wage offers is higher. Their lay-of probability is higher, but their search costs to obtain a job offer for sure (at $\lambda = 1$) are lower while they increase faster with desired job offer arrival rate. For vocationals, the largest risk is in the outside wage offer distribution, for generals it's in the match specific wage growth, at much lower level than the vocational maximum risk.

Now consider differences in parameter estimates for the mature. Essentially, the differences among the estimated parameters retain their sign. The vocational base wage is still lower but at smaller distance, tenure wage growth is still higher, experience wage growth is still less favourable (more negative), initial heterogeneity is still higher and continues to widen faster, the match specific wage shock remains lower. Like for the young, the lay-off rate for vocational is higher, but search cost parameters show sign reversals: aiming for a higher job arrival rate now requires less additional cost, for the unemployed, search cost

Table 3: Estimated Model Parameters - young (aged 23-35 between 1998 and 2010)

		Vocational	General
Labour Market Shocks			
Variance of match shock	σ_η^2 x 10	0.00261	0.01722
		(0.00004)	(0.0013)
Variance of the person-level shock	σ_ζ^2 x 10	0.01812	0.00162
		(0.0001)	(0.0001)
Measurement error	σ_v^2 x 10	0.050	0.030
		(0.0420)	(0.0205)
Lay off Probability	ρ	0.0124	0.0098
		(0.0002)	(0.0002)
Mean Offered Wage			
Return to tenure	c	0.0073	0.0063
		(0.0001)	(0.0009)
Return to experience	δ	0.0055	0.0084
		(0.0002)	(0.0002)
Constant term in the offered log wage equation	β_0	0.5488	0.6166
		(0.0046)	(0.0096)
Heterogeneity			
Heterogeneity in the offered match values	$\sigma_{a_o}^2$	0.0554	0.0064
		(0.005)	(0.006)
Heterogeneity in the person component	$\sigma_{u_o}^2$	0.0061	0.0083
of wages at the start of work life		(0.0009)	(0.001)
Search Cost			
Search cost of employed	K_e	5.340	14.443
		(0.1147)	(2.3452)
Search cost of unemployed	K_n	1.557	3.2164
		(0.0138)	(0.0183)
Search cost parameter (convexity)	γ	1.248	1.0852
		(0.0101)	(0.0242)

Notes: This table shows the parameter estimates of the model for the new young cohort - aged 23-35 between 1998 and 2010. The estimates are grouped by Labour Market Shocks (σ_η^2, σ_ζ^2, and σ_v^2 are respectively the variances of match- and person-level shocks and measurement error; ρ is the layoff probability), Mean Offered Wage (c and δ are the return to tenure and return to experience, respectively; β_0 is the constant term in the offered log wage equation), Heterogeneity($\sigma_{a_o}^2$ is the heterogeneity in the offered match values and $\sigma_{u_o}^2$ is the heterogeneity in the person component of wages at the start of work life), and Search Cost (K_e and K_n are respectively the search cost of employed and unemployed, and γ is the search cost parameter regarding the convexity). Standard errors are in parentheses.

Table 4: Estimated Model Parameters - mature (aged 36-48 between 2011 and 2019)

		Vocational	General
Labour Market Schocks			
Variance of match shock	σ_η^2 x 10	0.0119	0.0384
		(0.0002)	(0.0033)
Variance of the person-level shock	σ_ζ^2 x 10	0.0020	0.0012
		(0.0001)	(0.0005)
Measurement error	σ_v^2 x 10	0.016	0.011
		(0.0038)	(0.0035)
Lay off Probability	ρ	0.0242	0.0117
		(0.0003)	(0.0001)
Mean Offered Wage			
Return to tenure	c	0.0093	0.0080
		(0.0001)	(0.0011)
Return to experience	δ	-0.0055	-0.0021
		(0.000)	(0.0003)
Constant term in the offered log wage equation	β_0	0.5644	0.5855
		(0.0035)	(0.0030)
Heterogeneity			
Heterogeneity in the offered match values	$\sigma_{a_o}^2$	0.0511	0.0045
		(0.0004)	(0.0001)
Heterogeneity in the person component	$\sigma_{u_o}^2$	0.0094	0.0026
of wages at the start of work life		(0.0001)	(0.0001)
Search Cost			
Search cost of employed	K_e	7.0903	17.1093
		(0.737)	(0.384)
Search cost of unemployed	K_n	8.0184	6.111
		(0.087)	(0.0732)
Search cost parameter (convexity)	γ	4.7582	6.9934
		(0.035)	(0.017)

Notes: This table shows the parameter estimates of the model for the mature cohort - aged 36-48 between 2011 and 2019. The estimates are grouped by Labour Market Shocks (σ_η^2, σ_ζ^2, and σ_v^2 are respectively the variances of match- and person-level shocks and measurement error; ρ is the layoff probability), Mean Offered Wage (c and δ are the return to tenure and return to experience, respectively; β_0 is the constant term in the offered log wage equation), Heterogeneity($\sigma_{a_o}^2$ is the heterogeneity in the offered match values and $\sigma_{u_o}^2$ is the heterogeneity in the person component of wages at the start of work life), and Search Cost (K_e and K_n are respectively the search cost of employed and unemployed, and γ is the search cost parameter regarding the convexity). Standard errors are in parentheses.

at job offer for sure ($\lambda = 1$) is now higher for vocationals rather than lower.

Parameter estimates for the young in two periods

In Table B.2, in Appendix, we present parameters estimated for the young individuals between 2011-2019, the new young. Comparing with parameters estimated over 1998-2010 gives an indication of possible secular changes for young labour market participants.[9] Clearly, the parameter estimates are not stable over time. But only the measurement errors differ by an order of magnitude and both in the same direction (lower in the later period). The conclusions on the sign of the differences among vocational and general essentially are only affected for offered wages: return to tenure is now lower for vocational, whereas the constant term is higher. This suggests that the conclusion of the internal market as the relative stronghold of the vocationals has weakened somewhat. The results also indicate that the sign of differences in estimated parameters among vocational and a general among the young are mostly robust between our two interval of calendar time.

Comparing career stages

All parameter estimates differ among young and mature, and given the high precision of the estimates, most differences will have high levels of statistical significance. Comparing mature to young, we see that only 3 differences between vocational and general have changed sign: wage heterogeneity at the start, search cost when unemployed and the elasticity of job finding for search intensity. The other changes are changes in the magnitude of the gap. All ratio's between vocational and general parameters except measurement error, return to experience and search cost elasticity are higher for the mature, meaning that smaller values for the vocational than for the general have moved closer to parity and that larger values have moved further away from parity.

Higher search cost when unemployed instead of lower and lower effect of search intensity instead of higher mean a weakening of the relative position of vocational in the open market. The weakening is reinforced by a lay-off probability for vocational that is now double that for general. The higher variance of the person level shock for the young has turned lower initial wage heterogeneity for vocational into higher initial wage heterogeneity for vocational among the mature. The internal labour market is still a relatively safe

[9] We might make a similar comparison for mature individuals, but this comparison would be affected by the school reforms in 1963.

heaven for vocational: lower risk in the match shock, even more so for the mature than for the young. They continue to benefit more from tenure than from experience, among the mature the vocational even loose more from experience than the general.

So, the upshot is: Vocational graduates benefit more from the internal labour market than from the external market. This holds even more for the mature than for the young. This hurts as among the mature, vocational has higher lay-off probability. Stated otherwise: the stronghold for vocational is the internal labour market, the stronghold for general is the external labour market, and these differences are more pronounced for the mature than for the young.

While there are changes in the magnitude of the parameter differences between the two career stages, the signs of the differences are mostly identical: no change for labour market shocks, no change for the mean offered wage, no change for offered match heterogeneity, no change for base search costs. There is only sign reversal for person component heterogeneity at the start of the career stage, for search cost when unemployed and for the search cost elasticity. Thus while magnitudes of risk differences change between the two career stages, we cannot conclude to reversal of risks between the two career stages. Vocationals have higher lay-off rate and higher personal shock variance in each stage, lower variance of the match shock and lower search cost when employed. They also have higher offered match heterogeneity in both stages.

Model fit

Appendix Figures C.1 give an indication of the model fit. With the parameter estimates we predicted observed variables and plotted mean values for each sample wave (i.e. the 6 waves in which each individual participated), joint with observed mean values. There is no obvious pattern of over- or under estimation by variable, type of education, old or mature or quarter of observation, which, if anything, can be taken as reassuring.

5 Comparing to the literature

Liu estimated the model we use on data for US male employees aged 23-35, distinguishing high school and college graduates. Given the nature of the American school system, only comparison of our results for general and his results for high school is meaningful. Most of our parameter estimates are lower; only Portuguese return to tenure and search cost are

higher. This suggests a labour market in Portugal with less heterogeneity, less volatility, and more "insider power", which may well be true.

Analyses of differences in labour market risk for vocational and general education so far have been confined to probabilities of (un-)employment. The dominant view is that vocational graduates have early advantage and late disadvantages in employment, under recognition of much heterogeneity associated with the specific institutional structure of schooling and training (Hanushek et al. (2017); Hampf and Woessmann (2017); Eichhorst et al. (2015); Carruthers and Jepsen (2020)). Our samples show the same pattern: among the young, the employment rate is higher and unemployment is lower for vocational, among the mature, employment is lower and unemployment is higher. Our data show a higher transition rate from employment to unemployment for both young and mature and this is consistent with higher estimated lay-off rates. The higher observed transition rates from employment to unemployment are consistent with shorter tenure durations for both age groups. The observed transition rate from unemployment to employment is lower for the young and higher for the mature, which leads to anticipate higher unemployment duration for the young and low duration for the mature. Our data show the opposite: lower unemployment duration for the young, shorter for the mature. The apparent inconsistency can potentially be explained from participation behaviour. It would imply that unemployed young vocationals move faster into non-participation, while unemployed mature vocationals are more inclined to cling to participation (ie continue searching).

Among the young unemployed, search cost (at job finding rate 1) are lower, while among the mature unemployed these costs are higher, so this argument would work in the wrong direction. But the job finding elasticity of search cost is higher among the young and lower among the mature, so the different optimum job finding rates may solve the puzzle: high search cost may stimulate labour force exit. This explanation does not hold, however, as mature vocationals have lower inactivity rate and higher non-searching rate than generals, but this also holds for the mature. Perhaps the answer lies in differential effects of truncation, as we only observe labour market status at 3 months intervals, not continuously.

The literature on earnings volatility by level of schooling is developing but there are as yet no studies that focus on differences among vocational and general education. In

fact, there is no consensus view yet on the effect of schooling on earnings volatility.[10]. As Hartog (2014) in page 163 concludes: "We have as yet no reliable body of evidence on the magnitude of risk, how it varies with level of schooling, how it varies among countries, how it depends on the structure of the school system". Hence, comparison of our results to canonical findings, other than to the literature on the trade-off between early and late career wages and employment, is not yet feasible.

6 Conclusion

We have analysed labour market careers of graduates from vocational and general (or academic) secondary education in Portugal. The international literature shows support for an initial advantage for vocational graduates in wage and employment in the early career stage and a later reversal when careers advance. The thesis is linked to a notion of differential risks: vocational education would prepare directly for jobs that employers want to be filled, while general education trains more general skills and hence would prepare better for changes in labour demand that will evolve during future working life.

Our results are in line with the intertemporal trade-off hypothesis: between the early and the mature career stage, vocational graduates experience an increasing wage gap and loose an advance in their employment rate. Their heterogeneity increases. The development of wage risks and labour market transition risks is somewhat complex. We conclude that vocational graduates benefit more from internal labour markets, but also face increasing risk of being expelled from internal labour markets and then will be confronted with harsher conditions.

[10] See e.g Cunha et al. (2005), Chen et al. (2012), Mazza et al. (2013), Hospido (2015), Delaney and Devereux (2019), Liu (2019); for an overview of the literature see Hartog (2014)

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Appendix to "Risk and heterogeneity in benefits from vocational versus general secondary education: estimates for early and mature career stages in Portugal"

A Wage growth and job mobility

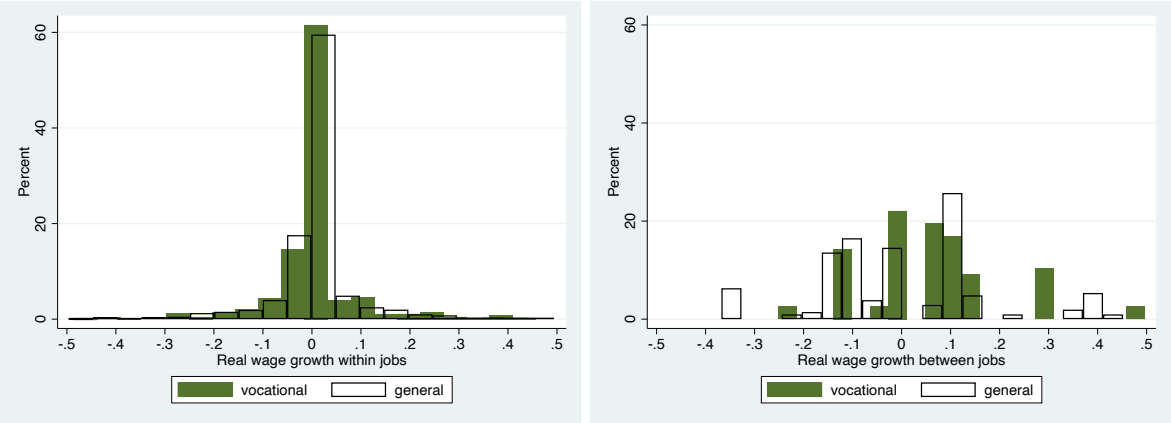
A.1 young cohort - 1998/2010

Table A.1: Proportion of Job Mobility by Quartile of Initial Life-Cycle Period

	Vocational mean	General mean
below 25th	1.6	0.8
25th - 50th	1.4	0.5
50th - 75th	0.0	0.8
above 75th	0.0	0.1
Total	0.9	0.6

Notes: This table shows the proportion of job mobility by Quartile of Initial Life-Cycle Period for the young cohort (aged 23-35 between 1998 and 2010).

Figure A.1: Distribution of within- and between-job log wage changes



(a) within-job (b) between-job

Notes: The two panels show the distribution of real log wage growth within-jobs (left) and between-jobs (right) for the young cohort (aged 23-35 between 1998 and 2010).

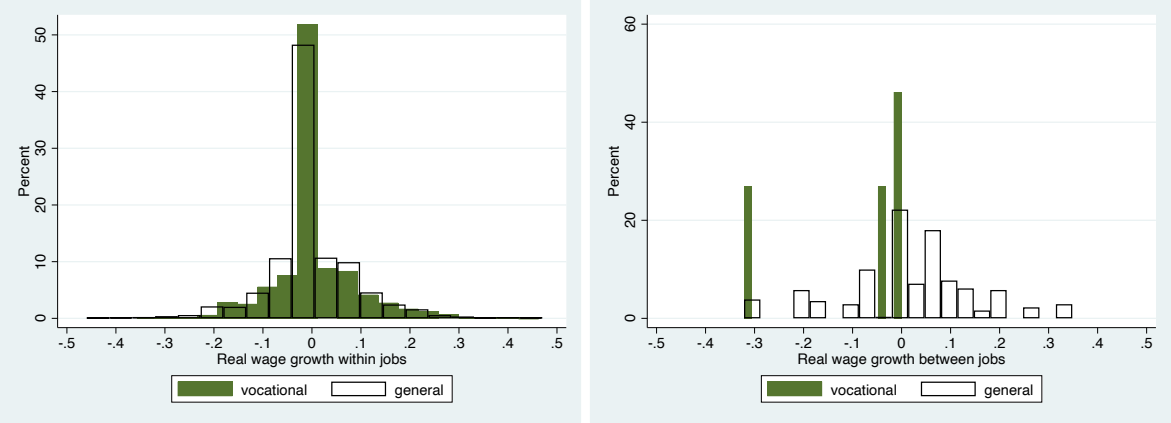
A.2 mature cohort - 2011/2019

Table A.2: Proportion of Job Mobility by Quartile of Initial Life-Cycle Period

	Vocational mean	General mean
below 25th	0.5	0.8
25th - 50th	0.4	1.0
50th - 75th	0.8	0.4
above 75th	0.0	0.8
Total	0.5	0.8

Notes: This table shows the proportion of job mobility by Quartile of Initial Life-Cycle Period for the mature cohort (aged 36-48 between 2011 and 2019).

Figure A.2: Distribution of within- and between-job log wage changes



Notes: The two panels show the distribution of real log wage growth within-jobs (left) and between-jobs (right) for the mature cohort (aged 36-48 between 2011 and 2019).

B New young cohort - aged 23-35 between 2011-2019

B.1 Summary Statistics for the new young

Table B.1: Summary Statistics - new young (aged 23-35 between 2011 adn 2019)

	Vocational		General	
	mean	sd	mean	sd
Labour Market Outcomes				
Log Wages (real)	0.988	0.259	1.048	0.320
Employment (%)	91.4	28.0	92.1	27.0
Not searching (% of Unemployment)	0.2	4.2	1.0	9.7
Job to job Transition (%)	0.6	7.7	0.9	9.4
Emp. to Unemp. transition (% of total Labour Force)	1.6	12.5	1.1	10.4
Emp. to Unemp. transition (% of Employment)	2.1	14.3	1.4	11.8
Tenure (in months)	66.8	53.6	85.9	56.8
Tenure (in quarters)	22.4	17.9	29.0	18.8
Unemp. to Emp. transition (% of total Labour Force)	1.9	13.5	1.2	10.9
Unemp. to Emp. transition (% of Unemployment)	25.5	43.6	18.1	38.5
Employment (% LF+NLF)	83.1	37.4	85.8	34.9
Unemploymwnt (% LF+NLF)	11.0	31.3	9.8	29.8
Inactive (% LF+NLF)	5.9	23.5	4.4	20.5
Individual Characteristics				
Age	29.7	3.7	31.5	3.4
Male (%)	53.9	-	46.4	-
Married (%)	35.7	-	48.3	-

Notes: For the new young cohort - aged 23-35, this table presents for both type of individuals, Vocational and General secondary graduates, the mean and the standard deviation of Labour market outcomes and individual attributes between 2011 and 2019. % LF + NLF stands for as a percentage of individuals in the Labour Force and not in the Labour Force.

B.2 Parameter estimates for the new young (aged 23-35 between 2011 adn 2019)

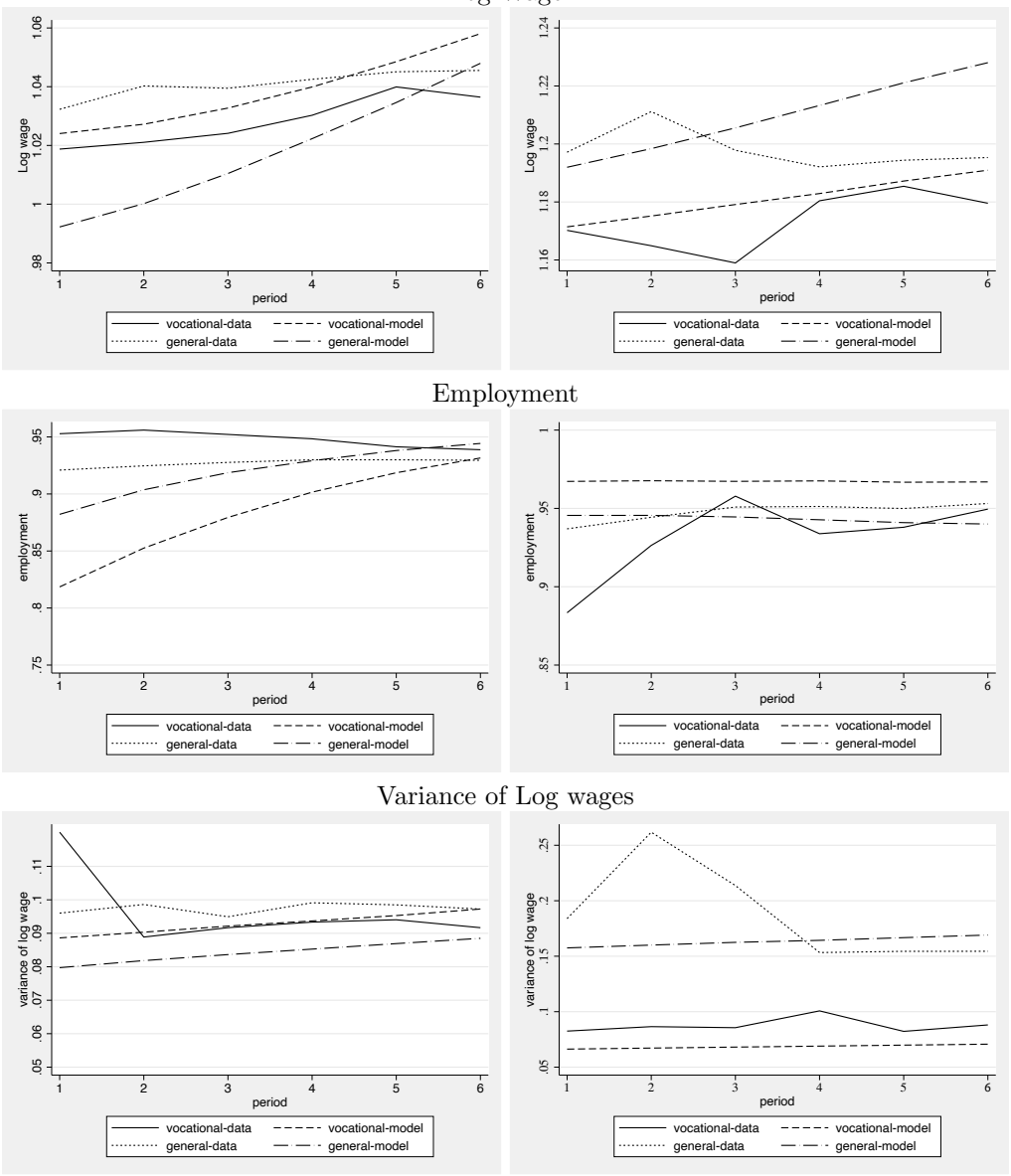
Table B.2: Estimated Model Parameters - new young (aged 23-35 between 2011 adn 2019)

		Vocational	General
Labour Market Schocks			
Variance of match shock	σ_η^2 x 10	0.0036	0.0167
		(0.0003)	(0.006)
Variance of the person-level shock	σ_ζ^2 x 10	0.0129	0.0014
		(0.0002)	(0.0001)
Measurement error	σ_v^2 x 10	0.0050	0.0051
		(0.0023)	(0.0039)
Lay off Probability	ρ	0.0194	0.0125
		(0.0001)	(0.0001)
Mean Offered Wage			
Return to tenure	c	0.0028	0.0061
		(0.0001)	(0.0001)
Return to experience	δ	0.0045	0.0078
		(0.0001)	(0.0001)
Constant term in the offered log wage equation	β_0	0.6425	0.6219
		(0.0029)	(0.0057)
Heterogeneity			
Heterogeneity in the offered match values	$\sigma_{a_o}^2$	0.0443	0.0091
		(0.003)	(0.001)
Heterogeneity in the person component	$\sigma_{u_o}^2$	0.0050	0.0151
of wages at the start of work life		(0.0001)	(0.0001)
Search Cost			
Search cost of employed	K_e	6.2606	15.94
		(0.178)	(1.804)
Search cost of unemployed	K_n	3.0558	4.4838
		(0.0469)	(0.0271)
Search cost parameter (convexity)	γ	1.7248	1.7415
		(0.0133)	(0.0097)

Notes: This table shows the parameter estimates of the model for the new young cohort - aged 23-35 between 2011 and 2019. The estimates are grouped by Labour Market Shocks (σ_η^2, σ_ζ^2, and σ_v^2 are respectively the variances of match- and person-level shocks and measurement error; ρ is the layoff probability), Mean Offered Wage (c and δ are the return to tenure and return to experience, respectively; β_0 is the constant term in the offered log wage equation), Heterogeneity($\sigma_{a_o}^2$ is the heterogeneity in the offered match values and $\sigma_{u_o}^2$ is the heterogeneity in the person component of wages at the start of work life), and Search Cost (K_e and K_n are respectively the search cost of employed and unemployed, and γ is the search cost parameter regarding the convexity). Standard errors are in parentheses.

C Model Fit

Figure C.1: Model fit by period - young and mature



(a) Young cohort (b) Mature cohort