# 2.4. What is the impact of human capital regional concentration on wages and capital returns?

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### 1. Motivation

Investment in education may generate two types of returns: private and social ones. Private returns are normally related to the wage gains associated to the individual level of education. The social returns on education arise from the positive impact on productivity explained by geographical concentration of educated workers, or as normally refered in the literature, human capital externalities. The estimation of these social returns is relevant to measure the return of the investment in education, return which justifies the public investment in education. This concept was originally presented by Marshall (1890) and then developed in a seminal work by Lucas (1988), which stated that such externalities could be large enough to explain economic growth variations across regions. Several empirical works tried to tackle this issue, particularly with data from the USA. These works find mixed results: Acemoglu and Angrist (2000) use variation in compulsory schooling laws to measure the magnitude of human capital externalities, concluding on its small size. Ciccone and Peri (2006) conclude that a one year increase of the average education, rises the wages at the state level by around 2%, while Moretti (2004) finds that a positive variation of one percentage point in the share of college graduates at the city level rises the productivity between 0.4% and 1.9%. Iranzo and Peri (2009) try to reconcile these results, developing a theoretical model with an empirical application, which shows no effect from the state concentration of high school graduates but a positive effect from the agglomeration of college graduates. Sousa et al. (2015), in a previous study for Portugal, find that an increase of one year in the average country education increases the labour returns by around 3%.

In this Section, we analyse how the concentration of high school and college graduates generate human capital externalities at the municipal level. Thus, we measure how the concentration of skilled workers affects the inputs within the firm, namely the productivity of workers with different education levels and the productivity of physical capital.

This question is particularly relevant in a country like Portugal, which made substantial investments in education during the last decades, in order to reduce the gap relatively to other western economies. Since the establishment of democracy in 1974, Portugal extended the mandatory schooling twice, first to 9 years (in 1986), and then for the present 12 years of schooling (in 2013). In order to accommodate the large number of new students, the number of state schools offering lower and upper secondary education increased from 277 in 1972 to 1,727 in 2017. During the same period the investment in education jumped from 1.3% to 3.7% of the GDP. This lead to a fall in the illiteracy rate from 25.7% in 1970 to 5.2% in 2011. Additionally, between 1998 and 2018, the share of population between 15 and 64 years old with high school graduation increased from 10.3% to 21.9% and the number of college graduates increased from 6.1% to 18.7%.

Despite this relevant evolution, Portugal presents quite an heterogeneous geographical distribution in what concerns the share of college and high school graduates. In the private sector, the average municipal share of high school graduates between 2005 and 2013 is 21.2% and the standard deviation is 5.4 p.p. In the same way, we observe a 14.3% average municipal share of college graduated workers and a standard deviation of 7.02 p.p.

Portugal still depicts an average schooling of its population below the benchmark of other European countries, however the Portuguese evolution across time raises the question about how all the investment in education was translated not just into private returns on education but how it was able to create regional skill spillovers, leveraging the growth and productivity of local firms.

## 2. The analytical framework

We use a matched employer-employee database (Quadros de Pessoal), merged with financial and accounting information (IES) on Portuguese firms between 2005 and 2013, observing around 490,000 different establishments across the 9 years. In Figure 20. we plot the quadratic relationship between the returns on labour and the return on capital versus the skills concentration of college and high school graduates at the municipal level. We observe a consistent positive relation between hourly wages and the municipal skill concentration, however regarding the return on capital, the figures are less sharp.



Figure 20: Quadratic relations between averages wages and return on capital and skill concentration

Note: Due to the large amount of data, the graphs depicts *binscatters*, meaning that each dot does not represent a single firm but a bin which aggregates a group of firms concentrated in that part of the graph.

Nevertheless, it is likely that this simple relation is biased by several confounding effects, such as variables related to the firm, its location or region specific time trends. Thus, we retrieve information about the number of hours worked by workers with different schooling levels as well as their respective wages, mean age of firm's workers, the proportion of women, the proportion of workers with tenure, firms sales and the value of its capital stock. Then, we use this set of information to estimate the following equation:

$$Y_{j,r,m,t} = \beta X_{j,r,m,t} + \gamma S_{m,t} + Trend_r + \eta_r + \alpha_j + \epsilon_{j,m,r,t}$$
(9)

This specification considers each firm j, in NUTS III region r, municipality m at time t.  $Y_{j,r,m,t}$  is taken as: a) workers' log hourly wages without high school graduation; b) workers' log hourly wages with high school graduation; c) workers' log hourly with college graduation; d) The return on capital.  $X_{j,r,m,t}$  is a set of firm controls;  $S_{m,t}$  stands for the municipal skill concentration variable, Trend<sub>R</sub> is a region (NUTSIII) specific time trend.  $\eta_r$  and  $\alpha_j$  control for constant invariant effects at the level of the region, *r* and firm, *j*.  $\epsilon_{j,m,r,i,t}$  is the error term. We consider two types of skill concentration,  $S_{c,t}$ : a) The share of college graduates at the municipal level; b) The share of high school graduated in the municipality. The impact of this skill concentration is given by the parameter  $\gamma$  in the equation above.

There are several issues regarding the identification of the unbiased effect of the concentration of skilled workers on firms' productivity. As a matter of example, if the most productive firms tend to be placed in urban regions, where the density of skilled workers is higher, then the impact on the productivity is not due to the spillover of high skilled workers interacting in the same geographical area, but due to firm's endogenous characteristics. In order to correctly filter the effect of the concentration of skilled workers, we exploit the exogenous impact created by the vast increase in the number of high schools in the country. Previous research, namely the work by Duflo (2001) looks at the long-run impacts of school construction programs. Combining information collected in the archives of the Portuguese Ministry of Education and directly from contacts with the schools we gathered the dates of construction of more than 400 state high schools in mainland Portugal. This information is summarized in Figure 21, which shows the number of high schools in 1970 and in 2018. It is clear that back in 1970, the highest concentration of high schools were in the city centers of Lisbon and Porto. From then on, the number of high schools increased not just around the main Portuguese cities, but in many municipalities in the inner land, the first high school was built.

Based on this source of variation we create an instrumental variable (IV) which measures the amount of schools, that on average, were available in the different municipalities during the workers' school age. This way we try to recover an exogenous shock in the variation of school supply, which allows us to isolate the true effect of the skill concentration on wages and return on capital. Using this approach, we report in Table 6. the results found. We find differences whether we consider the concentration of high school or college graduated graduated workers. A percentage point increase in the municipal share of high school graduates leads to an increase in wages between 0.2% and 0.9%. We can observe this impact in the wages of workers with different skill levels, but particularly for those ones with high school and college graduation. For the case of an increase in one percentage point in the municipal share of college graduated workers, the impact has a lower magnitude, being close to zero for the workers without high school graduation and between 0.2% and 0.3% for the remaining workers. Regarding the estimations on the return on capital



(a) Number of schools by municipality - 1970

(b) Number of schools by municipality - 2018

Figure 21: Municipal distribution of schools - 1970 and 2018.

a percentage point increase in the municipal share of high school or college graduated workers has a positive but non significant impact. However when we restrict the data, excluding the firms with the highest and lowest return on capital, we find a small impact of 0.01 Euros per unit of capital for each additional percentage point in the municipal con concentration of skilled workers.

Reforms of the education system are a commonly named structural reform for Portugal. Despite the lag still observed in relation to its main European partners, the evolution in the last decades in the amount of students graduated from high school and college is impressive. The investment made is expected to create knowledge concentration responsible for higher regional productivity dynamics. This is the question we tried to answer, using information on the performance of labour and capital in Portuguese firms, and building a variable which clear denotes the investment the country has been making in education: the increase in the number of high schools across the territory. We conclude that workers with different skills

	High school graduated	College graduated
Wages		
No high school	0.002***	0.000
	(0.000)	(0.000)
High school	0.007***	0.002***
	(0.000)	(0.000)
College	0.009***	0.003***
	(0.000)	(0.000)
Return on capital	0.017	0.006
	(0.062)	(0.022)

Table 6: IV results on the skill concentration (parameter  $\gamma$ )

Notes: Each individual estimation on wages is weighted for the amount of hours worked by the workers with the respective skill level and the estimation on the return on capital is weighted by the firm's physical capital level. Standard error in parentheses. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

levels are positively affected on their wages due the municipal concentration of high school graduated workers. Regarding the municipal concentration of college graduates, it has a smaller impact and mainly on workers with high school and college graduation. The estimation of the impact on the return on capital showed, on average, not to be significant. The observed difference between the social returns due to the concentration of high school and college graduates means that the investment in studying after the upper secondary education shows a private return significantly higher than the social one.

Our results try to bring light on the reasons behind regional economic disparities, showing that skill concentration is responsible for increasing labour productivity within the firm. Such fact shows the need for an integrated regional policy, given the asymmetries in the skill distribution across the territory.

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