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High skilled workers mobility in Spain and Europe: motivations and implications

Movilidad de trabajadores altamente cualificados en España y Europa: motivaciones e implicaciones



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I. INTRODUCTION

Most economies are experiencing a productive paradigm shift, since several industries are facing new challenges related to innovation races to create new goods and services and the amount of knowledge required to create these innovations. Since one of the main sources of knowledge for the firms are high-skilled workers, the global demand for these workers has also rapidly increased in such a way that they have become a scarce and desired. Nowadays, compared to low-skilled workers, high-skilled workers may change more easily their residence to locations where their needs are best met. According to OECD data, between 2001 and 2006 the stock of tertiary educated migrants increased by 108% in OECD countries.

The increasing mobility of high-skilled workers create significant threats to the innovative capacity of those companies and regions that cannot create incentives to retain these workers. Regions exporting talent face the risk of entering a vicious cycle where the scarcity of high-skilled workers limits the abilities of their local companies to innovate, but in turn these low rates of innovation do not create enough satisfying professional opportunities to high-skilled workers, who are forced to leave the region in search of better opportunities elsewhere. As long as high-skilled workers leave a region, the economy of the region does not only loose valuable workforce but also highly purchasing-wielding consumers. Therefore, the economy suffers also from negative spillovers from high-skilled worker



EXECUTIVE SUMMARY

Competing today through innovation requires attracting and retaining a high-skilled workforce. Compared to less skilled workers, high-skilled workers have a higher mobility. In order to help businesses and governments to create strategies that leverage or counter this high mobility of workers, this research explores the motivations and implications of regional concentration for high-skilled workers. The study analyses how the characteristics of the labor market and the dynamics of agglomeration of knowledge create incentives for the local concentration of engineers and scientists. The concentration of high-skilled workers is studied in Spain and Europe. At the empirical level the research shows how strong are the flows of workers moving from less-innovative regions to Madrid and Catalonia, since in some of these less-innovative regions more than 40 per cent of science and engineering engineers migrate. In Europe, the results show two coexistent phenomena: islands of innovation in some countries that attract most of the high-skilled workforce from that country and valleys of innovations formed by interconnected innovative regions. These regional concentrations of engineers and scientists are explained by unemployment rates of skills-exporting regions and greater concentrations of innovative activities. In this sense, the results suggest that the prospects for a future professional career rather than wage disparity is the most influencing factor in the regional concentration of high-skilled workers.

RESUMEN DEL ARTÍCULO

Competir hoy en día a través de la innovación requiere atraer y retener una fuerza de trabajo altamente calificada. En comparación con los trabajadores menos cualificados, los trabajadores altamente cualificados tienen una mayor movilidad. Con el fin de ayudar a las empresas y a los gobiernos a crear estrategias que aprovechen o modulen esta alta movilidad de trabajadores, esta investigación explora las motivaciones e implicaciones de la concentración regional de los trabajadores altamente cualificados. El estudio analiza cómo las características del mercado laboral y la dinámica de la aglomeración del conocimiento crean incentivos para la concentración local de ingenieros y científicos. La concentración de trabajadores altamente cualificados se estudia en España y Europa. A nivel empírico, la investigación muestra lo fuertes que son los flujos de trabajadores que se trasladan de regiones menos innovadoras hacia Madrid y Cataluña, ya que en algunas de estas regiones menos innovadoras más del 40% de los ingenieros científicos e ingenieros emigran hacia regiones más innovadoras. En Europa, los resultados muestran dos fenómenos coexistentes: "islas de innovación" en algunos países que atraen a la mayoría de la mano de obra altamente cualificada de ese país y "valles de innovación" formados por regiones innovadoras interconectadas. Los resultados indican que las concentraciones regionales de ingenieros y científicos en Europa se explican por las tasas de desempleo de las regiones exportadoras de trabajadores cualificados y las mayores concentraciones de actividades innovadoras en las regiones con mayor capacidad de atracción. En este sentido, los resultados sugieren que las perspectivas de una futura carrera profesional en lugar de disparidad salarial es el factor más importante en la concentración regional de trabajadores altamente cualificados.

consumption to labor markets for low-skilled workers (Mazzolari & Ragusa, 2013).

As a result of high-skilled workers mobility, economic differences between innovative regions, skills importers, and non-innovative regions, skills exporters, are increasing (Lee & Rodriguez Pose, 2013). Besides, once the vicious cycle of innovation-high skilled workers mobility starts, there is a serious risk of no turning back since former evidence shows that migration of high-skilled workers is a process rather than an event and that migration is spanning over a sequence rather than being exhausted by the responses of members of a single "cohort" (Stark & Wang, 2002). This process view implies

the perpetuation of the differences between regions and the irreversibility of these differences, posing serious managerial, political, economic and social challenges. For instance, existing literature shows that this process has an important effect on the location and concentration of multinationals, and on the capability or incapability of firms in innovative or not innovative regions to generate innovative business models based (Salt, 1992).

The main goal of this research is to confirm whether the pool of high-skilled workers is increasingly concentrated in few regions in Europe, to dig deep into the roots of this phenomenon and finally discussing the implications at the firm, regional and national level. At the empirical level, the research will first drive its attention towards the regional concentration of high-skilled workers, and more precisely scientists and engineers, in Spain and then to the regional concentration of scientists and engineers in Europe.

2. THEORETICAL DRIVERS OF THE REGIONAL CONCENTRATION OF HIGH-SKILLED WORKERS

The location and mobility of high-skilled workers has been a subject of research for several years. Two theoretical arguments stand out about others when it comes to explaining the regional concentration of high-skilled workers: the regional differences in terms of wage returns to educational attainment and the regional differences in terms of agglomeration economies.

In China, for instance, regional wage disparity is the main explanation to the local concentration of high-skilled workers which on the other hand is less influenced by the friction of distance, the regional

... one of the main sources of knowledge for the firms are high-skilled workers...

unemployment rate, and the concentration of foreign investment (Liu & Shen, 2017). Shen & Liu (2016) confirm that in China the low average wage level explains why high-skilled workers leave some regions, but also show that regions with small population, an excessive supply of university graduates, a small non-agricultural sector are also more likely to lose skills (Shen & Liu, 2016). Factors such as high unemployment rate or small amount of foreign investment better explain the interregional migration of low-skilled workers. The relevant role of wage disparity in the local concentration of high-skilled workers is confirmed also in Italy by Nifo & Vecchione, (2014) and Ermini et al., (2018). However, these works also show that in this country the better quality of governmental institutions is positively correlated to the regional concentration of high-skilled workers. This argument is not surprising, since previous research had also confirmed the role of some dimensions of the institutional quality of governments to explain the international migration of high-skilled workers to the US (Bang & Mitra, 2011).

Beyond wage disparity and institutions, the literature shows that the patterns of regional concentration of high-skilled workers are quite consistent with agglomeration economies (Kerr et al., 2017). Agglomeration economies are directly related to the number of job opportunities for high-skilled workers. For instance, interregional concentration of high-skilled workers in Finland is explained by the density of firms in the high tech industry and the fewer firms in other industries (Simonen et al., 2018). Similarly, Sanchez-Moral et al., (2018) found that skilled workers in Spain tend to migrate to regions with more job opportunities. This work also shows that in Spain, beyond the classic idea that agglomeration economies benefit all residents, big cities, and the capital Madrid in particular, had become 'escalator regions', propelling the careers of young creative workers that had been attracted to them. In fact, these urban areas have thick regional labor networks that are the main channel to flow the knowledge needed to promote innovation in the local firms (Almeida & Kogut, 1999) which in turn will create new job opportunities to these workers. Besides, network thickness will favor professional development of skilled workers not only through these professional opportunities, but also through long-life learning and reskilling opportunities. In fact, in innovative regional economies firms are embedded in an ecology rich in informal and labor market transmission mechanisms and in a web of contractual linkages among physically proximate organizations

KEY WORDS

High-Skills, Education, Innovation.

PALABRAS CLAVE

Alta Cualificación, Educación, Innovación.

which represent relatively transparent channels for information transfer that will favor knowledge transmission and therefore long-life learning and reskilling (Owen-Smith & Powell, 2014). Nevertheless, wage disparity, knowledge agglomerations and institutional quality cannot fully explain the reality, since the impact of these factors on the mobility of high-skilled workers and the economic competitiveness of regions and firms is very heterogeneous and differ from place to place (Iammarino et al., 2019). Therefore, the next sections will analyze more deeply the specific impacts of these variables in Spain and Europe as a whole.

3. MOBILITY OF GRADUATE STUDENTS IN SCIENCE AND ENGINEERING IN SPAIN

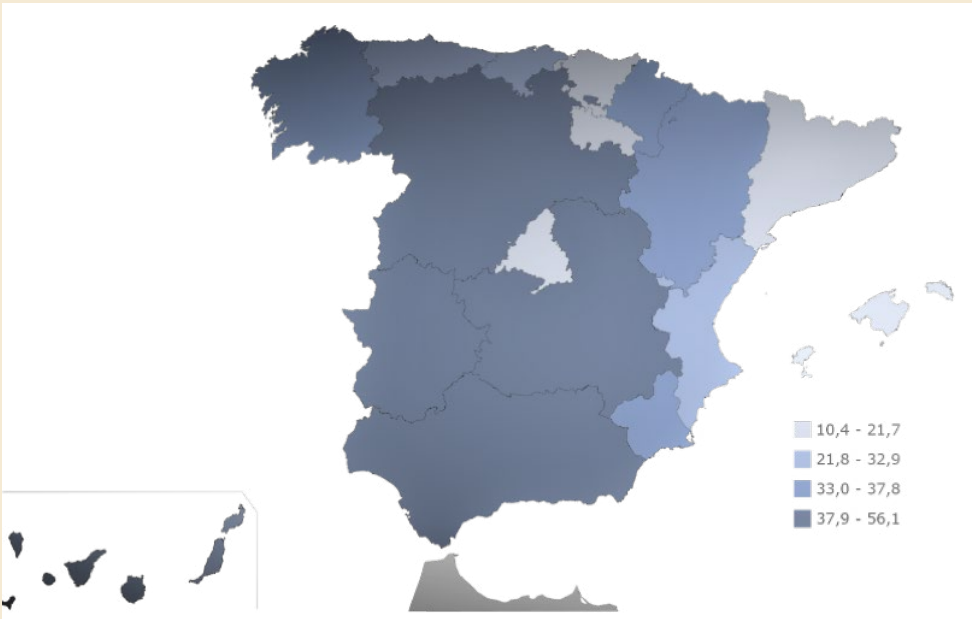
Spain is a good example of a country where the uneven regional distribution of talent shapes disparities in terms of economic development between regions (Kerimoglu, E., & Karahasan, 2012). Understanding the inter-regional mobility of skills in Spain, will help to understand the nature and reasons of the inter-regional and international mobility of high-skilled workers in similar regions. Spain has an intense interregional mobility of human capital in science and engineering. According to data from the Spanish National Statistical Institute (INE 2017), there are Spanish regions such as Castilla-La Mancha, Extremadura and Castilla y León where more than 40 percent of engineering (**Figure 1**) and science students (**Figure 2**) leave the region where they studied after graduation. These students typically move to the regions absorbing the majority of students graduated in science or engineering, which are also those with stronger economic development: Madrid and Catalonia. In Figure 1 and Figure 2, the regions with a darker color represent the regions with more than 42.2 per cent of graduate students in engineering and science migrating to other regions, three years after the graduation. Both for engineering and science studies, the regions with higher rates of brain drain are typically rural and less populated regions such as Castilla-Leon, Aragon, Galicia, Extremadura and Castilla-La Mancha. On the other hand, the regions receiving these skilled workers are Catalonia, Madrid and The Basque Country.



Figure 1. **Proportion of graduate students in engineering migrating to a work in a different region where they studied, by region.**



Figure 2. **Proportion of graduate students in science migrating to a work in a different region where they studied, by region.**



To check the factors that affect the mobility of science and engineering graduates, a regression model has been carried out for the 17 NUTS2 regions in Spain for 2011, which is the only year available related to the migration of graduate students. Previous studies for Italy (Dotti et al., 2013) or China (He et al., 2016) show that the main determinant of the mobility of graduate students is not wage disparity but the employability in the region where they have studied. That means, that in the early stages of professional development of scientists and engineers, wages are not as determinant as job opportunities for inter-regional mobility.

Therefore, our empirical model, rather than on inter-regional wage disparity, will focus more on a set of variables linked to the likelihood of finding a job in R&D-intensive sectors, such as the *Stock of R&D workers* in the region where students have completed their degree and the *unemployment levels* for science or engineering graduates in the region where students have completed their degree. In addition, variables linked to the quality of university institutions have been included in the model. The literature (i.e. Ciriaci, 2014) suggests that the quality of universities may also influence the mobility of graduate students, to the extent that students from better universities will have a better chance of finding a job in a different region. Within this second set of variables, the model measures the average quality of the universities in the region and their international exposure. More precisely, to measure the quality of universities in the region the model will consider the *Average Research Score of the region universities* in the Times Higher Education world university ranking, while to measure the international exposure of these universities we will use the *Average Internationalization Score of the region universities* in the Times Higher Education world university ranking, and the *Average Proportion of University Students* in the region that have completed international mobility stays.

The results of the robust estimation of the model shown in **Table 1** suggest that employability conditions have a significant impact on mobility, to the extent that regions with lower proportions of R&D workers or with higher rates of unemployment have a higher proportion of graduate students in science and engineering who migrate to other regions once they finish their studies. This explains the remarkable migration of graduates in science and engineering to regions with greater economic development such as Madrid and Barcelona, and to a lesser extent the Basque Country and the Valencian Community.



We have found that there are different factors explaining interregional and international migration of graduates in science and engineering. While, R&D intensity of the region, unemployment rates among science and engineering graduates and the mobility orientation of the skilled workers seem to explain interregional migration, for international migrations the main factor is the previous mobility experience of graduated students in science and engineering. This result is in line with former research suggesting that international experiences increase employability of students, since the international experience is linked to the forging of networks, opportunities for experiential learning, language acquisition and the development of soft skills related to cultural understandings, personal characteristics and ways of thinking (Crossman & Clarke, 2010).

Table 1. Factors explaining the mobility of graduated students in science and engineering in 2011, three years after the graduation.

	INTERREGIONAL MOBILITY OF SCIENTISTS	INTERREGIONAL MOBILITY OF ENGI- NEERS	INTERNATIONAL MOBILITY OF SCIENTISTS	INTERNATIONAL MOBILITY OF ENGI- NEERS
High-Skilled Workers Unemployment Rate	0.07***	0.28**	0.06**	0.57
R&D Workers Stock	-0.23***	-0.13*	0.17	0.18
University Students Mobility	1.63***	1.10***	1.15*	1.14
Regions University Internationalization	2.02	0.76	2.74	1.17
Regions University Research Ranking	-2.05	-0.75	-2.80	-0.16
Constant	8.94***	7.05***	5.25**	4.81
R ²	0.77	0.79	0.58	0.76

The results for Spain confirm that workers who are more qualified to be employed in innovative activities and companies tend to leave less innovative regions since these regions offer less job opportunities that match their skills. The loss of these skills means that firms and research organizations in these regions will find more difficult to recruit appropriate talent to support their innovative activities. Aggravating the gap between skilled workers' stocks can perpetuate interregional differences in terms of innovative capacity and economic development. On the other hand, at least for interregional

mobility, the quality of the tertiary education seems not to be relevant in fostering mobility of high-skilled workers. One of the reason is that on average more economically developed regions have better universities in Spain. In Spain, there are only nine universities among the 600 best universities in the world according to the Times Higher Education ranking. Seven out of these top universities are located in Madrid or Barcelona, and the remaining two are located in Navarra and Valencia, which are regions with lower levels of mobility. None of the regions exporting skills have universities with good reputation.

4. IS THE CONCENTRATION OF HIGH-SKILLED WORKERS IN EUROPE INCREASING?

In addition to inter-regional mobility of high-skilled workers one of the main goals of the research is to understand international mobility of these workers. It is well known that high-skilled workers tend to concentrate in certain regions such as Silicon Valley, Boston, Singapore, London, Paris or Bayern which attract skilled professionals not only from other regions in their countries but also from regions abroad. We want to look at this phenomenon in Europe. In fact, the question we resolve in this section is to examine whether the concentration of high skills in a few European regions is a growing phenomenon or not. The answer to this question will confirm if the different wealth redistribution policies undertaken by European governments and the European Commission for years have been able to reverse the inter-regional differences that provoke inter-regional mobility of high-skilled workers. To answer this question, we analyzed the evolution of the stocks of scientists and engineers from the European regions (at NUT2 level) of the European Union and Norway from 2007 to 2017.

A first indicator that can give us information on what has happened is the measurement of the stock of scientists and engineers in the regions that are European poles of attraction of skills. We will consider for the sake of this research as a pole of attraction of skills those regions grouped in the 95th percentile in terms of stock of engineers and scientists in 2007. The regions within the 95th percentile in terms of stock of engineers and scientists in 2007 were Ile de France and Rhone-Alpes in France, Bayern, Dusseldorf, Stuttgart and Koln in Germany, Madrid and Catalonia in Spain, Mazowieckie in Poland, Outer London in the United Kingdom, Southern Eastern Ireland in

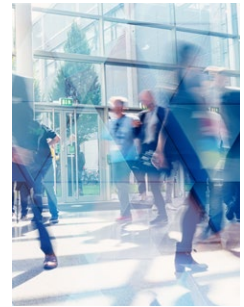


Ireland and Lombardy in Italy. In 2007, these regions concentrated a total of 2,669,000 engineers and scientists, which represents the 23 per cent of the total 11,592,000 scientists and engineers in our sample of countries.

Ten years later, in 2017, the stock of scientists and engineers grew significantly in Europe up to 18,448,000 individuals. During this decade, the regions in the 95th percentile have undergone some changes. First, new regions have joined the group of regions in the 95th percentile, such as Inner London in the UK or Berlin in Germany, while some other regions such as Dusseldorf left the group. The total number of scientists and engineers in these poles of attraction has grown to 4,009,000 scientists and engineers in 2017. Despite this growth, it can be said that in general terms the concentration of the stock of scientists and engineers has diminished in Europe, as the proportion of scientists and engineers in the 95th percentile went down to 20 per cent of the total stock in our sample. That is, although in absolute terms there has been an increase of more than 1.3 million scientists and engineers in three years in these leading regions, in relative terms there has been a reduction of three percentage points. Therefore, it seems that European policies to promote a more homogeneous development of the stocks of scientists and engineers have been successful. However, a more detailed analysis of reality reveals certain important nuances that should be included in this commentary, as the reality of European regions is much more heterogeneous than global statistics might suggest. **Figure 3** shows the contribution of each region to the increase in the stock of scientists and engineers in Europe between 2007 and 2017.

The regions represented with a red colour are those regions that are in the 95th percentile in terms of contribution to the increase of the European stock of engineers and scientists between 2007-2017. Brown regions are between 50 and 95 in terms of this variable, the darker the brown colour the closer the region is to the 95th percentile. Blue regions are below the 50th percentile, and the darker the blue colour the lower the percentile of the region.

Graph 3 shows how some of the regions that already had a high concentration of engineers and scientists in 2007 such as Outer London, Madrid, Catalonia, Oberbayern, Stuttgart, Lombardy or Rhone Alps have also registered a strong growth in the stock of scientists and engineers in the last decade. As shown in previous section for Spain, in some other countries there is also a “capital



effect” where some of the regions that host the capitals of their countries have also played a major role in the strong growth in the stock of scientists and engineers. Specifically, this “capital effect” can be seen in the regions of Lisbon in Portugal, Berlin in Germany, Stockholm in Sweden, Madrid in Spain, London in the UK or Vienna in Austria.

At the country level, the UK has experienced the strongest growth in the stock of engineers and scientists over the last ten years. There has been a strong growth in the stock of engineers and scientists in the regions of Inner London, Surrey, Sussex, Berkshire, Buckinghamshire, Oxfordshire, Gloucestershire, Wiltshire, Bristol/Bath, East Anglia, Derbyshire, Nottinghamshire, Greater Manchester, West Yorkshire and Eastern Scotland. This reflects the growing concentration of scientists and engineers in the South East of England, Manchester area, Edinburgh area and London.

Among the regions with the highest concentration of engineers and scientists in 2007, the French region of Ile de France is an anomaly, as in the last decade it has experienced a reduction in the stock of engineers and scientists by 27,000 individuals, 5 percent of those recorded in 2007.

In order to study in greater detail the motivations, we constructed a model that explains the factors that influence the greater or lesser growth of the stock of scientists and engineers in these European regions (**Table 2**). Within the different factors considered in the model, a first group of variables were linked to the regional labor market, such as the unemployment rate, the wage disparity and the quality of the regional institutions. The model expects that regions with lower unemployment rates (Eggert et al., 2010), higher average wages (Liu & Shen, 2017) and higher quality institutions (Charron, & Rothstein, 2016) will be more able than other regions to both retain and attract high-skilled workers. Therefore, we would expect that high scores on these variables are associated with higher relative growth in the stock of engineers and scientists compared to other regions in Europe. A second group of variables in the model measures the effects of knowledge agglomerations. These variables simply reflect the broad literature that explains how agglomeration economies and knowledge spillovers tend to favor the local concentration of high-skilled workers. The variables that reflect this effect in the model are the initial stock of scientists and engineers, the intensity in workers with tertiary education (Carrington, 1999), the intensity in medium-skilled workers



as a necessary complement to the productivity of high-skilled workers in high-tech industries (Christopherson & Clark, 2007) and the improvement in a region's innovative capabilities measured by the score in the Regional Innovation Scoreboard (Zaetel, 2006). GDP per capita of the region has been introduced as a control variable.

Graphic 3. **Contribution to growth.**

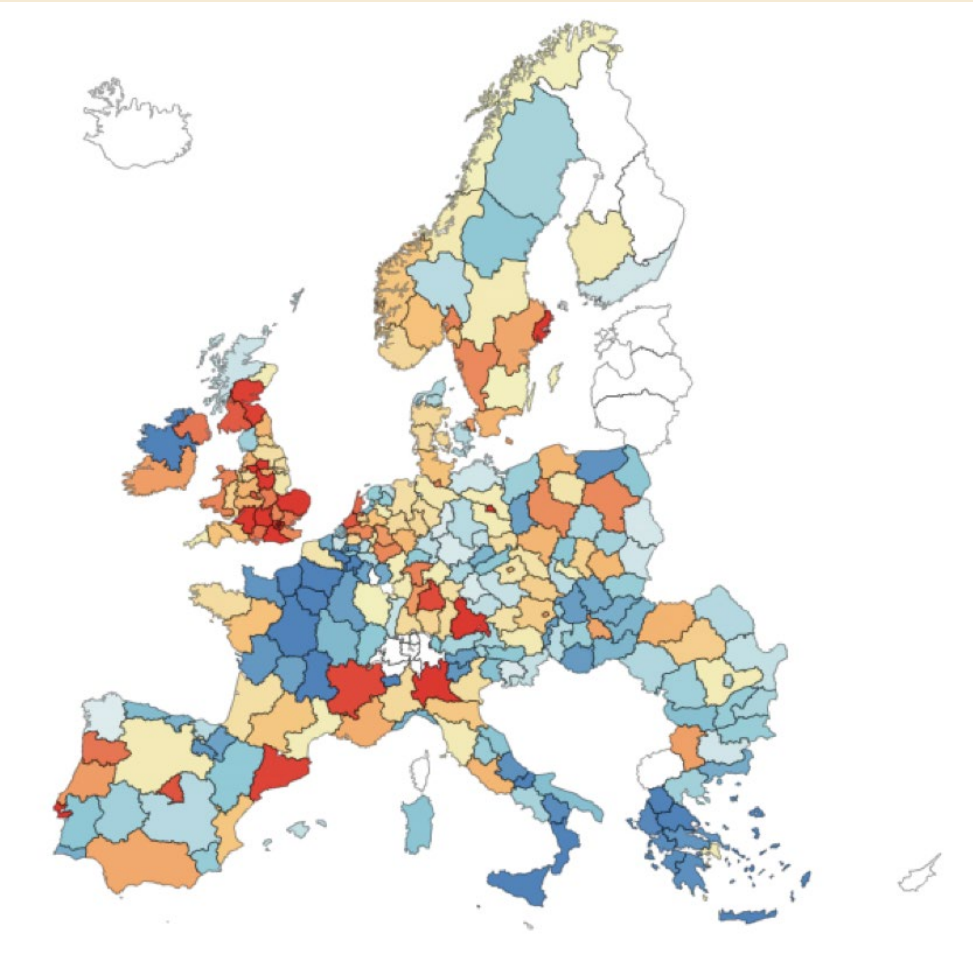


Table 2. **Variables for the estimation of the factors that explain the growth of the stock of scientists and engineers in European regions.**

Relative Increase in the Stock of Scientists and Engineers	(Moving Average Stock of Scientists and Engineers region i year 2017-Moving Average Stock of Scientists and Engineers region i year 2007)/(Moving Average Stock of Scientists and Engineers Europe year 2017-Moving Average Stock of Scientists and Engineers Europe year 2007)	Eurostat (2019)	Jacobsson & Os-karsson (1995)
Unemployment rate	Unemployment rate of region i in year 2007	Eurostat (2019)	Eggert et al., (2010)
Wage Disparity	Average Wage Region i year 2007/ Maximum Regional Average Wage for Country j year 2007	Eurostat (2019)	Liu & Shen (2017)
European Quality of Government Index (EQI)	Aggregated index built from three components: quality, impartiality and corruption	Quality of Government Institute of Gothenburg University (2017)	Charron, & Roths-tein. (2016)
Initial Stock of Scientists and Engineers	Number of scientists and engineers in region i in 2007/ Number of scientists and engineers in Europe in 2007	Eurostat (2019)	
High Skilled Workers	Proportion of the population with tertiary education in 2007	Eurostat (2019)	Carrington (1999)
Medium Skilled Workers	Proportion of the population with upper secondary education in high tech industries in 2007	Eurostat (2019)	Christopherson & Clark (2007)
Variation in Regional Innovation Capabilities	Innovation Scoreboard 2017 – Innovation Scoreboard 2009	European Commission (2019)	Zaletel (2006)
GDP per capita	GDP / Total Population in 2007	Eurostat (2019)	

The robust results of the estimation of the censored regression model confirms only partially the hypotheses. Regarding the relationship between labor market characteristics and skills concentration, only the variable measuring the *Unemployment Rate* of the region has a statistically significant relationship. In this sense, the stock of scientists and engineers will grow more in those regions with lower unemployment rates, confirming the results already observed for Spain. *Wage disparity* does not provide any statistically significant result, similarly to the variable *Quality of Regional Institutions*. The lack of statistically significant results can be explained by two theoretical arguments. In first place, workers face strong information asymmetries related to the average wages and the quality of

regional institutions specially in more distant regions. Together with social and language barriers, these asymmetries explain why inter-regional mobility is more frequent than international mobility. In fact, with some exceptions such as London or Bayern, the “capital effect” discussed above refers more to national patterns of skills mobility than to international flows towards capital cities. For instance, the concentration of engineers and scientists in Mazowieckie, Madrid, Berlin, Stockholm or Vienna reflects more the attraction force of these regions for scientists and engineers from nearby regions in their country. In that sense, these capital cities create unconnected islands of innovation in their countries. Contrasting to these islands of innovation, the analysis shows the existence of valleys of innovation formed by interconnected innovative regions with more distant knowledge exchanges. We can see one of these “innovation valleys” running from the Rhone-Alps and Lombardia, running through Switzerland and, Baden-Wuttenberg, Stuggart, Bayern up to Noord and Zuid Holland in the Netherlands. There is another “innovation valley” in terms of agglomeration of scientists and engineers connecting the South-East of England with Manchester through London and the Midlands.

Related to the knowledge agglomeration hypothesis, we can see in the results that this hypothesis is confirmed by both variables related to the innovation performance of the region and the proportion of workers with tertiary education. The results confirm previous research on the existence of a complementarity between engineers and scientists and other workers with tertiary education. However, the complementarity between the stock of engineers and scientists with the stock of workers with upper secondary studies is not confirmed. Probably, this complementarity, observed previously in the literature, is more specific of a few industries and regions, since the set of skills of workers with upper secondary studies is quite heterogeneous throughout Europe due to the lack of a standard European curriculum. The remaining variables do not provide statistically significant values (**Table 3**).

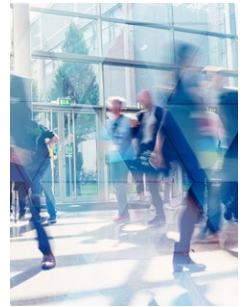


Table 3. Results of the estimation of the factors that explain the growth of the stock of scientists and engineers in European regions.

RELATIVE INCREASE IN THE STOCK OF SCIENTISTS AND ENGINEERS	COEFFICIENT
Unemployment rate	-0.00073**
Wage Disparity	0.00201
Quality of Regional Institutions	-0.0003
Tertiary Education	0.00323***
Initial Stock of Scientists and Engineers	0.00050
Upper Secondary in High Tech Industries	0.00069
Variation in Regional Innovation Capabilities	0.00203***
GDP per capita	-0.00076
Constant	0.29047***
Log Likelihood	1267.54
N	222
LR chi2	136.16
Prob>chi2	0.00000

5. CONCLUSION

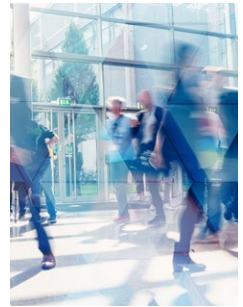
This research has analysed the phenomenon of geographical concentration of high skilled workers. The study has been carried out from two levels of analysis: the inter-regional mobility in Spain, and the international mobility in Europe.

For both levels of analysis a common conclusion is reached: the geographical concentration of scientists and engineers depends on the unemployment rate of the region in which they are located. The explanation for this fact is to be found in the greater mobility of scientists and engineers with respect to other categories of workers with fewer skills. In the analysis that has been carried out on the mobility of undergraduate students in Spain, it is shown that in several Spanish regions, the migration rate of graduate students in science or engineering is over 40 percent. Therefore, in the face of unfavorable labor markets, scientists and engineers are favored by a growing demand from those regions with an economic structure appropriate to their skills. The importance of the appropriate economic structure has been confirmed by the study that shows how economic models based more on high skilled workers and the development of robust regional innovative capabilities are the main factors in the development and

retention of high stocks of skilled workers. In this sense, the results of the study seem to indicate that a distinction must be made between economic structure and wealth. The non-significant results for the variables of wages or GDP per capita suggest, at least for the data analyzed, that the attraction of scientists and engineers cannot be based solely on high wages, but needs an adequate environment. This conclusion has important implications, since it means that regions wishing to increase the stock of scientists and engineers can not only rely on economic incentives, such as the tax-bonuses offered by several European countries to high-skilled workers, but must first seek to develop a business and industrial structure that will serve as a long-term basis for the career development of skilled workers. This argument is in line with recent research that shows how skilled workers respond better to incentives linked to their long-term professional development and life-long learning compared to short-term incentives based on salaries.

However, the departure of their scientists and engineers plunges regions into a vicious circle when it comes to developing an appropriate industrial structure. Regional governments in non-innovative regions face a chicken-egg challenge because of the endogenous relationship between skills and economic growth. Apparently, there are some common patterns in those regions in Taiwan, Rwanda, Chile or India that suggest that regions should start by a combination of policies aiming at both creating a large stock of high-skilled workers with low wages and policies to attract investment of foreign multinationals, which are the foundation of new innovation ecosystems in those regions.

The implications for firms' managers in non-innovative regions are similar. First, firms in these regions should offer jobs with tasks that match the skills of high-skilled workers, otherwise workers risk falling into the overqualification trap. This overqualification trap has some serious implications for firm performance. On one hand, former research shows that relying on an overqualified workforce may further damage the company's innovative capacity (Sandulli & Fernandez, 2019). Therefore, hiring high-skilled workers for jobs designed for lower skills may have the opposite effect as expected by reducing firm innovative performance. Second, in the middle and long term underemployment will limit firms' ability to retain high-skilled talent in the company. The results of this research point in the direction that high-skill workers make decisions about where



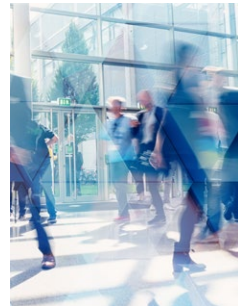


to work based more on long-term incentives such as professional career development than on short-term incentives based on wage premiums. In fact, recent research shows that expected wage gains of high-skilled workers are simply the long-term result of knowledge spillovers produced in knowledge agglomeration areas which lead to workers increasing capabilities over time (Lehmer & Ludsteck, 2011). High-skilled workers in non-innovative regions will expect lower wage gains in the long-term because of weaker knowledge spillovers which limits the development of their own capabilities. Therefore, firms in non-innovative regions willing to attract high-skilled workers should compensate for the lack of knowledge spillovers by creating programs aimed at reinforcing existing workers capabilities or building new capabilities. Therefore, training programs or intrafirm job mobility programs can play a more relevant role in attracting and retaining talent in those firms located in non-innovative regions compared to firms in knowledge agglomeration areas.

Finally, from the point of view of policy-making the research confirms that the challenge of regional integration has two level of analysis: islands and valleys of innovation. At the national level, we have shown in several countries the presence of islands of innovation, mostly in capital-city regions, that attract large proportions of high-skilled workers from neighboring regions. This is the most common form of high-skilled workers mobility in Europe, where high-skilled workers flows between more distant regions is less frequent than in the US or China. From a policy level, the existence of these islands have some relevant implications. On one hand, these regions create asymmetric knowledge agglomerations that favor their competitiveness and economic growth, but create demographic and economic imbalances in the whole country. In countries with islands of innovation such as Spain, Poland or Sweden the success of policies to fight regional inequalities depends on the capacity of governments to attract a minimum scale of firms and industries needed to break the vicious circle whereby the greater the agglomeration in the islands of innovation, the greater the difficulty of non-innovative regions to retain skills and talent needed to reorienting their productive structure towards higher value-added industries.

We have also described in this research the existence of valleys of innovation formed by regions linked by interconnected flows of knowledge and workers. There is one valley of innovation from ranging from Lombardia and Rhone Alps, crossing the center of

Europe through Switzerland, Baden-Wuttenberg and Bayern up to Nord and Zuid Holland, while there is another valley of innovation that covers from South-East of England to Manchester, through London. One of the natural solutions to these challenges would be the knowledge spillovers from innovative regions to less-innovative regions through the return of high-skilled workers to their home regions (Klagge & Kleinn-Hitpab, 2010). However, compared to the other parts of the world such as the US, more restrictive labor regulations and lower migration in Europe curtails these returning knowledge spillovers (Lee & Rodriguez-Pose, 2013). These institutional restrictions to knowledge flows also limit the capability of the valley of innovation from north Italy to the Netherlands to become a real central and integrated hub of innovation for Europe similar to Silicon Valley in the US. On the other hand, before the Brexit the valley of innovation in England benefited from lower institutional constraints to skills mobility that helped to build a solid economic growth based on high-value industries. However, more restrictive immigration regulations in the aftermath of Brexit deal may pose a serious risk also to the capabilities of the British valley of innovation.



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