Regional Human Capital and University Orientation: A case study on Spain

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Abstract: This paper explores the relationship between regional human capital (HC) and the processes of knowledge creation and mobilization due to Higher Education Institutions (HEIs). Although the nexus between these dimensions emerges frequently in both the scholarly and policy discourses, no study has so far investigated explicitly how their connection works. Using occupations as a proxy for the skill content of jobs, we analyse individual (gender, schooling and age) and regional (university orientation) factors that influence HC employment structure in Spanish regions over the period 2003-2010. The main finding is that teaching university mission is a robust predictor of high-skill employment, while the impact of engagement (research and knowledge transfer) activities is more sensitive to structural characteristics of the regional socio-economic context.

Keywords: Human Capital; University Orientation; Skills; Region

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1 Introduction

The present paper explores the relationship between demand and supply of regional human capital (HC). These two concepts are operationalised empirically by using data on the occupational structure of the workforce, a proxy of demand, and on the activities engaged by Higher Education Institutions (HEIs), a proxy of supply. Our claim is that the nexus between these two dimensions emerges only implicitly in the debates of scholars and policy-makers and that its inner workings are still understudied.

For what concerns HC, the canonical view holds that high levels of education in the population are a propellant for economic growth (e.g. Barro, 1991; Barro and Lee, 1994). Empirical evidence emphasizes labour market pools of high-skill workers as one of the key drivers for improving productivity, augmenting the innovation potential and accelerating regional economic development (e.g. Glaeser *et al.*, 1995; Florida *et al.*, 2008; Abel and Deitz, 2012; Goddard *et al.*, 2012). We notice that these studies share the common feature of relying on aggregate HC supply indicators such as the local ratio of graduates or the distinction between 'white-collar vs. blue-collar' workers. As will be argued later, we believe that these aggregate constructs conceal the crucial role of labour market demand for channeling HC into the fabric of the regional economy.

On the other hand, the contribution of HEIs to the surrounding socio-economic context is often articulated in terms of three "mission" constructs in reference to the activities of teaching, scientific research and knowledge transfer (Laredo, 2007). Although no one would cast doubts on the claim that the replenishment of the skill base is a key societal function of universities, the literature acknowledges that they contribute to the social and economic wellbeing of their surroundings through a variety of pathways (Geuna, 2001). This fuels a critical stance towards the so-called 'one-size-fits-all' model wherein universities are conceived as homogeneous institutions with equal capacity to contribute to social engagement through a mix of teaching, research and social engagement (Philpott et al., 2011). The main criticism towards this view is that it overlooks the complex nature of universities *qua* local institutions and, thus, the inherent heterogeneity in the ability to pursue and achieve a balance among the three archetypal missions (Sánchez-Barrioluengo, 2014).

In spite of the obvious connections between the two dimensions of demand and supply of skills, no study has so far studied explicitly the extent to which a particular mix of HEIs' missions affects the composition of HC in a region. We set out to fill this gap as follows. First, we propose a reconceptualization of regional HC using recent insights from labor economics that adopts occupations as proxies for the skill base of the workforce (Autor *et al.*, 2003; Levy and Murnane, 2004; Spitz−Oener, 2006; Goos and Manning, 2007; Autor and Dorn, 2013). Using this framework we focus on workers employed in occupations that entail intensive engagement with cognitive problem-solving and/or interpersonal skills. Looking at the composition of occupations in a region rather than to the total of graduates within the workforce affords the opportunity to capture the demand for skills by looking at how HC is embedded in local production activities via the institution of employment. This resonates with a thread in economic geography that endeavours to study the HC of regions on the basis of what they 'do' rather than on what they 'make' (Feser, 2003). For what concerns the supply of skills the input of HEIs is operationalised by means of an index of regional university orientation that uses data on universities' engagement with each of the three missions. This novel indicator captures synthetically the relative importance of university teaching and engagement by assigning key HEIs activities to a particular mission construct. Or, in other words, university orientation reflects the relative success of a mission in terms of performance, and we are concerned about whether relative success is associated with higher levels of skill utilization (abstract or non-routine cognitive skills) in the regional labor market.

Against this conceptual backdrop we develop an empirical analysis based on data on 17 regions and 47 public universities in Spain over the period 2003-2010. In particular, we connect changes in the employment structure of regions - that is, in the demand for skills - to the local configuration of knowledge supply provided by universities. This study contributes to the debate outlined above by addressing two research questions:

- What is the composition of regional HC?
- Does university orientation affect the evolution and endowment of regional HC?

The main finding is that teaching mission is a robust predictor of high-skill employment in a region, while the impact of engagement activities is more sensitive to structural characteristics of the socio-economic context. Accordingly, the paper claims novelty on two counts. First, we add to the literature of economic geography by offering an alternative measurement of HC based on the occupational configuration of the workforce. This is a step forward towards the widely debated need for better indicators of HC that goes beyond traditional characterizations of the labor force. A direct, albeit surely imperfect, measure of the skill content of occupations is revealing of how qualitatively different forms of know-how coalesce within an occupation. The second contribution is an articulation of the relation between demand and supply of knowledge as mediated by regional institutional processes like education and the labor market. By exploring this nexus we fill a gap in the literature that has disregarded the joint effect of knowledge production and knowledge use in regions.

The paper is structured as follows: Section 2 presents a synthesis of scholarly work on skills endowment and labor markets followed by a review on the role of HEIs in regional development and economic growth. Section 3 offers a summary of the empirical strategy, the data sources and of the methodology for the analysis that is carried out in Section 4. Section 5 concludes and summarizes.

2 Literature review

This section presents the empirical dimensions of interest, namely HC and HEIs' mission orientation in two steps. First, we raise the question of how can HC be alternatively measured taking into account the demand side. It will be argued that the workings of local labor markets play a crucial role in coordinating skills and thus in facilitating the fulfillment of latent economic potential. Subsequently we elaborate on the role of HEIs in shaping regional human capital through the multiplicity of knowledge-generating activities that they engage in.

2.1 Human capital, skills and employment

HC is a key input for economic growth, especially in the context of modern knowledge economies. This resonates with the traditional view that HC increases individual-level productivity and that societies with 'better' HC are enjoy greater development potential compared to societies with scarce or inadequate human resources (Becker, 1964; Nelson and Phelps, 1966; Schultz, 1972). In economic geography HC is often portrayed as akey driver of innovation capacity and local socio-economic development (i.e. Glaeser *et al.*, 1995; Glaeser, 2005; Florida *et al.*, 2008). Numerous studies draw attention to significant heterogeneity across regions in the capacity to create and retain HC (Moretti, 2004; Rodríguez-Pose and Vilalta-Bufí, 2005; Berry and Glaeser, 2005; Consoli et al, 2012).

At the same time the literature portrays knowledge as a byproduct of education and training, so much so that the count of the total number of individuals with college degree or more is the gold standard for measuring regional HC. In our view this indicator disregards the heterogeneity of forms of know-how shaped by local labour market dynamics (Florida et al., 2008) and reflects a strong disconnection between the analysis of regional knowledge and the workings of labour markets (Boschma *et al.*, 2014). People specialize in different areas, and even if one considers the cognitive abilities stemming from higher education as a closed set, skills develop differently across multiple career paths. HC is not a static pool of knowledge but rather a flow of competences that contribute to, but are in turn shaped by, work experience. This leads us to argue that, regardless of the level of geographic aggregation, the total number of graduates is a crude measure of the HC stock that does not take into account the diversity of know-how, and of how labour markets impinge upon it.

An alternative is to think of economic activities as being composed of work tasks whose execution requires the application of specific forms of know-how. Using occupations as unit of analysis one can think of vectors wherein work tasks and workers' skills match in fulfillment of job duties (Autor *et al.*, 2003; Levy and Murnane, 2004). In aggregate, the configuration of occupations is a proxy of the knowledge mix that is relevant in a particular context – i.e. industrial sector or geographical region. By the same token, as

industry or regional needs change, occupations evolve and so do the agreed tasks and the relevant skill mix (Vona and Consoli, 2015; Consoli and Rentocchini, 2015). In short, by putting emphasis on the connection between work tasks and the knowledge that is needed to carry them out, this alternative route restates the importance of focusing on individual characteristics to grasp the multidimensional character of HC.

2.2 Universities as human capital and knowledge producers

Even though their organization and role has evolved over time HEIs have traditionally been the main source of new HC (OECD, 2004). The teaching and research missions are part of a nexus of market-oriented and knowledge transfer activities (Louis *et al.*, 1989; Klofsten and Jones-Evans, 2000) that includes both 'soft' competences close to the traditional academic paradigm (i.e. advisory roles, consultancy, industry training, production of qualified graduates) as well as 'hard' ones related to patenting, licensing and spin-off activities (Philpott *et al.*, 2011). In the traditional approach HEIs' contribution to their local surroundings is conflated with capacity to provide skilled workers to local labor markets (Abel and Deitz, 2012). Cooke (2005) describes these institutions as 'knowledge generator subsystems' operating inside a virtuous circle of global knowledge flowing through the region and out into global markets that create beneficial spillovers for local firms (businesses are the 'knowledge utilizer subsystem') while at the same time attracting external investors. Similarly, the academic community highlights their importance for the development of positive externalities in the form of knowledge spillovers to the private sector (Anselin *et al.*, 1997; Goddard and Chatterton, 1999). Because of their role in creating and mobilizing knowledge HEIs receive support from local and regional authorities under the expectation that they will stimulate technical innovation and promote higher productivity.

The output of HEIs' activities is normally conceptualized in terms of missions, namely: teaching and training; scientific research; and the promotion of university-society synergies (Laredo, 2007; Drucker and Goldstein, 2007). Teaching is generation of HC in the form of specific knowledge and skills that will be embodied in the workforce (OECD, 2008). Conversely, the second and the third missions refer to a specific

knowledge component and are therefore interconnected. Indeed, the purpose of research is the production of knowledge and, since a significant portion of this knowledge (specifically those knowledge created for local purposes) is tacit rather than being easily codifiable (Arbo and Benneworth, 2007), third mission activities consists mainly of facilitating the transfer of such knowledge.

However attractive in the abstract, the notion that all universities engage in all missions is not necessarily in tune with the reality of their socio-economic contexts (EC, 2006). At the core of this criticism is the concern that the "one-size-fits-all" model overlooks the complex nature of the university *qua* institution (Olsen, 2007) and the many tensions which arise in the process of engagement (Pinheiro *et al.*, 2012) as a result of uneven unfolding of functions, resources, networks and spatial aspirations (Teichler, 1988; Martin, 2003; Teichler, 2004). In short, universities exhibit different capacities and abilities to engage and contribute to society. In addition, the "one-size-fits-all" framework neglects the dynamics that influence demand for skilled workers at regional level. Given the importance of HC to the economic performance of regional economies (see e.g. Barro, 1991; Barro and Lee, 1994; Glaeser *et al.*, 1995; Glaeser, 2005; Florida *et al.*, 2008), there is surprisingly little research on the factors that drive differences in HC accumulation across geographical areas (Abel and Deitz, 2012). Coherent with the framework outlined so far, HEIs' mission orientation is expected to play a key role by virtue of its broad spectrum of knowledge-generating activities.

2.3 Empirical operationalization of the literature

This section fixes ideas by detailing the connection between the shortcomings that were highlighted in previous sections and the empirical strategy of our analysis.

First, in order to integrate alternative measures of HC we follow previous literature in labour economics and use employment data from the Spanish Labor Force Survey. This allows us to assign occupations to specific categories depending on their skill content which is a proxy of the type of HC.[2] Previous literature identifies three categories of

[2] See Table 1 for more information.

occupations. First are high-skills professions that carry out abstract or non-routine cognitive tasks using problem-solving and interaction skills (e.g. scientists, managers and professionals). A second group includes mid-skill 'routine' occupations (e.g. clerks and production workers) that are intensive in both physical and cognitive work that can be easily expressed in codified instructions. Finally, at the low-end of the skill spectrum are occupations that require physical dexterity and adaptability to carry out non-routine manual tasks (e.g. truck drivers, security guards, waiters and cleaners) (see Autor *et al.*, 2003; Levy and Murnane, 2004). Our analysis focuses on the labour market demand for high-skill professionals, the occupations that use most intensively cognitive analytical and interpersonal forms of HC that are deemed essential in a knowledge society and whose supply depends on HEIs (OECD, 2008).

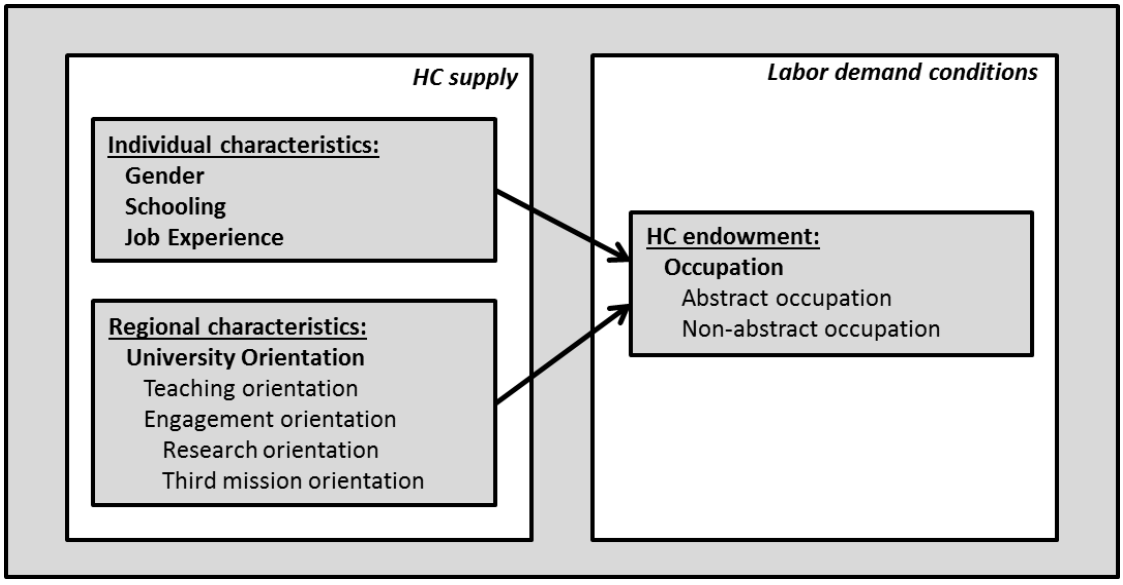
According to a now ample literature occupations that are more in demand are high-skill professionals and low-skill manual jobs while employment opportunities have been steadily shrinking for workers in the middle of the skill spectrum (Autor, Levy, and Murnane, 2003; Autor and Dorn, 2013; Goos et al, 2009). This pattern of growth at the two extremes of the skill spectrum is the signature mark of polarization (Goos and Manning, 2007), and is commonly interpreted as a byproduct of combined pressures from technology and globalization (Autor et al, 2013). On the one hand automated production processes complement high paying occupations intensive in cognitive tasks while they are a substitute for workers whose core job tasks involve routine (both cognitive and manual) activities (Levy and Murnarne, 2004). On the other hand, the expansion of international trade has accelerated the relocation of low-skill intensive processes to labour-abundant countries, such as i.e. China, and pushed US firms to offset price competition by investing in high-skill workforce to increase output quality (Bloom et al., 2014).

Drawing on this, we break down the employment structure of regions into functionally different occupational groups to capture changes in regional HC as mediated by the dynamics of local labour markets. This is done using information on the occupation of individuals, which is a proxy of availability of HC at local level, and on individual characteristics that influence employment outcomes such as gender, schooling and/or job experience (e.g. Moretti, 2004; Dolado et al., 2002; Mincer, 1974). Further, drawing

on the literature that emphasizes the role of HEIs in the creation, mobilization and generation of local spillovers we expect that the presence of a university shapes the regional HC endowment.[3] After the reform of 1983 universities in Spain have retained significant autonomy in administrative and financial matters which are agreed directly with regional government. This suggests adopting a multi-level approach. Assuming that missions are meaningful constructs to capture university orientation and that available indicators of current activities are adequate to analyze their performance, we use data on 20 indicators (i.e. total enrolled students, research and third stream funding, scientific production, knowledge-exchange activities) to build an index of regional university orientation. This is a novel measure of university "missions" performance that captures synthetically the relative importance of teaching and engagement by assigning key HEIs activities to a particular mission.

Building on these conceptual foundations, Figure 1 summarized the different elements that we are using in the empirical section of this paper.

Figure 1. Empirical model



[3]By 'HC endowment' we refer to the composition of the labour force available in a particular context, that is, the set of available skills, knowledge and know-how that workers have as a result of their education and work experience. This constitutes the employment demand side because includes the particular characteristics that will be required in the following workers' generation.

3 Empirical Strategy

Following on the backdrop laid out above this section presents the empirical strategy for our study in order to operationalize Figure 1. To reiterate, we use occupational categories as an indicator of regional HC and HEI missions as a compass to gauge regional university orientation. Subsequently we analyse the relation between university specialization and regional employment structure in Spain.

The proposed multilevel perspective combines data at two different levels: first, individual-level personal characteristics, schooling, and employment; and, second, regional-level variables encompassing environmental factors that are expected to affect the composition of the workforce. Individual-level variables resonate with the literature in which high-skill workers are identified with college graduates, while regional-level variables refer to the influential supply factors affecting HC endowment.

3.1 Human capital and employment structure (dependent variable)

The main variable of interest is HC measured by the composition of occupations in a region. The main data source is the Spanish Labor Force Survey (LFS)[4] containing information on the profile of the interviewees. We use yearly individual-level records for the period 2003-2010 weighting individuals by person weights to ensure the representativeness of the sample. We select individuals who are 16 years old or more (e.g. the legal working age in Spain) and employed in the private sector at the time of the interview. Each observation is assigned to the region in which (s)he works. Information about individual occupations is organized following the 2011 Spanish national occupation classification (CNO) which, like the Standard Classification of Occupations (ISCO-08), includes eight one-digit occupations (e.g. clerical support workers). Table 1 provides further details.

[4] The Spanish Statistical Office collects this information on a quarterly basis. More information available at: www.ine.es/en/inebaseDYN/epa30308/epa_inicio_en.htm

Table 1. Description of occupations

Occupation (CNO-11) in LFS	Occupation re-coded	Dependent variable
1. Directors and Managers	Abstract (ABS)	Abstract (ABS)
2. Professionals	Abstract (ABS)	
3. Technicians and associate professionals	Abstract (ABS)	
4. Clerical support workers	Routine (ROU)	Non-abstract (non-ABS)
5. Service and sales workers	Non-routine manual (NRM)	
6. Skilled agricultural, forestry and fishery workers	Routine (ROU)	
7. Craft and related trades workers	Routine (ROU)	
8. Plant and machine operators, and assemblers	Routine (ROU)	

Following the conceptual approach outlined before, employment information is a proxy of the type of HC that is needed to perform a job. Accordingly, occupations are grouped in three macro categories: abstract or non-routine cognitive (ABS or NRC) group categories 1, 2 and 3 of CNO-11, non-routine manual (NRM) refers to service and sales workers and routine (ROU) jobs include the rest of occupations. The extent to which labour markets have polarized around the world is still a matter of debate, and the present study seeks to add to existing studies with new evidence on a context other than the United States (see Autor and Dorn, 2012) and Britain (Goos and Manning, 2007). To guarantee coherence of the occupational categories used here with those proposed in the literature, and assuming that the main channel through which universities influence regional development is via cognitive jobs, our dependent variable is a dummy that takes value of 1 if an individual is employed in an abstract occupation, namely: directors and managers, professionals or technicians and associate professionals; and 0 otherwise.

3.2 Individual-level variables

Individual-level worker characteristics available in the LFS micro-data are the first block of independent variables of the analysis, namely: gender, age and level of studies (schooling). These are traditionally used in the labour economics literature when workers are the unit of analysis (see i.e. Moretti, 2004; Dolado et al., 2002; Mincer,

1974). In particular, gender captures the employment differences and gap that exist between men (value 1) and women (value 2). Gender differentials in labour market opportunities have been debated for some time. Dolado et al. (2002), in particular, ascribe the higher occupational segregation in the EU compared to the US to lower women participation in managerial and professional jobs. Age of employees is included as a proxy of tenure of work experience, which is expected to have a non-linear effect, meaning that older and more experienced workers are more likely to obtain a job in the high-paying sector but the effect is counterbalanced by the negative sign of the quadratic term (Mincer, 1974). Here we include a categorical variable for age to distinguish between young, prime age and older workers. The third variable concerns the level of studies of the individual. Recent work distinguishes only between college and non-college workers and finds that they are important determinants of particular increments in specific occupations. For example, Autor and Dorn (2013) find that greater relative supply of college-educated individuals predicts rising service employment among non-college individuals. The level of schooling in this study is codified as follows: 0= No studies; 1=Basic studies; 2=Vocational training; and 3=College. Finally, we include a sectoral variable to control for cross-occupational differences. Table 2 provides a summary of these variables.

Table 2. Variables

	Description	**Labels**
Dependent variable		
Abstract occupation	Individual working in an abstract occupation	1=Abstract; 0=Otherwise
Individual-level variables		
GENDER	Gender	0=Male; 1=Female
LEVEL OF EDUCATION	Maximum level of studies reached	0= No studies; 1=Basic studies; 2=Vocational training; 3=College
AGE	Age of the worker as a proxy of their professional experience distinguishing between young workers (employees with less than 29 years old); prime age workers (between 30 and 54) and older workers (over 54 years old and less than 65)	0=Young; 1=Prime Age; 2=Older
SECTOR	Standardized 2009 sector classification from the Spanish Classification of Economic Activities (CNAE), equivalent to Standard Industrial Classification (SIC), which distinguishes ten one-digit sectors.	0=Agriculture, forestry and fishing; 1= Mining; 2=Construction; 3=Manufacturing; 4=Transportation, Communications, Electric, Gas, and Sanitary Services;

		5=Wholesale Trade; 6=Retail Trade; 7=Finance, Insurance and Real Estate; 8=Services; and 9=Public Administrations
Regional-level variables		
UOI TEACHING	Regional university intensity in teaching mission	*Continuous*
UOI ENGAGEMENT	Regional university intensity in engagement mission	*Continuous*
UOI RESEARCH	Regional university intensity in research mission	*Continuous*
OUI THIRD MISSION	Regional university intensity in third mission	*Continuous*
LABOUR DEMAND CONDITIONS		
Unemployment rate	Ratio between thousands of unemployment between 15 years or over divided by the workforce at NUTS 2 regions	*Continuous*
% Manufacturing	Employment in the industrial (except construction) economic activity (using NACE rev.2) divided by the workforce at regional level	*Continuous*
LEGISLATIVE COMPETENCIES		
Statute	Dummy variable measuring if a region has enjoyed longer degree of legislative independence (i.e. its Statute has been revised before 2003)	1=Yes; 0=Otherwise
OTHER CONTROLS		
Multi-university	Region with more than one university	1=Yes; 0=Otherwise
Polytechnic	Region with at least one technical oriented unviersity	1=Yes; 0=Otherwise

3.3 Regional-level variables

The regional-level dimension concerns functional and institutional circumstances surrounding the generation of HC. The inclusion of this second level of analysis is justified by two reasons. First, regions in Spain exhibit remarkable differences due to both structural and contingent factors (Buesa *et al.*, 2006). Secondly, HEIs are autonomous institutions with administrative and financial management that depend on regional government as per the Higher Education Reform of 1983. Under a homogeneous national legal framework, HEIs pursue specific goals by means of local strategies. In fact, under a common legislative landscape, Spain exhibits a unitary university structure (Schubert et al., 2014) in which the one-size-fits-all model goes

beyond a theoretical approach for framing the contribution of universities through three distinct channels. We consider that regional characteristics constitute the frame within which labour relations develop and seek to understand to what extent particular regional conditions have an effect on the employment structure.

The Spanish higher education sector includes 73 universities (INE, 2008), 48 of which are public while the remaining 25 are private. Universities are some of the most important agents in the Spanish R&D system in that they account for 27.7% of total R&D expenditure, 47.1% of employment of full-time researchers in 2012. However, most of this goes to public universities, which absorb a quarter of total R&D resources and employ almost half of all researchers in Spain. The prominence of these public institutions in the organization of the national science system makes them a natural focus of analysis.[5] Public universities are distributed unevenly across 17 regions (NUTS2)[6] and Andalusia is the region with the highest number of universities (9) followed by Catalonia and Madrid with 7 and 6 HEIs respectively.[7]

We compute the *University Orientation Index (UOI)* to capture the relative importance of mission intensity of the universities located in a region. This is built using university-specific information on teaching, research and third mission drawn from different sources: Ministry of Education (ME) data on students and researchers; National Statistics Institute (INE) statistics on higher education; Conference of Spanish Rectors (CRUE) biannual report *"La Universidad Española en cifras"* (Spanish universities in figures) for academic, productive and financial information; Spanish Patent and Trademark (OEPM) information on patents; and RedOTRI, the Spanish Network of University Knowledge Transfer Offices, for third mission indicators.

[5] The National Distance Education University is excluded because it is the only distance learning organization in Spain and is the only university that continues to be administered by the national government.

[6] We exclude Ceuta y Melilla, two provinces located in North of Africa due to their specificities. These are considered autonomous cities with lower administrative competences compared to other Spanish regions.

[7] Valencian Community has 5; Castile-Leon, 4; Galicia, 3; Murcia and Canary Island, 2 and other regions 1 university.

Subsequently, we use 20 performance indicators capturing university activities[8] to construct the indexes for academic years between 2003/04 and 2009/10. Specifically, three indicators measure the first mission or teaching: enrolled students (Act_1), graduates (Act_2) and teaching revenues (Act_3); and seventeen indicators to measure the engagement of the university defined as a combination of the second mission or research and third mission or interaction with socioeconomic environment (ISEE): postgraduate students (master and PhDs –Act_4, Act_5-), number of theses (Act_6), research projects (number and income –Act_7, Act_8-), publications (in Spanish, foreign and ISI journals –Act_9, Act_{10}, Act_{11}-); number of patents (applications and granted -Act_{12}, Act_{13}), income from projects in collaboration with firms (Act_{14}), contract research income (Act_{15}), revenues from R&D contracts (Act_{16}), consultancy (number and revenues -Act_{17},Act_{18}-), royalties (Act_{19}) and spin-offs (Act_{20}).

The panel information is used to calculate a university orientation index (UOI) defined as the intensity of each institution in teaching and engagement strategies:

$$UOI\_Teaching_{it} = \frac{(Act_1 + ... + Act_3)_{it}}{3}$$

$$UOI\_Engagement_{it} = \frac{(Act_4 + ... + Act_{20})_{it}}{17}$$

where UOI_X_{it} is the relative effort of university i=1,..,47 in the teaching and engagement missions respectively in a two-academic-year period t=2003/04,…,2009/10 weighted by the number of indicators included to measure each strategy. These indexes capture in a synthetic way the relative importance of university engagement by assigning key HEIs activities to a particular mission construct. In particular, if the indexes are positive and high the university is more teaching or engagement oriented;

[8] Original values of the indicators have been transformed in order to make them comparable. First, each indicator is defined as the cumulative value for activities in two consecutive years because information is available biannually. Second, we normalize variables because indicators have different unit of measurement. Third, teaching indicators are controlled by university size by means of the division of the real value of the indicator by the number of doctoral researches in each university. Finally, we use imputation techniques to avoid missing values. For a detailed explanation about the selected indicators and their validity to measure mission constructs see Sánchez-Barrioluengo (2014).

on the contrary, negative and low indexes indicate low engagement in a particular mission.

Although universities develop ad-hoc strategies for teaching, research and third mission, we propose a common indicator to measure the two latest due to the positive and high correlation that exists between research and ISEE (Sánchez-Barrioluengo, 2014). To be sure, there has been a surge of interest towards universities in regional development (Lawton-Smith and Bagchi-Sen, 2012; Peer and Penker, 2014), and indeed driving regional development has been considered a novel component of the third mission (Perkmann et al., 2013). In consideration this, it seems worth extending the analysis by partitioning university 'engagement' into the two subcomponents, research and third mission orientation[9]:

$$UOI\_Research_{it} = \frac{(Act_4 + ... + Act_{11})_{it}}{8}$$

$$UOI\_ThirdMission_{it} = \frac{(Act_{12} + ... + Act_{20})_{it}}{9}$$

Finally, using information on individual universities, we construct the UOI at regional level taking into account the location of the institution. In this case UOI for region r=1,…,17 in year t is defined as the sum of the UOI value of the universities located in region r divided by the total number of universities in said region:

$$UOI\_X_{rt} = \frac{\sum_i UOI\_X_{it}}{\#univ.r} \text{ where X } \varepsilon \text{ \{Teaching, Engagement\}}$$

Besides the UOI described above, we control for a number of regional specific characteristics that are now detailed in the remainder.

First, we control for regional labour demand conditions by using the *unemployment rate* and the *share of employment in manufacturing* industries. The former is calculated

[9] To be sure that activities can be grouped in each mission construct (teaching, research and third mission), we test construct unidimensionality (factor analysis) and reliability coefficients (Cronbach's alpha). Factor analysis guarantee that simplifying original variables in three constructs the model explains 63.7% of total variability. Cronbach's alphas are 0.595 for teaching: 0.899 for research and 0.924 for third mission. These results guarantee the homogeneity of activities within each mission construct.

using information from Eurostat and taking the ratio between thousands of unemployment between 15 years or over divided by the workforce at NUTS 2 regions. Further, following literature that ascribes the shift in demand away from unskilled and toward skilled labor in U.S. to increased use of skilled workers within the manufacturing industries, rather than to reallocation of employment between industries (Berman *et al.*, 1994), we include a control for employment structure. This variable is calculated using Eurostat information on employment in industry except construction (based on NACE rev. 2) divided by the workforce at regional level. Contrary to previous literature on the US (e.g. Autor and Dorn, 2013), we expect abstract occupations to grow more rapidly in areas with lower unemployment and larger manufacturing employment.

Secondly, we control for the level of legislative independence of Spanish regions depending on when it has been first established. The point of reference is the Statute (in Spanish '*Estatuto de Autonomy'*) that determines, among other things, the competences devolved to local institutions. The baseline regime was established in the 1980s but underwent further revisions over the last three decades to expand legislative independence in areas such as health and education. Such changes have been enacted by local parliaments at different times, so that some regions have enjoyed relatively longer independence. In order to capture these different institutional changes, we create a dummy variable equal to 1 if the region has enjoyed longer degree of legislative independence (i.e. its Statute has been revised before 2003) and equal to 0 otherwise.[10]

The last set of controls concerns differential knowledge generation capacity across regions. In short, we consider that being host to more than one university implies a relatively higher influx of graduate and postgraduate students and, thus, of a broader pool of skilled HC. Likewise, the presence of polytechnics is important because these institutions normally exhibit higher engagement with third mission activities due to their technical academic orientation. To control for these factors we create two dummy

[10] The regions that have adopted the revisions more recently are Andalusia, Aragon, Baleares, Castile-Leon, Catalonia and the Community of Valencia.

variables: *multi-university* has the value 1 if a region has more than one HEI and 0 otherwise and *polytechnic* has the value 1 if at least one of the universities in a particular region is a technical institution.[11]

3.4 Analytical plan and methodology

We begin with an overview of descriptive statistics at country level using aggregate values for the share of employees in abstract, manual and routine occupations to capture changes in the employment structure over the period under analysis. Subsequently we narrow the focus on individual-level and regional-level data variables to illustrate the geographical distribution of the main variables of interest. Regressions are employed to analyze the impact of the independent variables outlined above on regional employment structure. Our response variable is a binary indicator of whether an individual is employed in an abstract job or not. The data has a two-level hierarchical structure: at level 1, we consider individual-level variables such as an age, gender and level of studies as well as individual controls (sector). Level 2 variables include the UOI, labor demand conditions, Statute and HEIs controls at regional level.

Denoting by y_{ir} the response for individual *i* in region *r*, we are interested in predicting the probability (π_{ir}) that an individual *i* works in an abstract occupation in region *r*, considering a two-level structure where a total of I individuals (at level 1) are nested within R regions (at level 2) with *ir* individuals in region *r*. x_{ir} are individual-level explanatory variables and x_r are regional-level explanatory variables. Accordingly, we estimate the following binomial logistic multi-level model (Snijders and Bosker, 2004):

$$\text{logit}\left\{\frac{\pi_{ir}}{1-\pi_{ir}}\right\} = \beta_0 + \beta_1 x_{ir} + \beta_2 x_r + u_r + e_{ir}$$

where the group effects or level 2 residuals u_r and the level 1 residuals e_{ir} are assumed to be independent and to follow normal distributions with zero means:

$$u_r = N(0, \sigma_u^2) \qquad e_{ir} = N(0, \sigma_e^2)$$

[11] Since 1970 with one of the Reforms of Spanish HEI, universities can distinguish between generalists and polytechnics: the first ones focus their teaching and research activities on general fields of knowledge, while the latter focus more on technical areas such as engineering or technology.

The coefficients in this specification are identified by cross-sectional variation among the independent variables. To mitigate any bias induced by potential omitted variables, we include year fixed effects to control for a wide array of unobserved individual-specific variables affecting regional human capital levels, as well as unobserved factors affecting HC over time (Abel and Deitz, 2012).

As a measure of fit we provide the Interclass correlation (ICC) that is the ratio of the variance of the linear predictor, divided by the total variance:

$$\mathrm{ICC} = \frac{\sigma^2}{\sigma^2 + \mathrm{VAR}(u_r) + \mathrm{VAR}(e_{ir})}$$

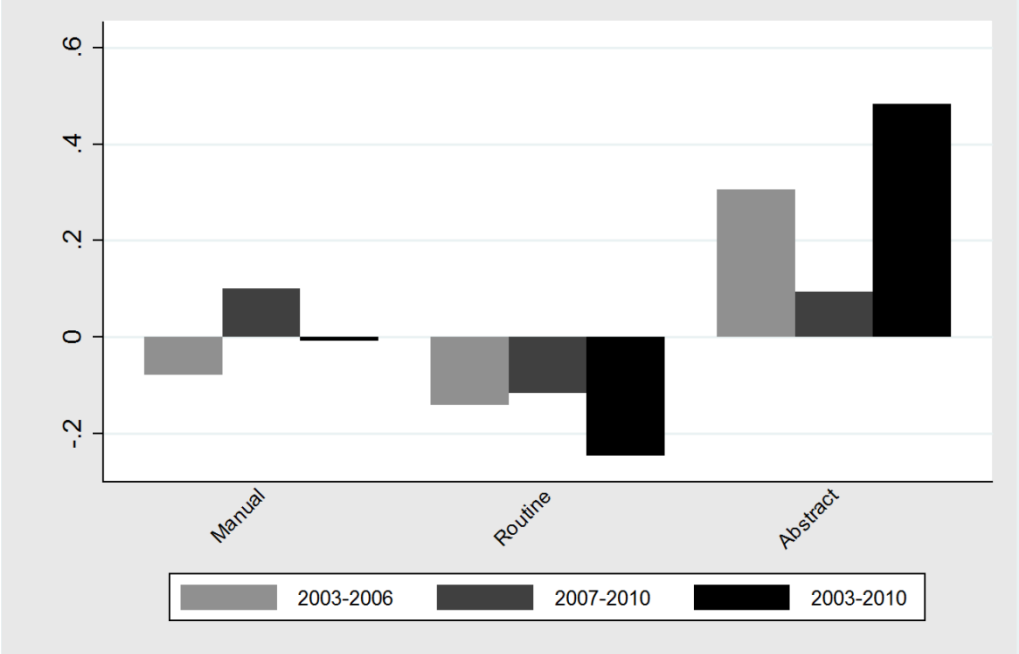
where σ^2 is the variance of the linear predictor. This is interpreted as the total variance explained by the independent variables excluding random effects (Snijders and Bosker, 2004).

4 Results

4.1 Employment polarization

As discussed above, the polarization of labor markets is a widely debated phenomenon. To reiterate, this is the circumstance in which the demand for occupations at the top and at the bottom of the skill distribution is faster than that of middle-skill occupations (Acemoglu and Autor, 2011). Figure 2 shows that the long-term dynamics of employment in Spain is no different from the trend observed in other countries (as reported by Goos et al., 2009). In particular employment in routine jobs has decreased by 14.1% while it has grown at the right-hand extreme of the skill distribution by 30.5% in the case of abstract occupations and decreased relatively less for manual occupations. Moreover, the diagram indicates that demand for high-skill workers early in the decade has slowed down significantly after the global economic crisis. The pattern of non-routine cognitive jobs during the last decade restates the importance of analyzing the factors that shape the demand for this type of high-skill occupation.

Figure 2. Percent of employment change in Spain (2003-2010)



4.2 Individual-level data: descriptive statistics

Table 3 contains basic information on the individuals surveyed by the LFS. The sample contains a majority of males (63%); as far as schooling 44.3% have a basic level of education (high school or below), 30.6% have a university degree while the remaining 23% has vocational training. Moreover, 63.3% of the workers in the sample are in their prime age (between 30 and 54 years old) while young workers (16-29) represent a quarter of the total and 12.2% are older employees (55-65). Looking at the sectors, agriculture and mining account for 12.06%, manufacturing and construction for 14.78% and the service sector absorbs the majority of the workforce (56.8%). Within the latter wholesale trade holds the lion share with 28.4% of individuals, followed by transportation, communication, electric, gas and sanitary services as well as finance, insurance and real estate with respectively 13.9% and 12.02%. Low skill service (mainly jobs related to the tourism –accommodation and restaurants) and retail trade are underrepresented. The correlation matrix (Annex I) shows that all the individual-level variables are positively correlated to the dependent variable, and especially level of

studies. Correlations between independent variables at individual level are low, between -0.14 and 0.26, which suggests that multicollinearity should not be an issue.

Table 3. Individual-level descriptive statistics

	Percentage	n
Sex		
Male	63.01%	348,206
Female	36.72%	
Level of studies		
No studies	2.19%	345,824
Basic studies	44.28%	
Vocational training	22.97%	
College or more	30.55%	
Age		
Young (16-29)	24.50%	348,206
Prime age (30-54)	63.28%	
Older (55-65)	12.22%	
Sector		
Agriculture, Forestry and fishing	4.73%	348,206
Mining	7.33%	
Construction	8.36%	
Manufacturing	6.42%	
Transportation, communication, utilities and sanitary services	13.87%	
Wholesale trade	28.36%	
Retail trade	6.81%	
Finance, insurance and real estate	12.02%	
Service	6.84%	
Public administration	5.26%	

4.3 Regional-level data: descriptive statistics

Table 4 shows descriptive statistics at regional level. The average national unemployment rate between 2003 and 2009 is about 11% while the percentage of workforce in manufacturing is slightly above 17%. About half of the regions modified their Statute to expand legislative competences after 2003, while the other half implemented those changes before the period under analysis. About two-thirds of the regions are host to more than one university while less than one third have a polytechnic university.[12]

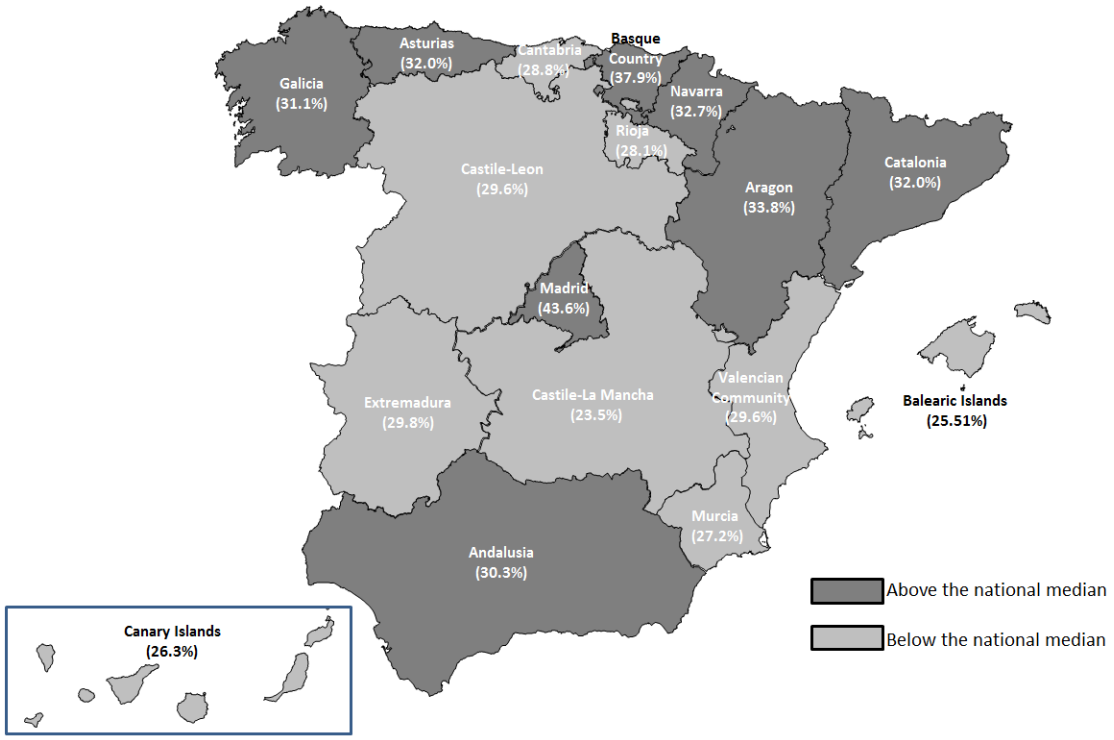
[12] Spain has 4 technical HEIs: Polytechnic University of Madrid, Polytechnic University of Catalonia, Technical University of Valencia and Polytechnic University of Cartagena located in Madrid, Catalonia, Valencian Community and Murcia respectively.

Table 4. Regional level-descriptive statistics

	Mean	Std. Dev.	Min.	Max.	n
Quantitative variables					
University Orientation Index					
Teaching	-0.039	0.222	-0.444	0.360	17
Engagement	-0.007	0.022	-0.044	0.032	17
Research	-0.015	0.055	-0.118	0.071	17
Third Mission	-0.011	0.040	-0.065	0.060	17
Local labour demand conditions					
Unemployment rate	10.65	3.03	6.81	17.35	17
% Manufacture firms	17.29	6.21	5.99	26.71	17
Categorical variables					
Legislative competencies					
Statute		49.59%			17
HEIs controls					
Multi-university		67.47%			17
Polytechnic		31.90%			17

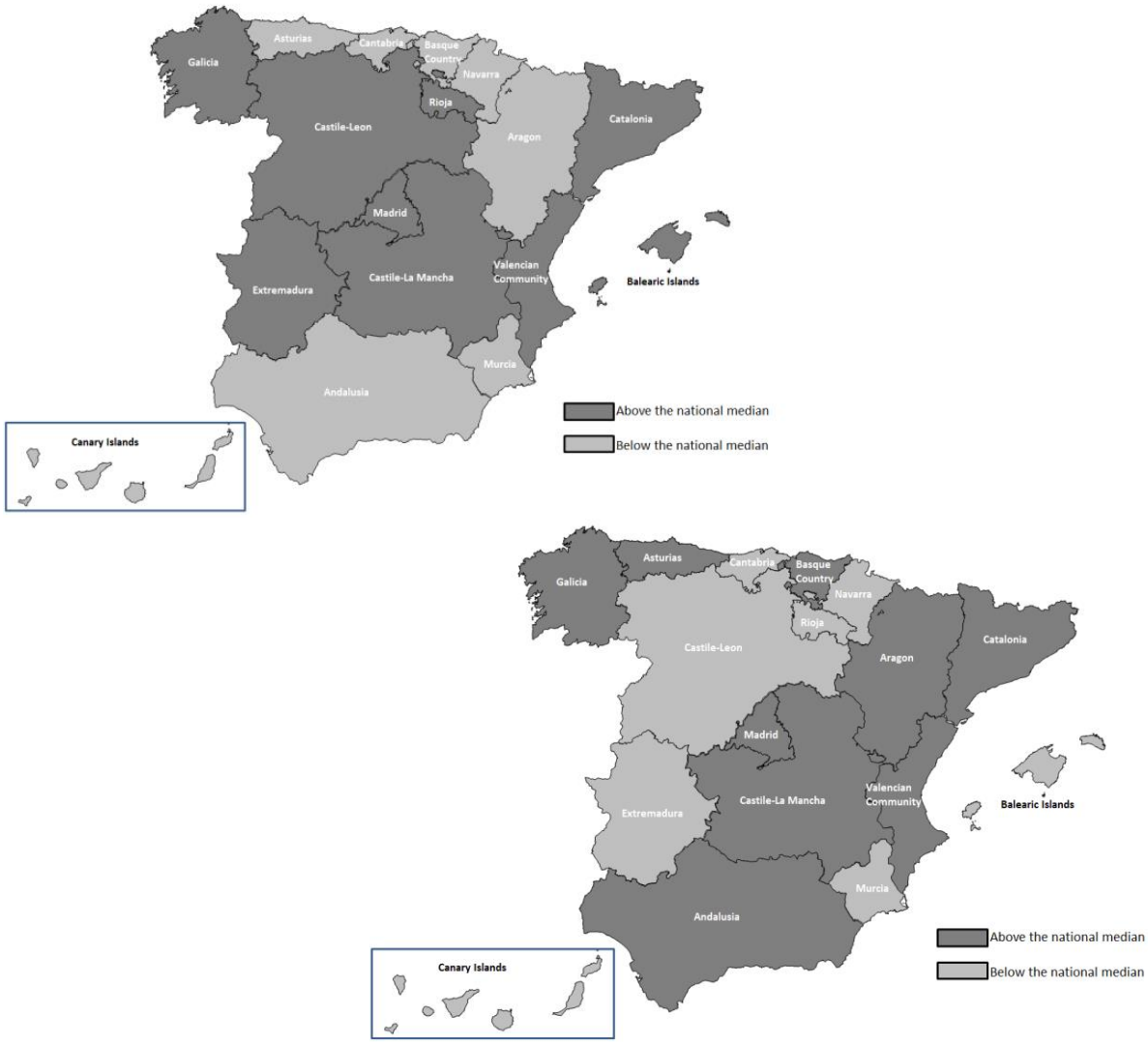
We now look at the skill distribution across regions with the aid of the maps in Figure 3 which features the average percentage of individuals working in abstract occupations in each region between 2003 and 2010 compared to the national median. The higher skill regions (dark-grey areas) are the Basque Country, Aragon, Catalonia and Navarra, all with a long-standing tradition of manufacturing industries, which employed 32% or more of the workforce at the end of the period. Unsurprisingly the region of Madrid is the leader with an average of 43.6% of workers in abstract occupations distributed across service activities such as wholesale and retail trade, transport, accommodation and food services. Asturias, Galicia and Andalusia are also above the national median of abstract occupations with percentages between 30% and 32%.

Figure 3. Skill distribution across regions: % abstract occupations compared to national median



The indicators of university orientation are not easy to interpret via descriptive statistics because they are constructed using normalized variables (that is, subtracting the mean and dividing by standard deviation). Instead we provide a diagrammatical summary in Figure 4 where university orientation indexes at regional level are compared with the national median. The left-hand side map contains data on teaching while on the right-hand side is the level of engagement through the second and the third missions. The figure shows that regions whose universities are mostly focused on teaching activities are Castile-La Mancha, Balearic Ireland, Rioja, Extremadura, Galicia, and Castile-Leon followed by, Catalonia, Valencian Community and Madrid. The latter three and Castile-La Mancha also exhibit high levels of engagement, with the difference that while Catalonia, Valencian Community and Madrid are leaders in second and third mission orientation, Castile-La Mancha, Andalucía, Galicia and Asturias are only mid-rank. Regions like Catalonia, Valencian Community and Madrid are, with the exception of Andalusia, the regions with the highest number of universities which implies a huge diversity within them (from more traditional universities to polytechnics institutions). For this reason, they are located at the top of the teaching and engagement contribution.

Figure 4. UOI across regions: Teaching (left) and Engagement (right)



4.4 Determinants of employment structure: results and discussion

Table 5 and 6 summarize the results of a binomial multi-level regression of individual and regional determinants of employment in abstract occupations (to reiterate: manager, technician, professional) across Spanish regions. Model A (Table 5) shows results with regional teaching and engagement UOIs as main explanatory variables, while in Models (B) and (C) the sub-components of engagement, research and third mission, appear separately. The first model captures the joint effect of all university missions while the others gauge the extent to which second and third mission have a differential effect on the employment structure of a region. Table 6 follows the same structure with the addition of various regional controls and is a robustness check of our main results. The

values of the ICC coefficients are relatively low while the models that include regional variables exhibit greater explanatory power compared to models with individual-levels variables only (not presented, ICC=0.00054).

For what concerns individual-level characteristics, results show a gender gap in favour of males who have higher probability to be employed in high-skill occupations relative to female workers. This is consistent with research showing that akin to other European countries women in Spain are less represented in managerial and professional jobs (e.g. Dolado et al., 2002). As expected, the higher the level of education the higher the probability to be employed in an abstract occupation. In particular, college workers are twice more likely to be employed in non-routine cognitive jobs. This is in line with previous literature on returns to human capital (e.g. Moretti and Thulin, 2012; Consoli et al., 2012). Age, a proxy for work experience, is also positively related to the employment status of individuals (Johnson, 1970; Oaxaca, 1973).[13] In particular, workers between 30 and 54 years old have high probability of being employed in abstract occupations compared to young workers, and this higher for individuals older than 54. We also control for the sector in which individuals work and note that the coefficients for finance, insurance and real estate as well as services sectors, followed by wholesale trade and public administration, are the highest.

Moving to the bottom part of the table, Model (A) shows that intensity of teaching and of engagement at regional level have a positive effect on high-skill employment. The relative importance of the second and the third missions taken together is higher relative to teaching, meaning that regions that exhibit higher HEIs engagement of activities oriented towards the socio-economic context have a stronger probability to employ HC in cognitive occupations. This is in line with previous work showing that the match between educational supply and local labour needs bears significantly on local economic performance (Rodríguez-Pose and Vilalta-Bufí, 2005). Our results resonate also with Abel and Deitz' (2012) claim that academic R&D activities increase local human capital. Indeed one of the findings of that study is that regions with stronger intensity of higher education tend to have a larger share of workers in high human capital occupations.

Models (B) and (C) in 5 show that even when research and third mission activities are considered separately, the effects remain positive and the impact of teaching is not

[13] Although we acknowledge the limitation of this approximation (Miller, 1993).

affected. Although the coefficient for third mission index is not significant, the relative value is higher relative to the index for research. This suggests that engaging the third mission has a stronger influence on local employment relative to investing in research. Our explanation for this result relates to the proximity effect. According to Hewitt-Dundas (2012) work, low-research intensive university, in our case those more focus on third mission activities, have a strong commitment to local and regional economic development that result in strong synergies between the university and business sectors. On the contrary, if there is a dominance of research-intensive universities, the strategic priorities for funds, sources and performance of these institutions lie outside of the region. At the same time, the mission-specific coefficients are lower than that of engagement where they are considered jointly. Clearly this decomposition cannot grasp the full picture of the role of HEIs but it is interesting to disentangle the relative importance of mission specific orientation.

Table 5. Multi-level regression results (I)

	Model A	Model B	Model C
Individual level			
Gender [Ref: Male]	-0.242*** (0.014)	-0.241*** (0.014)	-0.242*** (0.014)
Level of studies [Ref: No studies]			
Basic Studies	0.443*** (0.056)	0.443*** (0.056)	0.443*** (0.056)
Vocational Training	1.310*** (0.057)	1.310*** (0.057)	1.310*** (0.057)
College	2.641*** (0.057)	2.641*** (0.057)	2.642*** (0.057)
Age [Ref: Young (16-29)]			
Prime age (30-54)	0.661*** (0.015)	0.661*** (0.015)	0.661*** (0.015)
Older (55-65)	1.334*** (0.023)	1.335*** (0.023)	1.335*** (0.023)
Sector	Included	Included	Included
Regional level			
UOI Teaching	0.145** (0.071)	0.143** (0.073)	0.150** (0.076)
UOI Engagement	2.370** (0.944)		
UOI Research		0.567* (0.341)	
UOI Third Mission			0.754 (0.462)
Constant	-1.982*** (0.084)	-1.992*** (0.084)	-2.007*** (0.086)
ICC	0.00244	0.00295	0.00360
Log Likelihood	-80445.37	-80446.70	-80446.66
Observations	163,877	163,877	163,877
Number of groups	17	17	17

Note: All models are controlled by multi-university and polytechnic variables. Data included is a two-year period between 2003 and 2009. Year dummies are introduced as fixed effects. P-values: *=<0.1; **=<0.05; ***=<0.01

To check the robustness of these results, Table 6 includes full model and also additional regional controls. In Model (D) we add unemployment rate and share of employment in manufacturing as proxies of local labor demand in the regions akin to literature showing that service employment grows less rapidly in areas with higher unemployment and a

larger manufacturing employment share (Autor and Dorn, 2013). As expected, unemployment affects negatively while manufacturing employment influences positively the dependent variable, although the coefficient is significant only in the first case. Therein, teaching remains positive and significant but on the other hand university engagement is no longer significant. This means that the influence of second and third missions in a region is sensitive to local labour market conditions. Such a conclusion resonates with previous studies showing that the influence of university research and third mission activities depends on the level of absorptive capacity of the regions (Cohen and Levinthal, 1990) and its importance in a business' ability to identify, assimilate and apply new knowledge.

Model (E) shows that our basic result is robust to the inclusion of an additional control to discern the impact of differential tenure of legislative independence across regions. Finally Models (F), (G) and (H) include all the controls. In particular, the first mission remains consistently positive and significant, thus validating the importance of teaching activities as an influential factor affecting regional employment. On the other hand, the effect of a stronger orientation towards second and third missions is more contingent to structural characteristics of the attending regions. Looking at the components of engagement separately, both research (Model G) and third mission orientation (Model H) lose significance when the full controls are added and, thus, are not predictors of professional and managerial employment.

Table 6. Multi-level regression results (II)

	Model D	Model E	Model F	Model G	Model H
Individual level					
Gender [Ref: Male]	-0.242***	-0.241***	-0.242***	-0.242***	-0.242***
	(0.013)	(0.014)	(0.014)	(0.014)	(0.014)
Level of studies [Ref: No studies]					
Basic Studies	0.443***	0.443***	0.443***	0.443***	0.443***
	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)
Vocational Training	1.310***	1.309***	1.310***	1.310***	1.310***
	(0.057)	(0.057)	(0.057)	(0.057)	(0.057)
College	2.641***	2.641***	2.641***	2.641***	2.641***
	(0.057)	(0.057)	(0.057)	(0.057)	(0.057)
Age [Ref: Young (16-29)]					
Prime age (30-54)	0.661***	0.661***	0.661***	0.661***	0.661***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Older (55-65)	1.334***	1.335***	1.335***	1.335***	1.335***
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)
Sector	Included	Included	Included	Included	Included
Regional level					
UOI Teaching	0.186**	0.147**	0.185**	0.191**	0.206**
	(0.080)	(0.072)	(0.081)	(0.084)	(0.083)
UOI Engagement	1.682	2.408**	1.639		
	(1.131)	(0.958)	(1.151)		

UOI Research				0.262 (0.399)	
UOI Third Mission					0.802 (0.508)
Labour demand Conditions					
Unemployment rate	-0.008* (0.004)		-0.008* (0.004)	-0.009* (0.004)	-0.010** (0.004)
% manufacture	0.007 (0.005)		0.007 (0.005)	0.008 (0.005)	0.008 (0.005)
Legislative competencies [Ref: Recent change]					
Statute		0,011 (0,050)	-0,012 (0,063)	-0,024 (0,069)	0,001 (0,070)
Constant	-1.975*** (0.144)	-1.988*** (0.089)	-1.968*** (0.147)	-1.993*** (0.151)	-1.994*** (0.150)
ICC	0.00389	0.00242	0.00393	0.00486	0.00478
Log Likelihood	-80442.44	-80442.44	-80442.44	-80443.11	-80443.110
Observations	163,877	163,877	163,877	163,877	163,877
Number of groups	17	17	17	17	17

5 Concluding remarks

This paper is based on the premise that concepts such as human capital and university missions have been treated only in abstract terms by the literature on regional economic development. Also, we argued that their connection has not been explored empirically.

For what concerns HC, scholars have long since relied on aggregate supply indicators such as the local ratio of graduates which, in our view, neglects the influence of demand side forces, and in particular the reality of local labor markets. Other studies in labour economics propose a more nuanced view using occupations as unit of analysis and considering the skill content of occupations as main indicator of HC (Acemoglu and Autor, 2011; Autor and Dorn, 2013). By and large, however, this literature focuses on the aggregate country level and does not account for dynamics at lower level of geographical aggregation. On the other hand HEIs are widely acknowledged as key strategic actors in the generation of regionl HC, and thus in the economic development and social wellbeing of the context in which they operate (Geuna, 2001). Universities are expected to carry out three missions and, progressively, to fulfil an ever-growing range of roles: produce research; generate income via consultancy; embed knowledge in students and employees; upgrade regional business environments; and potentially improving the process of regional value capture (Benneworth and Hospers, 2007). Recent research takes a critical stance towards the prototypical "one-size-fits-all" model on the grounds that it overlooks the complex nature of the university *qua* institution and treats them as homogenous entities with equal capacity to contribute to social engagement (Sánchez-Barrioluengo, 2014).

We tackle the critical issues of the first stream of literature by focusing on the composition of the workforce as indicator of HC, and by distinguishing between abstract and non-abstract occupations. In so doing we analyze recent changes in the employment structure of Spain in a way that is comparable to recent literature (e.g. Goos and Manning, 2007; Autor and Dorn, 2013). Our results confirm that the Spanish labour market exhibits some degree of employment polarization over the period 2003-2010. The implication is that high-skill abstract occupations have grown while demand for middle-skill routine occupations has decreased. Madrid, Basque Country, Aragon, Navarra and Catalonia are the regions with the lion share of employment of managers, professionals and technical occupations.

We then turn to the question of what is the role of university orientation in this pattern of HC organization. Starting from the hypothesis that universities generate spillovers we computed two indexes of regional university orientation (UOI) to measure individual university performance in teaching and engagement activities. UOIs is presented here as a range of factors that affect the demand for skills at regional level. In so doing we frame the analysis of regional HC and regional employment as a multi-level process that depends on individual characteristics as well as environmental factors that condition job opportunities. Our empirical analysis indicates that teaching is a robust predictor of high-skill employment in a region, while the impact of engagement activities is more sensitive to structural characteristics of the socio-economic context.

This study has clear connections with the realm of policy. In particular, we show that the structure of employment in Spain exhibits the familiar shape of polarization with growth on the opposite extremes of the skill spectrum and decline of mid-skill job opportunities.[14] This happens in a context where growing skill mismatch affects both graduates, due to lack of employment opportunities (Dolado et al, 2000; Blazquez Cuesta, 2005), as well as firms who report inadequate training of high-skilled workers (Susaeta et al, 2013). Clearly mismatches have a variety of causes – demography, technology, globalization, to name a few – but the Spanish higher education system is often charged of being out of touch with the reality of the labour market due to, among other things, lack of integration with vocational training; infrequent actualization of curricula; inadequate involvement of practitioners or entrepreneurs. A responsive and

[14] The growth of low-skill employment is not the main focus of the present paper and will be explored in a separate manuscript currently in preparation.

flexible education system is beneficial for three types of individuals: long-term unemployed who are at risk of skill obsolescence which may eventually undermine the prospects of job market reintegration; educated workers who are employed in low-skill occupations and experience job dissatisfaction, besides crowding out unqualified workers; and, third, high-skill workers who have to keep up with the pressures of global competition for talent (Vona and Consoli, 2015). Our concern is that the persistence of the 'one-size-fits-all' model in the Spanish HE system may have stifled adaptability and exacerbated these shortcomings. This calls for a policy response that accommodates the continuing demand for globally competitive knowledge while at the same time tailoring knowledge creation and mobilization activities to the specific opportunities and challenges that emerge from the diverse mix of local economies in Spain. Acknowledging, rather than ignoring, these differences is a first step towards the full exploitation of university potential on the basis of the revealed pattern of specialization.

Of course, our work is not free from limitations. Changes in employment structure are known to respond slowly and to evolve significantly over longer time spans, and the period under analysis is rather short due to data availability of university missions. Inevitably, the LFS suffers from some limitations. First, the breakdown of occupations and sectors is only available at one-digit which prevents a more detailed analysis of the HC endowment within regions. Second, the information is available in quarterly intervals, rather than annual averages, and results may suffer from a seasonal bias. Third, the LFS is based on a representative sample of the population to which weight factors are applied in a second step. This may guarantee coherence in percentage terms but could yield individual biases. Fourth, the representation of young workers who recently completed their studies and started to work is generally low in this kind of data source. From an empirical point of view, results are based on logistic multilevel regressions where the dependent variable is a dummy. Although this dichotomous distinction is possible due to the absence of overlap between abstract and non-abstract occupations, the assignment of individuals to one or another category is based on the first job they include in the survey. For those individuals with more than one job, other information is not taken into account. Future analysis should incorporate additional measures to allow a better characterization of regional characteristics and evaluate the importance of university orientation. While we are aware of these limitations, we hope that the present

paper represents a first step towards a clearer articulation of the connection between regional human capital and the contribution of HEIs.

Acknowledgements

We acknowledge the constructive comments of two anonymous referees. MSB started research activities for this article at the Institute of Innovation and Knowledge Management, Ingenio (CSIC-UPV) Universitat Politecnica de Valencia with the financial support of the Formación de Profesorado Universitario (F.P.U.) program of the Spanish Ministry of Education. DC acknowledges the financial support of the Spanish Ministerio de Economia y Competitividad (RYC-2011-07888). DC would also like to thank Antonia Díaz, María Paz Espinosa and Sjaak Hurkens for setting an example of professional ethics. The views expressed here are those of the authors and in no circumstance should be regarded as representing the official position of the European Commission.

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Annex I. Correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Abstract occupation	1												
2 Gender	0.052***	1											
3 Level of studies	0.455***	0.150***	1										
4 Age	0.068***	-0.114***	-0.144***	1									
5 Sector	0.244***	0.248***	0.264***	-0.074***	1								
6 UOI Teaching	-0.027***	-0.019***	-0.075***	-0.015***	-0.030***	1							
7 UOI Engagement	0.073***	0.023***	0.092***	0.001	0.037***	-0.173***	1						
8 UOI Research	0.069***	0.019***	0.087***	0.002	0.045***	-0.157***	0.945***	1					
9 UOI Third Mission	-0.005**	0.001	-0.005*	0.009***	-0.024***	-0.155***	0.408***	0.350***	1				
10 Unemployment	-0.004	-0.001	-0.034***	0.014***	0.038***	0.095***	-0.203***	-0.179***	-0.000	1			
11 % manufacture	-0.005*	0.011***	0.057***	0.020***	-0.095***	-0.038***	0.274***	0.215***	0.326***	-0.476***	1		
12 Statute	0.024***	0.004***	0.071***	0.029***	-0.002*	-0.232***	-0.217***	-0.195***	-0.514***	-0.191***	-0.011***	1	
13 Multi-university	0.013***	0.011***	-0.018***	-0.019***	0.037***	0.145***	0.081***	0.065***	-0.336***	0.239***	-0.270***	-0.096***	1
14 Polytechnic	0.049***	0.026***	0.038***	-0.018***	0.037***	0.132***	0.480***	0.416***	0.141***	-0.172***	0.211***	-0.252***	0.476***

Note: *p-value=0.10; **p-value=0.05; ***p-value=0.01