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Low-skill employment in Spanish Local Labour Markets

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Abstract: This paper presents an empirical analysis of the evolution of employment in Spain. Using data of the Population and Housing Census Survey we capture changes in the structure of the workforce over three decades, 1981-2011, and across local labour markets. The main finding, consistent with previous literature, is the remarkable growth of employment in low-skill service occupations accompanied by declining demand for low- and middle-skill occupations. Our estimates show that the share of employment in these routine occupations is a robust predictor of the growth of low-skill jobs, and that the latter is stronger in provinces with the highest share of educated workers. These results are also robust to the inclusion of controls for regional characteristics and of instrumental variables that take into account the long-term patterns of specialization of the local labour markets.

JEL Codes: J21; J24; O33

1. Introduction

The goal of this paper is to analyse the evolution of the Spanish local labour markets over the period 1981-2011, a post-transition era characterised by profound social, political and economic changes. Give or take boom and bust cycles, the country's enduring struggle with high unemployment levels has arguably drawn attention away from no less critical phenomena such as the transformation of the occupational structure and the increasingly unequal distribution of opportunities and costs due to the economic catching-up of the last quarter century. Our study disentangles technological, economic and demographic forces underpinning growth and decline of specific occupational groups with a view to contribute to the debate concerning the regeneration of regions in the aftermath of the global economic crisis (Martin and Sunley, 2015). Labour is a prime instance of the structural and functional relations that underpin the functioning of a local economy, and gaining a thorough comprehension of how it is organized and how it is changing is essential to inform policy.[1]

The paper draws on the framework proposed by Autor, Levy and Murnane (2003) (ALM henceforth) to interpret the labour market outcomes observed in the United States (US) following the widespread diffusion of computerization in the 1990s. The central tenet is that technology is a chief cause of employment polarization, that is, a decline in the demand for mid-skills/wage occupations (i.e. clerks, production workers) accompanied by job growth at the top and at the bottom of the skills and earnings distributions (Goos and Manning, 2007; Autor, 2013). Recent empirical studies showing that the trends initially detected in the US are rather common across European countries corroborate the validity of this analytical framework (Goos et al, 2014; Michaels et al., 2014). Since the structural transformation of employment has been analysed mostly at aggregate level, it seems interesting to inquire whether these patterns play out in a similar fashion at lower levels of geographical aggregation. The only available evidence

[1] Throughout the paper we employ the term 'regional' in a generic way to denote various types of local economy including cities, metropolitan areas, provinces, commuting zones or regions. While acknowledging the important differences between these forms of spatial agglomerations we argue that they share sufficient similarities for the purpose of organizing a comprehensive literature review. Provinces are the unit of analysis for the second part of the empirical analysis but we prefer to couch the discussion in general terms to stress its relevance and usefulness in economic geography.

of similarities and differences across regions within a country is on the US (Autor and Dorn, 2013) and so there is scope for extending the analysis to other countries.

The present paper focuses on Spain, a large continental Europe economy whose regions exhibit profound institutional, economic and social heterogeneity. We elaborate an empirical study of long-term changes in the employment structure of the country and of its local labour markets with a view to:

(i) Disentangle structural changes of employment in relation to the diffusion of technology; and

(ii) Assess how this process plays out across fifty Spanish provinces.

The analysis builds on data of the Population and Housing Census Survey over three decades (1981-2011). Following the ALM framework, occupations are assigned to one of three job categories: high-skill non-routine cognitive (NRC), mid-skill routine (ROU) and low-skill non-routine manual (NRM). The key findings are four. First, the structure of employment in Spain exhibits polarization – that is, positive changes in the employment share of high- and low-skilled occupations accompanied by falling demand of mid-skill routine jobs. Second, there is a positive and robust correlation between the contraction of routine jobs and the diffusion of computing capital throughout the period. Both these findings are consistent with previous literature. Third, the expansion of NRM low-skill service occupations (about 8%) stands out together with a comparable decline (9%) of employment in other medium to low-skill occupations (e.g. clerks, production workers, construction). The last main finding of the paper is that the shift towards low-skill service employment is stronger in regions with initial high level of routine occupations. This is of interest for a number of reasons. Service employment accounts for a considerable portion of part-time work and entails an average wage gap of about 50% compared to similarly medium/low-skill occupations (e.g. transportation, farming, mining and craft). Moreover the demographics of these low-skill occupations has shifted from young to prime age, which suggests that service jobs have absorbed a portion of displaced routine workers. Last but not least, the average educational attainment of workers in low-skill NRM jobs is strikingly similar to those employed in mid-skill routine occupations over the entire period. Considering that the increase in low-skill employment has been stronger in provinces with the highest shares of educated workers, the evidence point to some degree of skill mismatch. These results

are robust to the inclusion of various controls and of instrumental variables that take into account the long-term industrial specialization of each local labour market.

Our analysis makes two contributions. First, it adds to a burgeoning strand of research in labour economics on the relation between human capital, employment and technology inspired by ALM (e.g. Acemoglu and Autor, 2011; Michaels et al, 2014; Goos et al, 2014). In particular, we provide novel empirical evidence on Spain, an empirical context that has not been studied so far, and at a finer level of geographical aggregation. Second, we identify patterns of specialization in local labour markets by means of changes in the relative importance of occupations. In so doing we connect with a somewhat latent thread in economic geography that emphasises the value of occupation-based (as opposed to industry-based) analysis for understanding complex patterns of specialization and transformation within regional economies (e.g. Thompson and Thompson, 1987; Feser, 2003; Markusen and Barbour, 2003). Our study points to the intriguing possibility of measuring regional human capital in a way that explicitly account for the inherent heterogeneity of workers' know-how (e.g. Florida et al, 2008).

The remainder of the paper is organized as follows. Section 2 includes a review of the literature presenting the two main approaches used in the paper: the task-based approach and the externalities and spillovers literature highlighting the importance of HC on economic development. Section 3 describes the context and data to be used in next sections. Through descriptive statistics Section 4 evidences the evolution of employment in Spanish local labour markets while Section 5 includes information about the main determinants of change. Section 6 concludes.

2. Literature review

This section presents an overview of two streams of scholarly literature. First, we focus on recent empirical and conceptual advances in the analysis of HC and technology, and subsequently turn our attention to the role of HC on local economic development.

2.1. Human capital, technology and employment

The literature ascribes recent transformations in the organization of employment to the intricate relation between HC and technology. Two analytical frameworks provide different interpretations for these phenomena. The so-called 'canonical model' is a theory-driven approach based on the intuition that the greater capacity for learning

possessed by highly educated individuals facilitates the adoption of innovation, especially at early stages. Accordingly, Skill-Biased Technical Change (SBTC) induces monotonic increases in skills and wages inequality (Goldin and Katz, 2008). In recent years this framework has been criticized on several counts. First the SBTC hypothesis does not stand the empirical test of labour market outcomes observed empirically over the last three decades. In particular, the canonical model falls short of accounting for employment polarization, namely increasing demand for occupations at the top and at the bottom of the skill distribution accompanied by sluggish or negative growth of employment for middle-skill workers (Autor et al, 1998; Acemoglu and Autor, 2011). Such a weak explanatory power is ascribed to conceptual roots, in particular to the mono-dimensional portrayal of human know-how in the SBTC framework which conceals both the heterogeneity of job tasks involved in human labour as well as the mechanisms by which technology affects the demand for the attendant skills.

This criticism has given way to an alternative data-driven framework, the task-based approach (Autor, 2013). Starting from a detailed analysis of the labour market effects of technology, the seminal work of ALM (2003) uncovered neglected nuances of the relation between workforce skills and technology. Therein the pervasive adoption of Information and Communication Technologies (ICTs) in the 1990s is considered the major driver in the decline of mid-skill 'routine' occupations (e.g. clerks and production workers). The rationale is that routine jobs consist mostly of physical and cognitive activities that can be executed more efficiently by automated processes. On the other hand, computer capital exhibits strong complementarities with high-skills occupations that involve problem-solving and personal interaction typical of scientists, managers and technical professionals (Levy and Murnarne, 2004). Lastly, a broad range of occupations requiring physical dexterity and adaptability are intensive in non-routine manual tasks and are generally not prone to be substituted by machinery (e.g. truck drivers, security guards, waiters and cleaners). Thus jobs at the bottom end of the wage scale survived automation, for different reasons, and hold the lion share of employment growth (Autor and Dorn, 2013). The resulting pattern is the trademark U-shaped relation between the rate of employment growth and skill intensity with a marked 'hollowing out' in correspondence of mid-skill occupations.

The task-based approach has become a common tool for the empirical analysis of changes in the organization of labour markets. From a conceptual viewpoint, and

compared to the SBTC hypothesis, this framework allows for a more nuanced understanding of how global economic forces stimulate the emergence of new abilities, the disappearance of old ones as well as the recombination of old and new skills. In it labour activities are vectors of functionally different tasks, and workers' skills are the inputs that are needed for performing these tasks. The diffusion of ICTs is a classic instance in which new technology exerts a 'selection effect' on some job activities, and on the associated HC endowment, but not on the entire vector of occupational tasks. This framework therefore accommodates circumstances in which technology plays a dual role, both complementing and substituting human work, as is the case with computers. Secondly, the task-based approach resonates with evidence on non-neutral labour market outcomes concerning: different institutional contexts other than the US (Goos et al, 2014; Michaels et al, 2013); other major technological transitions such as electrification in the XIX century (Gray, 2013); and the assessment of other significant global forces such as the expansion of international commerce (Autor et al., 2013; Consoli et al., 2014).

This framework is mostly based on country-level studies and we seek to take the extra step of analysing structural changes in employment at lower level of geographical aggregation. Using empirical evidence on Spain we inquire into the extent to which polarization is a feature of local labour markets, on the commonalities and differences across them, and on their determinants. This is a useful addition to the only available evidence on commuting zones in the United States (Autor and Dorn, 2013).

2.2. Human capital and regional economic development

Human capital is widely regarded as a major thrust of local economic development in regional economics. The vast majority of studies share the Marshallian hypothesis that physical and institutional proximity stimulate interactions and knowledge sharing thus triggering positive externalities (Jacobs, 1969). Therein HC spillovers are touted as the main source of systematic differences in economic performance across regions (Camagni, 2005), metropolitan areas (Rauch, 1993) and cities (Glaeser et al., 1995). Besides fixed structural conditions, the knowledge-creating capacity of regions has attracted considerable attention (Mathur, 1999). Several economists emphasise the role of higher education institutions in igniting local spillovers not only by supplying the education and training that are needed for the replenishment of the HC stock (Bradley and Taylor, 1996) but, also, by attracting talent (Bennett et al., 1995; Glaeser et al.,

2001). This has especially so when accompanied by local development strategies based on early specialization in innovative industries such as high-technology manufacturing, media and communication and knowledge intensive business services (Storper and Scott, 2009). The adaptability of highly qualified individuals enables entrepreneurialism and facilitates the renewal of a region's economic base, especially in the aftermath of a recession (Martin and Sunley, 2015). Yet other studies show that regional and urban competitiveness in a globalized economy depend on localized processes of knowledge creation that leverage 'soft' components of HC such as openness to diversity (Florida, 2002), creativity (Pinch et al., 2003; Morgan, 2004), and trust (Maleki, 2004). Still other works cast the analysis of HC spillovers in terms of synergies that emerge along the spectrum of public-private interactions (Glaeser, 2000; Audretsch and Feldman, 1996; Audretsch et al., 2012).

Some scholars are critical towards the operationalization of regional competitiveness solely based on the analysis of industry. As Markusen and Schrock (2006) acutely observe, this approach oversees the heterogeneity of know-how that characterizes local economies (see also Barbour and Markusen, 2007). An alternative view draws from the seminal work of Thompson and Thompson (1985, 1987) who suggested focusing on what workers 'do' (e.g. occupations and the skills that are used) rather than what they 'make' (e.g. as defined by industry output). That is to say, observe directly the job tasks of occupations rather than infer it from industry classification codes. This insight inspired interesting work in the area of economic geography. Using occupational data on the US, Feser (2003) shows that cluster constructs based on grouping together industries on the basis of input-output relationships do not capture important nuances of the underpinning skills base. A study by Renski et al, (2007) highlights significant differences when industries are grouped by labour content rather than value chains. In the same vein, Markusen (2004) and Markusen and Schrock (2006) find that industry is a poor predictor of occupational structure across US metropolitan regions. This evidence also emphasises that spatial heterogeneity in occupational composition is especially high when clusters are at an emerging stage (Frobel et al, 1979; Massey, 1984; Markusen, 1985; Saxenian, 1994; Gereffi and Korzeniewicz, 1994). This is consistent with the idea that new knowledge is created, or recombined creatively, at the onset of a technological paradigm, and the emergence of new, unstructured, work routines and occupations is the mark of the initial turbulence. Subsequently, as novelty

wanes off and activities consolidate, occupational composition tends to standardize and so does the attendant skill base (Vona and Consoli, 2015).

Building on these ideas, and seeking to adopt a more nuanced approach to the relation between human capital and labour markets, we propose an occupation-based analysis of the long-term structural changes of employment in Spain.

3. Data and variables

This section details the information sources and the procedures used to build the main database. Our empirical analysis draws primarily on the Population and Housing Census Survey (Census) of Spain from which we extract information on individuals' residence, sector of employment and main occupation. The analysis is carried out at the level of fifty provinces in Spain (NUTS 3).[2] Data on wages are drawn from the Spanish Structural Salary Survey (SSS) and subsequently matched with the Census by means of the Spanish national occupation classification (CNO) code.[3] Further information concerning the construction of specific variables on the socio-economic characteristics of the provinces is provided in the remainder of this section.

3.1. Occupation variables

The Spanish Statistical Office collects Census data every ten years on population samples that are representative of regions and provinces.[4] The present study covers three decades between 1981 and 2011.[5] The survey includes information about the profile of the interviewee as well as employment status and employer characteristics. To create occupational variables at local level we select full- and part-time employees in the private sector[6] and assign each observation to a province depending on the residence status. Observations are weighted by the corresponding factor.[7] Following Acemoglu and Autor (2011) we recode occupations in three categories using the 1991 CNO as a

[2] 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 provices.
[3] We unified information from CNO-94 and CNO-11. Conversion Tables are available upon request.
[4] More information available at: http://www.ine.es/en/censos2011_datos/cen11_datos_inicio_en.htm
[5] Although the original source of information for this survey is the Spanish Statistical Office, the 1981 database has been provided by iPUMS. More information at: https://www.ipums.org/
[6] This corresponds to codes 91 in 1981, 27 in 1991, 80 in 2001 and 84 in 2011 for workers' sector information.
[7] Since data for Census 1991 do not include a weighting factor, we applied a value of 20 for each individual following the iPUMS version of the same database for this year.

guide. The resulting categories are non-routine manual (NRM), routine (ROU) and non-routine cognitive (NRC) jobs.[8]

Since the Census does not include information on wages, we refer to the Spanish Structural Salary Survey (SSS) of 1995, 2002, 2006 and 2010.[9] This is built on a questionnaire that includes information on annual wages and number of hours worked by individuals. Using this we calculate the average hourly wage for the CNO principal group (adapted from ISCO-88). Since this is a unique code, we re-assign the classification of SSS codes to CNO- three categories as proxy for the occupations.[10]

3.2. Socio-economic characteristics of local labour markets

Coherent with the conceptual framework laid out above, we control for a broad range of province-specific characteristics of interest, namely: the level of education; labour market demand conditions; drivers of demand for local (i.e. non tradable) services; and the HC creation capacity of each province.

Previous literature uses various indicators to capture the human capital stock from school enrolment rates (Barro, 1991) to the share of primary, high school, or university graduates (e.g. Rodríguez-Pose and Vilalta-Bufí, 2005). Using information from the Census we capture the average level of education in each province as follows: no schooling, schooling, professional training, higher education and postgraduate training. This is recoded as the ratio between individuals with college education or postgraduate and non-college workers (non-schooling, schooling and professional training) to capture the educational stock available at local level.

Regional drivers of labour demand are captured by means of two variables, namely the unemployment rate and the share of employment in manufacturing. Using information from Eurostat, we calculate the unemployment rate as the ratio between thousands of unemployment between 15 years or over divided by the workforce at NUTS 3 level. We also include a control for employment structure. The rationale for this is grounded in prior literature that interprets changes in the composition of the US labour force towards high-level workers (to the detriment of unskilled ones) as a within-industry effect driven

[8] Conversion tables for assigning occupations to either NRM, ROU or NRC available upon request.
[9] More information available at: www.ine.es/jaxi/menu.do;jsessionid=31DE0E88E1657341920651DD7A866D46.jaxi01?type=pcaxis&path=/t22/p133&file=inebase&L=1
[10] Matching table is available by request.

by the surge of specialized manufacturing rather than between-industry reshuffling (Berman *et al.*, 1994). The relevant variable is calculated using Spanish Labor Force Survey (LFS)[11] information on manufacturing employment (based on NACE rev.2) divided by total workers at province level. Using Census information we also calculate the share of senior citizens in each province, i.e. individuals older than 65 years over total population as a measure of local demand drivers.

Lastly, we control for regional HC creation capacity role by considering the number of universities in each province.[12] In the case of a multi-campus university across various provinces, we include a control dummy variable to identify the province that hosts the main campus.

3.3. Machinery adoption

Previous literature suggests that the adoption of ICTs, and specifically computers, have displaced routine labour jobs (Doms and Lewis, 2010; Autor and Dorn, 2013). Our measure of local technology adoption is the total investment (thousands of euros) in office and industrial machinery per employee in each province. This information is available in a database maintained by the Fundación BBVA.[13]

4. Changes in Spanish Local Labour Markets

This section proposes empirical evidence on the evolution of employment in Spain. In particular we provide descriptive statistics of the main trends and structural changes in the composition of the labour force at national and local level.

4.1. Employment change in Spanish labour market: evidence at national level

The polarization of labour markets is a widely debated phenomenon. To reiterate, this is the circumstance in which employment grows faster at the top and at the bottom relative to the middle portion of the skill (and wage) distribution. Figure 1 confirms that, similar to the generalized pattern observed in other countries (e.g. Goos et al., 2014), Spain exhibits polarization of employment. In particular, between 1981 and 2011 employment

[11] More information about this survey in: http://www.ine.es/dyngs/INEbase/en/operacion.htm?c=Estadistica_C&cid=1254736176918&menu=ultiDatos&idp=1254735976595

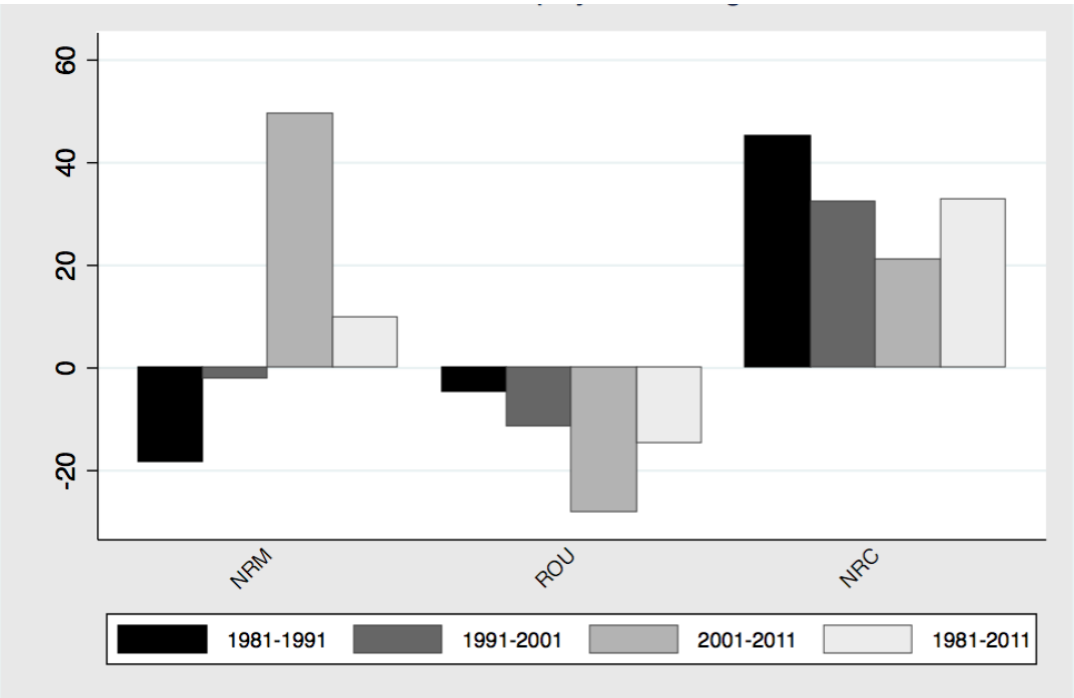
[12] Information about the year of birth of the universities is available in universities website and Spanish Official Bulletin.

[13] Stock and capital services in Spain: territorial and sectorial distribution. More information available at: http://www.fbbva.es/TLFU/microsites/stock08/fbbva_stock08_i31.html

in routine jobs has decreased by -14.7%, while it has grown by 9.8% among low-skill NRM occupations and by 32.9% for high-skill workers in NRC occupations. Both the decline in ROU and the growth of NRM are more pronounced during the 2000s while the acceleration of high-skilled NRC employment was faster during the 1980s and progressively slower thereafter.

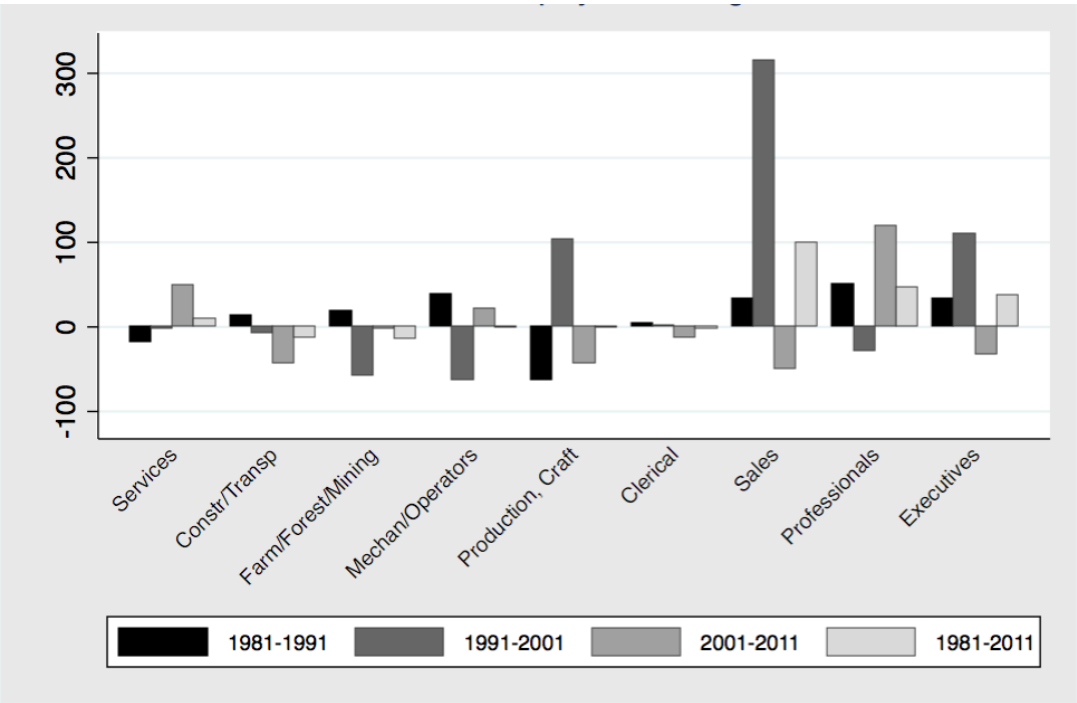
Figure 2 shows a breakdown of changes in employment for fine-grained occupations consistent with Acemoglu and Autor (2011). For what concerns routine occupations it is interesting to note that production/craft employment decreased in the 1980s and in the 2000s after a remarkable growth in the intermediate period. This pattern sets production employment apart from other ROU occupations whereby positive growth was mostly concentrated in the early period. Also construction jobs plunged over recent decades after the initial boom of the 1980s. As regards NRC occupations, the expansion of sales jobs in the 1990s stands out.

Figure 1. Changes (%) in aggregate employment shares (1981-2011)



Source: Census (INE, 1981-2011). Note: 1981-2011 calculated as the average of the three decades.

Figure 2. Changes (%) in employment shares (1981-2011)



Source: Census (INE, 1981-2011)

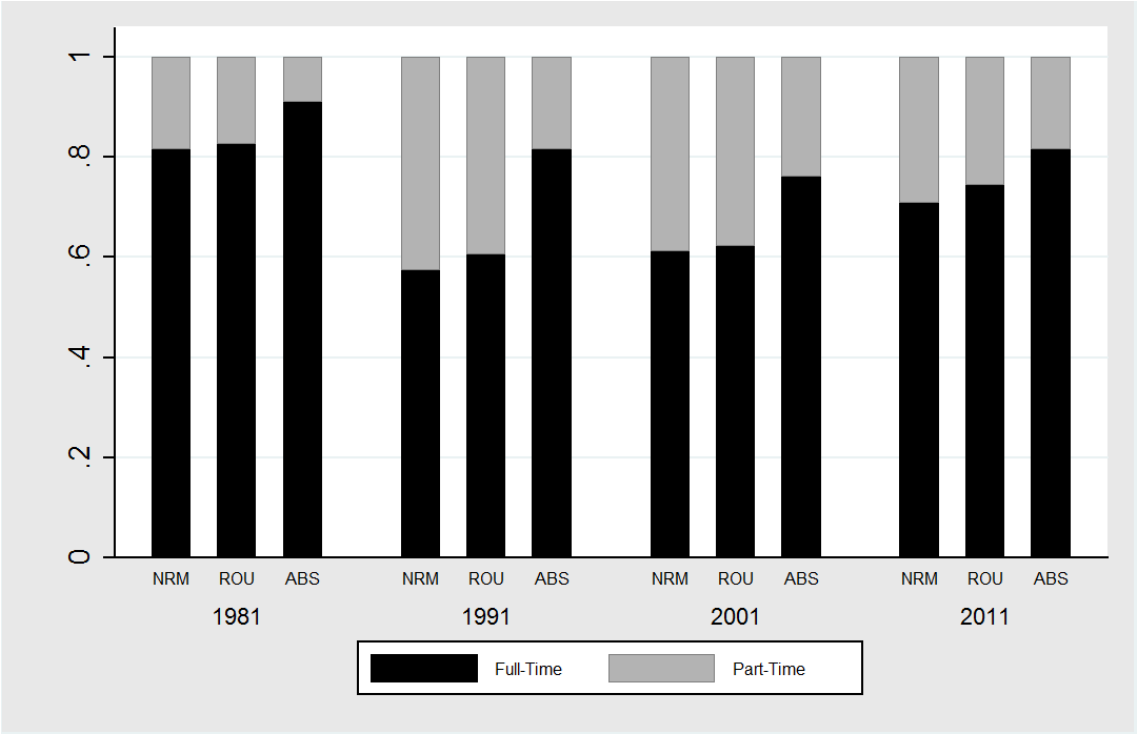
4.2. Characteristics of low-skill service occupations

Within the aggregate pattern of employment polarization in Spain, we call attention to the significant growth of employment in service occupations over the period under analysis. Service jobs are normally low-skill non-routine manual occupations and their expansion over the last decade stands in contrast with the decline of other similarly low-skill occupations in construction, transportation, mechanics, farm, mining, production and craft which declined of about 14% over the same period. The expansion of low-skill service employment deserves attention for a number of reasons. First, this category accounts for the highest share of part-time jobs (as high as 50% of all NRM employees in 1991). Second, service jobs entail an average wage gap of about 50% compared to similarly low-educated occupations. Third, NRM workers have exhibited important levels of aging. Lastly, the educational distribution among NRM workers is similar to ROU workers. Let us reflect on these aspects seriatim.

Figure 3 illustrates the evolution of employment structure at the beginning of each decade in the three groups of occupations broken down by full-time workers, i.e. those who have a contract for the maximum number of hours allowed by law (40 hours per week) and part-time workers. At the beginning and the end of the period, part-time jobs represent less than one quart of the employment in all types of occupations while this

percentage increases in between. In 2011 part-time employment falls across all occupations, probably as a result of the economic crisis. These figures highlight the interesting case of NRM occupations that include the highest percentage of part-time workers through the entire period, reaching more than 40% of the workforce in 1991.

Figure 3. Full-time and Part-time % by occupations (1981-2011)



Source: Census (INE, 1981-2011)

The second distinctive feature of NRM jobs is that these are at the bottom of the hourly salary scale. Table 1 shows that in spite of the increase between 1995 and 2010 (from 5.85 to 9.97 euros/hour) low-skill service jobs clearly suffer a substantial wage gap of about 53% compared to similarly low-educated occupations.

Table 1. Wage gap by occupation

	Wage per hour				Δ wage per hour			
	1995	**2002**	**2006**	**2010**	**Δ 95-02**	**Δ 02-06**	**Δ 06-10**	**Δ 95-10**
NRM	5.85	6.77	7.58	9.97	15.7%	11.9%	31.6%	70.4%
ROU	9.09	10.78	11.59	14.56	18.6%	7.5%	25.6%	60.2%
NRC	19.41	20.53	21.70	25.44	5.8%	5.7%	17.2%	31.1%
ΔNRM/ROU	55%	59%	53%	46%				

Source: Spanish Salary Survey (INE, 1995-2010)

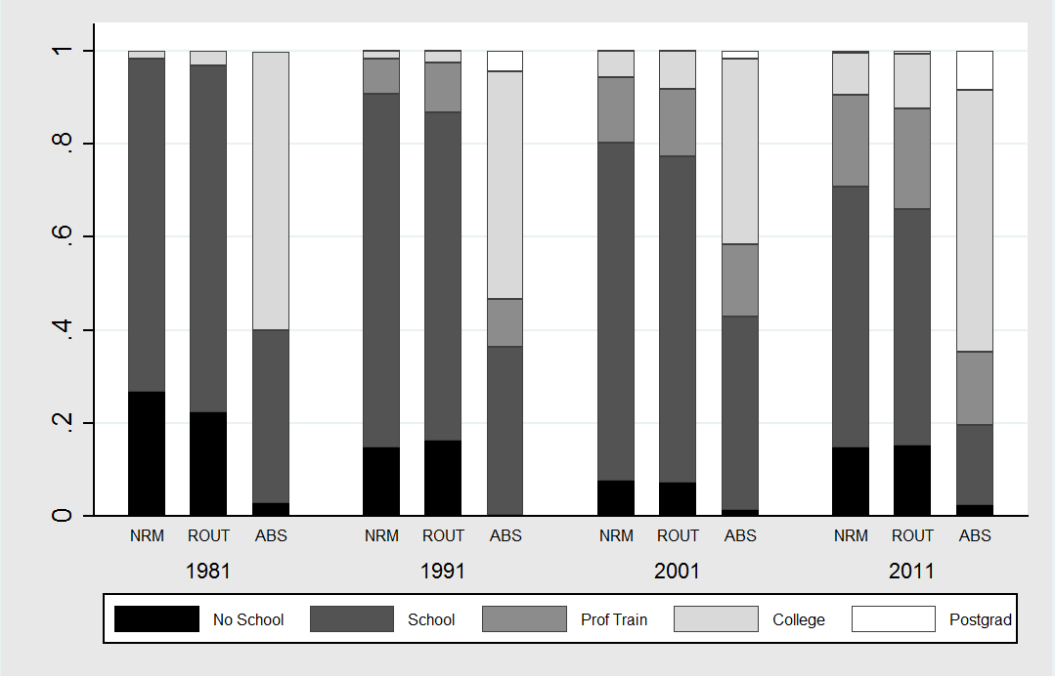
It is interesting to take a look at the changing demographic composition of low-skill service jobs. To do so we split this category of workers in three groups: young (less than

29 years old); prime age (between 30 and 54) and older (over 54 years old and less than 65). We calculate the share of each age category for each year.[14] We also calculate the increments in each decade and in the full period. Results in Table 2 show a clear aging of workers in service occupations with a decrement of more than a half of young people accompanied by an increment of almost 63% of prime age workers. This is interpreted as evidence of displaced routine workers with work experience being reabsorbed in jobs with a lower skill profile.

Table 2. % of workers in services by age

	% workers				Δ % workers			
	1981	**1991**	**2001**	**2011**	**Δ 81-91**	**Δ 91-01**	**Δ 01-11**	**Δ 81-11**
Young (16-29)	44.41%	45.09%	27.93%	19.35%	1.5%	-38.1%	-30.7%	-56.4%
Prime age (30-54)	41.48%	44.30%	62.17%	67.56%	6.8%	40.3%	8.7%	62.9%
Older (55-65)	12.76%	9.69%	8.80%	11.74%	-24.1%	-9.2%	33.4%	-8.0%

Figure 4. Evolution of the level of occupation within the occupations



Source: Census (INE, 1981-2011)

Yet another reason of interest of NRM jobs is that the average level of education among service workers in Spain is relatively high. Figure 4 plots the usual occupational groups broken down by education levels. Figure 4 shows that in 1981 around 25% of NRM workers were non-educated, and that this share decreases in the 1990s and afterwards.

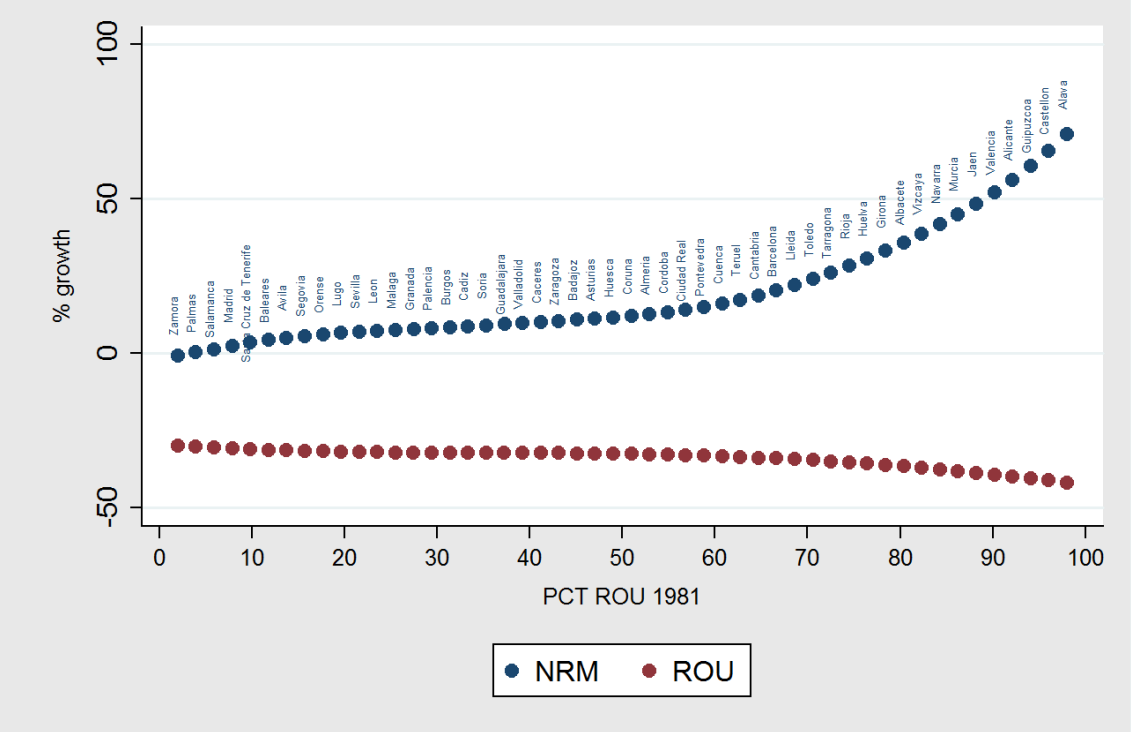
[14] Percentages do not sum 100% because there are some workers outside these intervals.

In fact, through the three decades under analysis the level of education of workers in NRM and ROU occupations is strikingly similar. This pattern resonates with previous work showing that the share of overqualified workers in Spain is twice that of other OECD countries (Dolado et al., 2013; Montalvo, 2013; OECD, 2010).

4.3. Employment change in Spanish local labour market: evidence at province level

Figure 5 shows changes in NRM and ROU employment between 1981 and 2011 when provinces are ordered by percentiles of initial shares of routine employment in 1981 (low to high routine intensity from the left- to the right-hand side of the distribution).

Figure 5. Employment change in local labour markets (1981-2011): NRM VS ROU jobs

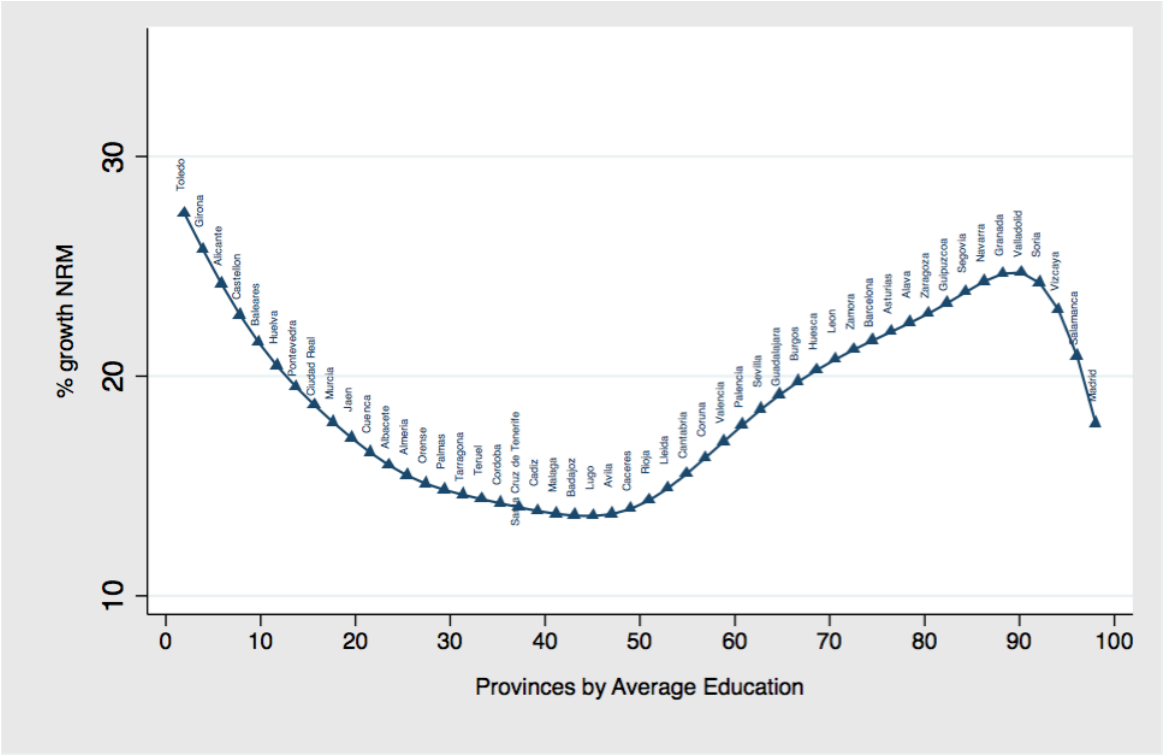


Source: Census (INE, 1981-2011)

Here we notice that both the growth of employment in NRM and the decline of routine-intensive jobs are generalised phenomena. Moreover, low-skill service employment has grown more in provinces with initially higher levels of routine jobs. This is evidence of the substitution effect between NRM and ROU jobs in the majority of the provinces, more so in Northern provinces (like Navarra, Guipuzcuoa, Viscaya), on the Mediterranean coast (Castellon, Valencia, Alicante, Murcia) as well as in the interior part of Spain, like Albacete and Jaen.

When the change in NRM employment is plotted by ordering provinces by increasing levels of average education (from left to right in Figure 6) we find that the growth of low-skilled service jobs is greater in provinces at the opposite end of the educational spectrum. This is striking considering that low-service job growth was higher not only among provinces with high levels of non-college education (as expected) but also in regions with high levels of education. As the figure shows, Barcelona, Valencia, Murcia, Toledo, Albacete and Córdoba experienced the highest growth.

Figure 6. Employment change in local labour markets (1981-2011): NRM mediated by level of education



5. Determinants of technological and employment change

The descriptive evidence above highlights that over the period 1981-2011 employment in Spain has polarized and exhibits a remarkable surge of low-skilled service jobs. In this section we employ econometric methods to identify the main determinants of these phenomena. In accord with previous literature we begin by focussing on technological change, and subsequently consider a battery of controls to capture specificities of the local labour markets of the fifty provinces under analysis.

5.1. Determinants of technological change

Recall that according to Autor and Dorn (2013) automated processing is an efficient substitute of workers in routine tasks and thus a driver of polarization. The effect of technology on employment is measured here in terms of investments in industrial and office machinery as detailed in section 3.3. To capture the territorial distribution we use accumulated machinery per employee in each province as a proxy of adoption. Accordingly, we estimate the capital-labour substitution by means of first-stage-estimates regressions as follows

$$\Delta Machinery_{jrt} = \delta_t + \beta_0 * ROU_{jt_0} + \gamma_r + e_{jrt}$$

where the dependent variable is the change in investments on machinery per full time employee between t_0 and t_1 in area j. ROU_{jt_0} is the share of routine employment at the start of the decade in the province; γ_r is a vector of regional dummies and β_0 the coefficient of interest capturing the within-region cross-local variation. Standard errors are clustered at the region level. Estimates show that the employment share of ROU jobs is highly predictive of machinery adoption. This confirms that the substitution between workers and technology, especially industrial machinery, was stronger in provinces with initially higher intensity of routine task specialization.

Table 3. Machinery adoption and Task specialization within local labour markets (1981-2011)

	(1) Δ Office machin.	(2) Δ Industrial machin.	(3) Δ Total machin.
ROU	1.123	0.924**	0.759*
	(1.113)	(0.433)	(0.399)
r2	0.892	0.485	0.607
N	150	150	150

Note: *p-value<0.1; **p-value<0.05. N=150 (3 time periods X 50 provinces). All models include an intercept, region dummies and time dummies. Robust standard errors in parentheses are clustered on regions. Models are weighted by start of period province share of workforce.

5.2. Determinants of employment change in low-skill service occupations

As shown above, employment polarization is substantially driven by the growth of low-skill service occupations. Following Autor and Dorn (2013), we expect this rise in NRM jobs to be most pronounced in initially routine task-intensive labour markets since the potential for displacement of non-college labour from routine activities is greater in these locations. The scatter plot in Figure 7 provides graphical evidence on this. Therein we depict an OLS regression of initial province routine share, ROU_{1981}, and changes in

shares of NRM employment over the entire period. The explanatory power of this bivariate relationship is substantial (R-sq=0.55) and confirms that provinces with the highest routine employment in 1981 are those where low-skill service employment has grown the most. On the contrary, areas with the lowest level of routine in 1981 saw a decrease of NRM employment share.

Figure 7. Change in NRM employment share by local areas, 1981-2011

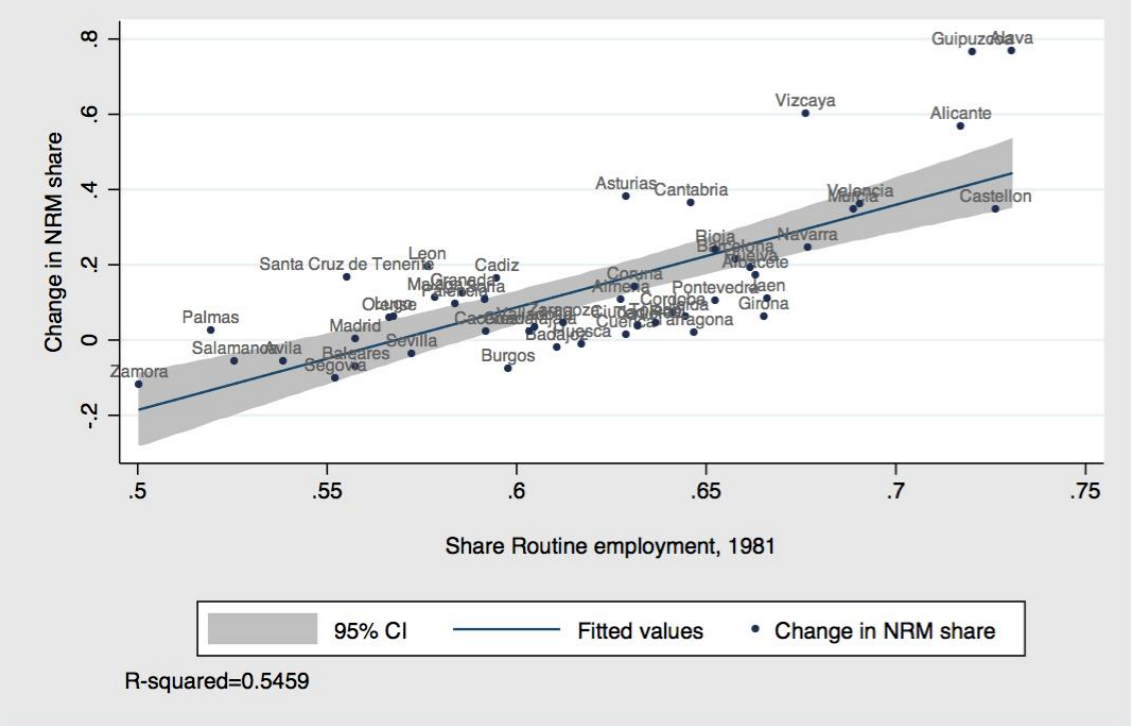


Table 4. Determinants of change in NRM employment by decade

	(1) Δ NRM 1981-1991	(2) Δ NRM 1991-2001	(3) Δ NRM 2001-2011
ROU	0.0344	0.207	2.054***
	(0.627)	(0.167)	(0.500)
r2	0.848	0.698	0.784
N	50	50	50

Note: *p-value<0.1; **p-value<0.05. N=150 (3 time periods X 50 provinces). All models include an intercept and region dummies. Robust standard errors in parentheses are clustered on regions. Models are weighted by start of period province share of workforce.

Table 4 provides a long-term perspective by regressing routine occupation employment share on the change in service occupation at the beginning of each decade. The relationship between ROU employment share and growth of service jobs is weak prior to the 1990s to become highly significant during the 2000s.

Following the work of Autor and Dorn (2013), we enrich the analysis by considering a broad spectrum of factors that may explain differences in the structure of local

employment. Specifically, we focus on province-specific forces such as educational stock, local labour demand conditions, potential demand shifters and HC creation capacity. Accordingly we estimate the following:

$$\Delta NRM_{jrt} = \delta_t + \beta_1 ROU_{jt_0} + \beta_2 X'_{jt_0} + \gamma_r + e_{jrt}$$

where ΔNRM_{jrt} is the change in the NRM employment share in province j located in region r between the years t_0 and t_1 (t represents the decade), and ROU_{jt_0} is the province's start of the routine-share. This equation stacks the three decades between 1981 and 2011, and includes a full set of time period effects, region effects, as well as the start-of-period values of the explanatory variables (X'_{jt_0}): local cognitive capacity by means of the percentage of colleges on non-colleges; local labour demand conditions using the percentage of employment in manufacturing and unemployment rates; potential demand shifters measured by percentage of old people over 65 years in the population; and the HC creation capacity of the local labour markets measured by the presence of HEIs. The procedure to solve this equation is using first stage estimates through OLS approaches by regressing the change in NRM employment share on the start of the period ROU employment share. Results under the Spanish context go in the same line that those in US (Autor and Dorn, 2013).

Table 5. Routine employment share and Growth of NRM within local labour markets (1981-2011)

	(1)	(2)	(3)	(4)	(5)	(6)
ROU	1.652***	1.849***	1.618***	1.652***	1.919***	1.963***
	(0.424)	(0.543)	(0.359)	(0.426)	(0.434)	(0.503)
College/Noncollege (ln)		10.79				3.335
		(6.768)				(7.567)
% Manufacture			0.182			0.0950
			(0.208)			(0.234)
% Unemployment			0.0704			-0.0179
			(0.349)			(0.318)
% Age 65+/pop				0.0139		0.693
				(0.507)		(0.640)
# Universities					5.846**	5.987**
					(2.032)	(2.307)
r2	0.922	0.923	0.923	0.922	0.929	0.930
N	150	150	150	150	150	150

Note: *p-value<0.1; **p-value<0.05. N=150 (3 time periods X 50 provinces). All models include an intercept, region dummies and time dummies. Robust standard errors in parentheses are clustered on regions. Models are weighted by start of period province share of workforce.

As a baseline, model 1 presents a pooled specification with the ROU share measure, time dummies and regional dummies. Model 2 captures shifts in the supply for NRM occupations: the ratio of college to non-college educated individuals (expressed in logarithms) in the population. This variable enters with a positive sign, as expected, meaning that greater relative supply of college-educated individuals predicts rising service employment among non-college individuals, although the coefficient is non-

significant. Model 3 considers two measures of local labour demand conditions: the unemployment rate and the share of employment in manufacturing. Service employment tends to grow more rapidly in areas with higher unemployment and with larger manufacturing employment share (although both are not significant). Model 4 includes potential demand shifters, namely: the elderly share of population, which accounts for local demand for non-tradable (often low-skill) services. Although the coefficient is not significant, the sign suggests that NRM employments grow more rapidly in provinces with higher shares of elderly population. In Model 5 we add the number of universities to capture local HC creation capacity. This resonates with the descriptive evidence on the unexpected relationship between services jobs and local average education (see Fig. 6). The coefficient is coherent with the graphical evidence and shows that NRM employment has expanded the most in provinces with higher number of universities. This may be at root of a potential mismacth between local human capital creation capacity and local employment opportunities. When the full set of controls is included (Model 6), the point estimate on the employment share of ROU jobs remains robustly significant and economically large. The only change is the sign of the unemployment rate variable, which is now negative but non-significant.

5.3. Robustness checks: instrumental variables and interactions

We check the robustness of these results with a two-fold strategy. First, following Author and Dorn (2013) we take into account long-term patters of specialization as reflected in the organization of production and employment across provinces. To do so, we consider an augmented version of the previous estimation:

$$\Delta NRM_{jrt} = \delta_t^{'} + \beta_1^{'} ROU_{jt_0}^{*} + \beta_2^{'} X_{jt_0}^{'} + \beta_3^{'} \nu_{j,t_{1967}} + \gamma_r^{'} + \varepsilon_{jrt}^{'}$$

This includes the term $\nu_{jt_{1967}}$ that is an unobserved, time-invariant attribute that affects both provinces' routine occupation shares and ΔNRM_{jrt}. We use as instrumental variable the percentage of manufacture workers on total workers in 1967 because this is the year that marks the end of the first strategic plan of economic growth in Spain (Requeijo-González, 2005). We solve this second equation using 2SLS model because coefficients are precisely estimated and are typically somewhat larger in magnitude than their OLS counterparts.

Table 6. Routine employment share and Growth of NRM within local labour markets including instrumental variables (1981-2011)

	(1)	(2)	(3)	(4)	(5)	(6)
ROU	1.357***	1.536***	1.258***	1.359***	1.717***	1.593***
	(0.348)	(0.477)	(0.248)	(0.356)	(0.373)	(0.395)
College/Noncollege (ln)		8.791				-0.308
		(5.976)				(7.798)
% Manufacture			0.205			0.243
			(0.348)			(0.289)
% Unemployment			-0.175			-0.266
			(0.291)			(0.294)
% Age 65+/pop				0.181		0.417
				(0.496)		(0.521)
# Universities					7.060***	7.250***
					(1.645)	(1.859)
r2	0.925	0.926	0.925	0.925	0.933	0.934
N	150	150	150	150	150	150

Note: *p-value<0.1; **p-value<0.05. N=150 (3 time periods X 50 provinces). All models include an intercept, region dummies and time dummies. Robust standard errors in parentheses are clustered on regions. Models are weighted by start of period province share of workforce.

Table 6 shows that the new estimates confirm the patterns disclosed above. Specifically we find that the share of ROU employment at the beginning of the decade is a robust predictor of the growth of NRM jobs. The exception appears in the case of the percentage of college on non-college population that now presents a negative sign in model 6. The explanation can be that both percentage of college on non-college population and university availability are capturing the supply of well-educated HC, being the latest more important as an explanatory factor of shifts in NRM employment.

The second robustness check consists in including interaction terms between ROU employment share and cognitive and HC creation capacity of the local labour markets. The objective is to capture if the effect of routine occupations on changing service employment vary across provinces with different capabilities. The estimating model is similar to previous ones (with and without instrumental variables) with the addition of two interaction terms:

$$\text{a)}\ \ Interaction_{jt_0} = (ROU_{jt_0})x1\cdot[College_{jt_0} > College_{jt_0}^{P_{50}}] \quad \text{or}$$

$$\text{b)}\ \ Interaction_{jt_0} = (ROU_{jt_0})x1\cdot[Univ_{jt_0} >= 1]$$

The first interaction term represents the routine employment share (ROU_{jt_0}) in province j at the beginning of the decade t_0 for the most well-educated local areas (those with percentage of colleges above the national median). The second interaction term represents again the routine employment share (ROU_{jt_0}) in province j at the beginning of the decade t_0 for areas with higher HC creation capacity, measured by the presence of the universities in t_0 as a proxy of an established HC supply capacity.

Table 7. Routine employment share and Growth of NRM within local labour markets including interactions

Panel A. Without instrumental variables

	(1)	(2)	(3)	(4)
ROU	1.848***	1.848***	1.901***	1.672***
	(0.418)	(0.422)	(0.421)	(0.319)
College (ln)	4.075	3.790*		
	(2.062)	(1.903)		
ROU x College		0.0126		
		(0.0554)		
# Universities			6.210***	-0.683
			(2.086)	(1.250)
ROU x Universities				0.279***
				(0.0535)
r2	0.925	0.925	0.930	0.942
N	150	150	150	150

Panel B. With instrumental variables

	(1)	(2)	(3)	(4)
ROU	1.536***	1.536***	1.600***	1.459***
	(0.304)	(0.307)	(0.308)	(0.293)
College (ln)	4.728	4.542**		
	(2.009)	(2.020)		
ROU x College		0.00758		
		(0.0480)		
# Universities			7.229***	-0.347
			(1.665)	(1.295)
ROU x Universities				0.266***
				(0.0478)
r2	0.928	0.928	0.934	0.943
N	150	150	150	150

Note: *p-value<0.1; **p-value<0.05. N=150 (3 time periods X 50 provinces). All models include an intercept, region dummies and time dummies. Variables measuring educational stock, local demand conditions and potential demand shifters are also included. Robust standard errors in parentheses are clustered on regions. Models are weighted by start of period province share of workforce.

Results in Table 7 distinguish regressions without (Panel A) and with (Panel B) instrumental variables. Panel A confirms the robustness of the influence of ROU employment on changes in NRM jobs. That is, those regions with initial higher levels of routine occupations have experienced higher changes towards service employment. The positive but non-significant sign of the interaction term (Model 2) means that this effect tends to be even higher in those local markets with more well-educated people. Similarly Model 4 confirms that high initial levels of routinization are strong predictors of changes in NRM jobs which, in fact, increase with the presence of established (old) universities. Panel B of Table 7 shows that these results are confirmed also after the inclusion of instrumental variables.

6. Concluding remarks

Building on previous works on Europe (Goos and Manning, 2007) and the US (e.g. Levy and Murnane 2004; Autor and Dorn, 2013) this paper has analysed shifts in the employment structure of Spanish local labour markets during three decades (1981-2011). Since the extent of employment polarization is beginning to receive academic study mostly at country level, we sought to uncover empirical patterns at lower levels of geographical aggregation. Our results show that Spain, like other industrialized countries, exhibits an employment polarization effect with employment in service occupations accounting for a substantial share of aggregate polarization. We propose an empirical analysis of the forces behind the changing shape of low-skill jobs in local labour markets. The expansion of service occupation during the 2000s is an interesting case of study for various reasons. These jobs are mostly part-time (as high as 50% of all low-skill employees in 1991); they entail an average wage gap of about 50% compared to similarly low-educated occupations; the average age of the workforce employed therein has increased; and, fourth, the educational profile of service workers has remained strikingly similar to that of mid-skill (e.g. clerical, production) workers. On the whole employment opportunities in Spain have seemingly shifted towards a sub-optimal status quo wherein a substantial portion of job creation is in occupational categories that present significant shortcomings in terms of quality of work. This is an issue for further reflection.

Our estimates indicate that the increase in service employment is stronger in provinces with the highest shares of educated workers (at least college education). We also find that the share of routine employment in the previous decade is a robust predictor of the growth of low-skill jobs. These results are robust to the inclusion of regional characteristics and instrumental variables that take into account the long-term pattern of industrial specialization of each local labour market. Motivated by the observation that workers in service occupations often co-locate with demanders of their services, we test empirical patterns at the level of 50 provinces (NUTS3 level). The main finding is that local labour markets that were initially relatively intensive in routine job activities—that is, tasks that became easily executed by automated processes in recent decades—exhibit differential changes in the structure of local production along two dimensions: (i) greater adoption of machinery, specifically industrial machinery; and (ii) greater reallocation of low-skill workers from routine task-intensive occupations into service

occupations (i.e., employment polarization). We measure regions' specialization in terms of routine task-intensive employment (following Autor and Dorn, 2013) and instrument this construct using the interaction between regions' employment structure and the national occupational composition of manufacture industries measured in 1967. The variation in routine task intensity across local labour markets is robustly predictive of changes in the task structure. Results are also robust to the inclusion of other factors affecting employment changes at regional level: educational stock, local labour demand conditions, potential demand shifters and HC creation capacity. In sum, our results suggest a critical role for changes in labour specialization, spurred by automation of routine task activities, as a driver of rising employment polarization in Spain following other industrialized countries.

References (TBA)