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Individual Earnings and Educational Externalities in the European Union

by

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Abstract

This paper examines whether differences in educational externalities affect individual earnings across regions in the EU. Using microeconomic data for more than 100,000 individuals from the European Community Household Panel, the analysis relies on spatial economic analysis in order to determine to what extent differences in individual earnings are the result of (a) the educational attainment of the individual, (b) the educational attainment of the other members of the household he/she lives in, (c) the educational endowment of the region where the individual lives, or (d) the educational endowment of the neighbouring regions. The results highlight that, in addition to the expected positive returns of personal educational attainment, place-based regional and supra-regional educational externalities generate significant pecuniary benefits for workers. These findings are robust to the inclusion of different individual, household, and regional control variables.

Keywords: Individual earnings, educational attainment, externalities, households, regions, Europe

1. Introduction

The determinants of individual earnings have been a major concern for researchers and decision-makers for more than a century. Most analyses on the topic show that earnings are determined by a mix of the intrinsic characteristics of the individual, such as training and education, type of occupation, work experience and health (Schultz, 1961; Becker, 1962; Becker and Chiswick, 1966; Spence, 1973; Mincer, 1974), together with the characteristics of the household s/he lives in, such as household income, size, and type, and tenure status (Basu and Foster, 1998; Basu et al., 2001; Gibson, 2001; Maddox, 2007; Lindelow, 2008).

These approaches have, however, tended to overlook the potential relevance of geography, proximity, and interactions among regions as a factor determining differences in individual earnings. This paper takes the analysis of wage determinants two steps further by considering the educational conditions of the immediate geographical environment and geographical spillovers as determinants of individual earnings potential. It considers whether the socioeconomic conditions of the region where the individual lives, such as regional economic development and agglomeration, and broader geographical influences, such as the economic development of neighbouring regions, matter for individual earnings.

The main research questions driving this paper are the following: do educational externalities matter for individual earnings in the EU? And, if that is the case, to what extent are they more or less important than individual or household educational characteristics? The aim is to assess how these factors interact and account for a significant part of differential individual earnings. In order to do this, we base our analysis on a Mincerian specification considering not only the educational attainment of an individual and of the household s/he lives in, but also the educational characteristics of the individual's region and of neighbouring regions. We develop and implement a simple model of earnings where the returns to schooling vary across individuals and where household, regional, and interregional characteristics play a direct role in generating this heterogeneity. This issue, despite its important policy implications, has until now remained underexplored. While much attention has been devoted to the empirical

investigation of the role of education in the process of regional economic growth, only a handful of studies have attempted to estimate the external household and regional education at the individual level and none have estimated the external interregional education effects.

The paper relies on microeconomic data in order to measure earnings, educational attainment, household environment, and some geographical factors. The microeconomic variables are extracted from the European Community Household Panel (ECHP) dataset, which gathers data for more than 100,000 individuals over a period of 8 years. The microeconomic information is complemented with data from Eurostat's Regio dataset in order to measure regional macroeconomic characteristics.

The paper will thus contribute to both increasing our understanding of the role that geography plays in the functioning and performance of wage variations and to strengthening the conceptual tools – by expanding Mincerian wage models – used to influence policy aimed at improving the earning potential of individuals.

The rest of this paper is structured as follows. Following this introduction, the next section discusses the theoretical underpinnings of different wage determinants, putting emphasis on the role of individual, household, regional, and supra-regional education attainment. Section 3 introduces the empirical model and provides its theoretical justification. This section also presents the variables used in the econometric model and presents some descriptive statistics. Section 4 is devoted to the econometric results. In the final section, we summarise the key points of our analysis and draw some preliminary implications for welfare and regional policy.

2. Educational attainment, externalities, and earnings

The link between educational attainment and earnings has been well documents since the pioneering works of Schultz (1961; 1963) and Becker (1962; 1964). As a general rule, the higher the level of schooling of the individual, the higher the earning potential. However, other educational factors that go well beyond a simple measure of the educational stock of the individual may also have a non-negligible effect on earnings. Different types of educational externalities are likely to play a role in determining earnings. Household

educational externalities have been at the forefront of the analysis on this topic (Basu and Foster, 1998; Gibson, 2001; Maddox, 2007). Other types of externalities, such as geographical externalities, have been, in contrast, neglected by the literature and our understanding of their relationship with earnings is, at best, partial. In this paper we will argue that individual earnings are determined not only by an individual's own education, but rather by a notion of effective education, which incorporates the educational attainment of other members of the household and externalities, related to the regional and interregional education environments.

In this section we look at how the literature has addressed these factors in turn.

2.1 Internal returns to schooling: no externalities

Education is an investment of current resources in exchange for future returns. According to Becker and Chiswick "the amount invested in human capital results from optimizing behaviour: each person is supposed to effect to invest an amount that maximizes his economic welfare" (Becker and Chiswick, 1966: 359). Hence university graduates on average can expect to earn more than less-educated individuals, making the correlation between earnings and education positive.

The reasons behind the positive correlation between education and earnings include that education increases people's social and job opportunities, as well as workers' productivity, allowing them to command higher earnings. Acquiring skills and qualifications that are not possessed by everyone thus pays economic dividends (Wolf, 2002). In addition, education may act as a 'label' or 'signal' in the job market (Spence, 1973). In this case, education has indirect effect on wages, as it can be considered as a detecting and labelling those who have certain skills (Champernowne and Cowell, 1998; Wolf, 2004).

Most of the work that has tried to analyse the individual returns to schooling has followed Mincer's (1974) approach in one way or another (i.e. Medoff and Abraham, 1980; Murphy and Welch, 1992; Albaramirez and Sansegundo, 1995; Serneels, 2008). However, the Mincerian positive education/wage relationship may be affected by the failure to take market failures into consideration and by the existence of externalities

which favour or prevent individuals from fulfilling their full earning potential (Harmon et al., 2003). The influence of household and geographical – both regional and interregional – externalities is also likely to be reflected in the wages of individuals. Therefore, the optimal level of schooling for a given individual depends not only on his/her investments but also on those of others (Becker and Chiswick, 1966). Hence overlooking all these externalities may result in upward-biased estimates of the link between education and earnings (Lam and Levison, 1991; Liu et al., 2000).

2.2 Household externalities

The issue of intrahousehold externalities has been examined in number of studies using a raft of approaches (i.e. Basu and Foster, 1998; Basu et al., 2001; Gibson, 2001; Maddox, 2007; Lindelow, 2008). These studies suggest that the household educational background has a strong effect on earnings, both directly and indirectly, through the returns to education. The earnings of an individual are likely to be related not only to his or her educational attainment, but also to the returns to schooling of the other members of his/her household. Household externalities are the result of educational interactions among household members and may benefit or burden the earning capacity of any individual.

Household educational externalities operate in a number of ways. First, the level of education of the other members of the household shapes the educational and occupational aspirations of an individual (Lindelow, 2008). Second, households are hubs for the dissemination of educational information (Datcher, 1982: 33). Third, "some people may even be directly able to help in acquiring higher level jobs through recommendations, information about job openings, etc" (Datcher, 1982: 33). External benefits may also accrue through assistance with administrative tasks and decision making (Lindelow, 2008). The combination of these factors usually means that a low educated individual living in a highly educated household is likely to see his or her earning potential increase, because the highly educated members of the household may help provide better occupational opportunities. Educated members may therefore raise the earning potential of the less educated members of the household. Basu et al. (2001), for instance, found

that an illiterate adult earns, on average, significantly more in the non-farm economy when living in a family with at least one literate member.

Households can also act as catalysts for achieving increased levels of education. Household and family environments provide incentives and disincentives to acquire education, making people living in a household with a high level of educational attainment more prone to increase their level of schooling than equally talented individuals living in a less auspicious educational environment (Sianesi and Van Reenen, 2003: 160).

Through these mechanisms the benefits of human capital accumulation may not be restricted to the direct recipient, but may also spill over to those living in constant interaction (Sianesi and Van Reenen, 2003: 160). Therefore an individual's educational attainment becomes linked not only to her/his human capital, but also to those of the household s/he lives in. Household spillover effects from knowledge accumulation will thus matter for individual earnings. High household income may also be correlated with household educational externalities such as high school quality and high informal information about educational and career opportunities (Datcher, 1982).

2.3 Regional externalities

The studies that look at educational externalities beyond the realm of the household are still rather rare. Starting with the work of Rauch (1993), Mincerian wage equations have been used in order to estimate the potential externalities generated by schooling. Rauch (1993) used this approach in order to estimate the effect on productivity of schooling externalities in a cross-section of US cities in 1980. He shows that there are productivity gains from geographic concentration of human capital. Ciccone and Peri's (2006) analyses for US cities and states between 1970 and 1990 yield, in contrast, no evidence of significant average-schooling externalities.[1]

However, the studies focusing on the link between educational externalities and earning are still few and far between, implying that the role the regional education environment

[1] The main exception is Moretti (2004) who finds evidence of a connection between the share of college graduates in US cities and wages between 1980 and 1999.

where the individual lives on her/his earnings may have been understimated. This factor is likely to be reflected on the fact that, despite the increased attention paid to the influence of education on earnings across individuals and households, there is still considerable uncertainty about the factors generating earning heterogeneity. Part of this uncertainty is attributable to the absence of models that explicitly recognize the possibility that earnings vary not only with household characteristics, but also with regional characteristics.

Regional education spillovers are particularly interesting because of the prominent role they play in theories of regional economic growth (Romer, 1986; Lucas, 1988) and because of their impact on individual earnings. If we consider the average level of human capital within a region (regional education endowment) as a public good (Schultz, 1961; Rauch, 1993) and if regional education endowment acts as a magnifier of the productivity of individuals living in a region, there will be a gap between the private and social return to schooling (Rudd, 2000). Social returns to schooling generate externalities in a number of ways. Knowledge, for instance, is likely to leak from one worker to another and this leakage will attain its maximum returns in regions with a high concentration of high-skilled individuals (Easterly, 2001; Tselios, 2008). As a consequence, the higher the educational endowment of a region, the higher the probability that an individual will increase his/her knowledge and productivity by interacting with others within the region (Jovanovic and Rob, 1989). These externalities are generally non-pecuniary (technological), because they work not through prices, but through the exchange of ideas, imitation, and learning-by-doing (Acemoglu and Angrist, 2001: 14). Workers may benefit from the skills of their managers and firms within the industry because they are likely to share common production technologies and may engage in knowledge sharing (Kirby and Riley, 2008: 620). Greater interaction between agents may generate knowledge spillovers favouring innovation and increasing the speed of learning (Di Addario and Patacchini, 2008: 1043). However, regional educational externalities may also involve pecuniary externalities, as ‘high’ human capital endowments encourage greater investment by firms, thus raising other workers’ wages (Acemoglu and Angrist, 2001: 15). Hence individual’s living in regions with a high educational endowment will tend to be more productive than those living in low educational endowment regions.

Under competitive conditions, this will translate into a higher wage for the individual living in the high educational endowment region (Rudd, 2000).

Furthermore, if knowledge and skills have an economic payoff, people will respond to this incentive by accumulating knowledge (Easterly, 2001; Tselios, 2008). The greater the presence of complementary educated individuals in the same region, the greater the incentive to get further qualifications (Wolf, 2002). In other words, "the higher the average level of human capital (knowledge) of the agents, the more 'luck' the agents will have with their meetings and the more rapid will be the diffusion and growth of knowledge. If this knowledge concerns technological improvements, we have a microeconomic foundation not only for external effects of human capital on total factor productivity, but also for making those external effects dependent on the average level of human capital" (Rauch, 1993: 381). Complementarity effects thus matter for regional spillovers, making concentrations of educationally disadvantaged groups detrimental for earnings and economic performance, while concentrations of educated and highly skilled individuals will have the opposite effect. The consequence of this is that educational spillovers not only increase overall productivity, but also workers' wages across the board (Di Addario and Patacchini, 2008). Thus workers with identical characteristics will tend to earn higher wages in 'human capital rich', rather than in 'human capital poor', regions (Rauch, 1993: 381).

Education can also generate spillovers that go well beyond those affecting productivity. High regional levels of education tend to be associated with a wide array of regional amenities (i.e. leisure, entertainment, crime reduction, good public services) which improve the quality of life (Roback, 1982; Glaeser et al., 2001). People living in regions with a high educational endowment generally have easier access to higher quality educational institutions than people living in regions with low educational endowment. This also results in higher individual earning in 'human capital rich regions'. This positive effect may be somewhat offset by higher costs of living.

2.4 Interregional externalities

Finally, interregional educational externalities may also affect wages. Regional externalities are likely to generate interregional externalities and vice versa, as

highlighted by endogenous growth theory (Romer, 1986; Lucas, 1988) and New Economic Geography contributions (Krugman, 1991; Krugman and Venables, 1995; Puga and Venables, 1996). Both strands argue that spillovers cannot be constrained within the boundaries of any given regional economy (López-Bazo et al., 2004) and that uneven regional development depends not only on the relative strength of returns to each region, but also on externalities across regions.

However, while the literature on interregional knowledge spillovers has blossomed, virtually no studies have delved on the potential effect of interregional educational spillovers on wages. Tselios (2008) and Rodríguez-Pose and Tselios (2009) found that interregional spillovers contribute significantly to aggregate regional wage and economic development levels. But there have been no previous attempts to measure the relationship between individual wages and interregional educational externalities.

The reason for this omission lay in the lack of adequate data and techniques that could help answer the question of the relationship between individual earnings and the educational attainment of neighbouring regions. The recent development of new spatial econometric techniques represents an important step in this direction to answer this question as they allow us to discriminate empirically between interregional ('global') and regional ('local') education spillovers (Bode, 2004).

What are the mechanisms through which educational externalities generated in one region may affect earning in another? As knowledge diffuses beyond political and administrative barriers, the total earning capacity of any person may not just be a function of the returns to his/her investments (Schultz, 1961; Becker, 1962; Schultz, 1963; Becker, 1964), but also of the educational investment of those who live in her/his region and in neighbouring regions (Vaya et al., 2004). The effect of education externalities may be affected by a number of factors, among which the geographical distance among regions may be the most important. The interaction among agents is, however, bounded by distance and time, so the smaller the geographical distance between regions, the higher the probability and intensity of interregional education spillovers. More specifically, if the spatial transaction costs among regions are low, a higher fraction of the knowledge available in neighbouring regions may actually spill over (Bode, 2004). Knowledge is

also likely to spill over from an aggregate level, such as the interregional level, to a disaggregate level, such as the individual level. This externality will occur if, for instance, an improvement in educational performance of the people who live in a region contributes to increase the earnings of an individual who lives in a neighbouring region. Hence, individuals with similar educational characteristics living in different regions may have different wages, because educational spillovers work out more effectively in one region than in another.

The diffusion of knowledge and technology – related to differences in educational endowments across regions – may also be at the heart of differences in wages and earnings. These externalities are again likely to be higher between regions that are not only geographically close to one another, but also more homogeneous in their traits and motivations (Dowrick and DeLong, 2003: 206). According to López-Bazo et al. (2004: 45), neighbouring regions may share markets for labour and goods, and have similar capital or managerial talent at their disposal: "when this is the case, pecuniary externalities could lead to concentration of firms in macro-areas spanning several regions, thereby transferring externalities at the firm level to the aggregate regional level" (p. 45).

Overall, location, proximity, and regional education homogeneity are likely to matter in exploiting individual wages. Externalities will be generated in a household and a regional economy, and may also be incorporated by other neighboring regional economies. This paper sets out to explore whether these externalities exist in the EU and to what extent they affect individual earnings.

3. Econometric specification, data and variables

The econometric specification developed in the paper is based on a set of individual, household, regional, and interregional hypotheses about the relationship between individual earnings and educational attainment outlined in the previous section.

We use microeconomic data in order to calculate not only the educational attainment of each individual, but also (a) that of the other members of the household s/he lives in; (b) that of his/her region; and (c) that of neighbouring regions. These variables are included

as independent variables in a standard Mincerian wage equation, with individual wages as the dependent variables. The model adopts the following form.

$$\log w_{irs,t} = \beta_1 educ_{irs,t} + \beta_2 heduc_{irs,t} + \beta_3 reduc_{s,t} + \beta_4 [Wreduc_t]_s + \beta_5 \exp_{irs,t} + \beta_5' \exp^2_{irs,t} + \\ + \beta_6 gender_{irs,t} + \gamma_1 x_{irs,t} + \gamma_2 y_{irs,t} + \gamma_3 z_{s,t} + \gamma_4 [Wz_t]_s + \upsilon_i + \varepsilon_{i,t}$$

where $\log w_{irs,t}$ is the logarithm of the wage of individual i, in household r, in region s, at time t; $educ_{irs,t}$ is a measure of the educational attainment of individual i, in household r, in region s, at time t; $heduc_{irs,t}$ is the average educational attainment of the other household members r for individual i, in region s, at time t; $reduc_{s,t}$ is the educational endowment of region s at time t; and $[Wreduc_t]_s$ is the educational endowment of the neighbouring regions s at time t. The specification of the interregional education interaction is represented by a spatial weight matrix W. In our Mincerian wage equation, W is a binary matrix with elements equal to 1 in the case of the $k-$nearest neighbouring regions with $k = 5$, 7 and 9, and 0 otherwise. $\exp_{irs,t}$ is a labour market experience measure and is included as a quadratic term in order to capture the concavity of the experience earnings profile (Mincer, 1974; Harmon et al., 2003). $gender_{irs,t}$ is a dummy variable for the gender of the individual. The coefficient β_1 represents the internal (private) returns to education, while the coefficients β_2, β_3 and β_4 represent the external returns to education.[2] More specifically, β_2, β_3 and β_4 capture household, regional and interregional education externalities, respectively. A significant coefficient of the average educational attainment of other household members, of the regional education endowment, or of the educational endowment of neighbouring regions will be an indication of the presence of external effects to education. However, these effects may not reflect 'true' educational externalities, but household, regional, and neighbouring region characteristics that are themselves correlated with the educational attainment at household, regional, and broader geographical levels, respectively (Rudd, 2000). In order to eliminate these potential effects, we add a vector of individual-specific

[2] We measure the social returns to education by the sum of the internal and external returns to education, as human capital investment decisions should be based on the social returns to education (Liu, 2007).

$x_{irs,t}$, household- (and individual-) specific $y_{irs,t}$, regional-specific $z_{s,t}$ and interregional-specific $[Wz_t]_s$ control variables. γ_1, γ_2, γ_3 and γ_4 are the coefficients of those specific controls. Finally, u_i is the unobserved time-invariant characteristics of individual i (such as innate ability) and ε_{it} is the disturbance term.

Overall, a measure of logarithmic earnings w for individual i, in household r and in region s is projected on the intrinsic characteristics of the individual i, the characteristics of the other member of the household r, the socioeconomic conditions of the region s where the individual lives, and the broader geographical influences of the neighbouring regions. As stated in the theoretical section, the average level of education in a household, in a region, and in its neighbouring regions is likely to affect the earnings of an individual in a manner that is external to the individual's own educational attainment. Our model moves towards an explicit accounting for the household, regional, and interregional interaction of a worker with other heterogeneous workers and ties together the literatures on the spatial patterns of wages in micro wage distributions with the work on macro regional wage distributions. This leads to an understanding of how distributional micro (individual and household) characteristics are associated with macro (regional and interregional) characteristics.

Our analysis uses a panel of pooled cross-sections for two main reasons. First, fixed effects estimators allow us to control for time-invariant individual characteristics u_i. Second, pooling the data increases the number of degrees of freedom underlying the estimates of the coefficients on the educational endowment of the region and the educational endowment of the neighbouring regions, as well as the estimates of the coefficients on the region-specific characteristics (Rudd, 2000).

The data used in this paper to test the Mincerian specification outlined above within the regions of the European Union are drawn from the ECHP dataset. The ECHP data went through a series of refinements, including the removal of cases with errors and missing variables and the aggregation of the data at NUTS I or NUTS II regional level. The

resulting dataset covers the period 1994-2001 for 56,691 individuals belonging to 38,066 households, living in 96 regions and 14 European countries (see Appendix 1).[3]

The variable '*wage and salary earnings*' from the ECHP is used as the main source for the individual earnings of the workers. The sample contains data for 417,594 individuals earning a wage or a salary. Of those 86.52 per cent are normally working (15+ hours/week), while 4.85 per cent and 8.35 per cent are unemployed or inactive, respectively. The rest of our sample (0.28 per cent) is non-respondents. Finally, 272,306 people (65.21 per cent of our sample) share a house with at least another individual member.

In order to calculate the education variables at individual, regional, and supra-regional level we use the ECHP variable '*highest level of general or higher education completed*'. This is a trichotomous variable including the following educational categories: (a) recognized third level education completed; (b) second stage of secondary level education completed; and (c) less than second stage of secondary level education completed. The use of this variable implies the assumption that any increment in education level completed represents an improvement in the capital stock – with the exception of postgraduate degrees, which are not considered in the ECHP – and that equivalent degrees are perfectly comparable across countries. This latter assumption is more problematic as, although the three levels of formal education are mutually exclusive and comparable, as defined by the International Standard Classification of Education, the reality is that the requisites for the completion of equivalent degrees varies across countries (Centre for Educational Research and Innovation and Organisation for Economic Co-operation and Development, 1998; Rodríguez-Pose and Tselios, 2007). In addition, there is considerable variation in terms of resources and preparation of students both within and across countries in the EU (Sianesi and Van Reenen, 2003; Rodríguez-Pose and Vilalta-Bufi, 2005; Rodríguez-Pose and Tselios, 2007).

In order to minimize the above problems, we express all educational variables as deviations from country means. This also has the advantage of making the size, sign, and

[3] The countries included in the study are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, Portugal, Spain, The Netherlands, and the United Kingdom. Appendix 2 displays the pooled regional distribution of the observations.

significance of the coefficients on the educational attainment at individual, household, regional, and supra-regional level directly comparable. At the risk of some oversimplification, educational attainment of individual i is 1 for less than second stage of secondary education, 2 for second stage of secondary level education, and 3 for recognised third level education. These values are normalised by country. The same procedure is used in order to calculate the educational endowment of other members of the household and of the regions. The educational endowment of the neighbouring regions s is calculated using a weights matrix of the normalised regional education endowment ($k-$nearest neighbouring regions, with $k = 5$, 7, and 9).

Due to lack of reliable data, the labour market experience proxy does not represent actual experience (typically recorded as the weighted sum of the number of years of part-time and full-time work since leaving full time education), but it is proxied by the 'potential' experience calculated as the age minus the education leaving age (Harmon et al., 2003). Finally, 56.1 per cent of our sample is male. We use women as the base category for our specifications.

Table 1 provides the descriptive statistics for the individual earnings, educational attainment at individual, household, regional, and supra-regional level, labour market experience and gender variables used in subsequent empirical analysis.

Insert Table 1 around here

The control variables used in this paper were chosen after considering the existing literature and data availability issues. The main source of these variables is, once again, the ECHP data survey, with other variables stemming from the Eurostat's Regio dataset. The sources, definitions and descriptive statistics of our control variables are given in Appendix 3.

4. Regression Results

The empirical analysis exploits the panel structure of the ECHP data survey using fixed effects estimation taking into account unobserved individual specific effects. Section 4.1 reports the results of the Mincerian specification with household, regional, and

interregional externalities, and Section 4.2 controls for individual, household, and regional characteristics in order to test the sensitivity of the results.

4.1. Testing the Mincerian specification with educational externalities

The empirical strategy adopted in the analysis is straightforward. We estimate a series of earning equations starting with the level of education of the worker as a regressor and sequentially add the schooling of the other members of the household, the regional education endowment, and the educational endowment of the neighbouring regions. The results are reported in Table 2.

Insert Table 2 around here

Regression 1 of Table 2 represents the standard Mincerian specification. The positive coefficient of individual returns to schooling, are in accordance with the human capital theory (Schultz, 1961; Becker, 1962; Schultz, 1963; Becker, 1964), indicating that the level of education of the individual pays off in terms of wages. The educational attainment of the individual combines with labour market experience in order to explain a non-negligible part of the variation in wages. The results also indicate that, as expected in a labour market were gender discrimination is still the norm, men earn on average more than women.

Regression 2 (Table 2) examines the relationship of the educational attainment of the other members of a household on individual earnings. The coefficient is negative and statistically significant, indicating a potential – often gender-based – division of tasks within a household. In cases of low intra-household education inequalities, there seems to be a tendency for individuals not to maximize their returns to education, possibly as a result of one of the one of the members of the household – and fundamentally women – sacrificing the earning prospects related to her/his education for other purposes (and fundamentally in order to raise a family, reproducing a traditional gender-based division of labour within the household). This type of behaviour leads to a rejection of Lindelow's hypothesis (2008: 563) that the benefits of intra-household education operate "through complementarities in knowledge and information between different individuals". Hence, the suggestion that the education of one individual can bring pecuniary benefits for other

members of the household (i.e. Basu and Foster, 1998; Basu et al., 2001; Gibson, 2001; Maddox, 2007; Lindelow, 2008) is fundamentally trumped by traditionally gender-based divisions of roles within the households and thus only seems to hold true for cases of high intra-household education inequalities. The robustness of these results is confirmed in Regression 3, where the coefficients of educational attainment of the individual and of the remaining members of the household keep the same sign and significance. However, individual returns to schooling fall by 11.44 per cent when the educational attainment of the other members is added to wage equations.

Regression 4 (Table 2) tests for the impact of the household educational attainment on individual earnings. The positive and significant coefficient of the level of education of the household signals the presence of positive household externalities, with members of highly educated households earning more, all else being equal, than those living in households with a lower level of education. The dimension of the coefficient for household educational externalities also indicates that these are no substitute for individual educational attainment, as the coefficient is considerably lower than that of the educational attainment of the individual.

Regressions 5 and 6 in Table 2 include the effects of regional and extra-regional externalities[4] on individual-level wages. Our results show a positive and significant effect of both on individual earnings, supporting the idea that education generates positive geographical externalities. Geographical influences such as the educational endowment of the region an individual lives in, of neighbouring regions, and the geographical locations of the various regions play thus a major role in explaining individual earnings. Not only do regional ('local') education spillovers matter for individual earnings, but also interregional ('global') geographical spillovers generate pecuniary benefits for workers. These geographical externalities have both local and global dimension which is shaped by the proximity and location of agents and regions. Hence, a person living in a region with a high educational endowment, surrounded by other regions with good educational endowments would thus tend to have higher wages than an individual sharing similar

[4] We use the $k-$nearest neighbours weights matrix and report the results for k=5. The results for k=7 and 9 are very similar and are omitted here for the sake of brevity. They are available from the authors upon request.

characteristics but living in a less well educationally endowed region, surrounded by similarly educationally backward regions.

Our result are consistent with the endogenous growth theory, in that investment in human capital within a region generates learning-by-doing and spillovers of knowledge (Romer, 1986) and increases the productivity of physical capital and the wider labour force (Lucas, 1988). They are also consistent with the predictions of the New Economic Geography, in that regional education endowment raises regional factors prices and induce factors inflows through backward and forward linkages raising worker's wages (Krugman, 1991; Krugman and Venables, 1995; Puga and Venables, 1996). Overall, the results of the analysis underline the productivity gains from the geographical concentration of human capital.

In brief, the regression results show that the role of educational attainment at the four levels of analysis (individual, household, regional, and supra-regional) matters for the earnings of an individual. The earnings of any individual are thus affected by a combination of (a) her or his educational attainment, (b) the educational attainment of the other members of the household s/he lives in, (c) the educational endowment of his or her region, and (d) the educational endowment of the neighbouring regions. Although none of the above explanations 'trump' any of the others, geographical externalities – and more specifically the level of education of neighbouring regions – play a role in determining the earnings of an individual. This begs the question of why geographical educational inequalities have, so far, attracted, so little attention. However, as externalities are, by their nature, particularly difficult to identify, these conclusions should be interpreted with caution (Dalmazzo and de Blasio, 2007: 361).

4.2 Sensitivity of the results

In order to test the robustness of the above results, we experiment with a number of alternative specifications. Several structural-control variables are added to the model at the individual, household, regional, and supra-regional dimensions. We control for these characteristics in order to assess whether the observed educational effects on earnings identified in Table 2 reflect true externalities or hide the influence of other individual, household, regional, or interregional characteristics that may be themselves correlated

with individual, household, regional, and interregional educational attainment, respectively.

Controlling for other individual characteristics

In Table 3, we control for a series of individual characteristics that may affect earnings. These include overeducation, the type of activity performed by the individual, the economic classification and sector of the job, whether this job is in the private or public sector, and the level of health of the individual. The coefficients of all main variables (educational attainment at four dimensions levels, work experience and its square, and sex) remain statistically significant at the 1 per cent level, highlighting the robustness of the results presented in Table 2. Other individual characteristics show that overeducation is negatively associated to individual earnings; that individual earnings are lower in the agricultural and private sectors; that legislators, senior officials, and managers have the highest earnings, while skilled agricultural and fishery workers have the lowest ones. Finally, the results also show that health matters for individual earnings as people lacking any chronic physical or mental health problem, illness, or disability and people who report a 'good' health have the highest earnings.

Insert Table 3 around here

Controlling for other household characteristics

Table 4 reports the results of the analysis of the sensitivity of including different household characteristics and, more specifically, of the impact of the wage and income of the other members of the household, the household size, the number of adults in the household, and the household type. Once again, the results presented in Table 2 prove robust. The elasticity coefficient on the wage and income of the other members remains negative and statistically significant. The results also show the negative relationship between household size and earnings and the positive relationship between the number of adults in the household and earnings. Finally, the household type with the highest earnings is 'couples with three children or more (all children aged less than 16)'.

Insert Table 4 around here

Controlling for other regional characteristics

In Table 5, we control for a series of regional and extra-regional characteristics. More specifically, we control for regional GDP per capita and the GDP per capita of the neighbouring regions, as a high average level of educational endowment is likely to be associated with a regional and extra-regional wealth and with high earnings (Rauch, 1993). We also control for regional sectoral decomposition, the level of regional innovation (measured by the patent applications to the EPO, in the year prior to the analysis, and by the total R&D expenditure as a percentage of GDP) and the transport infrastructure (road infrastructure, measured by the logarithm of the length of motorways per square kilometre, and by rail infrastructure, measured by the logarithm of the length of railway lines per square kilometre). The final control is density, as a somewhat imperfect proxy of agglomeration economies.

Once again, the coefficients on educational endowment of a region and its neighbouring regions remain highly robust and virtually unaffected by the introduction of all these different specifications. As for the coefficients on the control variables, the results show that the regional GDP per capita and the GDP per capita of the neighbouring regions is positively associated to individual earnings. The sectoral composition variables indicate that individual earnings tend to be lower in agricultural regions and higher in regions with a higher share of gross value added in the service sector.[5] Additionally, people who live in regions with high innovative activities tend to have higher earnings than people who do not. The coefficient on road infrastructure is positive and statistically significant, but the coefficient on rail infrastructure is negative and significant. Finally, the impact of regional population density on individual earnings is not robust.

Insert Table 5 around here

5. Concluding Remarks

[5] 'Agriculture' is the share of added value of agriculture, hunting, forestry and fishing in total added value; 'industry' is the share of added value of mining and quarrying, manufacturing, electricity, gas and water supply, and construction in total added value; and 'services' is the share of added value of services (excluding extra-territorial organizations and bodies) in total added value.

This paper has revisited the impact of individual and household educational attainment on earnings and combined this type of analysis with the analysis of geographical (regional and extra-regional) educational externalities across the regions of the EU. The emphasis on the latter of these factors, that is on the role played in the EU by geographical location and spatial proximity, is related to the fact that geographical externalities have tended to be overlooked by the literature in the past. However, the introduction of geographical and regional aspects in the analysis gives a more complex and realistic picture of the factors that affect wages, beyond that afforded by traditional microeconomic analyses, as it allows us to assess the importance of externalities, interactions, and spillovers within households, within regions, and across regions in determining differences in earnings.

The results of the Mincerian model analysed clearly corroborate that what matters for individual earnings is not only the level of education of the individual, but also how educational attainment is actually distributed within households and within and across regions. All coefficients show that individual earnings are the result of a complex combination of educational factors which include the educational attainment of the individual and the educational attainment of the other members of the household s/he lives in ('micro'-based factors), as well as of the educational endowment of the region where the individual lives and the educational endowment of the neighbouring regions ('macro'-based factors). In other words, individual earnings are determined not solely by an individual's own education (internal returns to schooling), but rather by a notion of effective education (external returns to schooling), which incorporates household, regional and interregional externalities. While individual educational attainment cannot be substitute and remains the fundamental factor in generating high earnings, geographical externalities, such as knowledge spillovers, formal and informal interactions among people, market-size and home market effects, and other broader geographical influences can be considered as key factors in explaining individual earnings. These results are robust to the inclusion of a large number of different individual, household, regional and supra-regional control variables.

The results also highlight the ambiguous influence households have on individual earnings. While the overall education level of the household is an important determinant of individual earnings, within-household educational inequalities also have a non-negligible bearing on earnings. In households with high overall levels of education, possibly as a result of traditional gender-based divisions of labour, a number of highly educated individuals – in all likelihood highly educated women – earn well below the potential determined by their level of educational attainment, even after controlling for gender. In households with significant inequalities in education among its members this does not seem to be the case. This means that when all adult members of the household are highly educated there is a tendency to divide roles, with one of the highly educated adults sacrificing (most likely) her earning potential for other tasks, i.e. raising a family. This is less likely to be the case in households with significant differences in the educational attainment among adults.

The analysis carried out highlights the importance of household, regional, and interregional education externalities for individual earnings. As this paper has shown wage disparities are the result of both composition and place-based effects and policy makers need to consider not only the 'micro' dimension when trying to improve the earning potential of individuals, but also the 'macro' dimension, as intraregional and interregional interactions can have important effects on individual outcomes.

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Table 1: Descriptive statistics of individual earnings and normalised educational attainment

	Obs.	Mean or %	Min	Max
Logarithm of individual wage	417594	9.136321	-1.361493	13.58844
Educational attainment of individual	417594	0.008312	-1.880914	7.789069
Educational attainment of the other members	272306	-0.0007526	-2.055209	7.772726
Educational attainment of household	417594	0.0023929	-2.234916	9.043854
Educational endowment of region	417594	-0.0008397	-2.818571	2.770054
Educational endowment of neighbouring regions	417594	0.0861395	-0.931677	1.463765
Work experience	417594	19.79943	0	76
Sex	417,594			
Male	234,259	56.1		
Female	183,335	43.9		

Table 2: Main results

	(1)	(2)	(3)	(4)	(5)	(6)
Educational attainment of individual	0.1495 (0.0019)***		0.1324 (0.0027)***		0.1318 (0.0027)***	0.1320 (0.0027)***
Educational attainment of the other members		-0.1270 (0.0023)***	-0.0537 (0.0028)***		-0.0544 (0.0028)***	-0.0540 (0.0028)***
Educational attainment of household				0.0697 (0.0027)***		
Educational endowment of region					0.0553 (0.0064)***	0.0632 (0.0064)***
Educational endowment of neighbouring regions						0.1154 (0.0085)***
Work experience	0.0782 (0.0005)***	0.0804 (0.0006)***	0.0798 (0.0006)***	0.0785 (0.0005)***	0.0798 (0.0006)***	0.0798 (0.0006)***
Work experience squared	-0.0014 (0.0000)***	-0.0015 (0.0000)***	-0.0014 (0.0000)***	-0.0014 (0.0000)***	-0.0014 (0.0000)***	-0.0014 (0.0000)***
Male	0.4970 (0.0027)***	0.4911 (0.0030)***	0.4897 (0.0030)***	0.4991 (0.0027)***	0.4897 (0.0030)***	0.4898 (0.0030)***
Constant	8.0788 (0.0043)***	8.0884 (0.0050)***	8.0794 (0.0050)***	8.0951 (0.0043)***	8.0792 (0.0050)***	8.0693 (0.0050)***
Observations	417594	272306	272306	417594	272306	272306
R-squared	0.1883	0.2099	0.2179	0.1762	0.2181	0.2188

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 3: Individual controls

	(1)	(2)	(3)	(4)	(5)	(6)
Educational attainment of individual	0.0933 (0.0027)***	0.1204 (0.0026)***	0.0870 (0.0025)***	0.0833 (0.0026)***	0.1275 (0.0028)***	0.1287 (0.0027)***
Educational attainment of the other members	-0.0567 (0.0027)***	-0.0595 (0.0027)***	-0.0561 (0.0025)***	-0.0432 (0.0026)***	-0.0556 (0.0029)***	-0.0540 (0.0028)***
Educational endowment of region	0.0955 (0.0072)***	0.0658 (0.0061)***	0.0682 (0.0056)***	0.0618 (0.0060)***	0.0503 (0.0068)***	0.0635 (0.0063)***
Educational endowment of neighbouring regions	0.1032 (0.0081)***	0.1338 (0.0083)***	0.1105 (0.0076)***	0.1071 (0.0080)***	0.0520 (0.0097)***	0.1174 (0.0086)***
Work experience	0.0648 (0.0006)***	0.0744 (0.0006)***	0.0649 (0.0006)***	0.0719 (0.0006)***	0.0805 (0.0006)***	0.0789 (0.0006)***
Work experience squared	-0.0011 (0.0000)***	-0.0013 (0.0000)***	-0.0011 (0.0000)***	-0.0012 (0.0000)***	-0.0014 (0.0000)***	-0.0014 (0.0000)***
Male	0.3582 (0.0031)***	0.4267 (0.0031)***	0.3734 (0.0029)***	0.4082 (0.0032)***	0.4887 (0.0032)***	0.4885 (0.0030)***
Overeducation	-0.0388 (0.0036)***					
Industrial sector[6]		0.5553 (0.0122)***	0.5229 (0.0115)***			
Service sector		0.4355 (0.0121)***	0.4075 (0.0115)***			
Public sector			0.1351 (0.0043)***			
Legislators, senior officials and managers[7]				0.9190 (0.0152)***		
Professionals				0.8576 (0.0148)***		
Technicians and associate professionals				0.7297 (0.0142)***		
Clerks				0.6469 (0.0142)***		
Service workers and shop and market sales workers				0.3782 (0.0141)***		
Craft and related trades workers				0.5738 (0.0139)***		
Plant and machine operators and assemblers				0.6218 (0.0144)***		
Elementary occupations				0.2830 (0.0140)***		
Lack of chronic physical or mental health problem, illness or disability					0.0418 (0.0050)***	
Health: very good[8]						0.1831 (0.0211)***
Health: good						0.1924 (0.0209)***
Health: fair						0.1506 (0.0209)***
Health: bad						0.0747 (0.0219)***
Constant	8.3562 (0.0059)***	7.7345 (0.0127)***	7.8904 (0.0121)***	7.6373 (0.0142)***	8.0553 (0.0069)***	7.8864 (0.0214)***
Observations	178271	230549	220296	235413	238778	266178
R-squared	0.2094	0.2505	0.2335	0.2724	0.2241	0.2197

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

[6] Base category: Agricultural sector
[7] Base category: Skilled agricultural and fishery workers
[8] Base category: Health: very bad

Table 4: Household controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Educational attainment of individual	0.1133 (0.0025)***	0.1137 (0.0026)***	0.1145 (0.0025)***	0.1147 (0.0026)***	0.1323 (0.0029)***	0.1115 (0.0026)***	0.1115 (0.0027)***
Educational attainment of the other members	-0.0121 (0.0026)***	-0.0194 (0.0027)***	-0.0102 (0.0026)***	-0.0180 (0.0027)***	-0.0536 (0.0029)***	-0.0120 (0.0027)***	-0.0183 (0.0028)***
Educational endowment of region	0.0937 (0.0059)***	0.0890 (0.0061)***	0.0943 (0.0059)***	0.0894 (0.0061)***	0.0584 (0.0067)***	0.0880 (0.0062)***	0.0829 (0.0064)***
Educational endowment of neighbouring regions	0.1516 (0.0079)***	0.1479 (0.0081)***	0.1481 (0.0079)***	0.1446 (0.0081)***	0.0931 (0.0089)***	0.1239 (0.0081)***	0.1204 (0.0084)***
Work experience	0.0629 (0.0005)***	0.0663 (0.0005)***	0.0648 (0.0005)***	0.0680 (0.0005)***	0.0822 (0.0006)***	0.0645 (0.0006)***	0.0679 (0.0006)***
Work experience squared	-0.0011 (0.0000)***	-0.0012 (0.0000)***	-0.0012 (0.0000)***	-0.0013 (0.0000)***	-0.0015 (0.0000)***	-0.0011 (0.0000)***	-0.0012 (0.0000)***
Male	0.3060 (0.0029)***	0.3289 (0.0031)***	0.3061 (0.0029)***	0.3296 (0.0030)***	0.5058 (0.0031)***	0.2974 (0.0031)***	0.3188 (0.0032)***
Logarithm of wage of the other members	-0.4005 (0.0020)***		-0.4003 (0.0020)***			-0.4237 (0.0021)***	
Logarithm of income of the other members		-0.3886 (0.0026)***		-0.3873 (0.0026)***			-0.4193 (0.0027)***
Household size			-0.1080 (0.0038)***	-0.0994 (0.0039)***	-0.1548 (0.0068)***	-0.1800 (0.0062)***	-0.1705 (0.0064)***
Number of adults in the household			0.0854 (0.0041)***	0.0697 (0.0042)***	0.0917 (0.0058)***	0.0862 (0.0053)***	0.0719 (0.0055)***
Couples without children (at least one person aged 65 or more)[9]					-0.0507 (0.0446)	-0.1634 (0.0409)***	0.0006 (0.0423)
Couples with one child (child aged less than 16)					0.0553 (0.0112)***	0.1002 (0.0102)***	0.1001 (0.0106)***
Couples with two children (all children aged less than 16)					0.0974 (0.0156)***	0.1636 (0.0143)***	0.1651 (0.0148)***
Couple with three children or more (all children aged less than 16)					0.1404 (0.0221)***	0.2290 (0.0202)***	0.2378 (0.0209)***
Couple with one or more children (at least one child aged 16 or more)					0.1170 (0.0138)***	0.1846 (0.0126)***	0.1800 (0.0131)***
Constant	11.9784 (0.0203)***	11.9076 (0.0258)***	12.1131 (0.0236)***	12.0459 (0.0287)***	8.2858 (0.0177)***	12.5006 (0.0268)***	12.5103 (0.0324)***
Observations	272306	272306	272306	272306	237801	237801	237801
R-squared	0.3298	0.2878	0.3322	0.2897	0.2316	0.3547	0.3097

*** p<0.01, ** p<0.05, * p<0.1; Standard errors in parentheses

[9] Base category: Couples without children (both persons aged less than 65)

Table 5: Regional and extra-regional controls

	(1)	(2)	(3)	(4)	(5)
Educational attainment of individual	0.1393 (0.0027)***	0.1414 (0.0027)***	0.1390 (0.0029)***	0.1525 (0.0039)***	0.1471 (0.0043)***
Educational attainment of the other members	-0.0422 (0.0028)***	-0.0393 (0.0028)***	-0.0471 (0.0030)***	-0.0349 (0.0041)***	-0.0442 (0.0044)***
Educational endowment of region	0.0192 (0.0068)***	0.0269 (0.0068)***	0.0268 (0.0083)***	0.0313 (0.0114)***	0.0455 (0.0143)***
Educational endowment of neighbouring regions	0.0961 (0.0096)***	0.1692 (0.0100)***	0.0662 (0.0101)***	0.1502 (0.0102)***	0.1305 (0.0115)***
Work experience	0.0815 (0.0006)***	0.0816 (0.0006)***	0.0806 (0.0006)***	0.0888 (0.0009)***	0.0915 (0.0010)***
Work experience squared	-0.0015 (0.0000)***	-0.0015 (0.0000)***	-0.0015 (0.0000)***	-0.0017 (0.0000)***	-0.0017 (0.0000)***
Male	0.4939 (0.0031)***	0.4945 (0.0031)***	0.4800 (0.0033)***	0.4839 (0.0044)***	0.4926 (0.0050)***
Logarithm of regional GDP per capita	1.5015 (0.0223)***	0.5558 (0.0418)***			
Logarithm of GDP per capita of neighbouring regions		1.2688 (0.0475)***			
Gross value added of industry per capita[10]			10.3050 (0.2853)***		
Gross value added of services per capita			11.6325 (0.2753)***		
Patent applications to the EPO by priority year (per million of inhabitants)				0.0021 (0.0001)***	
Total intramural R&D expenditure as a % of GDP					0.0852 (0.0197)***
Logarithm of motorways (km) per square kilometer				0.6027 (0.0269)***	0.8941 (0.0285)***
Logarithm of railway lines (km) per square kilometer				-0.5608 (0.1367)***	-0.7079 (0.1600)***
Population density				-0.0006 (0.0002)***	-0.0003 (0.0003)
Constant	-6.6182 (0.2187)***	-9.8585 (0.2497)***	-2.7131 (0.2572)***	8.9278 (0.5061)***	9.8462 (0.5938)***
Observations	243055	243055	220451	136554	109823
R-squared	0.2412	0.2438	0.2305	0.2273	0.2264

*** p<0.01, ** p<0.05, * p<0.1; Standard errors in parentheses

[10] Base category: Gross value added of agriculture per capita

Appendix 1: Individual, household, regional and country observations

Year	Observations			
	Individuals	Households	Regions	Countries
1994	46392	31465	58	10
1995	53612	36075	94	12
1996	56691	38066	96	14
1997	54355	36538	96	14
1998	54941	36620	96	14
1999	54302	35993	96	14
2000	49255	32677	96	14
2001	48046	31697	96	14

Appendix 2: Regional distribution of observations

a/a	Country	Region	Observations	Percent	a/a	Country	Region	Observations	Percent
1	Austria	AT1	8,511	2.04	**49**	Italy	IT6	3,003	0.72
2	Austria	AT2	5,020	1.20	**50**	Italy	IT7	2,433	0.58
3	Austria	AT3	7,298	1.75	**51**	Italy	IT8	3,775	0.90
4	Belgium	BE1	2,381	0.57	**52**	Italy	IT9	5,423	1.30
5	Belgium	BE2	9,361	2.24	**53**	Italy	ITA	2,865	0.69
6	Belgium	BE3	9,058	2.17	**54**	Italy	ITB	2,407	0.58
7	Germany	DE1	6,285	1.51	**55**	Luxemburg	LU	6,049	1.45
8	Germany	DE2	6,429	1.54	**56**	The Netherlands	NL	38,604	9.24
9	Germany	DE3	1,827	0.44	**57**	Portugal	PT11	7,373	1.77
10	Germany	DE4	2,127	0.51	**58**	Portugal	PT12	7,320	1.75
11	Germany	DE5	272	0.07	**59**	Portugal	PT13	4,551	1.09
12	Germany	DE6	449	0.11	**60**	Portugal	PT14	3,677	0.88
13	Germany	DE7	3,377	0.81	**61**	Portugal	PT15	3,832	0.92
14	Germany	DE8	1,535	0.37	**62**	Portugal	PT2	4,906	1.17
15	Germany	DE9	3,825	0.92	**63**	Portugal	PT3	4,659	1.12
16	Germany	DEA	9,097	2.18	**64**	United Kingdom	UK11	758	0.18
17	Germany	DED	4,087	0.98	**65**	United Kingdom	UK12	556	0.13
18	Germany	DEE	2,554	0.61	**66**	United Kingdom	UK13	750	0.18
19	Germany	DEF	1,058	0.25	**67**	United Kingdom	UK21	658	0.16
20	Germany	DEG	2,563	0.61	**68**	United Kingdom	UK22	443	0.11
21	Germany	DEX	2,421	0.58	**69**	United Kingdom	UK23	924	0.22
22	Denmark	DK0	24,126	5.78	**70**	United Kingdom	UK24	1,096	0.26
23	Spain	ES1	4,940	1.18	**71**	United Kingdom	UK31	1,754	0.42
24	Spain	ES2	6,334	1.52	**72**	United Kingdom	UK32	800	0.19
25	Spain	ES3	4,467	1.07	**73**	United Kingdom	UK33	376	0.09
26	Spain	ES4	5,675	1.36	**74**	United Kingdom	UK40	1,394	0.33
27	Spain	ES5	9,222	2.21	**75**	United Kingdom	UK51	774	0.19
28	Spain	ES6	7,521	1.80	**76**	United Kingdom	UK52	1,958	0.47
29	Spain	ES7	2,441	0.58	**77**	United Kingdom	UK53	1,296	0.31
30	Finland	FI	25,539	6.12	**78**	United Kingdom	UK54	936	0.22
31	France	FR1	6,060	1.45	**79**	United Kingdom	UK55	3,305	0.79
32	France	FR2	6,506	1.56	**80**	United Kingdom	UK56	1,068	0.26
33	France	FR3	2,242	0.54	**81**	United Kingdom	UK57	844	0.20
34	France	FR4	3,496	0.84	**82**	United Kingdom	UK61	1,641	0.39
35	France	FR5	4,770	1.14	**83**	United Kingdom	UK62	463	0.11
36	France	FR6	3,322	0.80	**84**	United Kingdom	UK63	893	0.21
37	France	FR7	4,111	0.98	**85**	United Kingdom	UK71	731	0.18
38	France	FR8	3,409	0.82	**86**	United Kingdom	UK72	1,379	0.33
39	Greece	GR1	7,410	1.77	**87**	United Kingdom	UK73	1,023	0.24
40	Greece	GR2	5,221	1.25	**88**	United Kingdom	UK81	751	0.18
41	Greece	GR3	7,786	1.86	**89**	United Kingdom	UK82	1,353	0.32
42	Greece	GR4	3,081	0.74	**90**	United Kingdom	UK83	699	0.17
43	Ireland	IE	22,845	5.47	**91**	United Kingdom	UK84	619	0.15
44	Italy	IT1	3,800	0.91	**92**	United Kingdom	UK91	735	0.18
45	Italy	IT2	5,345	1.28	**93**	United Kingdom	UK92	910	0.22
46	Italy	IT3	6,004	1.44	**94**	United Kingdom	UKA1	1,533	0.37
47	Italy	IT4	2,455	0.59	**95**	United Kingdom	UKA2	1,197	0.29
48	Italy	IT5	5,104	1.22	**96**	United Kingdom	UKA4	333	0.08

Appendix 3: Descriptive statistics of control variables

	Obs.	Mean or %	Min	Max	Source
CONTROL: INDIVIDUAL					ECHP
Overeducation	274,448				
Yes	144,734	52.74			
No	129,714	47.26			
Main activity of the local unit of the business or organisatioin in current job	352,105				
Agricultural sector	11,038	3.13			
Industrial sector	106,644	30.29			
Service sector	234,423	66.58			
Current job in private or public sector	336,901				
Private sector, including non-profit private organisations	232,609	69.04			
Public sector, including para-statal	104,292	30.96			
Occupation in current job	358,526				
Legislators, senior officials and managers	21,793	6.08			
Professionals	47,049	13.12			
Technicians and associate professionals	54,466	15.19			
Clerks	54,900	15.31			
Service workers and shop and market sales workers	46,722	13.03			
Skilled agricultural and fishery workers	7,601	2.12			
Craft and related trades workers	56,093	15.65			
Plant and machine operators and assemblers	32,396	9.04			
Elementary occupations	37,506	10.46			
Do you have any chronic physical or mental health problem, illness or disability?	364,218				
Yes	61,715	16.94			
No	302,503	83.06			
How is your health in general?	408,617				
Very good	106,092	25.96			
Good	203,750	49.86			
Fair	81,183	19.87			
Bad	14,905	3.65			
Very bad	2,687	0.66			
CONTROL: HOUSEHOLD					ECHP
Logarithm of wage of the other members	272306	9.119667	-2.296743	13.58844	
Logarithm of income of the other members	272306	9.287275	-2.296743	13.59144	
Household size	417594	3.330374	1	16	
Number of adults in the household	417594	2.571826	0	11	
Household type (couples)	326,406				
Couples without children (at least one person aged 65 or more)	5,136	1.57			
Couples without children (both persons aged less than 65)	75,396	23.1			
Couples with one child (child aged less than 16)	45,298	13.88			
Couples with two children (all children aged less than 16)	52,019	15.94			

Couple with three children or more (all children aged less than 16)	16,284	4.99			
Couple with one or more children (at least one child aged 16 or more)	132,273	40.52			
CONTROL: REGIONAL					EUROSTAT
Logarithm of regional GDP per capita	370869	9.798526	9.065636	10.73037	
Logarithm of GDP per capita of neighbouring regions	370869	9.850929	9.260146	10.31757	
Sectoral composition	337252				
Gross value added of agriculture per capita	13,210	3.92			
Gross value added of industry per capita	95,634	28.36			
Gross value added of services per capita	228,409	67.73			
Patent applications to the EPO by priority year (per million of inhabitants)	397582	118.819	0.1776	588.3949	
Total intramural R&D expenditure as a % of GDP	253336	1.581735	0.16	4.1	
Logarithm of motorways (km) per square kilometer	360067	-4.052841	-6.904852	-1.924372	
Logarithm of railway lines (km) per square kilometer	277628	-3.099334	-4.059428	-0.1469304	
Population density	357590	348.4953	16.8	6033.5	