EFFICIENCY IN THE TRANSFORMATION OF SCHOOLING INTO COMPETENCES: A CROSS-COUNTRY ANALYSIS USING PIAAC DATA

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Efficiency in the transformation of schooling into competences:

A cross-country analysis using PIAAC data

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Abstract

This study (i) compares the competence levels of the adult population in a set of OECD countries; (ii) assesses the comparative efficiency with which the education system in each country transforms schooling into competences, distinguishing by educational level, and (iii) tracks the evolution of this efficiency by birth cohorts. Using PIAAC data, the paper applies standard parametric frontier techniques under two alternative specifications. The results obtained under both specifications are similar and identify Finland, Sweden, Denmark and Japan as being the most efficient and Spain, the United Kingdom, Italy, Ireland and Poland as the least efficient. The evolution of the efficiency levels by age cohorts shows that higher education is more efficient for younger cohorts, while lower and upper secondary education present a stable trend over cohorts.

Key words: adult population competences; efficiency; PIAAC; parametric frontier techniques.

JEL codes: I21, C13.

1. Introduction

The consideration of human capital as a key factor both in the economic growth of countries and in the labor outcomes of individuals represents a long-standing tradition in the literature. Similarly, the limitations researchers face as they seek to measure this human capital – typically by resorting to the number of years of schooling (or, alternatively, the level of education attained) on the basis of Mincer’s (1970; 1974) proposal – have been well documented. More recently, various studies have recommended considering the cognitive skills or competences acquired by individuals – as well as the number of years of schooling – when measuring human capital. Borghans et al. (2001) discuss the advantages of such an approach, stressing that the level of education achieved by an individual is an imperfect indicator of their human capital at any one point in time. Indeed, several studies provide empirical support for such arguments and show that cognitive competences can account for a large part of a country’s growth in productivity (Hanushek and Kimko 2000; Barro 2001; Hanushek and Woessmann 2008) and for a part of an individual’s labor achievements that
cannot be explained by their educational attainments (McIntosh and Vignoles 2001; Green, and Riddell 2003).

If, therefore, we assume that an individual’s skills are defined not only by the quantity of education they have received (measured in terms of the number of years of schooling), but also by the quality of that education (measured in terms of the cognitive competences acquired), it is of great interest to researchers to (i) determine which factors account for the acquisition of competences throughout an individual’s life cycle and (ii) identify the greater performance that some individuals derive from their schooling in terms of competences than is obtained by others. The first of these issues has been broadly analyzed by estimating education production functions (Hanushek 1979; 1997). It has been concluded that not only the number of years of formal education received but other relevant variables, including an individual’s personal characteristics and his/her socio-economic environment, can determine the acquisition of cognitive competences (Björklund and Salvanes 2011; Mazzona 2014). When estimating education production functions, however, it is assumed that all the units included in the sample obtain the same benefit from each of the explanatory variables considered. In international comparisons, this means, for example, assuming that an additional year of schooling in two countries with different institutional environments — and, more specifically, with different education systems — is equally effective, on average, in translating higher levels of schooling into competences for their populations. In order to refine this assumption, we need to determine whether the efficiency in the transformation of the number of years of schooling received into competences varies by country. The estimation of production frontiers is useful for this purpose since it indicates, for a given reference unit, the distance from that unit to the frontier, estimated using the most efficient units in the sample. For a given set of countries, this technique would provide a sorting of countries as a function of their distance from the frontier, or what is the same, as a function of the efficiency with which their education systems transform an additional year of schooling into competences.

The importance attached to the analysis of efficiency in education has grown notably in recent years (see De Witte and López-Torres 2015, for an exhaustive review of the literature). The bulk of the work in this regard has focused on estimating the efficiency of different units (districts, schools or students) operating within the same country, with far fewer studies comparing the efficiency of education systems across countries. However, among the latter, the most relevant draw on information provided by the OECD’s PISA program as they compare from different perspectives the efficiency with which the education systems of different countries operate. For example, Afonso and Aubyn (2005; 2006) and Sutherland et al. (2009) analyze the efficiency of public spending on education for a group of OECD countries, and emphasize the role played by the institutions of each country in accounting for the disparity in the results reported. The influential role played by a country’s institutions is similarly stressed by De Jorge and Santín (2010), who, like Deutsch et al. (2013), consider an analysis of efficiency at the student level as the best approach to optimize the use of available information. Agasisti and Zoido (2015) assess efficiency at both the national and school level for a broad set of OECD countries. They document a notable heterogeneity both

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1 A review of papers using parametric boundary techniques to analyze various issues related to education can be found in Worthington (2001).
between and within countries in terms of the degree of efficiency achieved by their respective education systems and schools. Giambona et al. (2011), in contrast, focus on the role played by the students’ socio-economic characteristics in the determination of their competences. The authors assess the efficiency of the education systems of several EU countries with particular regard to their ability to help students from a poor family background achieve optimal development of their cognitive competences. The importance of the socio-economic environment is similarly stressed in Thieme et al. (2012). The authors compare the efficiency of a broad set of countries taking into account not only the results obtained by the students but also the degree of dispersion in the distribution of those results as an indicator of the equity of the system. Other studies use several waves of cross-sectional data in order to evaluate the evolution of a given output over time. This is the case of Agasisti (2014) when comparing the efficiency of public expenditure on education in twenty European countries between 2006 and 2009. In a similar vein, Giménez et al. (2017) examine student progress in terms of competences between 2003 and 2009, as they assess the extent to which their progress can be accounted for by the availability of better resources and/or the enhanced efficiency of their respective education systems. Other databases that have been used to evaluate the efficiency of education systems in an international setting include the Third International Mathematics and Science Study (TIMSS) – see Clements (2002) and Giménez et al. (2007); and the Progress in International Reading Literacy Study (PIRLS) – see Cordero et al. (2017).

The aforementioned papers adopt different methodologies (mainly non-parametric, but also semi-parametric and parametric) to calculate the efficiency with which different inputs are combined (at the country, school and/or student levels) in the production of various outputs related to student competences. However, despite this multiplicity of tools and results, they share a common limitation derived from their use of cross-sectional data that refer to individuals belonging to the same birth cohort. This means that we can only evaluate the efficiency of the education system for a given academic year (as in the case of TIMSS or PIRLS) or for a specific age (as in the case of PISA). In contrast, to the best of our knowledge, this paper is among the first that seeks to undertake an efficiency analysis for the education system as a whole, distinguishing by country and by level of education. This is possible as we draw on data from the Program for the International Assessment of Adult Competencies (PIAAC), a survey conducted by the OECD among individuals aged 16-65 that have received a varied number of years of schooling. By estimating standard stochastic frontier functions, our objectives are as follows: (i) to compare the competence levels of the adult population in a set of OECD countries; (ii) to assess the comparative efficiency with which the education system in each country transforms schooling into competences, distinguishing by educational level, and (iii) to track the evolution of this efficiency by birth cohorts.

Gupta and Verhoeven (2001) use information on adult population competences to make international comparisons of efficiency indicators. However, the aim of their study is not to evaluate the efficiency with which schooling is translated into competences, as is the case in our paper, but rather to compare the efficiency with which public expenditure on education and health improve a series of social development indicators, for some thirty African countries. For the specific case of education, the outputs assessed are school attendance rates in primary and secondary education and adult population competences.
The rest of the paper is structured in four sections: sections 2 and 3 outline the methodology and the database used, section 4 reviews the main results obtained and, finally, section 5 presents the study’s main conclusions.

2. Methodology

Here we propose an education production function and employ standard stochastic frontier techniques to calculate the distance from each country to the frontier. In this way, a classification of the countries is obtained as a function of the (in)efficiency with which they transform schooling into competences.

The education production function can be expressed as follows:

\[ Y_{ij} = \beta'X_{ij} + w_{ij} = \beta'X_{ij} + (V_{ij} - u_{ij}) \]

\[ E[u_{ij} / w_{ij}] = \delta_{ij} = h_i + \theta_j \]

in which the competences of individual “i” living in country “J” are accounted for by the variables included in “X_{ij}” plus a term of inefficiency or of distance with respect to the frontier, “u_{ij}”. The expected value of this distance from the frontier, for individual “i”, is given by “\delta_{ij}”, which is the result of the standard calculation of frontier distances when using stochastic frontiers.

The distance to the frontier for individual “i” living in country “J” has two components: the individual component “h_i”, which gathers the innate ability of individual “i”, and “\theta_j”, a component of the country that includes the average efficiency with which the country’s education system transforms schooling into competences. When calculating the average of the individuals living in country “J”, we obtain:

\[ \frac{\sum_{i=1}^{M} \delta_{ij}}{M} = \frac{\sum_{i=1}^{M} h_i}{M} + \theta_j \rightarrow \theta_j \]

In other words, for individuals from country “J”, insofar as the innate ability of the individuals within the same country tends to be compensated for, the average of the individual distances to the frontier will come closest to the average distance from the component country’s derived frontier, which may represent a way to approach the efficiency of that country’s education system.

The functional specification for the education production function suggests that using a linear, as opposed to a semi-logarithmic model, provides the best fit for the available data. Moreover, it appears that age and experience – two of the explanatory variables included in the model – have a free effect on the competences when creating dummy specific variables for age (i.e. a dummy for each age in years) and experience (i.e. a dummy for each experience in
years), compared to a more standard specification that suggests a linear effect for age and a quadratic effect for experience. We estimate both options with the available data and conclude that the latter gives the better outcomes (see Annex 1).

Standard stochastic frontier techniques are applied to Equation 1 under two different specifications. In the first, the influence of the explanatory variables is accounted for, which means the equation is estimated using the standard frontier function technique and that the estimated coefficients are common to all the countries considered. In the second, the frontier functions methodology is adapted so as to allow the coefficients (other than formal education) that affect the transformation of inputs into competences (including, for example, number of years of experience or type of occupation) to vary from country to country. This approach, which can be consulted in Annex 2, means we can isolate more precisely the (in)efficiency of the formal education system in transforming years of education received into competences. This said, both approaches in fact give very similar results.

3. Data

The data used in the present paper are drawn from the first wave of the PIAAC (corresponding to 2012), an OECD initiative aimed at assessing the competences of the population aged 16-65. This database follows in the wake of others that have measured the competences of the adult population (including IALS and ALL), although the number of participating countries is in this case greater and the competences evaluated refer not only to language skills, but also to mathematical skills and the use of new technologies. All these competences are measured using specific tests, the results of which are presented in terms of plausible values (ten for each skill). These plausible values indicate the performance of each individual on a scale of 0 to 500 points and are grouped into six levels. The survey, designed to facilitate a comparative analysis of the participating countries, also offers harmonized information on the use of the competences assessed in the workplace and in daily life; on the socio-demographic characteristics of the individuals surveyed (e.g. gender, age, nationality, level of education of parents); and on their training and job characteristics (e.g. education level, work experience throughout their working life, work situation: employed, inactive, unemployed, salary and other characteristics of the job: type of contract and working day, performance of supervision tasks, and even variables that allow for the identification of eventual educational or skill mismatches).

We have excluded from the sample those countries that give rise to any kind of concern regarding the reliability of the data they provide and those which fail to provide information on some of the variables considered in our study. Our model’s dependent variable is numeracy competences rescaled to 1000 so as to facilitate the interpretation of the results. The explanatory variables provide information about age, number of years of schooling, work experience (in quadratic terms), gender, first or second generation immigrant status, (the

3 All of the study’s estimations have been replicated using literacy skills as the dependent variable. The results obtained (available upon request) are, to a large extent, quantitatively and qualitatively similar to those presented here for numeracy.
absence of) coincidence between the mother tongue and the language in which the survey is carried out, the level of studies of the parents, type of occupation and possible attendance on non-regulated training courses.

Table 1 presents the descriptive statistics for the variables in the overall sample (excluding observations without information regarding any of the variables considered in the analysis, which limits the sample to around 79,000 observations). The average value of the numeracy competence is c. 542 points, with a marked standard deviation of around 96 points. The average number of years of schooling stands at 12.73 for individuals whose average age is 40 years old and who have an average work experience of 18.21 years. The proportion of first generation immigrants is 7.9% (falling to 1.7% for second generation immigrants), most individuals (92%) respond to the survey in their mother tongue and 38% (22%) have at least one ascendant with post-compulsory (higher) secondary education. Roughly two-thirds of the individuals in the sample work in a skilled occupation and, finally, around 40% reported participating on non-regulated training courses in the 12 months prior to the survey.

Table 1. Descriptive statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Average</th>
<th>Standard dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics Comp.</td>
<td>542.0646</td>
<td>96.1126</td>
<td>49.6917</td>
<td>888.2642</td>
</tr>
<tr>
<td>Schooling</td>
<td>12.7323</td>
<td>3.0259</td>
<td>3.0000</td>
<td>22.0000</td>
</tr>
<tr>
<td>Age</td>
<td>39.9555</td>
<td>14.4749</td>
<td>16.0000</td>
<td>65.0000</td>
</tr>
<tr>
<td>Experience</td>
<td>18.2143</td>
<td>13.1439</td>
<td>0.0000</td>
<td>55.0000</td>
</tr>
<tr>
<td>Man</td>
<td>0.4783</td>
<td>0.4995</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Immigrant 1st gen.</td>
<td>0.0796</td>
<td>0.2707</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Immigrant 2nd gen.</td>
<td>0.0173</td>
<td>0.1304</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Mother tongue</td>
<td>0.9233</td>
<td>0.2660</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Parents higher secondary ed.</td>
<td>0.3815</td>
<td>0.4858</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Parents higher ed.</td>
<td>0.2232</td>
<td>0.4164</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Qualified occupation</td>
<td>0.6122</td>
<td>0.4873</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
<tr>
<td>Non-regulated training</td>
<td>0.3919</td>
<td>0.4882</td>
<td>0.0000</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

Table 2 shows the average competences by country, with values ranging from 491 for Spain to 576 points for Japan. Table 3 ranks the countries by competences, with Japan and the Nordic countries heading the classification and Ireland, Spain and Italy finding themselves at the bottom of the ranking.
Table 2. Average competences by country

<table>
<thead>
<tr>
<th>Country</th>
<th>Average Competences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>560.7724</td>
</tr>
<tr>
<td>Czech. Rep</td>
<td>551.4677</td>
</tr>
<tr>
<td>Denmark</td>
<td>556.5568</td>
</tr>
<tr>
<td>Estonia</td>
<td>546.239</td>
</tr>
<tr>
<td>Finland</td>
<td>564.4532</td>
</tr>
<tr>
<td>Ireland</td>
<td>511.1808</td>
</tr>
<tr>
<td>Italy</td>
<td>494.2578</td>
</tr>
<tr>
<td>Japan</td>
<td>576.3407</td>
</tr>
<tr>
<td>Korea</td>
<td>526.7724</td>
</tr>
<tr>
<td>Holland</td>
<td>560.6922</td>
</tr>
<tr>
<td>Norway</td>
<td>556.5957</td>
</tr>
<tr>
<td>Poland</td>
<td>519.5378</td>
</tr>
<tr>
<td>Slovak Rep.</td>
<td>551.6152</td>
</tr>
<tr>
<td>Spain</td>
<td>491.6435</td>
</tr>
<tr>
<td>Sweden</td>
<td>558.1049</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>523.4517</td>
</tr>
</tbody>
</table>

Table 3. Ranking of countries by competences

<table>
<thead>
<tr>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
</tr>
<tr>
<td>Finland</td>
</tr>
<tr>
<td>Belgium</td>
</tr>
<tr>
<td>Holland</td>
</tr>
<tr>
<td>Sweden</td>
</tr>
<tr>
<td>Norway</td>
</tr>
<tr>
<td>Denmark</td>
</tr>
<tr>
<td>Slovak Rep.</td>
</tr>
<tr>
<td>Czech Rep.</td>
</tr>
<tr>
<td>Estonia</td>
</tr>
<tr>
<td>Korea</td>
</tr>
<tr>
<td>United Kingdom</td>
</tr>
<tr>
<td>Poland</td>
</tr>
<tr>
<td>Ireland</td>
</tr>
<tr>
<td>Italy</td>
</tr>
<tr>
<td>Spain</td>
</tr>
</tbody>
</table>

Finally, and given that throughout this study the efficiency indices are estimated distinguishing by level of education, Graph 1 presents average numeracy scores for each level of education contemplated. Note that the rankings of countries according to their average competences per level of study (see Table 4) present considerable similarities to those obtained as a function of the efficiency indices (see Graphs 2 and 3).
Graph 1. Average competences by country and level of studies

![Graph 1](image)

Table 4. Classification of countries as a function of their competence level, by level of studies

<table>
<thead>
<tr>
<th>Lower Secondary</th>
<th>Higher Secondary</th>
<th>Higher education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland</td>
<td>Holland</td>
<td>Belgium</td>
</tr>
<tr>
<td>Japan</td>
<td>Japan</td>
<td>Holland</td>
</tr>
<tr>
<td>Norway</td>
<td>Sweden</td>
<td>Sweden</td>
</tr>
<tr>
<td>Holland</td>
<td>Denmark</td>
<td>Slovak Rep.</td>
</tr>
<tr>
<td>Estonia</td>
<td>Finland</td>
<td>Finland</td>
</tr>
<tr>
<td>Denmark</td>
<td>Norway</td>
<td>Norway</td>
</tr>
<tr>
<td>Sweden</td>
<td>Belgium</td>
<td>Denmark</td>
</tr>
<tr>
<td>Belgium</td>
<td>Czech Rep.</td>
<td>Estonia</td>
</tr>
<tr>
<td>Slovak Republic</td>
<td>Estonia</td>
<td>Poland</td>
</tr>
<tr>
<td>Poland</td>
<td>Italia</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Korea</td>
<td>Korea</td>
<td>Korea</td>
</tr>
<tr>
<td>Italia</td>
<td>United Kingdom</td>
<td>Ireland</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>Spain</td>
<td>Italy</td>
</tr>
<tr>
<td>Ireland</td>
<td>Ireland</td>
<td>Spain</td>
</tr>
<tr>
<td>Spain</td>
<td>Poland</td>
<td>Belgium</td>
</tr>
</tbody>
</table>

4. Results

Graph set 2 shows the results of the estimation of the efficiency indices for specification 1 (see methodology, section 2), in which the influence of the explanatory variables is taken into account. Graph set 3 corresponds to specification 2, which also incorporates a frontier function but in which the coefficients (with the exception of formal education) that affect the transformation of inputs into outputs are allowed to vary from
country to country. In each case, the results are broken down into the three educational levels completed by the individuals: up to lower secondary; higher secondary, and higher education. Note that the results obtained from the two specifications are largely similar, with only minor differences.

Focusing on Graph set 2, similar patterns are found for the three levels of education (Graphs 2a, 2b and 2c). The efficiency in the transformation of the number of years of schooling into competences is greatest in three of the Nordic countries analyzed (Finland, Sweden and Denmark), Japan and Belgium. In contrast, the lowest levels of efficiency are recorded in Spain, Italy, Ireland, Poland, Korea and the United Kingdom. This pattern is repeated with only minor differences across the three levels of education: the order of the countries is largely similar, with some notable differences, (for example, in the case of higher education Italy presents an especially low level of efficiency and Poland presents a slightly higher level of efficiency).

Graph set 3 (Graphs 3a, 3b and 3c) presents the efficiency indices using specification 2 (in which the coefficients that affect the transformation of inputs into outputs vary from country to country). As in Graph set 2, the Nordic countries present the highest rates of efficiency, these indices being slightly higher than those reported for specification 1. Japan and Belgium present very similar levels of efficiency to those obtained with specification 1, but they fall in the overall ranking of countries by rates of efficiency. The United Kingdom and Italy present the lowest levels of efficiency, while Spain, Ireland and Poland present indices that are similarly low for both specifications. Here the differences in the efficiency indices between the three levels of education (which are small in the case of specification 1) are even smaller. All in all, the positions occupied by the countries in the rankings are very similar across the three levels of education.

Graph set 4 tracks the evolution of the efficiency levels over the different age cohorts for the three levels of education considered. In the case of higher education, it can be seen that in most of the countries considered the levels of efficiency in generating competences are higher among the younger cohorts. This increase in the index is most significant in Spain and Italy, but is also appreciable in the Nordic countries (with the exception of Denmark), Belgium, Holland and Korea. In the cases of the United Kingdom and Ireland, the increase is less pronounced. However, there are hardly any changes in the levels of efficiency in the remaining countries: Japan, Denmark and the four Eastern European countries considered (i.e. Czech Republic, Estonia, Poland and the Slovak Republic).

In the case of higher secondary education, the pattern presented is one of general stability across all the cohorts. The only deviations from this trend are recorded in the cases of Italy and the United Kingdom, where there has been a fall in efficiency among the youngest cohorts, and in that of Finland, where there has been an increase in efficiency.

Likewise, in the case of lower secondary education, efficiency levels in most countries remain stable across all the cohorts. There are exceptions to this general pattern. For example,

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4 Table A.3.1 of Annex 3 gathers the numerical indices calculated according to specification 1, and Table A.3.2 the numerical indices according to specification 2.
in Spain and Korea efficiency levels have increased among younger cohorts, whereas in Italy and the United Kingdom there has been a fall in efficiency levels for these same cohorts. In the Eastern European countries, the pattern of stability is interrupted in the cohort aged between 46 and 55 (26-45 in Slovakia) with marked declines in efficiency, associated in all probability with the historic evolution of the education systems in these countries.

5. Conclusions

The aim of this study has been to compare the degree of efficiency with which the OECD countries produce competences from the schooling provided and from other inputs and, also, to monitor how this efficiency has evolved over different age cohorts. To do so, we have estimated standard stochastic frontier functions applied to OECD data from the PIAAC. In order to estimate this frontier we used two specifications so as to verify the robustness of our results. In the first specification, the influence of the explanatory variables has been taken into account and a function was estimated whose coefficients are common to all of the countries considered; in the second, the frontier functions methodology has been generalized to allow the coefficients (other than formal education) that affect the transformation of inputs into competences (including, years of experience and type of occupation) to vary from country to country.

The levels of efficiency reported by the analyses were similar for both specifications. Furthermore, the results by level of education show that in most cases the efficiency indices are similar for all three levels of education. However, efficiency in the transformation of schooling into competences is greatest in Finland, Sweden, Denmark, Japan and Belgium, while the lowest levels of efficiency are to be found in Spain, the United Kingdom, Italy, Ireland and Poland.

Finally, as regards the evolution in the levels of efficiency associated with different age cohorts, we found that in the case of higher education, levels are higher among younger cohorts, whereas in the cases of lower and upper secondary education, the general pattern, albeit with some exceptions, is one of stability for all the cohorts considered.
Graph set 2. Efficiency indices for competence in mathematics. Specification 1.

Graph 2.a. Lower secondary

Graph 2.b. Higher secondary

Graph 2.c. Higher education

Graph 3.a. Lower secondary

Graph 3.b. Higher secondary

Graph 3.c. Higher education
Graph set 4. Efficiency indices for competence in mathematics according to level of education and cohort

Continental countries

Belgium

Holland

Mediterranean countries

Italy

Spain

Lower secondary  
Higher secondary  
Higher education
References


ANNEX 1. Selection of the functional form of age and experience in education production

Table A.1.1. Free Effect of age and experience

<table>
<thead>
<tr>
<th>Variables</th>
<th>Estimated coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schooling</td>
<td>9.93***</td>
</tr>
<tr>
<td>Age dummies: see Graph 1.A</td>
<td>87.65</td>
</tr>
<tr>
<td>Experience dummies: see Graph 2.A</td>
<td>-21.31***</td>
</tr>
<tr>
<td>Woman</td>
<td>-39.57</td>
</tr>
<tr>
<td>Immigrant 1st gen.</td>
<td>-33.73***</td>
</tr>
<tr>
<td>Immigrant 2nd gen.</td>
<td>-7.42***</td>
</tr>
<tr>
<td>Mother tongue</td>
<td>-19.92***</td>
</tr>
<tr>
<td>Parents basic ed.</td>
<td>-13.64</td>
</tr>
<tr>
<td>Parents secondary ed.</td>
<td>-30.98***</td>
</tr>
<tr>
<td>Unqualified occupation</td>
<td>-40.98</td>
</tr>
<tr>
<td>Without non-regulated training</td>
<td>-15.13***</td>
</tr>
<tr>
<td></td>
<td>-22.42</td>
</tr>
<tr>
<td></td>
<td>-27.94***</td>
</tr>
<tr>
<td>Constant</td>
<td>155.09</td>
</tr>
<tr>
<td>Schwarz Statistic</td>
<td>907087.7</td>
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<tr>
<td>Observations</td>
<td>78,825</td>
</tr>
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</table>
Graph 1.A. Effect of age

Graph 2.A. Effect of experience

Table A.1.2. Linear effect of age and quadratic effect of experience

<table>
<thead>
<tr>
<th>Variables</th>
<th>Estimated coefficients</th>
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<tbody>
<tr>
<td>Schooling</td>
<td>9.70***</td>
</tr>
<tr>
<td></td>
<td>87.39</td>
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<tr>
<td>Age</td>
<td>-1.50***</td>
</tr>
<tr>
<td></td>
<td>-31.94</td>
</tr>
<tr>
<td>Experience</td>
<td>1.85***</td>
</tr>
<tr>
<td></td>
<td>20.42</td>
</tr>
<tr>
<td>Squared experience</td>
<td>-0.02***</td>
</tr>
<tr>
<td></td>
<td>-11.88</td>
</tr>
<tr>
<td>Woman</td>
<td>-21.23***</td>
</tr>
<tr>
<td></td>
<td>-39.38</td>
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<tr>
<td>Immigrant 1st gen.</td>
<td>-34.24***</td>
</tr>
<tr>
<td></td>
<td>-24.25</td>
</tr>
<tr>
<td>Immigrant 2nd gen.</td>
<td>-7.51***</td>
</tr>
<tr>
<td></td>
<td>-3.68</td>
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<tr>
<td>Mother tongue</td>
<td>-20.05***</td>
</tr>
<tr>
<td></td>
<td>-13.69</td>
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<tr>
<td>Characteristic</td>
<td>Coefficient</td>
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<tr>
<td>-------------------------------------</td>
<td>-------------</td>
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<td>Parents basic ed.</td>
<td>-31.87***</td>
</tr>
<tr>
<td></td>
<td>-42.28</td>
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<tr>
<td>Parents secondary ed.</td>
<td>-15.82***</td>
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<td></td>
<td>-23.44</td>
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<tr>
<td>Unqualified occupation</td>
<td>-28.31***</td>
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<tr>
<td></td>
<td>-44.37</td>
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<tr>
<td>Without non-regulated training</td>
<td>-12.33***</td>
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<td>Observations</td>
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</tr>
</tbody>
</table>

**ANNEX 2. A proposal to generalize the frontier production function (Approach 2)**

The starting point is the competence production functions at the country level:

\[ Y_{ij} = \mu_j + \beta_j^i X_{ij} + \alpha_j S_{ij} + w_{ij} \]

where “i” is the individual and “j” the country. \(X_{ij}\) are the characteristics of the individual and \(S_{ij}\) are the number of years of education. From this, we obtain:

\[ Y_{ij} - \beta_j^i X_{ij} = \mu_j + \alpha_j S_{ij} + w_{ij} \]

\[ Y_{ij}^* = \mu_j + \alpha_j S_{ij} + w_{ij} \]

If “\(Y_{ij}^*\)” of equation (3) were directly observable, this equation could be estimated using the standard frontier function technique and assuming a common \(\alpha_j\). As this is not the case, the proposal is:

a)  Estimate (1) by OLS for the different countries. This enables us to obtain a consistent estimation of the “\(\beta\)” coefficients.

b)  From this consistent estimation of “\(\beta\)”, we obtain an estimation of \(\hat{Y}_{ij}^* = Y_{ij} - \hat{\beta}_j^i X_{ij}\).

This variable “\(\hat{Y}_{ij}^*\)” is an estimation of the competences of individual “i” living in country “j” after excluding the effects of experience, age, sex, and all the other variables on the competences acquired.

c)  Given that “\(\hat{Y}_{ij}^*\)” is the net of the contribution of the remaining variables of education, a frontier function can be estimated for this variable using the number of years of schooling as the only explanatory variable. Following this approach, the efficiency term estimated from this frontier will also refer uniquely to the years of schooling.
ANNEX 3. Efficiency indices calculated according to specifications 1 and 2

Table A.3.1. Efficiency indices by levels of study. Specification 1

<table>
<thead>
<tr>
<th>Country</th>
<th>Lower Secondary</th>
<th>Higher Secondary</th>
<th>Higher education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>87.02281</td>
<td>88.66001</td>
<td>91.17441</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>85.46297</td>
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<td>90.40039</td>
</tr>
<tr>
<td>Denmark</td>
<td>86.66442</td>
<td>89.10681</td>
<td>89.91032</td>
</tr>
<tr>
<td>Estonia</td>
<td>86.17697</td>
<td>88.31044</td>
<td>88.65252</td>
</tr>
<tr>
<td>Finland</td>
<td>88.54883</td>
<td>89.32155</td>
<td>90.65049</td>
</tr>
<tr>
<td>Ireland</td>
<td>82.19496</td>
<td>85.06034</td>
<td>86.77006</td>
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<tr>
<td>Italy</td>
<td>84.83895</td>
<td>87.80328</td>
<td>85.25765</td>
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<td>Japan</td>
<td>86.71206</td>
<td>90.28149</td>
<td>90.83987</td>
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<tr>
<td>Korea</td>
<td>83.38552</td>
<td>87.29479</td>
<td>87.14777</td>
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<tr>
<td>Netherlands</td>
<td>86.68916</td>
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<tr>
<td>Norway</td>
<td>85.86949</td>
<td>88.17571</td>
<td>89.82951</td>
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<td>Poland</td>
<td>83.86766</td>
<td>85.2742</td>
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<td>Slovak Republic</td>
<td>85.85493</td>
<td>89.64773</td>
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<td>Spain</td>
<td>82.65196</td>
<td>86.29001</td>
<td>86.30075</td>
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<td>Sweden</td>
<td>86.9926</td>
<td>89.72025</td>
<td>91.01138</td>
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<tr>
<td>United Kingdom</td>
<td>83.01533</td>
<td>86.13918</td>
<td>87.20603</td>
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</table>

Table A.3.2. Efficiency indices by levels of study. Specification 2

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<th>Higher education</th>
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<tbody>
<tr>
<td>Belgium</td>
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<td>Denmark</td>
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<td>Estonia</td>
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<td>88.8939</td>
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<td>Finland</td>
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<td>Ireland</td>
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<td>Italy</td>
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<td>Slovak Republic</td>
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<td>United Kingdom</td>
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CREAP2006-01
Matas, A. (GEAP); Raymond, J.LL. (GEAP)
"Economic development and changes in car ownership patterns"
(Juny 2006)

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Trillas, F. (IEB); Montolía, D. (IEB); Duch, N. (IEB)
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(Setembre 2006)

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(Octubre 2006)

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(Desembre 2006)

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(Desembre 2006)

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Camarero, M.; Carrion-i-Silvestre, J.L.L. (AQR-IREA); Tamarit, C.
"New evidence of the real interest rate parity for OECD countries using panel unit root tests with breaks”
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“The macroeconomics of the labor market: Three fundamental views”
(Desembre 2006)

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Raymond, J. Ll. (GEAP); Roig, J. Ll. (GEAP)
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“An empirical analysis of wealth taxation: Equity vs. Tax compliance”
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“Comparison of recent toll road concession transactions in the United States and France”
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“Innovation, R&D spillovers and productivity: the role of knowledge-intensive services”
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Bermúdez Morata, M. (FRA-IREA); Guillén Estany, M. (FRA-IREA), Solé Auró, A. (FRA-IREA)
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“Fiscal sustainability across government tiers”
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“Influencia de la inmigración en la elección escolar”
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“Car ownership and access to jobs in Spain”
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“The Black Box of Business Dynamics”
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Solé-Auró, A. (RFA-IREA), Guillén, M. (RFA-IREA), Crimmins, E. M.
“Health care utilization among immigrants and native-born populations in 11 European countries. Results from the Survey of Health, Ageing and Retirement in Europe”
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“Small firms, growth and financial constraints”
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Matas, A. (GEAP), Raymond, J.Ll. (GEAP), Ruiz, A. (GEAP)
“Traffic forecasts under uncertainty and capacity constraints”
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“Inter-regional redistribution through infrastructure investment: tactical or programmatic?”
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“The determinants of university patenting: Do incentives matter?”
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Ramos, R. (AQR-IREA), Suriñach, J. (AQR-IREA), Artís, M. (AQR-IREA)
“Human capital spillovers, productivity and regional convergence in Spain”
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Álvarez-Albelo, C. D. (CREB), Hernández-Martín, R.
“The commons and anti-commons problems in the tourism economy”
(Desembre 2009)

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García-López, M. A. (GEAP)
“The Accessibility City. When Transport Infrastructure Matters in Urban Spatial Structure”
(Febreir 2010)

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García-Quevedo, J. (IEB), Mas-Verdú, F. (IEB), Polo-Otero, J. (IEB)
“Which firms want PhDs? The effect of the university-industry relationship on the PhD labour market”
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“An introduction to parametric and non-parametric models for bivariate positive insurance claim severity distributions”
(Març 2010)

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Bermúdez, Ll. (RFA-IREA), Karlis, D.
“Modelling dependence in a ratemaking procedure with multivariate Poisson regression models”
(Abril 2010)

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“Parental education and family characteristics: educational opportunities across cohorts in Italy and Spain”
(Maig 2010)

XREAP2010-06
Simón, H. (IEB), Ramos, R. (AQR-IREA), Sanromá, E. (IEB)
“Movilidad ocupacional de los inmigrantes en una economía de bajas cualificaciones. El caso de España”
(Juny 2010)

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Di Paolo, A. (GEAP & IEB), Raymond, J. Ll. (GEAP & IEB)
“Language knowledge and earnings in Catalonia”
(Juliol 2010)

XREAP2010-08
“Prediction of the economic cost of individual long-term care in the Spanish population”
(Setembre 2010)

XREAP2010-09
Di Paolo, A. (GEAP & IEB)
“Knowledge of catalan, public/private sector choice and earnings: Evidence from a double sample selection model”
(Setembre 2010)

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Coad, A., Segarra, A. (GRIT), Teruel, M. (GRIT)
“Like milk or wine: Does firm performance improve with age?”
(Setembre 2010)

XREAP2010-11
Di Paolo, A. (GEAP & IEB), Raymond, J. Ll. (GEAP & IEB), Calero, J. (IEB)
“Exploring educational mobility in Europe”
(Octubre 2010)

XREAP2010-12
Borrell, A. (GiM-IREA), Fernández-Villadangos, L. (GiM-IREA)
“Clustering or scattering: the underlying reason for regulating distance among retail outlets”
(Desembre 2010)

XREAP2010-13
Di Paolo, A. (GEAP & IEB)
“School composition effects in Spain”
(Desembre 2010)

XREAP2010-14
Fageda, X. (GiM-IREA), Flores-Fillol, R.
“Technology, Business Models and Network Structure in the Airline Industry”
(Desembre 2010)

XREAP2010-15
Albalate, D. (GiM-IREA), Bel, G. (GiM-IREA), Fageda, X. (GiM-IREA)
“Is it Redistribution or Centralization? On the Determinants of Government Investment in Infrastructure”
(Desembre 2010)

XREAP2010-16
Oppedisano, V., Turati, G.
“What are the causes of educational inequalities and of their evolution over time in Europe? Evidence from PISA”
(Desembre 2010)

XREAP2010-17
Canova, L., Vaglio, A.
“Why do educated mothers matter? A model of parental help”
(Desembre 2010)

2011

XREAP2011-01
Fageda, X. (GiM-IREA), Perdiguero, J. (GiM-IREA)
“An empirical analysis of a merger between a network and low-cost airlines”
(Maig 2011)
XREAP2011-02
Moreno-Torres, I. (ACCO, CRES & GiM-IREA)
“What if there was a stronger pharmaceutical price competition in Spain? When regulation has a similar effect to collusion”
(Maig 2011)

XREAP2011-03
Miguélez, E. (AQR-IREA); Gómez-Miguélez, I.
“Singling out individual inventors from patent data”
(Maig 2011)

XREAP2011-04
Moreno-Torres, I. (ACCO, CRES & GiM-IREA)
“Generic drugs in Spain: price competition vs. moral hazard”
(Maig 2011)

XREAP2011-05
Nieto, S. (AQR-IREA), Ramos, R. (AQR-IREA)
“¿Afecta la sobreeducación de los padres al rendimiento académico de sus hijos?”
(Maig 2011)

XREAP2011-06
Pitt, D., Guillén, M. (RFA-IREA), Bolancé, C. (RFA-IREA)
“Estimation of Parametric and Nonparametric Models for Univariate Claim Severity Distributions - an approach using R”
(Juny 2011)

XREAP2011-07
Guillén, M. (RFA-IREA), Comas-Herrera, A.
“How much risk is mitigated by LTC Insurance? A case study of the public system in Spain”
(Juny 2011)

XREAP2011-08
Ayuso, M. (RFA-IREA), Guillén, M. (RFA-IREA), Bolancé, C. (RFA-IREA)
“Loss risk through fraud in car insurance”
(Juny 2011)

XREAP2011-09
Duch-Brown, N. (IEB), García-Quevedo, J. (IEB), Montolio, D. (IEB)
“The link between public support and private R&D effort: What is the optimal subsidy?”
(Juny 2011)

XREAP2011-10
Bermúdez, Ll. (RFA-IREA), Karlis, D.
“Mixture of bivariate Poisson regression models with an application to insurance”
(Juliol 2011)

XREAP2011-11
Varela-Irimia, X.-L. (GRIT)
“Age effects, unobserved characteristics and hedonic price indexes: The Spanish car market in the 1990s”
(Octubre 2011)

XREAP2011-12
Bermúdez, Ll. (RFA-IREA), Ferri, A. (RFA-IREA), Guillén, M. (RFA-IREA)
“A correlation sensitivity analysis of non-life underwriting risk in solvency capital requirement estimation”
(Sentembre 2011)

XREAP2011-13
“A logistic regression approach to estimating customer profit loss due to lapses in insurance”
(Octubre 2011)

XREAP2011-14
Jiménez, J. L., Perdiguero, J. (GiM-IREA), García, C.
“Evaluation of subsidies programs to sell green cars: Impact on prices, quantities and efficiency”
(Octubre 2011)
XREAP2011-15
Arespa, M. (CREB)
“A New Open Economy Macroeconomic Model with Endogenous Portfolio Diversification and Firms Entry”
(Octubre 2011)

XREAP2011-16
Matas, A. (GEAP), Raymond, J. L. (GEAP), Roig, J.L. (GEAP)
“The impact of agglomeration effects and accessibility on wages”
(Novembre 2011)

XREAP2011-17
Segarra, A. (GRIT)
“R&D cooperation between Spanish firms and scientific partners: what is the role of tertiary education?”
(Novembre 2011)

XREAP2011-18
García-Pérez, J. I.; Hidalgo-Hidalgo, M.; Robles-Zurita, J. A.
“Does grade retention affect achievement? Some evidence from PISA”
(Novembre 2011)

XREAP2011-19
Arespa, M. (CREB)
“Macroeconomics of extensive margins: a simple model”
(Novembre 2011)

XREAP2011-20
García-Quevedo, J. (IEB), Pellegrino, G. (IEB), Vivarelli, M.
“The determinants of YICs’ R&D activity”
(Desembre 2011)

XREAP2011-21
González-Val, R. (IEB), Olmo, J.
“Growth in a Cross-Section of Cities: Location, Increasing Returns or Random Growth?”
(Desembre 2011)

XREAP2011-22
Gombau, V. (GRIT), Segarra, A. (GRIT)
“The Innovation and Imitation Dichotomy in Spanish firms: do absorptive capacity and the technological frontier matter?”
(Desembre 2011)

2012

XREAP2012-01
Borrell, J. R. (GiM-IREA), Jiménez, J. L., García, C.
“Evaluating Antitrust Leniency Programs”
(Gener 2012)

XREAP2012-02
Ferri, A. (RFA-IREA), Guillén, M. (RFA-IREA), Bermúdez, I.I. (RFA-IREA)
“Solvency capital estimation and risk measures”
(Gener 2012)

XREAP2012-03
Ferri, A. (RFA-IREA), Bermúdez, I.I. (RFA-IREA), Guillén, M. (RFA-IREA)
“How to use the standard model with own data”
(Febrer 2012)

XREAP2012-04
Perdiguer, J. (GiM-IREA), Borrell, J.R. (GiM-IREA)
“Driving competition in local gasoline markets”
(Març 2012)

XREAP2012-05
D’Amico, G., Guillen, M. (RFA-IREA), Manca, R.
(Març 2012)
XREAP2012-06
Bové-Sans, M. A. (GRIT), Laguado-Ramírez, R.
“Quantitative analysis of image factors in a cultural heritage tourist destination”
(Abril 2012)

XREAP2012-07
“Changes in wage structure in Mexico going beyond the mean: An analysis of differences in distribution, 1987-2008”
(Maig 2012)

XREAP2012-08
“What underlies localization and urbanization economies? Evidence from the location of new firms”
(Maig 2012)

XREAP2012-09
Muñiz, I. (GEAP), Calatayud, D., Dobaño, R.
“Los límites de la compacidad urbana como instrumento a favor de la sostenibilidad. La hipótesis de la compensación en Barcelona medida a través de la huella ecológica de la movilidad y la vivienda”
(Maig 2012)

XREAP2012-10
Arqué-Castells, P. (GEAP), Mohnen, P.
“Sunk costs, extensive R&D subsidies and permanent inducement effects”
(Maig 2012)

XREAP2012-11
Boj, E. (CREB), Delicado, P., Fortiana, J., Esteve, A., Caballé, A.
“Local Distance-Based Generalized Linear Models using the dbstats package for R”
(Maig 2012)

XREAP2012-12
Royuela, V. (AQR-IREA)
“What about people in European Regional Science?”
(Maig 2012)

XREAP2012-13
Osorio A. M. (RFA-IREA), Bolancé, C. (RFA-IREA), Madise, N.
“Intermediary and structural determinants of early childhood health in Colombia: exploring the role of communities”
(Juny 2012)

XREAP2012-14
Miguélez. E. (AQR-IREA), Moreno, R. (AQR-IREA)
“Do labour mobility and networks foster geographical knowledge diffusion? The case of European regions”
(Juliol 2012)

XREAP2012-15
Teixidó-Figueras, J. (GRIT), Duró, J. A. (GRIT)
“Ecological Footprint Inequality: A methodological review and some results”
(Setembre 2012)

XREAP2012-16
Varela-Irimia, X-L. (GRIT)
“Profitability, uncertainty and multi-product firm product proliferation: The Spanish car industry”
(Setembre 2012)

XREAP2012-17
Duró, J. A. (GRIT), Teixidó-Figueras, J. (GRIT)
“Ecological Footprint Inequality across countries: the role of environment intensity, income and interaction effects”
(Octubre 2012)

XREAP2012-18
Manresa, A. (CREB), Sancho, F.
“Leontief versus Ghosh: two faces of the same coin”
(Octubre 2012)
XREAP2012-19
Alemany, R. (RFA-IREA), Bolancé, C. (RFA-IREA), Guillén, M. (RFA-IREA)
“Nonparametric estimation of Value-at-Risk”
(Octubre 2012)

XREAP2012-20
Herrera-Idárraga, P. (AQR-IREA), López-Bazo, E. (AQR-IREA), Motellón, E. (AQR-IREA)
“Informality and overeducation in the labor market of a developing country”
(Novembre 2012)

XREAP2012-21
Di Paolo, A. (AQR-IREA)
“(Endogenous) occupational choices and job satisfaction among recent PhD recipients: evidence from Catalonia”
(Desembre 2012)

2013

XREAP2013-01
Segarra, A. (GRIT), García-Quevedo, J. (IEB), Teruel, M. (GRIT)
“Financial constraints and the failure of innovation projects”
(Març 2013)

XREAP2013-02
Osorio, A. M. (RFA-IREA), Bolancé, C. (RFA-IREA), Madise, N., Rathmann, K.
“Social Determinants of Child Health in Colombia: Can Community Education Moderate the Effect of Family Characteristics?”
(Març 2013)

XREAP2013-03
Teixidó-Figueras, J. (GRIT), Duró, J. A. (GRIT)
“The building blocks of international ecological footprint inequality: a regression-based decomposition”
(Abril 2013)

XREAP2013-04
Salcedo-Sanz, S., Carro-Calvo, L., Claramunt, M. (CREB), Castañer, A. (CREB), Marmol, M. (CREB)
“An Analysis of Black-box Optimization Problems in Reinsurance: Evolutionary-based Approaches”
(Mai 2013)

XREAP2013-05
Alcañiz, M. (RFA), Guilén, M. (RFA), Sánchez-Moscon, D. (RFA), Santolino, M. (RFA), Latje, O., Ramon, L.
“Prevalence of alcohol-impaired drivers based on random breath tests in a roadside survey”
(Juliol 2013)

XREAP2013-06
Matas, A. (GEAP & IEB), Raymond, J., LL. (GEAP & IEB), Roig, J. L. (GEAP)
“How market access shapes human capital investment in a peripheral country”
(Octubre 2013)

XREAP2013-07
Di Paolo, A. (AQR-IREA), Tansel, A.
“Returns to Foreign Language Skills in a Developing Country: The Case of Turkey”
(Novembre 2013)

XREAP2013-08
Fernández Gual, V. (GRIT), Segarra, A. (GRIT)
“The Impact of Cooperation on R&D, Innovation and Productivity: an Analysis of Spanish Manufacturing and Services Firms”
(Novembre 2013)

XREAP2013-09
Bahraoui, Z. (RFA); Bolancé, C. (RFA); Pérez-Marin, A. M. (RFA)
“Testing extreme value copulas to estimate the quantile”
(Novembre 2013)

2014

XREAP2014-01
Solé-Auró, A. (RFA), Alcañiz, M. (RFA)
“Are we living longer but less healthy? Trends in mortality and morbidity in Catalonia (Spain), 1994-2011”
(Gener 2014)

XREAP2014-02
Teixidó-Figueres, J. (GRIT), Duro, J. A. (GRIT)
“Spatial Polarization of the Ecological Footprint distribution”
(Febrer 2014)

XREAP2014-03
Cristosal-Cebolla, A.; Gil Lafuente, A. M. (RFA), Merigó Lindhal, J. M. (RFA)
“La importancia del control de los costes de la no-calidad en la empresa”
(Febrer 2014)

XREAP2014-04
Castañer, A. (CREB); Claramunt, M.M. (CREB)
“Optimal stop-loss reinsurance: a dependence analysis”
(Abril 2014)

XREAP2014-05
Di Paolo, A. (AQR-IREA); Matas, A. (GEAP); Raymond, J. Ll. (GEAP)
“Job accessibility, employment and job-education mismatch in the metropolitan area of Barcelona”
(Maig 2014)

XREAP2014-06
Di Paolo, A. (AQR-IREA); Mañé, F.
“Are we wasting our talent? Overqualification and overskilling among PhD graduates”
(Juny 2014)

XREAP2014-07
Segarra, A. (GRIT); Tercel, M. (GRIT); Bové, M. A. (GRIT)
“A territorial approach to R&D subsidies: Empirical evidence for Catalan firms”
(Setembre 2014)

XREAP2014-08
Ramos, R. (AQR-IREA); Sanromá, E. (IEB); Simón, H.
“Public-private sector wage differentials by type of contract: evidence from Spain”
(Octubre 2014)

XREAP2014-09
Bel, G. (GiM-IREA); Bolancé, C. (Riskcenter-IREA); Guillén, M. (Riskcenter-IREA); Rosell, J. (GiM-IREA)
“The environmental effects of changing speed limits: a quantile regression approach”
(Desembre 2014)

2015

XREAP2015-01
Bolance, C. (Riskcenter-IREA); Bahraoui, Z. (Riskcenter-IREA), Alemany, R. (Riskcenter-IREA)
“Estimating extreme value cumulative distribution functions using bias-corrected kernel approaches”
(Gener 2015)

XREAP2015-02
Ramos, R. (AQR-IREA); Sanromá, E. (IEB), Simón, H.
“An analysis of wage differentials between full- and part-time workers in Spain”
(Agost 2015)

XREAP2015-03
Cappellari, L.; Di Paolo, A. (AQR-IREA)
“Bilingual Schooling and Earnings: Evidence from a Language-in-Education Reform”
(Setembre 2015)

XREAP2015-04
Álvarez-Albelo, C. D., Manresa, A. (CREB), Pigem-Vigo, M. (CREB)
“Growing through trade: The role of foreign growth and domestic tariffs”
(Novembre 2015)

XREAP2015-05
Caminal, R., Di Paolo, A. (AQR-IREA)
Your language or mine?
(Novembre 2015)

XREAP2015-06
Choi, H. (AQR-IREA), Choi, A. (IEB)
When one door closes: the impact of the hagwon curfew on the consumption of private tutoring in the Republic of Korea
2016

XREAP2016-01
Castañer, A. (CREB, XREAP); Claramunt, M M. (CREB, XREAP); Tadeo, A., Varea, J. (CREB, XREAP)
Modelización de la dependencia del número de siniestros. Aplicación a Solvencia II
(Setembre 2016)

XREAP2016-02
García-Quevedo, J. (IEB, XREAP); Segarra-Blasco, A. (GRIT, XREAP); Teruel, M. (GRIT, XREAP)
Financial constraints and the failure of innovation projects
(Setembre 2016)

XREAP2016-03
Jové-Llopis, E. (GRIT, XREAP); Segarra-Blasco, A. (GRIT, XREAP)
What is the role of innovation strategies? Evidence from Spanish firms
(Setembre 2016)

XREAP2016-04
Albalate, D. (GiM-IREA, XREAP); Rosell, J. (GiM-IREA, XREAP)
Persistent and transient efficiency on the stochastic production and cost frontiers – an application to the motorway sector
(Octubre 2016)

XREAP2016-05
Jofre-Monseny, J. (IEB, XREAP), Silva, J. I., Vázquez-Grenno, J. (IEB, XREAP)
Local labor market effects of public employment
(Novembre 2016)

XREAP2016-06
Next train to the polycentric city: The effect of railroads on subcenter formation
(Novembre 2016)

XREAP2016-07
Vayá, E. (AQR-IREA, XREAP), García, J. R. (AQR-IREA, XREAP), Murillo, J. (AQR-IREA, XREAP), Román, J. (AQR-IREA, XREAP), Suriñach, J. (AQR-IREA, XREAP),
Economic impact of cruise activity: the port of Barcelona
(Desembre 2016)

XREAP2016-08
Ayuso, M. (Riskcenter, XREAP), Guillén, M. (Riskcenter, XREAP), Nielsen, J. P.
Improving automobile insurance ratemaking using telematics: incorporating mileage and driver behaviour data
(Desembre 2016)

XREAP2016-09
Ruiz, A. (GEAP, XREAP), Matas, A. (GEAP, XREAP), Raymond, J. Ll.
How do road infrastructure investments affect the regional economy? Evidence from Spain
(Desembre 2016)

2017

XREAP2017-01
Bernardo, V. (GiM-IREA, XREAP); Fageda, X. (GiM-IREA, XREAP)
Globalization, long-haul flights and inter-city connections
(Octubre 2017)

XREAP2017-02
Di Paolo, A. (AQR-IREA, XREAP); Tansel, A.
Analyzing Wage Differentials by Fields of Study: Evidence from Turkey
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XREAP2017-03
Melguizo, C. (AQR-IREA, XREAP); Royuela, V. (AQR-IREA, XREAP)
What drives migration moves across urban areas in Spain? Evidence from the great recession
(Octubre 2017)
XREAP2017-04
Boonen, T.J., Guillén, M. (RISKCENTER, XREAP); Santolino, M. (RISKCENTER, XREAP)
Forecasting compositional risk allocations
(Octubre 2017)

XREAP2017-05
Curto-Grau, M. (IEB, XREAP), Solé-Ollé, A. (IEB, XREAP), Sorribas-Navarro, P. (IEB, XREAP)
Does electoral competition curb party favoritism?
(Novembre 2017)

XREAP2017-06
Esteller, A. (IEB, XREAP), Piolatto, A. (IEB, XREAP), Rablen, M. D.
Taxing high-income earners: tax avoidance and mobility
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XREAP2017-07
Bolancé, C. (RISKCENTER, XREAP), Vernic, R
Multivariate count data generalized linear models: Three approaches based on the Sarmanov distribution
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XREAP2017-08
Albalate, D. (GiM-IREA, XREAP), Bel-Piñana, P. (GiM-IREA, XREAP)
Public Private Partnership management effects on road safety outcomes
(Novembre 2017)

XREAP2017-09
Teruel, M. (GRIT, XREAP), Segarra, A. (GRIT, XREAP)
Gender diversity, R&D teams and patents: An application to Spanish firms
(Novembre 2017)

XREAP2017-10
Cuberes, D., Teignier, M. (CREB, XREAP)
How Costly Are Labor Gender Gaps? Estimates by Age Group for the Balkans and Turkey
(Novembre 2017)

XREAP2017-11
Murillo, I. P., Raymond, J. L. (GEAP, XREAP), Calero, J. (IEB, XREAP),
Efficiency in the transformation of schooling into competences: A cross-country analysis using PIAAC data
(Novembre 2017)