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# External return to education in Europe

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In the literature, social return to education is defined as the sum of human capital return and external return. The novelty of this study is that it provides an international comparison of external return to education. Many authors claim that the social return rate exceeds the pure technical rate of return by a considerable margin. However, measurement of social return is challenged methodologically and by data problems. The approach employed in this study is based on comparative advantage theory which allows control for potential endogeneity and self-selection into different streams of education. External return was found to be positive in all European countries although magnitudes varied. The external return was greater in smaller economies where there was a smaller proportion of highly educated people.

Keywords: return to education, private returns, external returns, social returns.

Although numerous studies have proved that investment in education is profitable at an individual level, not much is known about the profitability of tertiary education at an economic level. This study investigates human capital externalities in several European countries. These externalities exist since the decision to invest in education increases individual productivity and hence wages, and may also have the additional effect of increasing the productivity of other workers. Despite this, there is no general scheme for financing education. In some countries, investment in higher-level education is supported by the state, while in others it is exclusively private. It is, therefore, highly relevant to verify whether educational subsidy, as dictated by policy, enhances the welfare of society.

Undoubtedly, investment in human capital creates great opportunity for people, families, firms and society as a whole. Such an investment is considered to be the simplest means to higher levels of social welfare. Accumulation of human capital accelerates technological and economic growth. Education improves worker productivity and therefore has an influence on earnings. However, the total gains from investment in education could exceed the human capital rate of return. These gains may then lead to many positive externalities for society, for example, better hygiene and health standards. Educated people are presumed to be innovative and those less educated often follow their new habits and lifestyle. Educated members of societies have better capacity for understanding and processing new information and transmit this information to others. Therefore, it is rather obvious that

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external effects of education must exist; but, these external effects are challenging to quantify.

Many studies have shown that an additional year of schooling increases an individual wage by 5–10%; even up to 15% in countries with a relatively low GDP per capita during economic expansion (Psacharopoulos and Patrinos, 2002). However, the economic consequences of change in the mean number of years in education may be different to this human capital return. A positive change in average level of education increases the skilled-work supply, and could also influence labour demand. Such growth may increase total wages and human capital returns to education for two separate reasons. First, the standard neoclassical model suggests that, if educated and uneducated workers are imperfect substitutes, an increase in the proportion of educated workers will raise wages for both groups. Secondly, a human capital spillover may result from the exchange of ideas and learning by doing. Those with a lower level of education may acquire skills simply by imitation of highly educated workers. The increase in wages is an effect of increased productivity; however, if education also has a signalling effect, or if supply of other production factors is inelastic, this increase in wages is lower than the human capital rate of return on education. Therefore, the value of education to a society may exceed the rate of human capital return as a result of the positive external returns. Despite its potential significance to economic policy, much less is known about the external return to education than to human capital.

The concept of external return to education was brought into economic analysis by Acemoglu and Angrist (1999), and their approach was extended by Moretti (2004). The analysis departs from the concept of social capital. Bourdieu (1986) raised the argument that "social capital is an attribute of an individual in a social context. One acquires social capital through purposeful action and can transform social capital into conventional economic gain". In this context, social return to education may be defined as the part of the return that can be attributed to social capital. Social effects increase the return on education, but cannot be captured in a standard human capital-based framework.

In order to formalise this concept, Moretti (2004) defined social return to education as the sum of human capital return and external return. The former is often treated as a private return. The latter is defined as the effect of an increase in the proportion of educated workers in the area on the total sum of wages less the change in human capital return. For the reasons already mentioned, private and external returns should be estimated simultaneously. However, there is no straightforward direct measure that captures the external return to education. The usual proxy suggested in the literature is the effect on wages caused by the increased numbers of educated workers.

Many economists have studied human capital returns to education. Several economic surveys have found a positive relationship between an educational degree and salary received. Labour market research indicates that in the United States, each additional year of education increases an average wage by 7.5% (Acemoglu and Angrist, 1999). In a similar article, Blundell et al. (2005) showed, using various econometric techniques, that a degree raises the average salary by 25% in the United Kingdom. Similar results have been obtained in studies of other European countries, where the estimated rate of return ranges between 7 and 12% (Psacharopoulos and Patrinos, 2002). Brunello et al. (2001) examined Italian labour market data and showed that the average yearly rate of return on university education was approximately 6.2% for males and 7.5% for females. Comparable results for the EU-15 were obtained by Harmon et al. (2002). They estimated the average annual rate of return at 6.5%. De la Fuente (2003),

in a report prepared for the European Commission, estimated the yearly rate of return to education at 6.2% for the "old" EU members, while he stressed that in the long term there is an additional 3.1% premium from quicker technological development.

The empirical literature on social returns to education is rather limited; evidence is provided only by a few studies. Studies at a microeconomic level report individual log wages by individual years of education, average years of education in the relevant geographical area of interest and additional control variables. The social returns are the sum of the two education coefficients: one for human capital return and the other for external return. Rauch (1993), in one of the few studies on the topic, found evidence for an 8.1% social rate of return with a 3.3% external rate in the United States by comparing wage increases with average educational attainment in an area. Acemoglu and Angrist (1999) estimated social return as approximately 7.5% (external 4.6%) using ordinary least squares (OLS) and the instrumental variable method, 9.1% with a 1.8% external rate. Moretti (2004) estimated spillover from college education by comparing wages for otherwise similar individuals working in cities with contrasting proportions of college graduates in the labour force. They found a positive, significant relationship between an increased supply of college graduates and average wages. However, all these studies are limited to the U.S. labour market.

The other branch of this research involves sector analysis within an industry. Sekelletoriu and Maysami (2004) studied this type of external effect in Latin American countries and found a positive external effect of 2–4%. In the United Kingdom, Kirby and Riley (2008) found a positive external return to education at industry level. The margin is approximately 3%, which is comparable to previous findings.

The macroeconomic approach to return on education uses cross-country regression and uses the log of GDP per capita explained by average schooling and additional control variables. Heckman and Klenow (1997) compared the schooling coefficient from the human capital model with one calculated according to a macroeconomic model; their estimate of social return was 10.6%. Bils and Klenow (1998) used a similar approach. When they accounted for differences in technology, the magnitude of social returns approached private returns and external return disappeared. In a similar study, Topel (1999) also used cross-country regressions and estimated an external return to education of 6.2%.

In this study, the following question is asked: "Is the level of external return similar in all European countries?" If the external return were to vary, it would prompt the further question: "Does this variation equalise the social return to education between countries or does it contribute further to differences in profitability yielded by higher education in different countries? This has significance for policy-making. If the social return on education is similar across Europe, there should be no direct economic incentives to emigrate to obtain higher returns, and consequently better living conditions. If the opposite is the case, after labour market liberalisation, one might expect a greater tendency towards migration among well-educated. The model is based on the comparative advantage theory, and Mincerian wage equations are estimated. In order to assure robustness of the main results, two different datasets are explored: the Consortium for Household Panels for Socio-Economic Research (CHER) for 1990–2000 and the European Community Household Panel (ECHP) for 1994–2001. The novelty of this study is that internationally harmonised data is used, with additional effort to control for the potential endogeneity of decisions about education, average schooling and self-selection.

## Methodology

Measuring social capital is an ambiguous task. There is no widely held consensus on how to measure it, or at which level, macro or micro. The between-country regression approach usually neglects differences in technology level, or uses coarse proxies. Moreover, within-country exceeds between-country variation for education. For this reason, macro-level estimates tend to be significantly higher than those at an individual level. Psacharopoulos and Patrinos (2002) warned that overall results using the macroeconomic approach are inconclusive.

The underlying problem with the microeconomic approach is that the factors potentially responsible for creation of external return to human capital are not easy to quantify. Some methods proposed in the literature suggest that level of education of the population and its geographical concentration are good proxies for associative behaviour; therefore, they can be measures for the external effect as a part of social capital (Moretti, 2004).

There are several ways of estimating the rate of return to education. In this study, the Mincer human capital model was employed (1974). This is the most frequently used model in empirical economics. The Mincerian wage equations are commonly used in several areas of labour economics, such as return to education, wage inequalities, or the pay–gender discrimination gap. This method entails fitting empirical data to the logarithm of the actual wage by linear regression. Characteristics such as level of education, age as a measure of work experience and socio-demographic characteristics are used as explanatory variables.

The analysis of the social return on education, in addition to a human capital rate of return to education, must accommodate educational spillover effects. Education may affect national income in ways that are not fully measurable by wages. For example, education is positively correlated with level of participation in the labour force. Several aspects of daily life, including health and safety standards, electoral participation, and voting behaviour are influenced by a society's educational level. For example, in developing countries, education is negatively associated with women's fertility and positively associated with infant health (Kreuger and Lindahl, 2001). The more educated societies are, the better they understand the interdependencies between different aspects of life, and the better the collective decisions they take. These indirect effects are a vital part of social return. Moretti (2004) formulated a theoretical framework that allows for social return. In his general equilibrium model, an increase in the number of educated workers in the local labour market may raise the average wage above the private return on schooling, even in the absence of any spillover. This is the case in a market with a high intensity of highly skilled workers. The concern is that, according to this model, individuals in regions with high human capital are inherently better workers than individuals with the same observable characteristics who live in regions with low human capital intensity. This situation leads to a self-selection problem, as predicted by the Roy model of self-selection. According to this model, people with similar social and demographic backgrounds are more likely to take up education if they live in a region with a high intensity of skilled labour.

Our empirical approach is similar to that of Acemoglu and Angrist (1999). We define social return to education as the sum of human capital return to education and the indirect effect of an increase in the proportion of educated workers on wages. The latter is called the external wage effect in the literature. This effect is equal to the effect of an increase in the proportion of educated workers minus the effect of private returns to education. The model itself is based on the comparative advantage theory. Individuals choose

their preferred education level. In order to do that, they compare streams of future income with alternative education levels. They could withdraw from the education system at any moment. Continuing education is considered an investment because it entails choice between current costs and future income. Education postpones entry into the labour market and reduces working activity time. Analogously to the standard cost-benefit analysis of investment project, it is possible to calculate the internal rate of return.

In order to reduce the complexity of the analysis, the rate of return to education is treated as the parameter characteristic of an individual. It is assumed that investment at an individual level has no impact on the general equilibrium of the economy. Thus, the marginal return rate is not affected by the decision of other society members. The next simplifying assumption is that study costs are uniformly distributed over a study period. In reality, they are usually higher at the beginning and then decline.

Let $I_{ij}$ be the lifetime labour income of person $i$ with education level $j$. Let $X_i$ be a vector of observable abilities and sociodemographic characteristics and $\varepsilon_i$ a vector of unobservable terms that have an influence on labour income. Then, the lifetime income is defined by:

$$I_{ij} = f(X_i, \varepsilon_i). \tag{1}$$

Assume that the cost of achieving education level $j$ for an individual $i$ is equal to $C_{ij}$. It varies among individuals due to specific abilities and predisposition heterogeneity. Let $V_{ij}$ be a value of utility function derived for person $i$ from an education level $j$. The mechanism of choosing the desired education level can be represented as:

$$V_{ij} = \max_j (I_{ij} - C_{ij}). \tag{2}$$

It is presumed that people behave according to a maximum utility theory. Therefore, one chooses education level $j$ that maximises the difference between future incomes attached to this level and the cost required to achieve it.

The analytic formula is an extension of Willis and Rosen's (1979) model of demand for education combined with Moretti's (2004) approach. From the former, we borrow the selection mechanism, and from the latter, an additional regressor for education in the local area. In our model, in addition to human capital return, we also consider social return to education. We distinguish between highly skilled workers $H$ and lower-skilled ones $L$. We emphasise return to the secondary (high school or equivalent) and tertiary levels (university or equivalent) of education. At the first stage of education, primary school is compulsory; therefore, the lack of an appropriate comparison group makes a return calculation for that education level impossible. Each education level has its own initial earnings: $w_{L0}$ for secondary education and $w_{H0}$ for tertiary. We assume that wages are increasing functions of time. The rate of wage growth $g$ depends on skills achieved during the education process and equals $g_H$ for a person with a higher skill level (university or equivalent education in case of return on tertiary education, or high school or equivalent in case of secondary education) and $g_L$ for workers with fewer skills. The schooling process is time-consuming. In order to attain a higher degree of education, a person has to sacrifice some of his potential labour activity time. The amount of time necessary to achieve a degree is represented as $T$ years. If one chooses a higher level of education, his future stream of incomes $w_{Hi}$ is given by

$$w_{Hi}(t) = \begin{cases} 0 & 0 \le t \le T \\ \underline{\quad} \\ w_{Ho} \exp(g_H(t - T)) & T < t < \infty \end{cases}. \tag{3}$$

The variable $t$ represents working time and $(t - T)$ is a measure of work experience.

We can describe an income equation for a low-educated person in a similar manner:

$$w_{Li}(t) = \overline{w_{Lo}} \exp(g_L t) \quad 0 \leq t < \infty . \qquad (4)$$

An income stream is determined by two parameters: the starting salary for each education level $w_{.0}$ and the growth rate $g$. A person making a decision regarding a desired education level compares discounted future values of potential income. The person $i$ chooses university education if the net benefits from achieving a higher degree are greater than the benefits from a lower level of education.

The discounted values of an education level reflect the economic mechanism of choosing between two different education levels. The salary level is a function of education, experience measured by age and social and demographic characteristics. In labour economics, it is commonly assumed that the distribution of earnings is well approximated by the log normal distribution. The wage equation for each education level could be represented by the classical linear regression model. Following Acemoglu and Angrist (1999) and Moretti (2004), we allow for human capital spillover by letting worker productivity depend on the proportion of educated workers in the local labour market. a human capital quality measure is added to the following wage equation:

$$\ln(w) = Y_{edu\,i}\gamma + X'_i\beta + \left(\frac{H}{H+L}\right)\delta + \varepsilon . \qquad (5)$$

where $X_i$ is a matrix of socio-demographic characteristics including working experience and its square, betas are wage equation coefficients, $Y_{edui}$ is the number of years spent in an education system (education level proxy), $H$ is the number of highly-skilled workers in a local labour market, and $L$ is the size of the local lesser-skilled labour force. The coefficient is an estimate of the average yearly return on schooling and is the proxy for the external effect. The latter is the coefficient of interest, which is the estimate of the effect of the proportion of those with higher education on average wages after controlling for private returns to education.

As indicated by Moretti (2004), the wages of uneducated workers benefit from an increase in the proportion of educated workers for at least two reasons. First, an increase in the number of educated workers raises uneducated worker productivity because of imperfect substitution. Second, the spillover raises their productivity further.

The principal challenge in estimating a causal effect of education on wages is identification. Individual education and average schooling levels could both be correlated with wages for various reasons; thus, the observed relationship between variables is not necessarily causal (Acemoglu and Angrist, 1999). The education level, up to a point, is pre-determined by the social background of the person (Becker, 1976). It is more likely that a person's decision to study is positively affected by living in an area where most of the people are highly educated. As a result, an individual's education and the average education are possibly correlated. Moreover, educational decisions depend on the ability of the person, something which is not directly observed. Therefore, the process of choosing a desired education level could be treated as self-selection. Moreover, as is shown in many studies, individual wages are related to an unobserved characteristic (i.e. ability). There could be an endogeneity problem and a potential sample selection problem. The schooling decision could be endogenous due to the fact that education of the individual influences the proportion of highly skilled people in the area; at the same time, those living with highly educated neighbours are more likely to obtain higher education that those who live in other communities. The reasons for potential self-selection are twofold. The first involves

the influence of a person's ability on their schooling decision. Unfortunately, ability is not directly observed. Otherwise, we find no support in the literature for the suggestion that people in one particular area could have more educational talent than populations elsewhere. The second reason involves the individual's behaviour in the labour market. In order to calculate the returns, one needs to observe wages. However, the opportunity cost of work differs between countries.

In the presence of an endogeneity or self-selection problem, standard estimators would be inconsistent (Blundell et al., 2005). In order to alleviate the endogeneity problem, an instrumental variable approach must be used; that is, education in the area has to be replaced by set of instruments, and in the case of selection bias, it is necessary to include a selection equation in the model. This equation describes the mechanism for selecting the observations–working people–for the estimation sample. The non-labour income is used to identify selection equation and regional dummies are used only in selection equation. The complete model can be expressed as

$$\begin{cases} w_0 = Z_i'\alpha + \xi_i \\ \ln(w) = Y_{edu\,i}\gamma + X_i\beta + \left(\frac{H}{H+L}\right)\delta + \varepsilon \end{cases}. \quad (6)$$

where $w_0$ is the selection indicator interpreted as a wage offer above a reservation wage, $Z_i$ is the selection variable matrix, and alphas are selection equation coefficients.

## Data

Two broad datasets were used to analyse the external effect of education. The first, the ECHP, was a harmonised European longitudinal survey of households, income, and living conditions. The survey ran from 1994 to 2001 and encompassed 15 EU member states (the EU-15 or "old member states"). The sample for each year comprised information on approximately 65 000 households and 130 000 adults (170 000 individuals including children). Unfortunately, it was not possible to take advantage of the longitudinal nature of the data in the analysis for two reasons. Firstly, for most countries, the data had a rolling panel design; secondly, the results for the remaining countries might have been heavily influenced by attrition bias[1].

The second source of empirical data was CHER, an internationally comparative microeconomic database that integrated longitudinal datasets from Europe and the United States over a many years (1990–2001) and included countries in the ECHP. However, for most countries, data were available from 1994. The base contains data for 18 countries (14 EU members in 1994, as well as Switzerland, Poland, Hungary, and the United States). Topics encompassed by the data are labour force participation and related issues, income components, and social relationships. These data contain the averages of approximately 75 000 households and 150 000 individuals surveyed annually; however, the number of participating countries varied from year to year[2].

Both datasets mentioned are from national surveys; therefore, not all relevant variables for the analysis were available for all countries. This issue is discussed later. Here, it was decided to use both datasets for several reasons. The ECHP data contained more observations for each country, while the CHER data covered a larger number of countries. Pursuing the analysis on both datasets provided a simple robustness check. The list of countries and sample sizes is presented in Table 1.

The empirical sample is restricted in terms of several dimensions. First, analogously to Kirby and Riley (2008), the analysis was narrowed to individuals aged 30 to 55. Younger

[1] The attrition rate is approximately 15%.

[2] We excluded the United States from the CHER sample as it is a non-European country.

Table 1
*Sample sizes*

| Sample | ECHP | | | CHER | | |
|---|---|---|---|---|---|---|
| | full | NUTS | NUTS&town | Full | NUTS | NUTS&town |
| Austria | 44 909 | 15 007 | 11 945 | 45 920 | 17 412 | 4 231 |
| Belgium | 40 698 | 16 815 | 13 267 | 48 344 | 13 319 | 13 304 |
| Finland | 41 831 | 18 854 | 13 725 | 41 982 | 20 706 | 0 |
| France | 86 770 | 32 818 | 26 243 | 95 171 | 33 933 | 7 242 |
| Greece | 83 276 | 25 073 | 19 567 | 85 748 | 30 356 | 6 738 |
| Hungary | – | – | – | 25 668 | 8 088 | 4 604 |
| Ireland | 44 171 | 13 035 | 7 768 | 53 116 | 16 982 | 2 489 |
| Italy | 122 429 | 43 032 | 33 794 | 129 151 | 46 094 | 0 |
| Portugal | 87 682 | 29 524 | 25 335 | 91 437 | 34 935 | 8 451 |
| Poland | – | – | – | 41 776 | 10 364 | 7 552 |
| Spain | 114 566 | 33 766 | 24 579 | 115 779 | 36 856 | 0 |
| Sweden | 45 177 | 22 863 | 20 536 | – | – | – |
| United Kingdom | 67 790 | 28 567 | 23 622 | 103 498 | 36 408 | 31 319 |

Based on ECHP and CHER data.

people were omitted in order to avoid bias from the direct influence of their schooling decisions on earnings. In some countries, the first job contract is limited by law. In the case of older workers, an attempt was made to exclude the influence of retirement decision. Second, people who received income from work or self-employment were investigated. In addition, information was rejected on part-time employees, people with combined incomes from employment and social assistance or those whose work was not their main source of income. This step was necessary because the data did not provide exact hours worked; so, it was not possible to calculate hypothetical full-time earnings. In addition, all groups of workers mentioned may have decided to work on a non-earnings basis; their wages may not have reflected the actual value of their work abilities. In the self-selection specification, sources of income were controlled directly through a selection equation. The next restriction involved farming income, highly correlated with land productivity and very weakly related to human capital productivity. As a consequence, a farmer's income could only be partly determined by education and abilities. In order to overcome the problem of eventual bias, the data was rejected from households for which farming was the only or the main income source. Handling the problem in this manner is justified in economic theory.

The additional restrictions originated from the data availability issue. Missing information on labour income is controlled by selection. In order to construct a proxy for measuring spillover effects, the data sets on education level and location of the residence (NUTS[3] and town size variables) require exploration. Unfortunately, some data were not available for a significant number of countries in both samples. NUTS information, when present, was only available at the NUTS1 level, which encompassed a large area of 3–7

[3] NUTS: Nomenclature of Units for Territorial Statistics, which are territory units used by Eurostat.

Table 2
*ECHP sample average characteristics for 1998*

| Country | Log wage | Gender | Work experience | Years of education | Family | Public employment | Self employment |
|---|---|---|---|---|---|---|---|
| Austria | 9.73 | 0.35 | 21.22 | 12.08 | 0.62 | 0.27 | 0.06 |
| | 0.63 | 0.48 | 9.49 | 1.94 | 0.49 | 0.44 | 0.24 |
| Belgium | 9.73 | 0.36 | 20.02 | 13.57 | 0.68 | 0.23 | 0.06 |
| | 0.65 | 0.48 | 10.00 | 3.25 | 0.46 | 0.42 | 0.24 |
| Finland | 9.73 | 0.47 | 22.43 | 13.38 | 0.63 | 0.37 | 0.06 |
| | 0.79 | 0.50 | 10.04 | 3.12 | 0.48 | 0.48 | 0.24 |
| France | 9.74 | 0.40 | 22.25 | 12.34 | 0.66 | 0.31 | 0.07 |
| | 0.66 | 0.49 | 10.05 | 3.24 | 0.47 | 0.46 | 0.26 |
| Greece | 9.31 | 0.34 | 21.63 | 12.46 | 0.75 | 0.28 | 0.26 |
| | 0.66 | 0.47 | 10.40 | 3.23 | 0.44 | 0.45 | 0.44 |
| Ireland | 9.58 | 0.32 | 20.55 | 12.34 | 0.68 | 0.33 | 0.12 |
| | 0.66 | 0.47 | 9.96 | 2.99 | 0.46 | 0.47 | 0.32 |
| Italy | 9.46 | 0.35 | 22.99 | 11.26 | 0.71 | 0.29 | 0.20 |
| | 0.74 | 0.48 | 9.79 | 2.54 | 0.45 | 0.45 | 0.40 |
| Portugal | 9.09 | 0.41 | 22.89 | 10.48 | 0.75 | 0.20 | 0.13 |
| | 0.79 | 0.49 | 10.07 | 2.76 | 0.43 | 0.40 | 0.33 |
| Spain | 9.48 | 0.32 | 21.42 | 12.14 | 0.68 | 0.22 | 0.14 |
| | 0.78 | 0.47 | 10.55 | 3.49 | 0.47 | 0.41 | 0.35 |
| Sweden | 9.29 | 0.45 | 22.89 | 13.30 | 0.25 | 0.21 | 0.03 |
| | 0.73 | 0.50 | 10.60 | 2.92 | 0.44 | 0.40 | 0.18 |
| United Kingdom | 9.65 | 0.37 | 21.38 | 13.40 | 0.65 | 0.24 | 0.12 |
| | 0.72 | 0.48 | 10.76 | 3.69 | 0.48 | 0.43 | 0.32 |

Based on ECHP data. The numbers in top row for each country represent mean value of characteristics in the sample; the numbers appearing on the bottom line are standard deviations.

million inhabitants. For these reasons, small countries, like Luxembourg and Denmark, comprised only one NUTS. In addition, for Finland and Sweden, the NUTS variable was not available in the CHER sample. For several countries: Germany, Italy, the Netherlands, Spain, and Sweden in both samples the town size variable was not available for reasons of data anonymity. Moreover, the variable definition differs between the ECHP and CHER data. In the former, the town variable may take three distinct values, while in the latter only the urban–rural indicator is available. In addition, incomplete observations were discarded.

Being aware of major sample reductions, particularly in terms of the number of countries examined, it was decided to adjust the empirical strategy to available data and perform the analysis at two levels of data disaggregation: NUTS and town, and NUTS level. In the former, educational profiles were calculated for the areas defined by the product of NUTS and the town variable, while

Table 3
*CHER sample average characteristics for 1998*

| Country | Log wage | Gender | Work experience | Years of education | Family | Public employment | Self employment |
|---|---|---|---|---|---|---|---|
| Austria | 9.50 | 0.35 | 21.54 | 11.99 | 0.89 | 0.25 | 0.14 |
| | 0.54 | 0.48 | 9.47 | 1.88 | 0.32 | 0.43 | 0.35 |
| Belgium | 9.62 | 0.45 | 20.62 | 13.19 | 0.89 | 0.23 | 0.15 |
| | 0.74 | 0.50 | 9.69 | 3.31 | 0.32 | 0.42 | 0.35 |
| France | 9.12 | 0.56 | 22.97 | 12.34 | 0.88 | 0.22 | 0.06 |
| | 0.92 | 0.50 | 12.97 | 3.65 | 0.33 | 0.41 | 0.24 |
| Greece | 9.24 | 0.49 | 22.52 | 12.13 | 0.93 | 0.24 | 0.32 |
| | 0.63 | 0.50 | 10.79 | 3.13 | 0.26 | 0.43 | 0.47 |
| Hungary | 7.95 | 0.48 | 22.12 | 11.46 | 0.96 | 0.25 | 0.06 |
| | 0.66 | 0.50 | 8.57 | 2.92 | 0.20 | 0.43 | 0.24 |
| Ireland | 9.77 | 0.31 | 21.20 | 12.11 | 0.91 | 0.29 | 0.15 |
| | 0.62 | 0.46 | 10.16 | 2.98 | 0.29 | 0.45 | 0.36 |
| Italy | 9.51 | 0.33 | 23.11 | 11.16 | 0.93 | 0.28 | 0.25 |
| | 0.54 | 0.47 | 9.69 | 2.49 | 0.25 | 0.45 | 0.43 |
| Poland | 7.40 | 0.48 | 24.33 | 10.87 | 0.93 | 0.38 | 0.19 |
| | 0.57 | 0.51 | 9.27 | 2.47 | 0.25 | 0.36 | 0.39 |
| Portugal | 8.90 | 0.43 | 23.26 | 10.48 | 0.98 | 0.17 | 0.18 |
| | 0.74 | 0.49 | 10.45 | 2.81 | 0.15 | 0.37 | 0.38 |
| Spain | 9.35 | 0.38 | 22.05 | 12.03 | 0.96 | 0.19 | 0.21 |
| | 0.82 | 0.49 | 10.47 | 3.44 | 0.20 | 0.39 | 0.41 |

Based on CHER data. The numbers in top row for each country represents mean value of the characteristics in the sample; the numbers in the bottom line are standard deviations. All numbers are for 1998, except Hungary (1997).

in the latter they were defined by NUTS only. It was known that the latter method of data preparation might be not suitable to capture the external effect, if present. In this approach, it was assumed that within one NUTS, concentration of human capital only depended on size of town.

The datasets did not directly provide information on years of schooling. For the purpose of the analysis, this was obtained by imputation using information contained in the achieved education level. In order to obtain results that were comparable for different countries, the assumptions were made that ISCED level 2 required 9 years of education, level 3 required 12 years and levels 5 or 6 require 17 years of education. Before the return rate of university was calculated, the basic sample characteristics for each country were analysed. This data are presented for the NUTS level, because when a town variable was collected, it was very rarely missing. After all data correction operations, approximately a third of the initial observations remained in the sample for each country. The main characteristics for the EHCP sample are presented in Table 2 and those for the CHER sample are presented in Table 3. The values are for the year 1998, but are fairly similar for the other

Table 4
*Educational structure in European countries (in %)*

| Country \ Education level | ECHP | | CHER | | OECD | |
|---|---|---|---|---|---|---|
| | Tertiary | Secondary | Tertiary | Secondary | Tertiary | Secondary |
| Austria | 6.0 | 59.9 | 6.0 | 59.8 | 11 | 56 |
| Belgium | 27.6 | 32.3 | 24.4 | 29.4 | 25 | 31 |
| Finland | 25.5 | 38.2 | 25.5 | 38.2 | 32 | 39 |
| France | 10.9 | 39.3 | 11.0 | 39.3 | 11 | 40 |
| Greece | 14.9 | 28.1 | 15.1 | 28.1 | 16 | 26 |
| Hungary | – | – | 10.3 | 52.2 | 13 | 50 |
| Ireland | 17.9 | 34.3 | 18.2 | 34.3 | 21 | 30 |
| Italy | 6.8 | 32.5 | 6.9 | 32.6 | 9 | 31 |
| Poland | – | – | 10.0 | 65.8 | 11 | 64 |
| Portugal | 7.0 | 12.4 | 7.0 | 12.3 | 9 | 11 |
| Spain | 26.4 | 58.3 | 26.7 | 58.1 | 24 | 57 |
| Sweden | 25.3 | 44.9 | – | – | – | – |
| United Kingdom | 25.9 | 55.4 | 23.7 | 59.4 | 24 | 57 |

Source: Own computation based on ECHP and CHER data and OECD (2000).

years. The year 1998 was chosen to maximise the number of countries in CHER sample.

The basic characteristics of both datasets are fairly similar. The dependent variable is the logarithm of yearly gross wages and salaries expressed in 2005 Euros. Yearly wages, rather than hourly rates, were used to eliminate the differences in working hours between countries. Original numbers in national currencies were converted to euros using the annual exchange rate published by Eurostat and deflated by the HCPI to be comparable between different countries. For six countries, the averages of log wage were higher in the CHER sample and for two countries in ECHP sample. The differences arise from the random nature of representative samples. Fortunately, these differences did not influence the results as it was the relative percentage difference between workers with high and low education levels that were of interest, rather than their actual wages.

The sample averages for gender, number of years spent in education and years of work experience were fairly similar in both datasets. Noticeable differences were observed for family and self-employment indicators. The difference in the family variable originates from its construction. In the ECHP sample it is derived from the marital status variable, while in the case of the CHER sample it is derived from household size. This was done purposely in order to reduce the problem caused by missing values for marital status in the CHER sample. The varying values for the self-employment dummy reflect a different definition of the variable. Generally, the definition in the CHER sample comes from the labour activity section of the data and includes self-employed and self-employed with co-workers, whereas in the ECHP the self-employed are identified by declared main source of income.

Table 4 presents the educational structure in the analysed European countries.

The levels are based on the ISCED classification. People that declare ISCED level 3 are treated as possessing secondary education and these who report a higher ISCED level are considered highly educated. There are tremendous educational disparities between European states. Three of them, namely Austria, Denmark and the United Kingdom, are characterised by the fact that a vast number of their citizens possess at least secondary education. Otherwise, secondary education is rare in Greece, Portugal and Spain. For education at university level, observed variation is even greater. The group of countries with a low proportion of highly educated citizens includes Austria, Hungary, Italy, and Portugal. Conversely, in Belgium and the protestant countries, the density of highly educated people is high.

This diversified education structure among European countries indicates that the accumulation of human capital is also diversified. There is a clear north–south gap. In northern European countries, the proportion of the population who have secondary and tertiary education is higher than in southern Europe. There are some historical reasons for this, such as industrialisation.

## Results

Here results are presented from an estimation of the external returns to education models based on a cross-sectional treatment of data from the ECHP and the CHER. External returns to education are not described well in the literature. The assumption is that they are heterogeneous, which would imply that they vary for different types and levels of education. Currently, the vast majority of pupils achieve the secondary level of education. To a certain extent, this is required by the law, because school is compulsory until the age of 16 or 18, depending on a country's internal regulations. There are different stipulations for university education – there are as many systems as countries; in other words, each country has a unique university system. The differences lie in the length of the study periods, tuition fees, admission requirements, curricula and many other aspects.

In order to capture education's eventual spillover effect, a variable was created to indicate the proportion of secondary and tertiary school graduates in the local area. The local area is defined by a NUTS variable for "NUTS-only" models and by a product of the NUTS and a town size variable for "NUTS and town size" models.

In order to provide robustness to the results, the analysis was conducted using different estimation techniques. Bearing in mind the reasons enumerated in the methodological section, apart from the standard OLS, in order to control for possible self-selection into education, two-stage selection models were explored (SEL). The scope of the analysis is restricted to people aged 30–55 and therefore it was assumed that selection reflected educational choice, not a labour market related decision. The two-step procedure was used as it is more robust to eventual misspecification and violation of the bivariate normality assumption than the standard parametric Heckman correction. For some respondents, more than one observation was used in pooled regression and accounted for by residual clustering.

In the OLS model, the average schooling is assumed to be exogenous, while the selection model treats the achieved level of education as a result of economic decision making. in the latter model, several characteristics, namely gender, experience and its square, years of education, type of family, non-labour income, and also town size and regional dummies are used in a construction of the selection equation. The important variable for identification of the model parameters in the case of the self-selection setting is non-labour income. This acts as an important determinant of presence in the labour force. Non-labour income is observable for all individuals and is not directly

related to current wages; hence, it can be used for identification of the selection process. The following rationale was employed for the inclusion of regional dummies only in the selection equation: in general, educational aspirations show no regional variation within one country. They influence educational choices but not wages.

The estimates for the human capital return and spillover effects are reported in Tables 5 and 6 for the ECHP sample and in Tables 7 and 8 for the CHER sample. The former tables (5 and 7) contain results for models in which the education profile for a local area is computed for areas defined by the product of NUTS and town size variable, whereas the latter tables (6 and 8) present the outcomes for an analysis considering only the NUTS region as a local area indicator.

We estimated two different specifications for each model, namely, OLS and SEL. in order to conserve space, we report the OLS result when there is no evidence of endogeneity or selection. In cases where education seems to be endogenous or there is selection, SEL results are presented. As shown by Lechner (2005), the selection model eliminates the problem of endogeneity. However, when the results from both models are very similar, the OLS results are reported, it being the simplest method. In all model specifications, the dependent variable is the natural log of wage. Coefficients of interest are estimates excluding years of schooling and the educational variable. The former indicates the human capital return on education, while the latter indicates the size of the external effect. Several independent variables were included in the model. Gender was used to control for the male–female wage gap, with experience and its squared term used to eliminate wage differences due to different experience levels. Type of employment was also controlled for. To achieve this, dummies for public employment and self-employment were included. Marital status and type of family were also included in order to control for differences in social background.

For brevity and clarity of presentation, only summary results are presented. The second column of each table reports the estimation method for spillover from tertiary education, whilst spillover for secondary education level is shown in the seventh column. The coefficients for variables included in the wage equation have sizes and magnitudes in accordance with labour market theory. The positive "gender" variable indicates that employers tend to pay men higher wages even if women have similar qualifications

Table 5
*External returns to education estimates, area defined by NUTS and town size*

| ECHP / Country | Tertiary education | | NUTS and town size | | | Secondary education | | NUTS and town size | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Method | External | *t* | Human | *t* | Method | External | *t* | Human | *t* |
| Austria | OLS | 0.9 | 7.93 | 6.3 | 14.62 | SEL | 0.4 | 7.38 | 6.9 | 26.17 |
| Belgium | SEL | 0.7 | 7.85 | 6.0 | 5.72 | OLS | 0.6 | 4.95 | 6.2 | 22.00 |
| France | SEL | 0.7 | 14.29 | 10.8 | 34.91 | SEL | 0.1 | 1.17 | 7.7 | 14.63 |
| Greece | SEL | 0.7 | 7.54 | 3.4 | 6.58 | SEL | 0.5 | 9.51 | 4.9 | 13.13 |
| Ireland | SEL | 1.6 | 3.38 | 6.8 | 17.69 | SEL | 0.8 | 1.76 | 4.2 | 2.32 |
| Portugal | SEL | 1.2 | 8.83 | 12.5 | 14.71 | SEL | 0.9 | 21.10 | 11.7 | 57.23 |

Based on ECHP data. OLS stands for standard regression model and SEL for model with selection equation. Please note that the returns are in percentage points.

Table 6
*External returns to education estimates, area defined by NUTS*

| ECHP / Country | Tertiary education | | | NUTS only | | Secondary education | | | NUTS only | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Method | External | *t* | Human | *t* | Method | External | *t* | Human | *t* |
| Austria | SEL | 0.1 | 2.21 | 9.9 | 17.48 | OLS | 0.9 | 4.90 | 6.2 | 21.54 |
| Belgium | SEL | 0.4 | 4.52 | 7.6 | 12.15 | OLS | 1.0 | 3.45 | 5.5 | 21.73 |
| Finland | SEL | 1.1 | 16.65 | 8.6 | 14.90 | OLS | 1.3 | 11.00 | 5.3 | 16.88 |
| France | SEL | 1.0 | 16.92 | 10.9 | 36.41 | SEL | 0.3 | 2.83 | 8.1 | 21.44 |
| Greece | SEL | 0.5 | 5.51 | 4.6 | 9.33 | SEL | 0.2 | 1.92 | 5.0 | 11.21 |
| Ireland | SEL | 2.3 | 7.44 | 3.2 | 1.99 | OLS | 0.9 | 7.29 | 6.1 | 15.58 |
| Italy | SEL | -0.1 | -0.41 | 6.8 | 14.31 | SEL | 1.1 | 7.84 | 4.9 | 14.35 |
| Portugal | SEL | 2.3 | 11.52 | 13.5 | 14.73 | SEL | 1.4 | 20.58 | 12.1 | 64.61 |
| Spain | SEL | 1.1 | 10.86 | 7.2 | 9.08 | SEL | 0.7 | 6.81 | 6.3 | 19.97 |
| Sweden | SEL | 1.1 | 22.11 | 7.5 | 17.18 | OLS | 1.1 | 9.45 | 4.3 | 15.11 |
| United Kingdom | SEL | 0.3 | 6.13 | -0.8 | -0.76 | OLS | 0.7 | 9.58 | 3.7 | 27.12 |

Based on ECHP data. OLS stands for standard regression model and SEL for model with selection equation. Please note that the returns are in percentage points.

and work experience. The coefficients of the Mincerian wage equation are similar to those found in other studies. Despite some minor methodological differences, the estimates of the human capital return on education are close to Heinrich and Hildebrandt's (2005) results obtained from the ECHP data.

The first important observation is that in many models estimated on the basis of the ECHP sample, a simple OLS approach is not valid, although it is sufficient, in particular, for secondary education models. A similar pattern is observed for models estimated on CHER data. This suggests that the vast number of citizens in each country, particularly in younger cohorts, possess at least secondary education; therefore, the selection is weak. Moreover, the method of construction of a variable to describe proportions of educational attainment is important. This variable has greater variance in the ECHP sample. In addition, in all empirical specifications, human capital return on education estimates are positive, significant and have sizes comparable to those found in other studies.

The external or spillover effect of education was found to be significant in all but one model. The exception was in the analysis for Italy in areas defined by NUTS as a proxy for capturing the effect, where the result was not significantly different from zero. As long as NUTS-based analysis is not capable of providing unequivocal evidence, this is not a major concern. In both samples that were analysed, the results from models with different area definitions are very closely related. This suggests that the size of the area is not very important from the viewpoint of the methodology applied. However, one has to bear in mind an implication from the underlying theory. The external effect arises in small local areas. When one uses large, non-homogeneous regions instead of local areas, it may be that the variable used to capture the external effect describes

Table 7
*External returns to education estimates, area defined by NUTS and town size*

| CHER / Country | Tertiary education | | NUTS and town size | | | Secondary education | | NUTS and town size | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Method | External | *t* | Human | *t* | Method | External | *t* | Human | *t* |
| Austria | OLS | 1.1 | 3.52 | 6.6 | 8.94 | OLS | 0.4 | 2.33 | 7.2 | 13.66 |
| Belgium | SEL | 0.4 | 2.19 | 6.2 | 10.09 | OLS | 0.3 | 1.69 | 5.5 | 21.70 |
| France | SEL | 0.9 | 6.48 | 14.4 | 6.05 | OLS | 0.4 | 4.93 | 8.3 | 40.43 |
| Greece | OLS | 1.4 | 7.24 | 3.5 | 2.52 | OLS | 0.9 | 7.05 | 7.5 | 17.65 |
| Hungary | OLS | 1.4 | 9.47 | 9.8 | 9.83 | OLS | 0.8 | 9.76 | 9.3 | 25.60 |
| Ireland | SEL | 1.9 | 4.77 | 5.6 | 8.40 | OLS | 1.6 | 4.93 | 7.0 | 16.57 |
| Poland | SEL | 1.7 | 5.95 | 5.2 | 9.27 | OLS | 0.7 | 3.90 | 5.3 | 26.35 |
| Portugal | OLS | 1.5 | 10.45 | 9.6 | 6.88 | OLS | 1.0 | 7.46 | 13.7 | 47.37 |

Based on CHER data. OLS stands for standard regression model and SEL for model with selection equation. Please note that the returns are in percentage points.

Table 8
*External returns to education estimates, area defined by NUTS*

| CHER / Country | Tertiary education | | NUTS and town size | | | Secondary education | | NUTS and town size | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Method | External | *t* | Human | *t* | Method | External | *t* | Human | *t* |
| Austria | SEL | 1.0 | 4.29 | 6.1 | 12.54 | SEL | 0.2 | 1.78 | 6.4 | 25.40 |
| Belgium | OLS | 0.3 | 2.32 | 6.6 | 4.26 | OLS | 0.3 | 1.94 | 5.5 | 21.74 |
| France | OLS | 1.1 | 20.07 | 9.0 | 25.35 | SEL | 0.2 | 4.55 | 8.1 | 68.52 |
| Greece | SEL | 0.7 | 8.50 | 4.7 | 17.90 | SEL | 0.5 | 13.37 | 5.5 | 29.90 |
| Hungary | SEL | 1.4 | 6.98 | 9.6 | 18.00 | SEL | 0.7 | 9.68 | 4.1 | 11.14 |
| Ireland | SEL | 1.6 | 9.60 | 5.5 | 10.92 | SEL | 0.9 | 10.96 | 7.5 | 39.92 |
| Italy | – | – | – | – | – | SEL | 0.8 | 13.03 | 6.1 | 48.70 |
| Poland | SEL | 1.6 | 8.23 | 7.1 | 16.13 | SEL | 0.3 | 5.44 | 5.1 | 4.37 |
| Portugal | SEL | 2.0 | 10.43 | 11.5 | 26.68 | SEL | 1.3 | 19.90 | 4.9 | 30.42 |
| Spain | SEL | 0.8 | 9.11 | 5.0 | 14.68 | SEL | 1.0 | 20.36 | 6.2 | 42.32 |

Based on CHER data. OLS stands for standard regression model and SEL for model with selection equation. Please note that the returns are in percentage points.

inter-regional differences within the country, rather than educational spillover. Dummies for regions included in the model only control for the part of the difference that does not change with time. This implies that variation in economic growth rate between the regions is not controlled.

Considering the results with the area variable defined by the NUTS and town size, they are similar in terms of samples and across countries. The overall size of the external effect of tertiary education is approximately 1%, with the lowest estimate for Belgium and the highest for Ireland, Poland and Portugal.

It is difficult to analyse the external effect in Belgium because it is in three completely different parts. Perhaps this particular country should be treated as three one-NUTS countries and therefore omitted in the analysis. The highest estimate for Ireland could be explained by the Irish economic boom in the 1990s and that for Poland and Portugal by the relative scarcity of highly educated people in the country.

The analysis of results obtained at the NUTS level causes the picture to be blurred. However, Ireland, Portugal and Poland are still the countries with the highest estimated external returns to education, while Belgium, again, and Greece are among those with the lowest spillover effect. The external return to secondary education is generally below 1%, with the exception of Portugal in both samples and Sweden and Finland in the ECHP sample. These results confirm that the system for general education functions very well in the Scandinavian countries. It also seems that European economies are very similar in terms of the educational spillover effect.

The difference between the return rates to secondary and tertiary education is consistent with Kreuger and Lindahl's (1998) findings. They argue that the expansion of human capital at a lower level has a non-wage effect, yet, it reduces the crime and welfare participation rate, in particular; expansion of tertiary education creates a spillover effect in the form of increased productivity and technological progress. Therefore, larger social returns in terms of wages should be observed for university level education.

Unfortunately, the empirical approach used here has potential and rather obvious shortcomings. The econometric models deal with individual data, and, for that reason, are not fully able to include some additional and potentially important external effects. Secondary schools, universities, and commercial and industrial areas are located mostly in towns. Therefore, towns accumulate human capital stock and the observed spillover effect to a certain extent might be a town effect. This was partly controlled for in the analysis by inclusion of only those people who declared that they lived in the same area for the entire survey period. For that reason, the external effects are believed to be stronger in the cities. This should not be a problem in this study owing to the specific construction of the variable to describe prevalence of educational attainment. It has a constant value for the entire area defined by NUTS and town size. In addition, dummies for NUTS and town sizes in a wage equation must eliminate regional differences, and those for years differences related to time. However, part of the measured return might reflect regional differences in NUTS--only models. Second, due to the cross--sectional nature of the data, it was not possible to eliminate these regional differences.

## Conclusions

Findings from the study suggest potentially significant spillover from education. Analysing the effect of average education in a local area on individual wages, it was possible to replicate standard estimates for human capital returns to education. In addition, a one percentage point increase in the tertiary education was shown to increase workers' wages by 1–2%, creating a social return significantly above the private return. For secondary education, the external effect was weaker, as expected. The estimated size of the external effect was slightly lower than was found in studies in the United States; however, a countrywide analysis was conducted in this study, while other authors restricted their analysis to cities or industries in one country.

During the investigation, no evidence was found that external returns offset human capital in a manner that equalised social returns. The external effects were at a similar level across European economies. In the opinion

of the author, the important message is that the existence of positive externalities is confirmed. Evidence of the return on education has implications for both economic theory and policy. A sizeable review of the literature estimated private return to education to be to the order of 6–10%. However, private returns are only part of the story. The economic literature emphasises the role of the external effect on education. The main explanation for this is that the existence of external effects causes private return on education to be an underestimate of the economic value of schooling. The result supports the belief that investment in education is important from the policy-making viewpoint. Simply relying on individuals to cover the cost of education may lead to regrettable underinvestment as compared with the socially desirable level. An open question, beyond the scope of the present study concerns the optimal method of financing higher education.

The final concern is that the model presented in this study does not account for unobserved heterogeneity in ability. The identification of external effects of education requires exogenous variation in both individuals and average schooling. Diversification of the former is obvious. For the latter, in this paper, a geographical and educational structure of population is used to mimic variation in the average schooling. Nevertheless, individuals who live in regions with a high level of human capital may simply be better workers than those who live in regions with low human capital. As indicated by Rauch (1993), higher-quality workers may move to areas with higher educational profiles. This is a direct consequence of the Roy model, in which the skills move to jobs which place more value on skill. Regions that have industrial structures and thus require more educated workers are also likely to obtain better prices for unobserved ability (Moretti, 2004). To attempt to control for these effects, area dummies and a selection mechanism were included.

The overall results confirm the existence of educational externalities which account for approximately 16% of the human capital return[4]. The direct implication for policy is that private investment in education may not be adequate to provide the socially optimal prevalence of highly educated people.

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[4] External return is compared with human capital return in Tables 7 and 8.

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