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Inequalities in income and education and regional economic growth in western Europe

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Abstract Does inequality matter for regional growth? This paper addresses this question, using regionally aggregated microeconomic data for more than 100,000 individuals over a period of 6 years. The aim is to examine the relationship between income and educational distribution and regional economic growth in western Europe. Our results indicate that, given existing levels of inequality, an increase in a region's income and educational inequality has a significant positive association with subsequent economic growth. Educational achievement is positively correlated with economic growth, but the impact of initial income levels is unclear. Finally, the results suggest that inequalities in educational attainment levels matter more for economic performance than average educational attainment. The above findings are not only robust to the definition of income distribution, but also across inequality measurements.

JEL Classification O15 · O18 · D31 · E24

1 Introduction

The link between inequality and growth is far from being well understood, especially at a regional level. Decades of economic, sociological, and political studies offer evidence that the inequality–growth relationship is, indeed, complex (Galor 2000; Galor and Moav 2004). While there is a range of theoretical and empirical evidence suggesting

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that inequality can actually be good for growth (Mirrlees 1971; Rebelo 1991), other studies support the idea that inequality may harm growth (Perotti 1996; Easterly 2001), and a third strand combines both effects (Galor 2000; Bertola et al. 2006).

This paper aims at shedding light on the inequality–growth relationship at a regional level in western Europe. Do income and educational inequalities matter for growth? To what extent are inequalities associated with growth at a regional level? The goal is to examine how changes in income and educational distribution for a sample of more that 100,000 individuals across regions in Europe affect the evolution of regional economic growth. Aggregated microeconomic changes in income and in human capital endowments are measured by average and inequality levels. As this paper contributes to two different strands within the field of economic growth, income per capita, educational attainment and growth, on the one hand, and inequality and growth, on the other, it also tries to determine which of these factors prevails in shaping growth. On this ground, it discriminates between endowments and inequality in wealth and education. The methodology is based on the estimation of cross-section and panel data regression models.

The remainder of the paper is structured as follows. In Sect. 2, the theoretical underpinnings of the impact of income and educational inequalities on regional economic growth are presented. Section 3 illustrates the econometric specification and the regression results of growth models. Section 4 concludes.

2 Theoretical considerations

2.1 The impact of income inequality on regional economic growth

A number of economic theories have been constructed in the quest to uncover the link between income inequality and economic growth. They are focused on the ways in which income distribution affects aggregate output and growth through factors such as incentives, investment in physical and human capital, and innovation (Aghion et al. 1999). What are the possible transition mechanisms that might link inequality and growth? Different arguments have been put forward as to why more or less egalitarian societies can actually be good for growth and why redistribution policies from the rich to the poor and government interventions may harm or enhance growth.

First of all, the relationship between economic growth and income inequality is determined by *economic incentives*. The operation of the free market in the pursuit of private profit not only provides strong incentives for work, but may also generate inequalities (Champernowne and Cowell 1998). Many sociologists and economists—going back to Adam Smith—support the idea that inequality generates incentives and therefore should be viewed as growth-enhancing (Mirrlees 1971; Rebelo 1991; Aghion et al. 1998). Inequality promotes a productive economy by creating incentives and encouraging competition. Free markets provide signals that help to optimise production, resulting in greater gains, but not necessarily in lower income inequality (Heyns 2005, p. 167). Along these lines, Voitchovsky (2005, p. 276) argues that in an economic structure where ability is rewarded, effort, productivity, and risk-taking will also be encouraged, generating higher growth rates and income inequality as a result.

Hence, the greater the income inequality, the stronger the incentive to invest either in physical or in human capital, and thus the higher the growth rate. Without incentives, entrepreneurial and business activity and risk-taking might cease, capital markets would dry up and economic growth would grind to a halt (Heyns 2005, p. 165). Hence, under certain circumstances, any public policy aimed at reducing income inequality may produce negative incentives for economic efficiency and, therefore, may harm economic growth. Champernowne and Cowell (1998, p. 16) demonstrate that strong policies of redistribution may hamper the ability of efficient and successful firms and entrepreneurs to expand and attract staff with the best talents by offering them the inducement of unusually high pay. Thus, in a *laissez-faire* economy, in which government intervention is minimal, inequality is perceived as fundamentally good for incentives, which, in turn, enhance growth. In contrast to this view, equality may also empower a greater number of individuals and increase activity in the market place (Austen 2002; Gijsberts 2002).

Income inequality may also affect growth through *investments in physical and human capital*. Classical economists (Keynes 1920; Kaldor 1956) support the notion that greater income inequality fosters physical capital accumulation, as rich agents have a higher marginal propensity to save compared to the poor.[1] This increases aggregate savings which, in turn, increases growth rates. However, and in contrast to the classical approach, recent work (Galor 2000; Galor and Moav 2000, 2004) suggests that the relationship between income inequality and growth depends on the stage of economic development (or industrialisation). During the early stages of economic development, physical capital accumulation is the prime engine of economic growth. High initial income inequality stimulates high aggregate savings that, in turn, increase physical capital accumulation. Physical capital then stimulates the process of economic development. Hence, income inequality enhances economic development by channelling resources towards individuals with a higher propensity to save. At later stages of economic development, human capital accumulation replaces the accumulation of physical capital as the prime engine of growth, due to capital-skill complementarity. During the economic process, the increased availability of physical capital raises the return on investment in human capital. However, due to credit market imperfections (Galor and Zeira 1993; Bénabou 1994, 2000, 2002), the poor may find their access to human capital curtailed.[2] Thus, in sufficiently wealthy economies, equality may stimulate investment in human capital which promotes economic growth, as human capital accumulation is greater if it is shared by a larger segment of society. In other words, equality promotes growth via investment in human capital, because more individuals are able to invest in human capital (Perotti 1996; Easterly 2001); and equality could also alleviate the adverse effect of credit market constraints on

[1] Most empirical studies support the theory of a positive relationship between inequality and savings (Kelley and Williamson 1968). Smith (2001), however, has found evidence that income inequality affects savings only in countries with low levels of financial market development.

[2] Flug et al. (1998), for example, show that economic volatility—lack of financial markets, income or employment volatility, and income inequality—has a negative effect on the accumulation of human capital. Dixit and Pindyck (1993) show that uncertainty also has a negative effect on investment in physical capital. Flug et al. (1998) argue that volatility has a stronger correlation with investment in human capital than with investment in physical capital.

human capital accumulation (Galor and Moav 2004). Furthermore, during the process of development, the constraints on the credit market gradually diminish, differences in savings behaviour between rich and poor agents decline, and the effect of income inequality on economic growth becomes insignificant (Galor and Moav 2004, p. 1021). Low levels of income inequality facilitate positive changes for regions, as they offer plenty of economic chances to both advantaged and disadvantaged groups. This may allow for a better allocation of resources and more efficiency in physical and human capital investments. For instance, by lowering income inequalities, fewer people under-invest in education because of credit market imperfections (Galor and Zeira 1993; Galor and Moav 2000). Finally, taking only physical capital into consideration, Banerjee and Newman (1993) and Aghion and Bolton (1997) support the notion that with credit market imperfections, equality positively affects an individual's physical capital investment opportunities. In brief, the effect of inequality on economic growth depends not only on the region's level of income, but also on the relative returns to physical and human capital.

The demand side of the relationship between inequality and growth also depends on the market size and price effect through *innovation* (Bertola 2000; Bertola et al. 2006). On the one hand, income distribution has a dynamic market size effect. An unequal distribution of income means that there are small regional markets for new products and those markets grow slowly, as only a small number of consumers can afford to buy them (Bertola et al. 2006). Thus, the market size effect implies that a more egalitarian income distribution favours innovation and growth. On the other hand, a dynamic price effect implies that inequality may be beneficial for growth, because the richest consumers have a very high willingness to pay for new goods (Bertola et al. 2006). The existence of a wealthy class is a necessary condition to foster innovation activities. Consequently, innovation incentives, which depend on whether or not there is a group of rich consumers willing and able to purchase a new product, matter for the inequality–growth relationship. Whether or not the dynamics of prices outweighs the dynamics of market size depends on the scope of price setting (Bertola et al. 2006). In other words, if the number of consumers willing to purchase a new good is more relevant, the market size effect becomes more important; while if how rich the potential consumers are prevails, the price effect dominates (Bertola et al. 2006). This dichotomy leads to contrasting views. Falkinger (1994), for instance, shows that when growth is driven by innovations, income inequality is beneficial for growth. Zweimüller (2000), however, proves that innovation may be more profitable with a more equal income distribution as markets develop more quickly into mass markets.

The relationship between income inequality within a nation and economic growth can also be investigated through *political economy* models such as the voting models (Perotti 1992; Aghion et al. 1999). The basic argument for a potential negative effect of inequality on growth is that the higher the income inequality, the higher the rate of taxation, the lower the incentive to invest, and the lower the growth rate (Bertola 1993; Persson and Tabellini 1994). The argument in support of a positive effect, on the other hand, is that the higher the income inequality, the higher the rate of taxation, the larger the expenditure on public education programmes, and thus the higher the public investment in human capital, and the higher the growth rate (Aghion and Bolton 1990;

Saint-Paul and Verdier 1993).[3] Hence, the trade-off between the incentive to invest (which is the fundamental mechanism of a *laissez-faire* economy) and the expenditure on public education programmes (which reflects a fundamental government policy) determines the inequality–growth relationship.

The effect of income inequality within a nation on economic growth also depends upon the effect of *socio-political instability* (Mauro 1995; Alesina and Perotti 1996). This channel plays a key role in the inequality–growth relationship of less-developed countries beset by political and social unrest or violence. In a society with a considerable income inequality, the gap between the mean income and the potential legal income of low-skilled workers is large, and hence this is likely to give incentives for the very poor to engage in disruptive activities such as crimes against property and crimes of violence (Nilsson 2004, p. 3). Additionally, the more unequal the distribution of income, the higher the probability for disruptive activities and protests, and the higher the frequency of government changes. Thus, when the gap between rich and poor widens, the poor may experience a greater temptation to engage in disruptive activities (Bénabou 1996). The above cases accentuate the negative effect of inequalities on growth.

The empirical research that has been carried out on the effect of income inequality on economic growth is no less ambiguous than the theory. The majority of the reduced-form estimates tend to find that inequality has a negative effect on growth (Persson and Tabellini 1994; Perotti 1996; Barro 2000). A number of empirical studies, however, supports a positive effect of inequality on growth (Li and Zou 1999; Forbes 2000). For instance, Forbes (2000) uses panel estimation and her results suggest that in the short and medium term, an increase in a country's level of income inequality has a significant positive relationship with subsequent economic growth. All the above studies examine the relationship between income inequality within a nation and economic growth. The regional dimension, in contrast, has been somewhat overlooked with the exception of Panizza (2002), Partridge (2005) or Ezcurra (2007).

2.2 The impact of educational inequality on regional economic growth

Economic performance depends increasingly on talent, creativity, knowledge, skills, and experiences. In modern economies, those characteristics shape opportunities and rewards (Wolf 2002, p. 14). Consequently educational attainment is progressively gaining importance in economic growth analyses (Stokey 1991; Barro 2001; Rodríguez-Pose and Vilalta-Bufí 2005), but the number of analyses is still limited and the results on the link between educational inequality and economic performance not straightforward. Several factors have been highlighted to shape the relationship between education inequality and growth. These include incentives, technological progress in production, and life expectancy.

As in the case of income inequality, educational inequality may be regarded as fundamentally good for *incentives* and, therefore, growth-enhancing (Mirrlees 1971; Rebelo 1991; Aghion et al. 1998). From this perspective, the greater the educational

[3] Nevertheless, Sylwester (2000) stresses that the larger the expenditure on public education programmes, the lower the growth rate.

inequality, the greater the incentive for an individual to attain a higher educational level and more academic qualifications and training. However, most people require qualifications that are not possessed by everyone (Wolf 2002). The existence of less talented and educated individuals creates incentives to seize the higher returns associated with skills (Voitchovsky 2005). As Chiswick (1974, p. 17) indicates

> 'since human capital is created at a cost, no one would willingly invest in human capital unless it generated sufficient monetary or nonmonetary benefits to compensate for the cost'.

This is likely to enhance economic growth.

Educational inequality also determines growth through *technological progress*. In the early stages of economic development, a wide distribution of human capital may be a necessary condition for take-off. Inequality may encourage members of the highly educated segments of society to increase their investment in human capital, while equality may trap the whole society at low levels of investment in human capital (Galor and Tsiddon 1997, p. 94). Inequality can thus be viewed as essential for a region to increase the aggregate level of human capital and output. In addition, economic growth is affected by the percentage of individuals who inherit a large enough amount of wealth to enable them to invest in human capital (Galor and Zeira 1993, p. 51). The parental level of human capital, which is known as the home (or local) environment externality, is a critical factor in the positive inequality–growth relationship. The importance of the parental education input in a child's education has been stressed in studies by Becker and Tomes (1986) and Coleman (1990). Local human capital externalities may also lock-in income inequality across generations (Bénabou 1994). In the mature stages of economic development, technological progress is positively related to the level of human capital in society (Schultz 1975). The growth process may increase the rate of adoption of new technologies, which induces income convergence via diffusion. More specifically, as the investment in human capital of the highly educated increases, the accumulated knowledge trickles down to the less-educated via a technological progress in production, which is known as the global production externality (Galor and Tsiddon 1997, p. 94).

The relationship between educational inequality and economic growth is also affected by *life expectancy*. Investment in human capital depends on the individual's life expectancy, which, in turn, depends to a large extent on the environment in which individuals grow up. Due to the relative lack of available data on educational inequality, the impact of inequality on growth remains underexplored from an empirical perspective (with some exceptions, such as Birdsall and Londono 1997; López et al. 1998; Castelló and Doménech 2002). Most empirical studies resort to the international data on educational attainment of Barro and Lee (1993, 1996, 2001). Birdsall and Londono (1997) explore the impact of the distribution of assets (both physical and human capital) on growth, emphasizing the role of human capital accumulation via basic education and health. Their results illustrate a significant negative correlation between education dispersion and economic growth. López et al. (1998) demonstrate that an unequal distribution of education tends to have a negative effect, while an increase in mean education is positively associated with growth. They also note that the impact of education on growth is affected by the macroeconomic policy

environment of a country, which determines what people can do with their education. For example, policy reforms can increase the returns from formal education and enhance the impact of education on growth through trade and investment. López et al. (1998) also show that the distribution of education is related to technological progress and industrial upgrading. Finally, Castelló and Doménech (2002) find a negative relationship between human capital inequality and growth for a broad panel of countries. This negative relationship exists not only through the efficiency of resource allocation, but also through a reduction in investment rates. They argue that countries with higher educational inequality experience lower investment rates and less efficiency in resource allocation than countries with lower levels of human capital inequality. For them, the lower the investment rates and the lower the efficiency in the allocation of resources, the lower the growth rates, with their educational inequality measures providing more robust results than their income inequality measures.

To sum up, educational inequality is a significant factor shaping economic growth rates. However, the limitations of the theoretical and empirical literature on the impact of educational inequality on growth prevent us from having a clear position on the dimension of the relationship.

3 Econometric specification, data and regression results

In order to assess whether income and educational inequality matter for regional growth in western Europe and to determine whether these inequalities are more relevant for growth than income and educational endowments, we use cross-section and panel data analysis in order to capture different responses to the growth model and to better justify of the results.

We use economic analysis based on micro data in order to measure intra-regional inequality in income and human capital endowment at a regional level in Europe. Regional variables based on micro data are extracted from the European Community Household Panel (ECHP) data survey during the period 1994–2001.[4] This survey is complemented by macroeconomic variables extracted from the Eurostat's Regio dataset.[5] The ECHP dataset is based on NUTS[6] 1995 version and the Eurostat's Regio on that of 2002. The elaboration process of both datasets is coordinated by Eurostat, making comparisons reliable. However, some adjustment of regions in order to match the two different datasets is required. The resulting dataset includes data for 102, from thirteen of the fifteen members of the EU at the time of the completion of the ECHP.[7]

[4] The surveys were conducted regularly during the period 1994–2001 at approximately 1-year intervals. In these surveys between 104,953 and 124,663 individuals were interviewed about their socioeconomic status and information is collected about their income changes, job changes, education status, living places, age, etc. For a review of the ECHP, see Peracchi (2002).

[5] This type of panel data consists of repeated observations on larger entities, the individual regions (NUTS) of the EU.

[6] NUTS—an acronym for *Nomenclature d'Unités Territoriales Statistiques* or Nomenclature of Statistical Territorial Units—is the regional division defined by the European Union (EU) for statistical purposes and is generally based on comparable levels of national administrative subdivisions in the EU member states.

[7] The exceptions being the Netherlands (for which no data were available) and Finland (as a result of the discrepancies between the 1995 and the 2002 NUTS regional divisions).

A further limitation of resorting to Eurostat's Regio dataset is that regional economic development is not instantaneous, so that changes in economic development (growth) from one year to the next are probably too short term to be really useful and reliable. Therefore, we calculate growth using a 5-year period for the cross-section analysis and at 2-year intervals for the panel data analysis.

We initially examine the impact of inequality on growth using the following cross-sectional econometric specification.

$$\begin{aligned}\text{Growth}_{i,1997-2002} = {} & \beta_1' \text{Incpc}_{i,1995} + \beta_2' \text{IncIneq}_{i,1995} + \beta_3' \text{EducAtt}_{i,1995} \\ & + \beta_4' \text{EducIneq}_{i,1995} + \beta_5' x_{i,1997} + \varepsilon_{i,1997} \end{aligned} \quad (1)$$

with i denoting regions ($i = 1, \ldots, N$). $Growth_{i,1997–2002}$ is the growth of income per capita of the regions of western Europe between 1997 and 2002; $\text{Incpc}_{i,1995}$ is income per capita in 1995; $\text{IncIneq}_{i,1995}$ denotes regional income inequality in the same year; $\text{EducAtt}_{i,1995}$ is proxy for educational attainment in 1995; $\text{EducIneq}_{i,1995}$ is proxy for educational inequality; $x_{i,1997}$ represents a vector of control variables; $\beta_{1,\ldots,5}$ are coefficients; and $\varepsilon_{i,1997}$ is the error term. Following Banerjee and Duflo (2003), we address endogeneity by introducing income and educational variables with 2-year lags. This model is estimated by Ordinary Least Squares (OLS). The OLS coefficients reflect the long-run impact of income and education on growth (Partridge 2005).

However, any cross-sectional model may be affected by omitted-variable bias, as a consequence of unobserved heterogeneity. Measurement error, mainly relating to the educational variables, may be another problem, as these variables measure the input of formal education without considering the output of knowledge, skills, and competences embodied in individuals (Sianesi and van Reenen 2003). Panel data analysis addresses these problems better and allows us to control in a more natural way for the effects of missing or unobserved variables (Hsiao 2003). Therefore, we also examine the impact of inequality on growth using the following panel data econometric specification.

$$\begin{aligned}\text{Growth}_{i,t-(t+2)} = {} & \beta_1' \text{Incpc}_{i,t-2} + \beta_2' \text{IncIneq}_{i,t-2} \\ & + \beta_3' \text{EducAtt}_{i,t-2} + \beta_4' \text{EducIneq}_{i,t-2} + \beta_5' x_{it} + u_{it} \end{aligned} \quad (2)$$

where i denotes regions ($i = 1, \ldots, N$) and t time ($t = 1, 2, 3$),[8] $\text{Growth}_{i,t-(t+2)}$ is the 2-year growth of regional GDP per capita; and u_{it} is the composite error ($u_{it} = \upsilon_i + \varepsilon_{it}$, with υ_i being the time-invariant unobserved heterogeneity and ε_{it} is the error term). As in the case of the cross-section model, the panel data model addresses endogeneity by introducing income and educational variables with 2-year lags. The gains from accounting the omitted-variable bias and measurement errors with panel data models are, however, jeopardized by the possibility of income variations during short-time intervals to be mainly influenced by economic cycle, making it impossible to consider long-run income dynamics based on 2-year time intervals.

[8] $t = 1$ denotes 1996, $t = 2$ denotes 1998 and $t = 3$ denotes 2000.

Depending on how the time-invariant effect υ_i values are defined, the panel data equation may adopt a pooled OLS, Fixed Effects (FEs), and Random Effects (REs) model. We estimate all these models and the appropriate tests are used in order to consider the relationship between the unobserved effect and the regressors (Hausman 1978; Breusch and Pagan 1980). First, pooled OLS models assume that there is no correlation between the explanatory variables and the composite error. If income and educational variables mostly vary cross-sectionally, their pooled OLS regression coefficients will, in all likelihood, reflect long-run effects (Partridge 2005). Second, FEs coefficients can be interpreted as short/medium-run or time-series effects, as they reflect within-region time-series variation (Mairesse 1990; Durlauf and Quah 1999; Forbes 2000; Partridge 2005). FEs models eliminate any omitted-variable bias that may occur, in the event of unobserved regional characteristics that affect growth and are correlated with the included explanatory variables. However, this reduction in bias comes at a significant cost, because it removes cross-sectional variation from the data, potentially reducing the efficiency of the parameter estimates (Higgins and Williamson 1999). Third, the REs approach exploits the serial correlation in the composite error in a Generalised Least Squares (GLS) framework (Wooldridge 2002). REs coefficients can thus be interpreted as long-run effects, because the cross-sectional differences are retained (Griliches and Mairesse 1984; Mairesse 1990; Barro 2000; Partridge 2005). In the absence of measurement error, pooled OLS and REs estimates should be similar when most of the variation is cross-sectional (Partridge 2005). Overall, the (pooled) OLS and GLS estimators reflect long-run effects and the FEs estimators reflect short/medium-run or time-series effects.

Table 1 shows the description and sources of the main variables. The 5-year (1997–2002) regional economic growth is higher than the average 2-year growth between 1996 and 2002. Personal income and educational inequality are initially measured using different indices, which include the Theil index, the relative mean deviation index, the Gini index, the squared coefficient of variation, and the Atkinson index.[9] As the correlations among inequality indices are very high (above 0.8), we only report the descriptive statistics of inequalities measured by Theil index. The Theil minimum value is 0 for perfect equality and its maximum value is $\ln N$ where N is the total population of all individuals within a region. We also consider income distribution, not only for the whole of the population, but also for normally working people. The figures in Table 1 show that, during the period of analysis, income per capita, both for the population as a whole and for normally working people, increased slightly, while income inequality decreased. The educational distribution followed a similar trend: educational attainment (measured by the average education level completed) increased marginally and educational inequality decreased.

[9] Information on personal income is collected using the variable *Total net personal income (detailed, NC, total year prior to the survey)*, which is extracted from the ECHP data survey. Income data refers not only to each individual in the household, but also for each normally working (15+ h/week) individual—using the variable *Main activity status-Self defined (regrouped)* which is also extracted from the ECHP data. Information on education is extracted from the variable *Highest level of general or higher education completed* of the ECHP. This variables includes three categories: (a) less than the second stage of secondary education; (b) second stage of the secondary education; and (c) a recognised higher education degree. Every individual is classified into any one of these three educational categories, which are mutually exclusive.

Table 1 Main variables

Main variables	Description	Year	Mean	SD	Min	Max	Sources
Regional economic growth	(a) 5-Year regional economic growth (1997–2002)	1997–2002	0.2586	0.0814	0.0906	0.5101	EUROSTAT
	(b) 2-Year regional economic growth	Average (1996–2002)	0.0990	0.0445	0.0057	0.2686	
Natural logarithm of income per capita	(a) Natural logarithm of income per capita for the whole of the population (/1000)	1995 2000	2.2035 2.4670	0.4089 0.4443	1.2239 1.3998	2.9406 3.0512	ECHP
	(b) Natural logarithm of income per capita for normally working (15+ h/week) people (/1000)	1995 2000	2.5231 2.7491	0.3469 0.3768	1.5976 1.7584	3.3473 3.3781	
Income inequality	(a) Income inequality for the whole of the population (Theil index)	1995 2000	0.4162 0.3602	0.1571 0.1365	0.1750 0.1057	0.8296 0.7368	
	(b) Income inequality for normally working (15+ h/week) people (Theil index)	1995 2000	0.2421 0.2142	0.0754 0.0708	0.1263 0.0569	0.4902 0.4099	
Educational attainment	Average in education level completed	1995 2000	0.6550 0.8050	0.2352 0.2708	0.1223 0.1907	1.1749 1.2345	
Educational inequality	Inequality in education level completed (Theil index)	1995 2000	0.9014 0.7176	0.4542 0.3927	0.2123 0.1744	2.3839 2.0223	

Table 2 displays the cross-sectional regression results for model (1) above using income per capita and income inequality for the whole of the population as independent variables.[10] Although the cross-sectional results have the advantage of using longer time intervals of growth than panel data results, the *p*-values of Breusch and Pagan (1980) Lagrange Multiplier test reject the validity of the pooled OLS estimator. In addition, the FEs model is preferred to the REs model by the Hausman (1978) test, meaning that the unobserved effect is correlated with the explanatory variables and that the values for each region are not independent and identically distributed (Johnston and Dinardo 1997). We, nevertheless, report both the OLS and FEs estimators, as they reflect different responses to the growth model. Table 3 depicts the OLS regression results, which reflect longer-run effects, while Table 4 displays the FEs results, which show short-run effects. The OLS and REs estimates are similar because most of the variation is cross-sectional.[11] The variance-inflating factor analysis shows

[10] The regression results for normally working people are cut by the same cloth. They are not reported because of space constraints, but may be obtained upon request. In addition, since the regression results are highly robust across inequality measurements, we present only the results for inequalities measured using the Theil index.

[11] The REs results may be obtained upon request.

Table 2 Cross-sectional analysis: OLS results

	Without control variables			With control variables								
				Time-variant control variables				Time-variant and time-invariant control variables				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Two-year lag of natural logarithm of income per capita	−0.0617 (0.0259)**		0.0639 (0.0359)*	0.0707 (0.0374)*	0.0559 (0.0371)	0.0322 (0.0408)	0.0504 (0.0370)	0.1390 (0.0663)**	−0.0505 (0.0706)	0.0287 (0.0656)	0.0704 (0.0462)	0.0569 (0.0546)
Two-year lag of income inequality	0.1013 (0.0673)		0.2551 (0.0712)***	0.2258 (0.0903)**	0.3454 (0.0937)***	0.3585 (0.1060)***	0.2362 (0.1111)**	0.3859 (0.1380)***	0.4958 (0.1464)***	0.4061 (0.1130)***	0.3180 (0.1102)***	0.3273 (0.1158)***
Two-year lag of educational attainment		0.0957 (0.0703)	0.2511 (0.0810)***	0.2721 (0.0857)***	0.2066 (0.0912)**	0.2556 (0.0980)**	0.2899 (0.0989)***	0.3156 (0.1591)*	0.3280 (0.1267)**	0.2402 (0.0989)**	0.2624 (0.1011)**	0.2674 (0.1004)***
Two-year lag of educational inequality		0.1434 (0.0364)***	0.2189 (0.0433)***	0.2336 (0.0485)***	0.2040 (0.0506)***	0.1993 (0.0533)***	0.2361 (0.0529)***	0.2179 (0.0724)***	0.1450 (0.0647)**	0.1877 (0.0560)***	0.2236 (0.0545)***	0.2123 (0.0571)***
Population ageing				0.0006 (0.0042)	0.0056 (0.0043)	0.0033 (0.0042)	−0.0015 (0.0049)		0.0067 (0.0057)	0.0052 (0.0044)	0.0027 (0.0046)	0.0027 (0.0044)
Work access (source: ECHP)				−0.1121 (0.1656)								
Work access (source: Eurostat)					0.0036 (0.0022)							
Unemployment						−0.4971 (0.3158)			−0.7674 (0.4959)	−0.3508 (0.3754)	−0.2183 (0.3560)	−0.4554 (0.3273)
Inactivity							0.5565 (0.2484)**					
Female's work access						0.0014 (0.0021)	0.0030 (0.0020)		0.0034 (0.0026)	0.0007 (0.0021)	0.0011 (0.0021)	0.0016 (0.0021)
Road stock (fixed)								1.0722 (1.3027)				
Rail capital (fixed)								−1.2667 (0.6662)*				
Urbanisation (fixed)									0.0843 (0.0510)			
Liberal										−0.0016 (0.0759)		

Table 2 continued

	Without control variables			With control variables								
				Time-variant control variables				Time-variant and time-invariant control variables				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Corporatist										−0.0316 (0.0711)		
Residual										−0.0544 (0.0948)		
Mainly Catholic											0.0366 (0.0268)	
Mainly Orthodox											0.0989 (0.0481)**	
											0.0405	
Mainly Anglicans											(0.0302)	
North/Central family structure												0.0068 (0.0718)
Southern/Catholic family structure												0.0365 (0.0921)
Constant	0.3559 (0.0791)***	0.0701 (0.0772)	−0.3467 (0.1552)**	−0.3481 (0.2769)	−0.7772 (0.3023)**	−0.4843 (0.2942)	−0.6557 (0.2751)**	−0.5497 (0.2503)**	−0.6473 (0.4012)	−0.5091 (0.3530)	−0.5926 (0.3095)*	−0.5473 (0.3298)
R-squared	0.2064	0.3047	0.3924	0.3968	0.4508	0.4570	0.4740	0.4328	0.4562	0.4773	0.4891	0.4607
Observations	94	94	94	94	84	84	84	34	53	84	84	84

(*), (**), and (***) indicates significance at the 10%, 5% and 1% level, respectively

that multicollinearity is not a problem in our specifications. Finally, there is no much difference between the significance of the homoskedasticity and the heteroskedasticity consistent covariance matrix estimator, showing that the determinants of regional economic growth are robust to the model specification about the error term. Thus, Tables 2, 3, and 4 present only the homoskedasticity consistent covariance matrix estimator.

In the following subsections we look successively at the association between, first, income levels and inequality and the growth of GDP per capita, before looking at that of educational attainment and inequality on growth and finally at the combined association.

3.1 Growth and income inequality

Regression 1 (Tables 2, 3, 4) shows the association between the natural logarithm of income per capita and income inequality on regional economic growth. The *elasticity coefficient on the lagged income per capita* is negative indicating convergence. The findings also show a short-run positive association between the *lagged income inequality* and regional economic growth (Table 4). Existing levels of inequality across regions in Europe seem to be fundamentally good for incentives and should therefore be viewed as potentially growth-enhancing (Mirrlees 1971; Rebelo 1991; Aghion et al. 1998). Hence a moderate level of income inequality, such as that observed across regions in western Europe, seems to favour capital accumulation through a higher marginal propensity to save of the rich with respect to the poor, increasing aggregate savings and growth. The results also are inconsistent with the approaches that posit that given current levels of European development, greater equality would stimulate greater investment in human capital and growth. The positive coefficient on income inequality may also highlight that innovators may be interested in consumers who have a very high willingness to pay. In other words, price effects may dominate over market size effects: the wealth of potential consumers may dominate over the overall number of consumers (Bertola et al. 2006). Finally, the positive coefficient on income inequality may reflect the political economy standpoint that the higher the income inequality, the higher the rate of taxation, the greater the expenditure on public education programmes, the higher the public investment in human capital, and the higher the (national) economic growth (Saint-Paul and Verdier 1993).

3.2 Growth and educational inequality

The relationship between educational attainment and educational inequality and economic growth across regions in western Europe is presented in Regression 2. The results of the analysis highlight the existence of a positive coefficient for *lagged educational attainment* (Table 3). This result indicates, as expected, the importance of the overall education of the population as a factor for sustained regional growth (Hannum and Buchmann 2005). The positive coefficient also points to the major role of education not only in increasing the individual's capacity and potential, but also in facilitating the process of adaptation to new technologies so as to speed up the diffu-

Table 3 Panel data analysis: OLS results

	Without control variables			With control variables								
				Time-variant control variables				Time-variant and time-invariant control variables				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Two-year lag of natural logarithm of income per capita	−0.0269 (0.0107)**		0.0190 (0.0147)	0.0287 (0.0153)*	0.0184 (0.0152)	0.0186 (0.0172)	0.0171 (0.0151)	0.0872 (0.0315)***	−0.0263 (0.0283)	−0.0057 (0.0221)	0.0505 (0.0190)***	0.0025 (0.0211)
Two-year lag of income inequality	0.0101 (0.0271)		0.0917 (0.0272)***	0.0455 (0.0333)	0.0903 (0.0344)***	0.0739 (0.0377)*	0.0447 (0.0397)	0.2366 (0.0565)***	0.0627 (0.0555)	0.1103 (0.0384)***	0.0623 (0.0389)	0.0887 (0.0398)**
Two-year lag of educational attainment		0.0574 (0.0196)***	0.0858 (0.0216)***	0.1018 (0.0229)***	0.0911 (0.0262)***	0.0992 (0.0260)***	0.1053 (0.0258)***	0.0479 (0.0578)	0.0694 (0.0342)**	0.0539 (0.0304)*	0.0577 (0.0304)*	0.0775 (0.0271)***
Two-year lag of educational inequality		0.0734 (0.0127)***	0.0860 (0.0148)***	0.1047 (0.0167)***	0.0956 (0.0178)***	0.0996 (0.0190)***	0.0995 (0.0171)***	0.0815 (0.0304)***	0.0485 (0.0242)**	0.0716 (0.0200)***	0.1007 (0.0211)***	0.0843 (0.0197)***
Population ageing				−0.0024 (0.0017)	−0.0001 (0.0017)	−0.0002 (0.0017)	−0.0029 (0.0021)		0.0010 (0.0023)	0.0018 (0.0017)	−0.0003 (0.0018)	0.0009 (0.0017)
Work access (source: ECHP)				−0.1598 (0.0701)**								
Work access (source: Eurostat)					0.0000 (0.0008)							
Unemployment						−0.0109 (0.1220)			−0.0883 (0.2165)	0.0834 (0.1382)	0.2672 (0.1379)*	0.0076 (0.1257)
Inactivity							0.2312 (0.1095)**					
Female's work access						−0.0005 (0.0007)	0.0003 (0.0008)		0.0008 (0.0009)	−0.0001 (0.0008)	−0.0002 (0.0007)	0.0001 (0.0008)
Road stock (fixed)								−0.1788 (0.5488)				
Rail capital (fixed)								−0.3848 (0.2953)				
Urbanisation (fixed)									0.0265 (0.0201)			
Liberal										0.0373 (0.0176)**		
Corporatist										0.0199 (0.0165)		

Table 3 continued

	Without control variables			With control variables								
				Time-variant control variables				Time-variant and time-invariant control variables				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Residual										−0.0113 (0.0260)		
Mainly Catholic											0.0115 (0.0103)	
Mainly Orthodox											0.0663 (0.0205)***	
Mainly Anglicans											0.0296 (0.0111)***	
North/Central family structure												0.0329 (0.0165)**
Southern/Catholic family structure												0.0171 (0.0259)
Constant	0.1574 (0.0332)***	−0.0039 (0.0240)	−0.1146 (0.0526)**	0.0486 (0.1044)	−0.1160 (0.1091)	−0.0954 (0.1164)	−0.0940 (0.1008)	−0.2820 (0.1065)**	−0.0492 (0.1608)	−0.1258 (0.1258)	−0.1736 (0.1151)	−0.1394 (0.1257)
R-squared	0.0720	0.2015	0.2468	0.2686	0.2712	0.2734	0.2917	0.3207	0.1995	0.3343	0.3365	0.3003
Observations	204	196	196	196	180	180	180	74	110	180	180	180
LM test	9.15 (0.0025)	5.57 (0.0182)	8.97 (0.0027)	6.76 (0.0093)	8.17 (0.0043)	7.92 (0.0049)	9.57 (0.0020)	7.81 (0.0052)	5.86 (0.0155)	9.64 (0.0019)	8.38 (0.0038)	8.45 (0.0036)
Hausman test	5.55 (0.0623)	3.77 (0.1588)	18.76 (0.0009)	33.95 (0.0000)	26.11 (0.0002)	56.84 (0.0000)	33.87 (0.0000)					

(*), (**), and (***) indicates significance at the 10%, 5% and 1% level, respectively. LM test is the Lagrange Multiplier test for the random effects model based on the OLS residuals (Breusch and Pagan 1980). Hausman test is the Hausman (1978) test for fixed or random effects

Table 4 Panel data analysis: FEs results

	Without control variables			With time-variant control variables			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Two-year lag of natural logarithm of income per capita	−0.1193 (0.0501)**		−0.3032 (0.1127)***	−0.1760 (0.1104)	−0.2478 (0.1153)**	−0.1510 (0.1063)	−0.2208 (0.1131)*
Two-year lag of income inequality	0.2690 (0.1505)*		0.2690 (0.1326)**	0.0989 (0.1314)	0.1438 (0.1375)	0.0293 (0.1266)	0.0935 (0.1376)
Two-year lag of educational attainment		0.1139 (0.0706)	0.2453 (0.0924)***	0.2041 (0.0880)**	0.2709 (0.0966)***	0.2181 (0.0900)**	0.2935 (0.0948)***
Two-year lag of educational inequality		0.1639 (0.0650)**	0.1300 (0.0634)**	0.1187 (0.0593)**	0.1244 (0.0664)*	0.1098 (0.0607)*	0.1386 (0.0648)**
Population ageing				−0.0223 (0.0084)***	−0.0236 (0.0089)***	−0.0150 (0.0083)*	−0.0231 (0.0090)**
Work access (source: ECHP)				−0.7997 (0.2655)***			
Work access (source: Eurostat)					−0.0075 (0.0044)*		
Unemployment						1.3112 (0.3674)***	
Inactivity							−0.0521 (0.3421)
Female's work access						−0.0111 (0.0035)***	−0.0114 (0.0040)***
Constant	0.2732 (0.1208)**	−0.1176 (0.1021)	0.4047 (0.2374)*	1.6600 (0.4356)***	1.8227 (0.5048)***	1.3376 (0.4477)***	1.8689 (0.4666)***
R-within	0.0715	0.0960	0.1929	0.3121	0.2606	0.4056	0.3100
Observations	204	196	196	196	180	180	180

(*), (**), and (***) indicates significance at the 10%, 5% and 1% level, respectively

sion of technology throughout the EU (Aghion et al. 1998). Education seems to allow those European regions with currently less advanced technologies to learn more and better assimilate spillovers from more advanced regions and thereby help the former to achieve a higher degree of productivity improvement when innovating and a higher growth rate (Rodríguez-Pose and Crescenzi 2008). The positive association between education and growth may, however, hide that the education system is not necessarily aimed at helping individual growth, but rather at educating, training and sorting individuals for the labour market (Hannum and Buchmann 2005). Education also seems to have implications for the optimal capital structure. Technologically advanced societies seem to build more human capital relative to physical capital (Aghion et al. 1998).

As in the case of income inequality, the positive coefficient on *lagged educational inequality* (Tables 2, 3, 4) highlights that existing levels of inequality across regions in western Europe may be regarded as fundamentally good for incentives and growth-enhancing. Hence, existing inequality may create an incentive for people to increase their returns on investment in human capital by enabling members of the highly educated segments of society to increase their investment in human capital, while avoiding the risk of a low level of investment in human capital trap (Galor and Tsiddon 1997, p. 94).

3.3 Growth and income and educational inequality

Tables 2, 3, and 4 (regressions 3 and beyond) examine the combined impact of income and educational inequality on regional economic growth. In addition to the simple association between endowments and inequalities in income and education and growth, we further assess the robustness of our findings by introducing first a series of time-variant and then time-invariant control variables in the model. These control variables cover a series of factors generally regarded to affect economic performance at a regional level. They include different aspects of population ageing, access to employment, infrastructure endowment, geography, and institutions—ranging from welfare regimes to family structures. The specific control variables and their sources are presented in Table 5 in Appendix.

The cross-sectional analysis and the OLS panel data analysis of regressions 3–12 in Tables 2 and 3 display the longer-run combined association of income and educational inequality on growth. The FEs results of regressions 3–7 in Table 4 present the short-run impact, eliminating the time-invariant variables.

The findings show an ambiguous impact of lagged income per capita on growth: the elasticity coefficient on income per capita is sensitive to the inclusion of additional control variables. The short-run and longer-run coefficient on lagged educational attainment, in contrast, is positive, significant, and robust to the inclusion of control variables. Hence the current educational endowment of a region in western Europe seems to matter more for economic growth than its relative wealth. The results also show that, given the existing moderate levels of inequality across regions in western Europe, an increase in a region's income and educational inequality has a significant positive relationship with subsequent economic growth, but also that the short-run coefficient on income inequality is not robust.

The inclusion of a series of control variables confirms, in most cases, the robustness of the above-mentioned coefficients. Our first control variable is *population ageing* (Regression 4). Its longer-run coefficient is statistically insignificant. This seems to support Disney's (1996) finding that the relationship between an population ageing and productivity is unclear. Nevertheless, the short-run coefficient on population ageing is negative and statistically significant, underscoring that older workers may be, on average, less productive than younger ones for several reasons (Tang and MacLeod 2006). First, younger and older workers differ in their levels of technology adoption, as the former are the primary adopters and beneficiaries of new technologies, while the latter tend to be, by and large, less willing or capable to learn new ways of doing things (Galenson and Weinberg 2000). Second, both types of workers may differ in work effort, as younger workers in general tend to work longer hours, tend to be healthier and on average take fewer days in sick leave than older workers (Cheal 2000). Since productivity declines as a worker gets closer to retirement (Bhattacharya and Russell 2001), population ageing is negatively associated with regional economic growth. Hence, differences in technology adoption and work effort may lead to different productive capacities across different age groups of the workforce.

We also control for *access to work* which is measured either as the percentage of normally working respondents (source: ECHP) (Regression 4) or as the economic activity rate of the total population (source: Eurostat) (Regression 5). The results seem to reject the view that a high participation in the labour market contributes to a competitive economic environment, which promotes allocative efficiency (Azzoni and Silveira-Neto 2005).

Unemployment and *inactivity* are controlled for in regressions 6 and 7 respectively. The positive and statistically significant coefficient on unemployment in the short-run and inactivity in the longer-run are in line with the theoretical work of Hall (1991) and Caballero and Hammour (1994), who indicate that recessions may stimulate growth. More specifically, inactivity and unemployment may generate efficiency gains by causing less efficient firms to exit, and may encourage firms to reorganise investments and adopt innovative activities.

Our final labour force control is *female participation in the labour market* (Regression 6). The short-run association of women's work access with economic growth is negative and statistically significant, highlighting that, on average, women and men still occupy different positions, with women traditionally more likely to be poorer and less-educated relative to men. These results underline the persistence of gender wage and social differentials.

The link between *transport infrastructure* and growth is examined in Regression 8. A number of studies (Aschauer 1989; Banister and Berechman 2000) have defended what they regard as a fundamental contribution of transport infrastructure to economic growth. The net benefits associated with public transport infrastructure are related to increases in net local income, which stem from either private investments due to the reductions in transport costs and travel times, or positive externalities, as the income of the non-users of the infrastructure may increase due to increases in local demand on the part of the infrastructure users (McCann and Shefer 2004). An increase in the level of connectivity may imply a greater ability on the part of local firms to develop profitable market relationships with firms and consumers. Firms that are

located in areas with a better infrastructure will become integrated into the market system and more exposed to competition and, thus, under greater pressure to improve productivity (Vickerman 1991; Deichmann et al. 2004). Therefore, infrastructure can contribute to growth, either directly as a measurable final product, or indirectly as an intermediate input, because infrastructure enhances the productivity of all other inputs in producing output (Wang 2002) and generates positive externalities. These views are, nevertheless, opposed by our results. The coefficient on road infrastructure is not statistically significant, but the coefficient on rail infrastructure is negative and significant (Table 2).[12] This is likely to show that while a transport infrastructure may encourage development in under-developed regions, its construction alone will not be enough to bring about the desired economic changes (McCann and Shefer 2004, p. 179). Other factors, such as the resource endowments of the region, the economic climate, the prices of input factors of production, government policies, or historically developed infrastructure would tend to determine the economic viability of a region far more than its transport infrastructures (Vickerman 1991; McCann and Shefer 2004). Our results are hence more consistent with the studies of Holtz-Eakin (1994) and Holtz-Eakin and Lovely (1996). The negative impact of the rail infrastructure is likely to show more limited benefits than other modes of transport infrastructure. However, bearing in mind that data for only a few regions were available, some caution is called for in the interpretation of the results.

The findings for *urbanisation* (Regression 9) show that it has no impact on economic growth. Although cities generate multiple technological and pecuniary externalities, related to the proximity of and constant interaction among people, ideas, and knowledge and the constant flows and exchanges these interactions create (Jacobs 1970; Polese 2005), the longer-run impact of urbanisation on economic growth at a regional level in our model remains unclear.

We finally control for the influence of some institutional factors such as *welfare state* (Regression 10), *religion* (Regression 11), and *family structure* (Regression 12). The findings show that the association between these type of institutions and regional economic growth in our model is generally not relevant, despite the fact that, once all other factors are controlled for, regions with an Orthodox majority tend to perform better than mainly Protestant areas.

Considering the standardised coefficients for the above regressions (Table 6 in Appendix), educational attainment, income inequality, and educational inequality explain the largest variation in growth rates. The results also suggest that inequalities in educational attainment levels matter more for economic performance than average level of educational attainment.

[12] Since the transport infrastructure of 1995–2000 has been constructed over many years, both variables may reflect lagged requirements and patterns of development rather than current and prospective ones (European Commission 1999). Additionally, the physical scale measurement does not give a clear picture of infrastructure stock, as it is extremely difficult to approach the estimation of the qualitative characteristics of the infrastructure capacity (Rovolis and Spence 2002, p. 394). Indicators of quality are even more difficult to define. For the rail network, the extent of electrification and the number of separate tracks, which affect both the speed of the service and its carrying capacity, provide a reasonable indication of quality but, as a whole, neither the indicators of scale nor of quality can convey how suitable the existing transport endowment in any region is to its regional development needs (European Commission 1999, p. 122). As a consequence, the results of the analysis need to be interpreted with caution.

4 Concluding remarks

Both income and educational distributions are basic determinants in regional economic growth analyses. First, numerous arguments that have been made as to why more or less skewed income distributions can be good or bad for growth and why government interventions may harm or enhance growth. Second, educational distribution is also often seen as an engine for economic growth and central to any modern economy. Wolf (2002, p. 244), for instance, argued that education now matters more for growth than ever before in history, but only when individuals have the right qualifications, study the right subjects, and are employed in the right jobs.

However, the combined impact of both income and educational distribution on growth is far from being well understood and is indeed complex. This is especially the case at a regional level in Europe, where the issue has been hardly addressed. The limited existing theoretical and empirical literature shows that there is a high correlation between income and educational inequalities (Rodríguez-Pose and Tselios 2008). This paper has addressed using an economic analysis based on micro data of income and educational distribution, measured by average and inequality levels, whether this link also affects the economic performance of regions across Europe and whether any potential correlation is affected by the introduction of other variables.

As a whole, our results indicate that both income and educational inequality matter for regional growth. Existing levels of income and education inequality seem to be fundamentally good for socioeconomic incentives and thus should be considered as growth-enhancing. The findings also suggest that the association between income per capita and regional growth in western Europe is not clear, as the elasticity coefficient on lagged income per capita is very sensitive to the inclusion of income inequality, education, and other control variables. The results confirm the general belief that educational achievement has a positive connection with economic growth, but also show that, as a whole, the association between inequality in education and growth is stronger than that between growth and educational attainment. The above findings are not only robust to the definition of income distribution, but also robust across inequality measurements.

Overall, existing income and human capital inequality are likely to increase growth, but the magnitude of their impact is relatively small. Nevertheless, increasing inequality cannot be considered as a simple policy remedy for promoting economic growth at a regional level in western Europe, as the changes in the level of income and educational inequality towards greater or lower inequality may tilt the positive influence they currently have on economic incentives beyond the threshold in which the incentives become disincentives.

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Appendix

The control variable and standardised coefficients are given in Tables 5 and 6.

Table 5 Control variable

Control variables	Description	Sources
Population ageing	The average age of respondents	ECHP
Work access	(a) The percentage of normally working (15+ h/week) respondents	ECHP
	(b) The percentage of economic activity rate of total population	EUROSTAT
Unemployment	The percentage of unemployed respondents	ECHP
Inactivity	The percentage of inactive respondents	ECHP
Female's work access	The percentage of female's economic activity rate	EUROSTAT
Road stock (*time-invariant*)	The average of the length of road-motorways per square kilometres (1995–2000)	EUROSTAT
Rail capital (*time-invariant*)	The average of the length of railways per square kilometres (1995–2000)	EUROSTAT
Urbanisation (*time-invariant*)	The percentage of respondents who live in a densely populated area (1999–2000)	ECHP
Welfare state		
Socialism (social-democratic)	Sweden, Denmark	Esping-Andersen (1990), Ferrera (1996), Berthoud and Iacovou (2004)
Liberal	United Kingdom, Ireland	
Corporatist (conservatism)	Luxembourg, Belgium, France, Germany, Austria	
Residual ('Southern')	Portugal, Spain, Italy, Greece	
Religion		
Mainly protestant	Sweden, Denmark, Northern Germany, Scotland	http://www.cia.gov, http://csi-int.org, http://www.wikipedia.org/
Mainly catholic	France, Ireland, Luxembourg, Portugal, Spain, Italy, Austria, Southern Germany, Belgium	
Mainly orthodox	Greece	
Mainly anglicans	England	
Family structure		
Nordic (Scandinavian)	Sweden, Denmark	Berthoud and Iacovou (2004)
North/Central	UK, Belgium, Luxembourg, France, Germany, Austria	
Southern/Catholic	Ireland, Portugal, Spain, Italy, Greece	

Table 6 Standardised coefficients

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Cross-section												
2-Year lag of natural logarithm of income per capita	−0.3027		0.3134	0.3470	0.2631	0.1515	0.2371	0.8335	−0.2278	0.1353	0.3312	0.2679
2-Year lag of income ineq.	0.1910		0.4810	0.4256	0.6408	0.6652	0.4382	0.7340	0.9274	0.7534	0.5900	0.6072
2-Year lag of educational attainment		0.2702	0.7087	0.7679	0.5476	0.6774	0.7682	0.7268	0.7912	0.6365	0.6954	0.7086
2-Year lag of educational inequality		0.7816	1.1932	1.2730	1.0126	0.9893	1.1722	1.0943	0.7009	0.9319	1.1099	1.0538
Population ageing				0.0147	0.1209	0.0701	−0.0332		0.1427	0.1111	0.0581	0.0578
Work access (source: ECHP)				−0.1020								
Work access (source: Eurostat)					0.2600							
Unemployment						−0.1964			−0.3004	−0.1386	−0.0862	−0.1799
Inactivity							0.3875					
Female's work access						0.1323	0.2887		0.3631	0.0637	0.1058	0.1511
Road stock (fixed)								0.1765				
Rail capital (fixed)								−0.4840				
Urbanisation (fixed)									0.2311			
Liberal										−0.0085		
Corporatist										−0.1761		
Residual										−0.2930		
Mainly catholic											0.2130	
Mainly orthodox											0.2452	
Mainly anglicans											0.2180	
North/central family structure												0.0375
Southern/catholic family str.												0.1984

Table 6 continued

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel-data												
2-Year lag of natural logarithm of income per capita	−0.2415		0.1744	0.2643	0.1619	0.1629	0.1504	0.7993	−0.2498	−0.0500	0.4434	0.0222
2-Year lag of income ineq.	0.0360		0.3227	0.1599	0.3151	0.2577	0.1560	0.8349	0.2202	0.3846	0.2172	0.3094
2-Year lag of educational attainment		0.3655	0.5463	0.6477	0.5446	0.5927	0.6292	0.1991	0.4740	0.3220	0.3446	0.4629
2-Year lag of educational inequality		0.7205	0.8441	1.0274	0.8462	0.8816	0.8808	0.6281	0.4679	0.6340	0.8917	0.7459
Population ageing				−0.1007	−0.0050	−0.0063	−0.1187		0.0440	0.0729	−0.0103	0.0347
Work access (source: ECHP)				−0.2559								
Work access (source: Eurostat)					−0.0051							
Unemployment						−0.0077			−0.0609	0.0588	0.1882	0.0053
Inactivity							0.3078					
Female's work access						−0.0940	0.0570		0.1599	−0.0198	−0.0461	0.0257
Road stock (fixed)								−0.0485				
Rail capital (fixed)								−0.2345				
Urbanisation (fixed)									0.1443			
Liberal										0.3842		
Corporatist										0.2067		
Residual										−0.1126		
Mainly catholic											0.1267	
Mainly orthodox											0.3010	
Mainly anglicans											0.3022	
North/central family structure												0.3475
Southern/catholic family str.												0.1726

References

Aghion P, Bolton P (1990) Government domestic debt and the risk of default: a political economic model of the strategic role of debt. In: Dornbusch R, Draghi M (eds) Public debt management: theory and history. Cambridge University Press, Cambridge

Aghion P, Bolton P (1997) A theory of trickle-down growth and development. Rev Econ Stud 64:151–172. doi:10.2307/2971707

Aghion P, Caroli E, Garcia-Penalosa C (1999) Inequality and economic growth: the perspective of the new growth theories. J Econ Lit 37:1615–1660

Aghion P, Howitt P, Brant-Collett M, García-Peñalosa C (1998) Endogenous growth theory. MIT Press, Cambridge, MA

Alesina A, Perotti R (1996) Income distribution, political instability, and investment. Eur Econ Rev 40:1203–1228. doi:10.1016/0014-2921(95)00030-5

Aschauer DA (1989) Is public expenditure productive. J Monet Econ 23:177–200. doi:10.1016/0304-3932(89)90047-0

Austen S (2002) An international comparison of attitudes to inequality. Int J Soc Econ 29:218–237. doi:10.1108/03068290210417106

Azzoni CR, Silveira-Neto R (2005) Decomposing regional growth: labor force participation rates, structural changes, and sectoral factor reallocation. Ann Reg Sci 39:221–239. doi:10.1007/s00168-004-0207-8

Banerjee AV, Duflo E (2003) Inequality and growth: what can the data say? J Econ Growth 8:267–299. doi:10.1023/A:1026205114860

Banerjee AV, Newman AF (1993) Occupational choice and the process of development. J Polit Econ 101:274–298. doi:10.1086/261876

Banister D, Berechman J (2000) Transport investment and economic development. UCL Press, London

Barro RJ (2000) Inequality and growth in a panel of countries. J Econ Growth 5:5–32. doi:10.1023/A:1009850119329

Barro RJ (2001) Human capital and growth. Am Econ Rev 91:12–17

Barro RJ, Lee JW (1993) International comparisons of educational attainment. J Monet Econ 32:363–394. doi:10.1016/0304-3932(93)90023-9

Barro RJ, Lee JW (1996) International measures of schooling years and schooling quality. Am Econ Rev 86:218–223

Barro RJ, Lee JW (2001) International data on educational attainment: updates and implications. Oxf Econ Papers New Ser 53:541–563. doi:10.1093/oep/53.3.541

Becker GS, Tomes N (1986) Human capital and the rise and fall of families. J Labor Econ 4:S1–S39. doi:10.1086/298118

Bénabou R (1994) Theories of persistent inequalities—human capital, inequality, and growth—a local perspective. Eur Econ Rev 38:817–826. doi:10.1016/0014-2921(94)90118-X

Bénabou R (1996) Inequality and growth. National Bureau of Economic Research, Cambridge, MA

Bénabou R (2000) Unequal societies: income distribution and the social contract. Am Econ Rev 90:96–129

Bénabou R (2002) Tax and education policy in a heterogeneous agent economy: what levels of redistribution maximize growth and efficiency? Econometrica 70:481–517. doi:10.1111/1468-0262.00293

Berthoud R, Iacovou M (2004) Social Europe: living standards and welfare states. Edward Elgar, Cheltenham, UK

Bertola G (1993) Factor shares and savings in endogenous growth. Am Econ Rev 83:1184–1198

Bertola G (2000) Macroeconomics of distribution and growth. In: Atkinson AB, Bourguignon F (eds) Handbook of income distribution, chapter 9. Elvesier, Amsterdam

Bertola G, Foellmi R, Zweimüller J (2006) Income distribution in macroeconomic models. Princeton University Press, Princeton, NJ

Bhattacharya M, Russell S (2001) Aging and productivity among judges: some empirical evidence from the high court of Australia. Aust Econ Pap 40:199–212. doi:10.1111/1467-8454.00122

Birdsall N, Londono JL (1997) Asset inequality matters: an assessment of the World Bank's approach to poverty reduction. Am Econ Rev 87:32–37

Breusch TS, Pagan AR (1980) The Lagrange multiplier test and its applications to model specification in econometrics. Rev Econ Stud 47:239–253. doi:10.2307/2297111

Caballero RJ, Hammour ML (1994) The cleansing effect of recessions. Am Econ Rev 84:1350–1368

Castelló A, Doménech R (2002) Human capital inequality and economic growth: some new evidence. Econ J 112:C187–C200. doi:10.1111/1468-0297.00024

Champernowne DG, Cowell FA (1998) Economic inequality and income distribution. Cambridge University Press, Cambridge
Cheal DJ (2000) Aging and demographic change. Canadian Public Policy Analyse De Politiques 26:S109–S122
Chiswick BR (1974) Income inequality. Columbia University Press, New York
Coleman JS (1990) Foundations of social theory. Harvard University Press, Cambridge, MA
Deichmann U, Fay M, Koo J, Lall SV (2004) Economic structure, productivity, and infrastructure quality in Southern Mexico. Ann Reg Sci 38:361–385. doi:10.1007/s00168-003-0171-8
Disney R (1996) Can we afford to grow older? a perspective on the economics of aging. MIT Press, Cambridge, MA
Dixit AK, Pindyck RS (1993) Investment under uncertainty. Princeton University Press, Princeton, NJ
Durlauf SN, Quah DT (1999) The new empirics of economic growth. In: Taylor JB, Woodford M (eds) Handbook of macroeconomics, vol 1A. North-Holland: Elsevier, Amsterdam; New York
Easterly WR (2001) The middle class consensus and economic development. J Econ Growth 6:317–335. doi:10.1023/A:1012786330095
Esping-Andersen G (1990) The three worlds of welfare capitalism. Polity, Cambridge
European Commission (1999) The European regions: sixth periodic report on the socio-economic situation in the regions of the European Union. Official Publication Office, Luxembourg
Ezcurra R (2007) Is income inequality harmful for regional growth? evidence from the European Union. Urban Stud 44:1953–1971. doi:10.1080/00420980701471877
Falkinger J (1994) An Engelian model of growth and innovation with hierarchic consumer demand and unequal incomes. Ricerche Economiche 48:123–139. doi:10.1016/0035-5054(94)90003-5
Ferrera M (1996) The "southern model" of welfare in social Europe. J Eur Soc Policy 6:17–37. doi:10.1177/095892879600600102
Flug K, Spilimbergo A, Wachtenheim E (1998) Investment in education: do economic volatility and credit constraints matter? J Dev Econ 55:465–481. doi:10.1016/S0304-3878(98)00045-5
Forbes KJ (2000) A reassessment of the relationship between inequality and growth. Am Econ Rev 90:869–887
Galenson DW, Weinberg BA (2000) Age and the quality of work: the case of modern American painters. J Polit Econ 108:761–777. doi:10.1086/316099
Galor O (2000) Income distribution and the process of development. Eur Econ Rev 44:706–712. doi:10.1016/S0014-2921(99)00039-2
Galor O, Moav O (2000) Ability-biased technological transition, wage inequality, and economic growth. Q J Econ 115:469–497. doi:10.1162/003355300554827
Galor O, Moav O (2004) From physical to human capital accumulation: inequality and the process of development. Rev Econ Stud 71:1001–1026. doi:10.1111/0034-6527.00312
Galor O, Tsiddon D (1997) The distribution of human capital and economic growth. J Econ Growth 2:93–124. doi:10.1023/A:1009785714248
Galor O, Zeira J (1993) Income distribution and macroeconomics. Rev Econ Stud 60:35–52. doi:10.2307/2297811
Gijsberts M (2002) The legitimation of income inequality in state-socialist and market societies. Acta Sociologica 45:269–285. doi:10.1080/000169902762022860
Griliches Z, Mairesse J (1984) Productivity and R&D at the firm level. In: Griliches Z (ed) R&D, patents, and productivity. The University of Chicago press, Chicago
Hall RE (1991) Recessions as reorganisations. NBER Macroecon Annu
Hannum E, Buchmann C (2005) Global educational expansion and socio-economic development: an assessment of findings from the social sciences. World Dev 33:333–354. doi:10.1016/j.worlddev.2004.10.001
Hausman JA (1978) Specification tests in econometrics. Econometrica 46:1251–1271. doi:10.2307/1913827
Heyns B (2005) Emerging inequalities in Central and Eastern Europe. Annu Rev Sociol 31:163–197. doi:10.1146/annurev.soc.30.012703.110637
Higgins M, Williamson J (1999) Explaining inequality the world round: cohort size, Kuznets curves, and openness. NBER Working Paper No. 7224, National Bureau of Economic Research
Holtz-Eakin D (1994) Public-sector capital and the productivity puzzle. Rev Econ Stat 76:12–21. doi:10.2307/2109822
Holtz-Eakin D, Lovely ME (1996) Scale economies, returns to variety, and the productivity of public infrastructure. Reg Sci Urban Econ 26:105–123. doi:10.1016/0166-0462(95)02126-4

Hsiao C (2003) Analysis of panel data. Cambridge University Press, Cambridge
Jacobs J (1970) The economy of cities. Cape, London
Johnston J, Dinardo J (1997) Econometric methods. McGraw-Hill, New York
Kaldor N (1956) Alternative theories of distribution. Rev Econ Stud 23:83–100. doi:10.2307/2296292
Kelley AC, Williamson JG (1968) Household saving behavior in developing economies—Indonesian case. Econ Dev Cult Change 16:385–403. doi:10.1086/450300
Keynes JM (1920) The economic consequences of the peace. Macmillan, London
Li H, Zou H-F (1999) Income inequality is not harmful for growth: theory and evidence. Rev Dev Econ 2:318–334. doi:10.1111/1467-9361.00045
López RE, Thomas V, Wang Y (1998) Addressing the education puzzle: the distribution of education and economic reforms. World Bank, Economic Development Institute, Office of the Director and Macroeconomic Management and Policy Division, Washington, DC
Mairesse J (1990) Time-series and cross-sectional estimates on panel data: why are they different and why they should be equal. In: Hartog J, Ridder G, Theeuwes J (eds) Panel data and labor market studies, North Holland, New York
Mauro P (1995) Corruption and growth. Q J Econ 110:681–712. doi:10.2307/2946696
McCann P, Shefer S (2004) Location, agglomeration and infrastructure. Pap Reg Sci 83:177–196. doi:10.1007/s10110-003-0182-y
Mirrlees JA (1971) Exploration in theory of optimum income taxation. Rev Econ Stud 38:175–208. doi:10.2307/2296779
Nilsson A (2004) Income inequality and crime: the case of Sweden. Working Paper Series 6, IFAU—Institute for Labour Market Policy Evaluation
Panizza U (2002) Income inequality and economic growth: evidence from American data. J Econ Growth 7:25–41. doi:10.1023/A:1013414509803
Partridge MD (2005) Does income distribution affect U.S state economic growth? J Reg Sci 45:363–394. doi:10.1111/j.0022-4146.2005.00375.x
Peracchi F (2002) The European Community Household Panel: a review. Empir Econ 27:63–90. doi:10.1007/s181-002-8359-0
Perotti R (1992) Income distribution, politics, and growth. Am Econ Rev 82:311–316
Perotti R (1996) Growth, income distribution, and democracy: what the data say. J Econ Growth 1:149–187. doi:10.1007/BF00138861
Persson T, Tabellini G (1994) Is inequality harmful for growth. Am Econ Rev 84:600–621
Polese M (2005) Cities and national economic growth: a reappraisal. Urban Stud 42:1429–1451. doi:10.1080/00420980500150839
Rebelo ST (1991) Long-run policy analysis and long-run growth. J Polit Econ 99:500–521. doi:10.1086/261764
Rodríguez-Pose A, Crescenzi R (2008) Research and development, spillovers, innovation systems, and the genesis of regional growth in Europe. Reg Stud 42:51–67. doi:10.1080/00343400701654186
Rodríguez-Pose A, Tselios V (2008) Education and income inequality in the regions of the European Union. J Reg Sci (forthcoming)
Rodríguez-Pose A, Vilalta-Bufí M (2005) Education, migration, and job satisfaction: the regional returns of human capital in the EU. J Econ Geogr 5:545–566. doi:10.1093/jeg/lbh067
Rovolis A, Spence N (2002) Promoting regional economic growth in Greece by investing in public infrastructure. Environ Plan C Gov Policy 20:393–419. doi:10.1068/c9761
Saint-Paul G, Verdier T (1993) Education, democracy and growth. J Dev Econ 42:399–407. doi:10.1016/0304-3878(93)90027-K
Schultz TW (1975) Value of ability to deal with disequilibria. J Econ Lit 13:827–846
Sianesi B, van Reenen J (2003) The returns to education: macroeconomics. J Econ Surv 17:157–200. doi:10.1111/1467-6419.00192
Smith D (2001) International evidence on how income inequality and credit market imperfections affect private saving rates. J Dev Econ 64:103–127. doi:10.1016/S0304-3878(00)00126-7
Stokey NL (1991) Human capital, product quality, and growth. Q J Econ 106:587–616. doi:10.2307/2937948
Sylwester K (2000) Income inequality, education expenditures, and growth. J Dev Econ 63:379–398. doi:10.1016/S0304-3878(00)00113-9
Tang HM, MacLeod C (2006) Labour force ageing and productivity performance in Canada. Can J Econ 39:582–603. doi:10.1111/j.0008-4085.2006.00361.x
Vickerman RW (1991) Infrastructure and regional development. Pion, London

Voitchovsky S (2005) Does the profile of income inequality matter for economic growth? J Econ Growth 10:273–296. doi:10.1007/s10887-005-3535-3
Wang EC (2002) Public infrastructure and economic growth: a new approach applied to East Asian economies. J Policy Model 24:411–435. doi:10.1016/S0161-8938(02)00123-0
Wolf A (2002) Does education matter?: myths about education and economic growth. Penguin, London
Wooldridge JM (2002) Econometric analysis of cross section and panel data. MIT Press, Cambridge, MA
Zweimüller J (2000) Schumpeterian entrepreneurs meet Engel's law: the impact of inequality on innovation-driven growth. J Econ Growth 5:185–206. doi:10.1023/A:1009889321237