



Exploring the Links Between Education and Income Inequality at the Municipal Level in Greece

Anastasia Panori¹  · Yannis Psycharis¹

Received: 1 November 2016 / Accepted: 25 August 2017 /

Published online: 14 September 2017

© Springer Science+Business Media B.V. 2017

Abstract This paper builds upon the EU2020 strategy, following the smart and inclusive growth paradigm, that treats human capital as a central component of regional development. However, there are cases of smart growth policies, focusing on skills' empowerment, which may not yield the expected results, in terms of social cohesion aspects. Given this fact, the role of regional specificities, such as the extent to which an economy is characterized by a knowledge-based structure, constitute essential parameters that need to be taken into consideration during a policy-design process. This study aims to provide an evidence-based sub-regional analysis to assist processes regarding place-based policy design for socio-economic inclusion, in the case of Greece. More specifically, it investigates the links between education and income inequality, at a municipal level during the period 1994–2012, using a balanced panel dataset. The results indicate a negative effect of educational level on the formation of income inequality, probably due to the lack of an advanced knowledge-based economic structure in the case of the Greek economy. The significance of incorporating local particularities in the analysis, such as human capital endowments and time-varying socio-economic disturbances, as the 2008 economic crisis, is also stressed. Finally, the econometric method used in this paper includes the development of a DSEM model estimated by a system GMM estimator.

Keywords Regional development · Inequality · Income · Education · EU2020 strategy · Dynamic SEM

✉ Anastasia Panori
an.panori@panteion.gr

Yannis Psycharis
psycharis@panteion.gr

¹ Department of Economic and Regional Development, Panteion University of Social and Political Sciences, 136 Syngrou Avenue, 17671 Athens, Greece

Introduction

The delivery of the EU2020 developmental goals is largely founded on the notions of smart and inclusive growth. Two of the most important flagship initiatives, included in the EU2020 agenda, are the empowerment of people through the development of their skills, as well as the promotion of social and territorial cohesion (EC 2010). Under this context, knowledge is considered as a key driver of future economic growth, while at the same time empowerment of skills is thought to be a crucial part for building cohesive societies, where people would be able to anticipate and manage changes. Both these factors constitute essential components of a knowledge-based economy.

Following the definition of OECD (1996), a knowledge-based economy is *one which is directly based on the production, distribution and use of knowledge and information*. OECD also tries to define this notion, by indicating that *in a knowledge-based economy, organisations and people acquire, create, disseminate and use knowledge more effectively for greater economic and social development*. Nonetheless, rapid development of a knowledge-based economy could generate potential shortages of human capital stock, given the fact that human capital is one of its fundamental elements (OECD 2013). Thus, the formulation of systematic policies regarding human resources, aiming to increase quantity and quality of human capital, should be an important part of growth-promoting strategies, during the EU's ongoing effort to strengthen regional cohesion (De la Fuente and Ciccone 2002).

Increasing educational attainment is one of the most robust parameters for fostering economic growth in the long-run, offsetting partially rising earnings' inequality (OECD 2015). At the same time, it is important to maintain a relatively equal educational distribution across regional population, throughout the process of human capital empowerment of a region, otherwise this could negatively affect the overall social welfare growth rate (Rodríguez-Pose and Tselios 2015). Investing in education should be considered as a crucial policy initiative in the case of inclusive growth strategic planning, targeting to reduce inequalities (van Ham et al. 2016).

At the same time, the provision of an evidence-based framework for delivering decision-making processes constitutes an integral part of EU's policy framework. Establishing a solid evidence base, upon which effective long-term policies can be framed, improves the overall quality of governance. Evidence-based policy-making helps promoting well-informed decisions, using the best available evidence at the heart of policy development processes, aiming to assist competitiveness and inclusive growth (Davies 1999; Niemi 2007, EC/EACEA/Eurydice 2017). Moreover, it helps decision-makers find ways to best tailor policy actions and interventions to the heterogeneous local contexts, fact which is regarded as a crucial issue for policy design and delivery (Rodrik 2007). Place-contingent policy solutions assist the promotion of a place-based policy approach, characterizing the overall EU Cohesion Policy paradigm shift (O'Brien et al. 2017), which extracts and builds on local specificities using evidence-based analysis (Gianelle et al. 2016), increasing the need for expanding the explorative analysis using available data sources.

In most cases, EU regional policies are designed and applied based on the Nomenclature of Territorial Units for Statistics (NUTS) classification. More specifically, NUTS2 level is the basic unit for the implementation of regional policies, whereas NUTS3 are smaller regions for specific diagnoses, which are used in fewer cases.

However, regional averages in many cases mask important existing disparities, failing to reveal essential spatial concentrations of human capital or income that might exist within them (Piacentini 2014). These deviations in spatial concentrations constitute place-dependent characteristics, which probably play a key role in the development and the evolution of regional disparities over time. Under this context, exploring socio-economic phenomena at sub-regional levels, lower than NUTS2 or NUTS3, is an important step for improving the effectiveness of policy interventions, based on smart and inclusive growth principles (EC 2008). These levels include Local Administrative Units (LAU1), which are lower level administrative divisions of a country, such as municipalities. Investigating socio-economic phenomena, such as income inequality, that take place within these sub-regional units, is crucial for defining place-based contexts. These might include geographical specificities, as well as particularities arising due to time-varying socio-economic conditions, such as the 2008 economic crisis.

Based on the above, this paper, being inspired by the smart growth paradigm, treats human capital as a central part of territorial cohesion, aiming to provide an evidence-based sub-regional analysis to foster place-based policies for socio-economic inclusion, in the case of Greece. More specifically, it investigates the links between education and income inequality, at a municipal level. Income inequality is calculated within each municipality, based on the individual equivalized income of its residents. The study finds evidence highlighting the importance of considering *local specificities of human capital distribution* and *time-varying socio-economic disturbances* as crucial parameters, that need to be taken into consideration during a policy-design process for inclusive growth.

The structure of the paper is organized as follows: [Theoretical Background and Related Literature](#) Section presents the theoretical background, including existing research on income inequality and education. In [The Case of Greece](#) Section a short description of the socio-economic developments in Greece, compared to the EU case for the period under investigation, is illustrated, while [Data and Methodology](#) Section describes the main data sources and the methodology used in this study. Furthermore, [Empirical Results](#) Section presents the main findings of this empirical application, while the main conclusions and discussion regarding potential policy implications are illustrated in [Concluding Remarks](#) Section.

Theoretical Background and Related Literature

The adoption and implementation of the EU Cohesion Policy, targeting on a more inclusive Europe is an essential parameter that has led to a gradual and significant decrease in disparities between EU countries (Artelaris and Petrakos 2016; Bachtler and Mendez 2016; Becker et al. 2016; Kramar 2016; Bachtler and Turok 2013; Fingleton 2013; Doran and Jordan 2013; EU Parliament 2007). Under this framework, social cohesion and inclusion have been operationalized using indicators and targets, where income distribution measures have an essential role (Bernhard 2010; Nivière 2005). Mixed findings have been delivered through research, regarding this phenomenon during the post-2007 crisis period, especially in terms of social conditions and vulnerability of the regions (Ballas et al. 2017a, b, 2014; Hennig et al. 2015; Hadjimichalis

and Hudson 2014; Smith 2013; Hadjimichalis 2011; Martin 2011; Rae 2011), indicating a somehow restricted effectiveness of the EU Cohesion Policy during this recession period.

By following EU2020 Agenda's (EC 2010) smart growth perspective, which is based on a knowledge-oriented economic model, and given its additional focus on the inclusive growth paradigm, education and skills' empowerment are core parameters for designing effective policy-making processes. Under this policy framework, the role of education becomes more essential in promoting social inclusion. Thus, the need for investigating interactions between education and income inequality trends emerges not only, because of the continuously persistent regional disparities' phenomenon, but also, due to the shift of policy-makers' attention to more effective ways of achieving social cohesion, under a knowledge-based economic framework.

Literature offers significant insights, coming from several empirical applications, of investigating the links between human capital and income, along with their inequality components. In almost all cases, education appears to be one of the most highly associated parameters to income inequality. This is evident, starting from the early works of Becker and Chiswick (1966) and Mincer (1974), focusing on the returns to education, and moving on to more recent studies, that analyze the ways in which education affects income distribution, and vice versa (Cecchi 2000; Pritchett 2001; Thorbecke and Charumilind 2002; Rodríguez-Pose and Tselios 2008a, b, 2011; Yang et al. 2009; Houghton and Khandker 2009; Atkinson and Bourguignon 2014).

An interesting fact is that only few studies have used educational inequality measures, alongside with the overall level of education, as explanatory variables (Chiswick 1971; Tinbergen 1972; Marin and Psacharopoulos 1976; Psacharopoulos 1982; Winegarden 1979; Ram 1990; Bourguignon and Morrisson 1998; Park 1996; Rees et al. 2002; Cecchi 2000). Although in most cases, an increasing educational level has a reversed impact on income inequality, educational inequality seems to be positively associated with it. Földvári et al. (2010), unpublished manuscript have illustrated evidence in favor of this positive association between educational and income inequality, whereas no evidence was found to support the hypothesis that a more equal educational distribution leads to higher income levels.

Efforts have also been made recently, to further explore potential causal relationships between these variables. Developments in the field of econometric and computational analysis (software and high-performance hardware) have been recognized as focal milestones, regarding the construction and settlement of high-complexity econometric models. To the best of the author's knowledge, some of the most comprehensive studies that explore links between education and income inequalities at a national/regional level have been performed by De Gregorio and Lee (2002) and Tselios (2014). The main advantage of these studies is the fact that they do not constitute unilateral approaches to the interaction between income and education, but rather they try to investigate all possible ways in which these variables are related to each other. This is achieved through treating education and income inequality as dependent variables, interchangeably.

In the first case, De Gregorio and Lee (2002) construct an unbalanced panel dataset on education and income that includes six time waves for several countries around the world. Furthermore, they construct an equation system using the Mincerian wage equation as a baseline, which they estimate using the seemingly-unrelated-regression

(SUR) technique. A set of regional dummy variables is also included in their analysis, which distinguishes regions according to their geographical location. Their findings indicate that educational factors, such as attainment and distribution, seem to play an important role in the formation of income inequalities, whereas regional dummies appear to be statistically significant only in some cases. Furthermore, Tselios (2014) chooses a spatial cross-regressive VAR framework to apply Granger-causality tests, to reveal any possible causal relationships that arise between education and income inequalities, in the case of EU regions. Remaining consistent to a regional analysis framework, and creating a balanced data set from the European Community Household Panel (ECHP) data survey (1995–2000), he reveals the existence of a bidirectional heterogeneous causality between income inequality and education. Moreover, his findings illustrate that space, through the geographical externalities that it imposes, also constitutes a crucial parameter during the formation process of such interactions.

In both previous cases, insights are offered regarding the importance of space and regional externalities in shaping diversified interactions between education and income, as well as their inequality derivatives, fact which should not be overlooked. In policy-making terms, these findings constitute evidence-based outcomes that could be used as inputs for developing diversified place-based policy agendas, helping to implement in practice the ongoing paradigm shift of the EU Cohesion Policy framework (O'Brien et al. 2017; Garcilazo 2011; Bachtler 2010; Barca 2009; Elias 2008). The effectiveness of this kind of decision-making processes, could be further improved by expanding the analysis at even lower spatial units, fact which would strengthen the emphasis on the spatial dimension.

Nonetheless, sub-regional empirical applications are relatively limited in the literature and in most cases, try to shed light on spatial distribution of income inequalities (Paredes et al. 2016; Florida and Mellander 2014; Lee et al. 2015), since their estimation is hindered by the level of availability and transparency of the necessary data. However, progress has been achieved in recent years, through the development of new computational methods that have reinforced the application of small-area models (Fabrizi and Trivisano 2016; Fenton 2013; Ballas et al. 2005). The new data era enables the creation and exploitation of large-scale datasets, able to incorporate low spatial scale territorial units, as well as information coming from the recent 2008 financial crisis.

Based on the above, this paper builds on the concepts of smart and inclusive growth EU strategic frameworks, focusing specifically on the effects of education on the formation of income inequalities. It uses an evidence-based analysis for the case of Greece, which is characterized not only by local specificities, but also by a severe still on-going economic crisis, that has led to notable reforms in its fiscal policy. This analysis, aims to promote insights and inputs for improving the effectiveness of place-based policy design under a knowledge-based economic framework, targeting to use education as a tool for assisting social cohesion. The analysis uses municipalities as its main components, for strengthening the importance of the local spatial dimension, and covers a 14-year period (1994–2012), including pre- and post-crisis time spans.

The Case of Greece

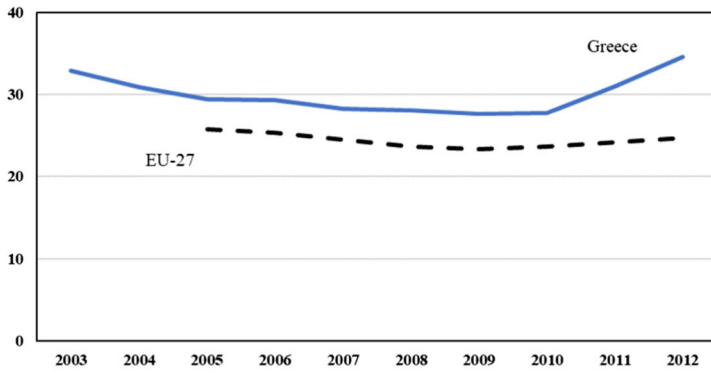
During the last decade, Greece has experienced the 2008 financial crisis undoubtedly in a more severe way than any other European country. In terms of social conditions, there

has been a sharp increase of people living under the poverty line or in social exclusion, especially after 2010. The severity of the still on-going economic crisis is even more stressed when comparing the Greek case with the overall EU-27 average (Fig. 1a). At-risk-of-poverty rates have sharply increased in Greece between 2008 and 2012, whilst EU-27 values indicate only a slight rise during this post-crisis period.

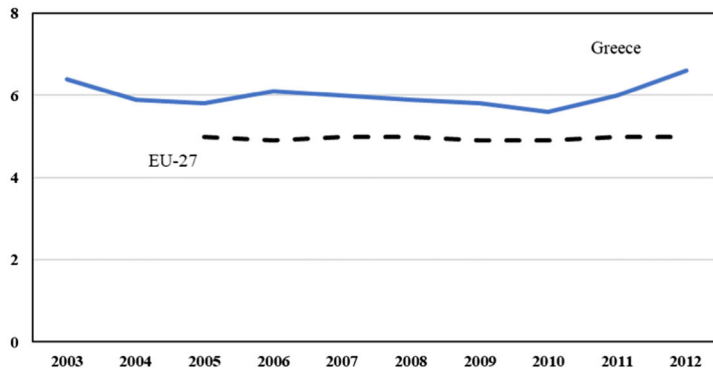
Although data referring to poverty and social exclusion are closely related to social conditions, they do not incorporate the distributional dimension of income. Income quantile share ratio (S80/S20) and Gini index (Fig. 1b, c) offer a clearer picture regarding these relative changes between different socio-economic groups over time. In both cases, there seems to be a slight broadening of income inequalities within Greece, during the period 2010–2012, fact which comes in contrast with the overall EU trend towards a reduction of income disparities between social groups. Interesting facts also arise from the scientific literature, as the evolution of income inequalities have received increased attention in Greece (Katsimi et al. 2015; Mitrakos 2014). Recent trends of inequality and social conditions indicate that has been an increase on income inequality and relative poverty, during the post-crisis period, fact which has been reinforced by recession and austerity policies. Nonetheless, there is no evidence strongly supporting the hypothesis that inequality has risen dramatically (Mitrakos 2014; Matsaganis and Leventi 2011).

Regarding the nature of the implemented policies and the ways in which they have affected inequality, some crucial questions refer to the lack of socio-spatial justice in the austerity policies being implemented (Hadjimichalis 2011). In many cases, unbalanced horizontal austerity measures are responsible for broadening the already unequal spatial distribution of economic activity in Greece, thus reinforcing regional disparities (Monastiriotis 2011). The distributional impact of different consolidation policies on the evolution of the Gini index for the case of Greece, during the period 2009–2014, indicates that there is a positive effect to the overall income inequality, in cases where the implemented policies mostly affect households belonging to the top of income distribution (e.g. cuts in public sector salaries and pensioners' solidarity contributions). On the contrary, measures related to poorer social groups (e.g. cuts in unemployment benefits) trigger negative inequality effects (Leventi and Matsaganis 2016). Austerity policies seem to have caused consumption inequality to rise in some cases, whereas at the same time there is evidence that they have led to an initial reduction of income inequality during the first years of recession (Kaplanoglou and Rapanos 2015; Matsaganis and Leventi 2014; EU 2010).

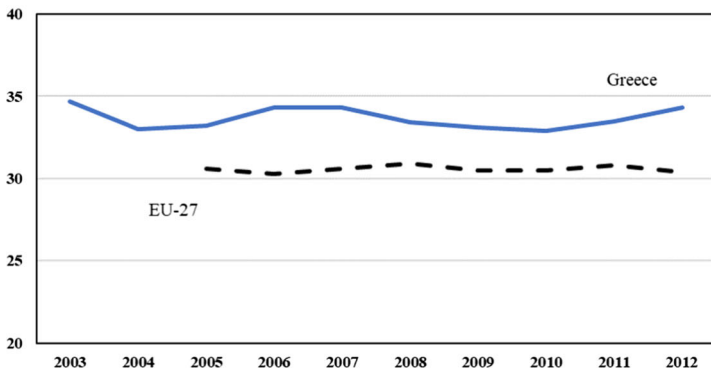
Regional specificities, such as population density, have also gain attention, when exploring the regional impact of economic crisis on income distribution for the Greek case. According to Psycharis et al. (2014) highly urbanized areas, such as Athens, are positively associated to higher levels of development during periods of economic prosperity, but at the same time they are affected the most throughout periods of economic recession. A similar conclusion is also derived, when the analysis is focused on social inclusion, as Athens has experienced a particularly severe rise in poverty rates during the post-crisis period (Leventi and Matsaganis 2016). Nonetheless, findings indicate that the distribution of income at a NUTS3 level did not change considerably during the post-crisis period, with the Attica region still maintaining its sovereignty to the overall national income distribution (Psycharis and Pantazis 2016).



(a) People at risk of poverty or social exclusion (%)



(b) Income quantile share ratio (S80/S20)



(c) Gini coefficient for income (%)

Fig. 1 Evolution of (a) at-risk-of-poverty or social exclusion (%), (b) income quantile ratio (S80/S20) and (c) Gini coefficient for income (%) in Greece 2003–2012. *Source: Eurostat [t2020_50, ilc_di11 and ilc_di12]*

Although, in these cases the role of spatial dimension has been highlighted, little attention has been given when trying to move from a regional perspective to the local level, as data limitations have hindered the analysis of income variables in Greece at lower spatial units. One of the few studies that refers to the analysis of the distribution of income at a local level, comes from Prodromidis (2006). This study uses tax-reported income declarations for the year 2001, based on data at post-code level, provided by the General Secretariat in Information Systems of the Ministry of the Economy and Finance. The main advantage of this study is the use of income data derived from the greater part of the total population in all localities. The results indicate that there is considerable heterogeneity in income distribution at a local level within Greece, whilst regional characteristics, such as population density and the overall educational level, are positively associated to greater concentration of high income values.

The above analysis identifies some crucial points that need to be considered, regarding the Greek case. First, *time-varying socio-economic disturbances*, such as the 2008 financial crisis have influenced to some extent income distribution, affecting income inequality and thus, social inclusion. Secondly, *regional specificities*, including human capital endowments and population density, play a significant role to local resilience, pointing out the need for designing place-based interventions. Finally, there is a gap in the existing empirical literature referring to the Greek case, regarding the *analysis of income distribution at a sub-regional level*, mostly due to lack of available data.

Data and Methodology

Data

Given the fact that there are no census data referring to individual income at a municipal level for Greece, input sources in this paper come from the available dataset of Panori et al. (2016). In their study, Panori et al. (2016) develop a static spatial microsimulation model, the *SimAthens* model, used to artificially generate data for the case of Greece, aiming to estimate income and other socio-economic characteristics at a municipal level, for the period 1994–2012. The source code for the *SimAthens* model is available online (<http://www.sciencedirect.com/science/article/pii/S0198971516301685>).

The data generation process, is based on an iterative proportional fitting (IPF) algorithm, used to reweight ECHP and EU-SILC records of individuals to fit in small-area descriptions for Greece. The IPF algorithm is based on a set of constraint variables, including demographic and socio-economic characteristics for each individual (sex, age, marital and activity status and educational level). The aggregate values at a municipal level are taken from the 1991, 2001 and 2011 censuses. Data regarding the inter-census years are derived through interpolation. The existing links between different data sources used in the model are presented in Fig. 2.

It should be noted that the choice of constraint variables in the model uses income as the main target variable. The validation process of the model has illustrated a high-level goodness of fit, between the actual census data and the simulated aggregate results at a municipal level, both in terms of internal and external validation process. More specifically, internal validation has shown that in the case of constraint variables, including educational level, there are no significant divergences between actual and

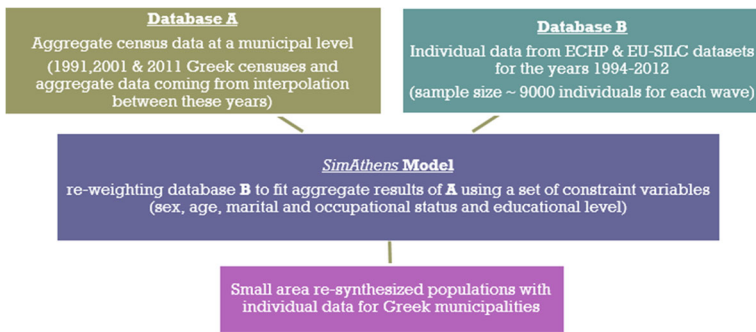


Fig. 2 Links between different data sources used for the development of the *SimAthens* model

simulated values, due to the TRS integerization method that was followed. In the case of external validation, occupational and sectoral structure of the local economies were used as baselines, indicating satisfactory results regarding the goodness-of-fit, with very small statically significant deviations between actual and simulated values.

Given that both ECHP and EU-SILC are consistent in terms of household income measurement and equivalized household size, it is possible to compare results coming from these two discrete data sources. Based on this, a unified balanced panel data set was created for the period 1994–2012, using the 1027 Greek municipalities as its main cross-sectional units. The panel includes variables related to socio-economic characteristics of Greek municipalities. In this study, we choose to use mean equivalized household income, calculated at a municipal level, as our main income variable, as well as average years of schooling as the main variable for education.

Regarding the effect of the simulation method on the area estimates, starting from the latter case, educational level has been used as a constraint variable in the model. Thus, the validation process has shown that there are no deviations between actual and simulated values. On the other hand, we cannot provide a direct validation process for the income variable, as there are no available actual data at a municipal level. The fact that the model treats income as its target variable, alongside with the satisfying results of the external validation, using variables that affect to a large extend regional income (occupational and sectoral structure), is an important parameter that can be used in favor of the simulated results. Moreover, some indicative evidence referring to income derivatives, such as the poverty gap, at-risk-of-poverty rates and the Gini index for the case of Greece, for the year 2006, are illustrated in Table 1. As it is shown, the deviations from the actual values do not exceed 6% in most cases.

Given the fact that only indirect ways exist for testing the distributional fitting of income with available actual data, the evidence indicates that there is a good level of fitting regarding the simulated results, without being perfect. However, in cases of data shortage or even non-existing data, such as the case of Greece, that kind of simulated values should be considered as important sources, able to provide evidence related to trend or causal analysis. Of course, these data cannot be used as basis for deriving precise or value-dependent results.

Table 1 Actual and simulated values of income-based variables for Greece (2006)

Income-based variable	Actual	Simulated	Difference (%)
Poverty gap (in euros)	5910	6198	4.64
At-risk-of-poverty rate (%)	20.80	20.08	-3.59
At-risk-of-poverty rate by sex (%)			
Men	19.80	18.66	-6.12
Women	21.70	21.45	-1.14
At-risk-of-poverty rate by age group (%)			
18–64	18.40	19.15	3.94
65+	25.50	23.41	-8.92
Gini coefficient	34.30	33.32	-2.94

Authors' calculations and ELSTAT

Methodology

According to Bartels (1982), *the social relevance of regional science research is very much determined by the quality of regional policy analysis*. Thus, research in this scientific field should focus on regional policy evaluation, to provide insights regarding the effectiveness of the implemented policies on several socio-economic aspects, such as social cohesion and inequality. In general, methods that have been used for policy assessment, could be categorized into three discrete general approaches: descriptive, structural and experimentalist (Holmes 2010). Between them, structural modeling constitutes one of the most promising empirical research approaches in regional analysis, as it tries to identify the quantitative impact of a policy change, through the identification of causal relationships that arise within a well-specified economic model (Reiss and Wolak 2007; Mitze 2012, 2014; Mitze and Stephan 2013). Under this framework, recent advances in econometric modeling, alongside with the expansion of the computational capacity of ICT infrastructure, have proven to be crucial, in terms of thoroughly investigating inequality trends, related to implemented policies, between regional performance (Holmes 2010; Rickman 2010).

Following the structural modeling approach, we use the Mincerian wage equation model (Eq. 1), indicating the effect of education on individual earnings, to gradually develop our structural econometric model:

$$\ln Y = \ln Y_0 + rS + u \quad (1)$$

where, Y is individual earnings, Y_0 is the earnings of a person with no education and S is years of schooling. Moreover, r corresponds to the returns of schooling, whilst u expresses other parameters affecting earnings apart from education. Following De Gregorio and Lee (2002), we derive from Eq. (1) the distribution of earnings function (Eq. 2):

$$\begin{aligned} Y_{ineq} &= \text{Var}[\ln Y] = \text{Var}[\ln Y_0 + rS + u] = \text{Var}[rS + u] \\ &= \bar{r}^2 \text{Var}[S] + \bar{S}^2 \text{Var}[r] + 2\bar{r}\bar{S}\text{Cov}[r, S] + \text{Var}[u] \end{aligned} \quad (2)$$

Equation (2) indicates that there is a relationship between variance of earnings $Var[\ln Y]$ and educational level \bar{S}^2 and distribution $Var[S]$. Apart from the relationship between education and income inequality, that needs to be explored, the existence of a Kuznets-type curve between income and its distribution within a region, should also be investigated. According to Park (1996), this type of relationship could be expressed as:

$$Y_{ineq} = \alpha_0 + \alpha_1 \ln Y + \alpha_2 (\ln Y)^2 + u \quad (3)$$

Combining Eqs. (2) and (3), we estimate the following regression (Eq. 4):

$$G_{inc_{i,t}} = \alpha_0 + \alpha_1 G_{inc_{i,t-1}} + \alpha_2 AYS_{i,t-1} + \alpha_3 G_{edu_{i,t-1}} + \alpha_4 \ln Y_{i,t-1} + \alpha_5 (\ln Y_{i,t-1})^2 + \alpha_D D_{i,t} + u_{i,t} \quad (4)$$

where: $G_{inc_{i,t}}$ and $G_{edu_{i,t}}$ is the Gini index for income and education within each municipality i in year t ; $AYS_{i,t}$ is average years of schooling for municipality i in year t , used to express the regional educational level; and $Y_{i,t}$ is mean equalised income, also calculated at a municipal level.

Variables referring to regional characteristics, as well as time dummies capable of indicating the effect of the economic crisis on the formation of regional disparities, are also used in the analysis ($D_{i,t}$). In the first case, we choose to include a set of variables related to regional specificities, referring to: i) population density, in order to investigate whether highly urbanized areas are lack in socio-economic inclusion terms; ii) the participation share of tertiary sector of production, for exploring whether highly knowledge-based local economies indicate higher/lower levels of income inequality; and iii) regional human capital proximity, for investigating whether spatial and at the same time educational proximity play an significant role in the level of social inclusion. Finally, the set of time dummies referring to the post-crisis period include the years between 2008 and 2012, and try to capture any significant effect of the 2008 economic crisis period on the evolution of income inequality and educational level. Short descriptions regarding these variables are given in Table 2.

Table 2 Variables referring to regional and time-based characteristics

Name	Description
<i>capital</i>	Dummy variable including municipalities being capital of a NUTS3 region – related to high population density
<i>ter_sec</i>	Percentage of tertiary sector of production (%) – related to knowledge-based economy
<i>high_hc</i>	Dummy variable including municipalities with high educational level, surrounded by areas with high educational level – related to human capital endowments
<i>low_hc</i>	Dummy variable including municipalities with low educational level, surrounded by areas with low educational level – related to human capital endowments
<i>Y2008 - Y2012</i>	Dummy variables including the post-crisis period 2009–2012

In order to finalize the structural model, exploring the possible bidirectional relationships arising between education and income inequality, a second regression is used in this study (Eq. 5), focusing on their relationship, this time from the reverse point of view. In this case, educational level is used as endogenous variable, whereas the effects of income inequality on it are investigated.

$$AYS_{i,t} = \alpha_0 + \alpha_1 AYS_{i,t-1} + \alpha_2 G_inc_{i,t-1} + \alpha_3 G_edu_{i,t-1} + \alpha_4 \ln Y_{i,t-1} + \alpha_D D_{i,t} + u_{i,t} \quad (5)$$

In both cases (Eqs. 4 and 5), it is important to distinguish the difference between *effect* and *correlation* concerning education and income inequality variables. More specifically, *effect* refers to the relationship between time-lags of explanatory variables and the dependent variable, whilst on the other hand, *correlation* arises between variables referring to the same period. This means that, during the empirical analysis, we try to explore if there are any significant links arising between the explanatory variables, referring to period $t-1$, causing an effect on the endogenous variable of period t . At the same time, we investigate whether the endogenous variable, used in each case, is associated with specific regional characteristics of the same period.

Apart from defining the structural model, expressing the theoretical perspective of our analysis, another crucial part is the estimation method that is going to be applied. Within the context of the selected structural approach, two main methods are reported in the literature, regarding the econometric model estimation: dynamic equation models (Dynamic Simultaneous Equation Models – DSEM) and structural autoregressive models (Structural VAR Models – SVAR). According to Gottschalk (2001), in the case of DSEM models, an AR representation of the structural model is followed, while on the other hand, in the case of SVAR models, this representation takes the form of a moving average (MA), calculating the corresponding impulse response functions. This essential differentiation makes DSEM models appropriate for policy-analysis applications, where issues of reverse causality usually harass the analysis of dynamic relationships, while SVAR models are thought to be better suited to cases where monetary transmission mechanisms are under examination. Within the context of current analysis, an equation-by-equation DSEM methodology is expected to be the most appropriate estimation method, using Dynamic Panel Data (DPD) estimators (Mitze 2012; Roodman 2009, 2006).

Regarding the choice of the most appropriate DPD estimator, in recent decades there has been significant progress in this field. Beginning with the early work of Hsiao and Anderson (1981), several innovative approaches have gradually been developed (Holtz-Eakin et al. 1988; Arellano and Bond 1991; Arellano and Bover 1995; Blundell and Bond 1998) for calculating DPD estimators. The Arellano-Bond approach sets up a *generalized method of moments (GMM) problem in which the model is specified as a system of equations, one per time period, where the instruments applicable to each equation differ* (Baum 2013). In this case, an extension of the Arellano-Bond DPD estimator has been used. The Arellano-Bover/Blundell-Bond (AB/BB) DPD-GMM estimator (Arellano and Bover 1995; Blundell and Bond 1998) (known also as *system GMM estimator*) was chosen, based on its increased effectiveness relative to the other methods. Moreover, the *Sargan/Hansen* (Sargan 1958; Hansen 1982) and *Arellano/Bond* (Arellano and Bond 1991) tests are performed to test the model for possible over-identification problems or the existence of auto-correlation. Finally, it must be pointed

out that each variable used as an endogenous in the model, has been checked previously for non-stationarity, using Harris-Tzavalis unit root test (Harris and Tzavalis 1999).

Empirical Results

This section presents the main findings of the model estimates. However, before looking at the statistical analysis, some indicative descriptive results are presented. First, the relevant position of the Greek regions within the EU-27 framework, in terms of gross domestic product (GDP) per inhabitant, is illustrated in Fig. 3. The map indicates the eligibility of Greek regions regarding the EU cohesion funds, based on GDP per inhabitant (in PPS), by NUTS2 regions. Although the depicted results refer to the programming period 2014–20, their basis of analysis includes calculated GDP per inhabitant (in PPS) over the period 2007–2009, expressed as percentage of the EU-27 average. By looking at Fig. 3, it becomes clear that there is an essential number of Greek regions characterized as less developed, whereas regions of Attiki and Notio Aigaio are the only ones considered to be as most developed, following this classification.

Moving on to the sub-regional/local level, Fig. 4 illustrates the spatial distribution of income at a municipal level within Greece, in terms of decile distribution, during the period 1994–2012. By looking at the maps, we are able to get a better overview regarding the existence of any high-income or low-income municipality concentrations within the NUTS2 Greek regions. In general, it becomes clear that there is an increased concentration of high-income municipalities within the Attiki region, which includes the large urban agglomeration of Athens, indicated with darker color on the maps. In addition to this, there is a number of dispersed dark-colored municipalities within the

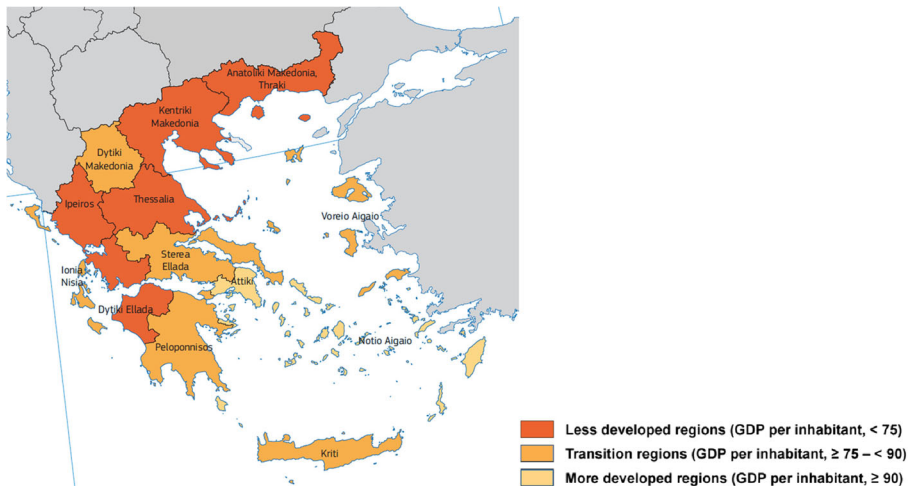


Fig. 3 Eligibility of Greek regions for cohesion funds based on gross domestic product (GDP) per inhabitant (in PPS), by NUTS 2 regions, the programming period 2014–20 (% of EU-27 average). Note: GDP per inhabitant (in PPS) over the period 2007–09 was used as the basis for the allocation of structural funds for 2014–20; as such, calculations relating to regional eligibility were based on the NUTS 2006 classification and with reference to the EU-27 average. Source: European Commission, Directorate-General for Regional and Urban Policy

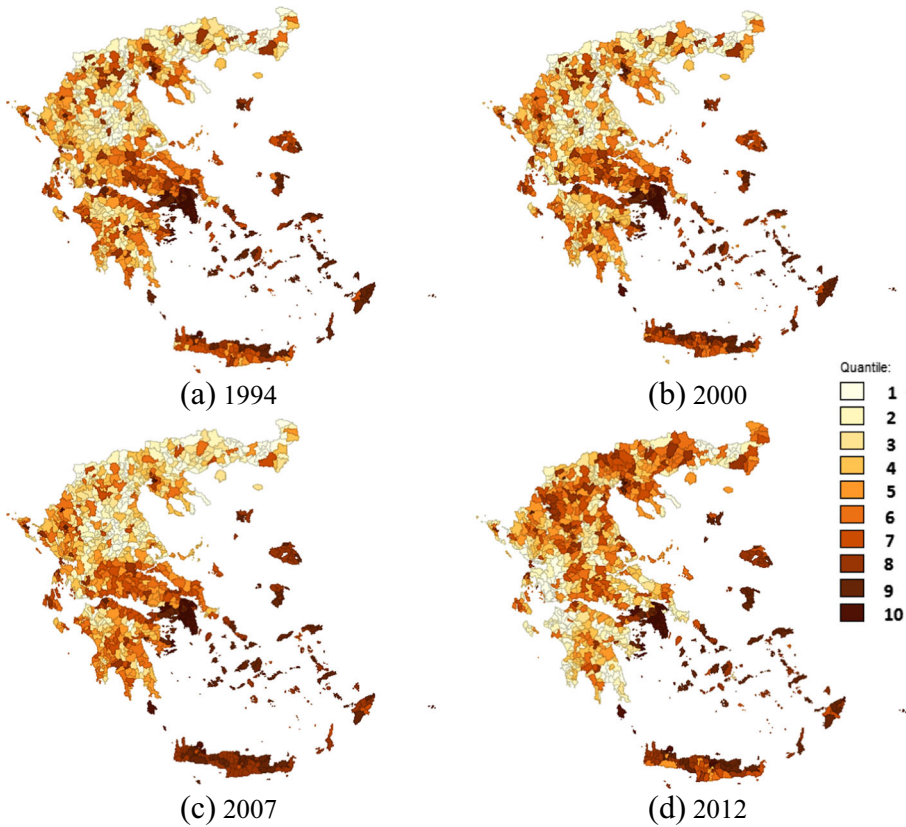


Fig. 4 Spatial distribution of income in deciles at a municipal level for the period 1994–2012. *Source:* Authors' calculations

wider area of Greece, corresponding to capital municipalities of the Greek NUTS3 regions, indicating income values belonging to higher deciles of the income distribution.

The spatial distribution of income, in decile terms, seems to change throughout the period under investigation, specifically between 2007 and 2012. In the case of Southern Greece, especially for the region of Peloponnisos, there is a shift of mean municipal income values towards lower deciles, depicted with lighter colors on the map. The opposite movement takes place in the case of Northern Greece, for the regions of Kentriki and Dytiki Makedonia. In all these cases, it is important to have in mind that deciles do not express absolute values, but instead they indicate the relative position of a municipality within the overall income distribution. This practically means that the parameter that seems to have changed between 2007 and 2012 is the ranking of these municipalities, without knowing whether there was a decrease or an increase in income, in absolute terms.

In order to better understand the evolution of the absolute income changes, during the pre- and post-crisis period, Table 3 presents their calculated values for each decile for the corresponding years. By looking at the results, it becomes evident that during the pre-crisis period (1994–2007) there was a gradual increase in the overall income level, positively affecting all deciles. However, the decreasing income trend that followed during the post-crisis period (2008–2012), although it affected negatively

Table 3 Mean calculated income values for each decile (1994, 2000, 2007 and 2012)

Mean equivalized income	1994	2000	2007	2012	1994/07 (%)	2007/12 (%)	1994/12 (%)
<i>Decile 1</i>	4079	5076	8102	6733	99	-17	65
<i>Decile 2</i>	4301	5324	8545	7120	99	-17	66
<i>Decile 3</i>	4426	5476	8848	7303	100	-17	65
<i>Decile 4</i>	4540	5636	9038	7418	99	-18	63
<i>Decile 5</i>	4692	5788	9194	7496	96	-18	60
<i>Decile 6</i>	4798	5954	9510	7596	98	-20	58
<i>Decile 7</i>	5013	6130	9963	7728	99	-22	54
<i>Decile 8</i>	5386	6452	10,521	7972	95	-24	48
<i>Decile 9</i>	6010	7178	11,082	8548	84	-23	42
<i>Decile 10</i>	7370	8896	12,649	9706	72	-23	32
Gini coefficient	36.45	33.23	33.51	31.24	-8	-7	-14

Authors' calculations

all deciles, it was not characterized by an equal distributional effect between them. This resulted to an uneven negative effect on the Greek municipalities, changing their ranking within the overall income distribution. Moreover, it is important to point out that gaps between intermediate deciles (D2 – D8) for the year 2012 are very small. Thus, if we take for example a municipality belonging to D7 in 2007, a movement to a lower decile in 2012 makes very small difference, whether it happens between D2 or D6. This in fact can explain the large variations between 2007 and 2012 in Fig. 4.

Moreover, it is interesting to notice that the overall change in income, between 1994 and 2012, has been positive in all cases, and especially for the low-income deciles. This lack of robustness between income-evolution trends, during periods of economic growth and recession, seems to have positively affected the evolution of income inequality within Greece at a municipal level, resulting to its gradual decline. More specifically, the Gini coefficient calculated values for the case of Greece are given in the last row of Table 3, indicating this decreasing trend.

In the previous sections, we pointed out that regional specificities related to education, such as the human capital stock of a region, influence social inclusion. Moreover, the spatial proximity of an area to other regions with similar characteristics, related to education in our case, can be considered as another essential regional particularity, which should not be overlooked, given the cumulative character of education. Based on this fact, it is crucial to further investigate the existence of spatial autocorrelation between Greek municipalities, in terms of human capital endowments. This, will help us explore whether there are sub-regional concentrations of municipalities, characterized by similar educational levels.

In order to do so, the global Moran's I values are calculated, for the case of average years of schooling at a municipal level of analysis. Results, referring to a selected number of years, are illustrated in Table 4, indicating that global Moran's I values are significant in all cases.

Given the previous findings, that highlight the existence of spatial autocorrelation in terms of education, it becomes interesting to specify the existing groups of

Table 4 Global Moran's I values for the average years of schooling variable (1994, 2000, 2007 and 2012)

Year	Moran's I values	Standard Deviation	z-values
1994	0.636	0.0170	37.392
2000	0.632	0.0167	37.891
2007	0.629	0.0169	37.224
2012	0.613	0.0169	36.239

Authors' calculations

municipalities, illustrating similar or diversified human capital endowments, compared to their neighboring areas. In this case, annual LISA maps are constructed, through the calculation of the Moran's I local values, corresponding to the average years of schooling at a municipal level (Fig. 5). The results illustrate a dense concentration of municipalities indicating similar educational characteristics, related to higher levels of education, around the metropolitan areas of Athens and Thessaloniki, depicted by the

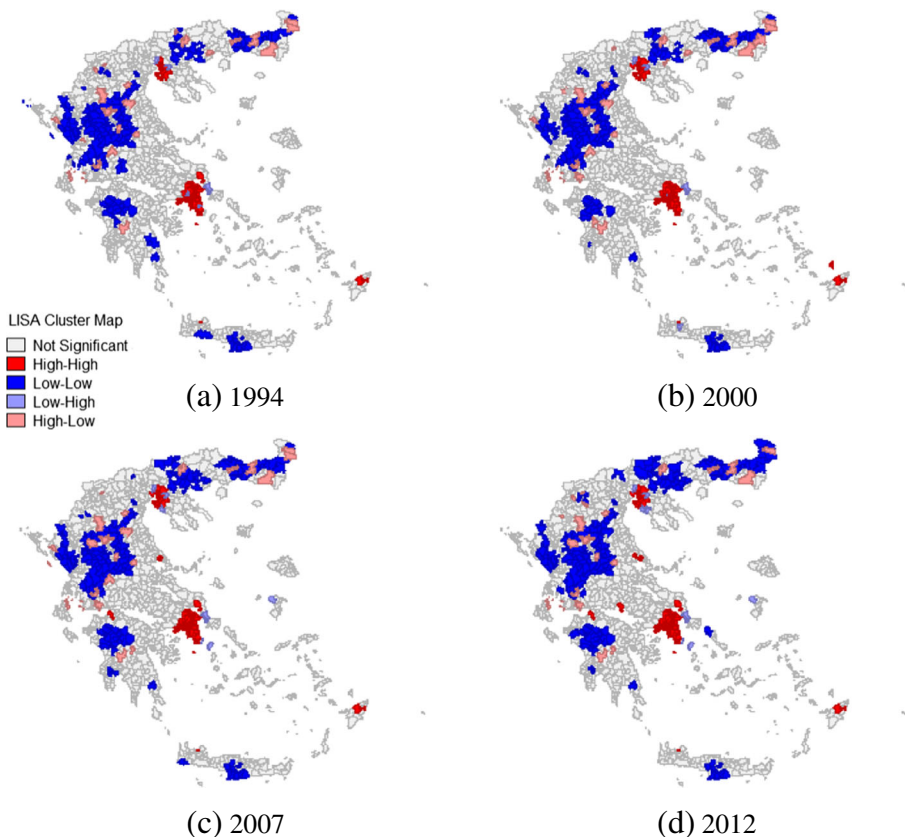


Fig. 5 LISA maps for local Moran's I values calculated for average years of schooling (1994, 2000, 2007 and 2012). Source: Authors' calculations

red color on the maps. At the same time, there is also a number of municipality concentrations characterized by low human capital endowments, which are depicted with blue color on the maps. In many cases, these concentrations cover wide parts of NUTS2 regions, such as Ipiros, Anatoliki Makedonia & Thraki and Peloponnisos, which are traditionally described as regions with relatively low educational level.

Based on these results, we choose to construct the regional dummy variables (Table 2) related to educational proximity at a municipal level, that will be used in our structural model. More specifically, we choose to include the following two dummies: i) municipalities with high educational level, surrounded by areas with high educational level (*high_hc*, red color on the map); and ii) municipalities with low educational level, surrounded by areas with low educational level (*low_hc*, blue color on the map). Values for both of these dummies are derived by the annual LISA map representations referring to the period under investigation (1994–2012).

Moving on to the estimation results regarding the effects of education on income inequality for the case of Greece, the estimated coefficients for the model presented in Eq. (4) are illustrated in Table 5 below. Looking at the estimated results, the effect of

Table 5 Estimation results for the structural DSEM model referring to income inequality

Dependent variable: Income GINI (<i>G_inc</i>)				
Group variable: Municipality		Number of obs. = 18,486		
Period: 1994–2012		Number of groups = 1027		
Number of instruments: 16		Obs. per group = 18		
		Coefficient		<i>p</i> -value
Endogenous/ Predetermined variables	<i>G_inc</i> (−1)	−0.259	***	0.001
	<i>AYS</i> (−1)	0.171	***	0.000
	<i>G_edu</i> (−1)	−4.332	***	0.000
	<i>Ln_inc</i> (−1)	0.267	***	0.000
	<i>Ln_inc2</i> (−1)	−0.031	***	0.000
Regional Characteristics	<i>capital</i>	−0.293	***	0.000
	<i>ter_sec</i>	0.678	***	0.000
	<i>high_hc</i>	−0.526	***	0.000
	<i>low_hc</i>	0.049	***	0.000
Post-crisis time dummies	<i>Y2008</i>	0.005		0.290
	<i>Y2009</i>	−0.008	**	0.072
	<i>Y2010</i>	−0.006		0.186
	<i>Y2011</i>	−0.025	***	0.000
	<i>Y2012</i>	−0.069	***	0.000
Arellano – Bond Test for AR(1) in first differences:		Pr > z = 0.004		
Arellano – Bond Test for AR(2) in first differences:		Pr > z = 0.690		
Sargan test for overid. restrictions:		chi2 (2) = 3.63 Prob. > chi2 = 0.163		
Difference-in-Hansen test		chi2 (2) = 0.40 Prob. > chi2 = 0.820		

Authors' calculations

***, ** and * indicate statistical significance at the 1%, 5% and 10%, respectively

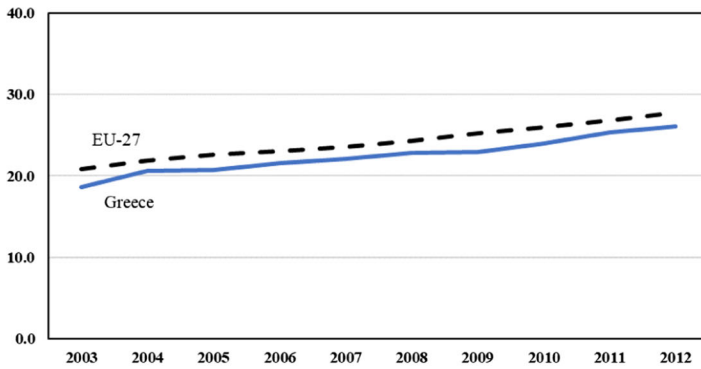
educational level in period $t-1$, on income inequality in period t , is found to be positive and statistically significant, meaning that lagged high levels of education lead to higher levels of income inequality during the next period. An increase in the educational level of a municipality would lead to an expansion of income inequality within this area, as in many cases the returns to education are disproportionate between different educational groups. A similar explanation could also be provided for the case of the *ter_sec* variable, being positive and statistically significant. Municipalities characterized by high levels of tertiary sector participation at time t , which is closely related to a knowledge-based economic structure, will illustrate higher values of income inequality during the next period, due to the disproportionate effect of this sector on wages.

In general, effects referring to the returns on education are considered to be stronger in cases where local economies are entering a knowledge-based phase during their economic structure evolution, accompanied with an expansion in both educational level and tertiary sector of production. In the case of Greece, indicators related to the knowledge-based economic structure, including educational attainment, expenditure on R&D and employment in knowledge-intensive activities, show that until 2012 the country was in all cases, under the EU-27 average (Fig. 6). As a result, previous findings, indicating a negative effect of education on income inequality, are related to the fact that Greece is not considered to be an advanced knowledge-based economy, and thus, there is still a lot of space for increased returns on education.

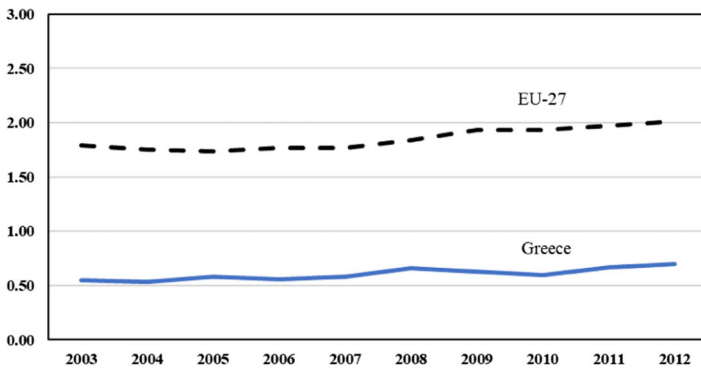
Furthermore, the results indicate that a Kuznets-type curve exists between income and income inequality. Regarding the dummies used in the model disclosing regional specificities, in terms of population density (*capital*) and educational proximity (*high_hc* and *low_hc*), all of them are found to be statistically significant. More specifically, higher levels of income inequality are negatively related to municipalities being *capital* municipalities of the Greek NUTS3 regions, indicating an adverse relationship between population density and income distribution. Highly urbanized municipalities seem to have more equally distributed incomes between their residents. In terms of educational proximity, spatial concentrations of municipalities with high human capital endowments seem to be related also to lower levels of income inequality, as the *high_hc* dummy variable is negative and statistically significant. On the contrary, cases of low human capital municipalities' spatial agglomerations, are related to higher income inequality.

These findings once more, are related to the existence of diversified returns on education. Differences on educational returns are eliminated as we move to municipality agglomerations characterized by higher educational levels. On the other hand, municipalities illustrating lower levels of education encompass a more diversified sample of residents, whose returns on education might be characterized by a large variation, leading to increased income inequalities. Spatial concentration of municipalities indicating similar low levels of human capital endowments, seems to strengthen this phenomenon.

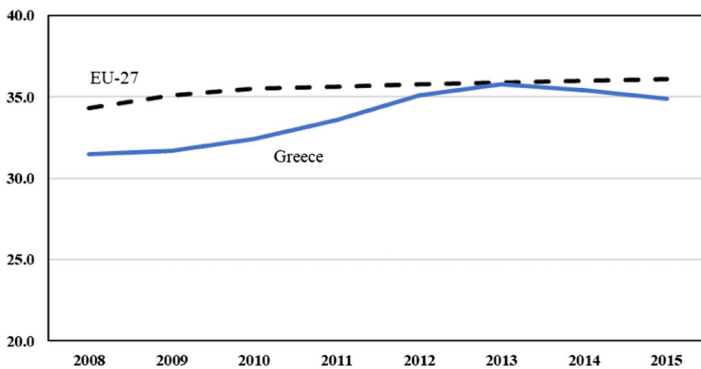
At the same time, only two of the *post-crisis* related dummies, that try to capture the effect of the 2008 economic crisis on income inequality, are statistically significant. A negative relationship with the intra-municipal income inequality is found for the years 2011 and 2012, meaning that the effects of economic recession tend to decrease income inequality, despite their negative impact on income levels. An attempt to interpret this finding suggests that during the last decade, the economic crisis has caused a decrease in the overall income levels, shortening the previously enlarged income gaps within municipalities, leading to lower levels of income disparities.



(a) Tertiary education attainment of population aged 25-64 (%)



(b) Gross domestic expenditure on R&D (% of GDP)



(c) Employment in knowledge-intensive activities (%)

Fig. 6 Evolution of (a) tertiary educational attainment of population aged 25–64 (%), (b) gross domestic expenditure on R&D (% of GDP) and (c) employment in knowledge-intensive activities (%) in Greece. Source: Eurostat [edat_lfse_04, rd_e_gerdtot and htec_kia_emp2]

In order to expand our analysis, beyond a one-way exploration of the links between education and income inequalities, we also investigate for the effect of income inequality on educational level. Using our DSEM model, we estimate Eq. (5), including average years of schooling as endogenous variable this time. The results are presented in Table 6.

In this case, income inequality on period $t-1$ does not affect educational level in period t , so we do not observe a bidirectional causal effect between these two variables. However, income is positively associated with higher levels of education, as expected by human capital theory (Becker and Chiswick 1966; Mincer 1974; Lucas 1988; Krueger and Lindahl 2000; Pritchett 2001; De la Fuente and Doménech 2006). At the same time, educational inequalities on period $t-1$, are positively correlated with higher levels of education on period t . This fact is consistent with the findings of De Gregorio and Lee (2002), indicating that educational inequality of the previous period promotes educational attainment in the following period. A theoretical explanation for this result, could be given by the fact that a high level of educational dispersion would increase the returns of investing on education, leading to higher educational attainment in the subsequent period.

Table 6 Estimation results for structural DSEM model referring to level of education

Dependent variable: Average years of schooling (AYS)				
Group variable: Municipality		Number of obs. = 18,486		
Period: 1994–2012		Number of groups = 1027		
Number of instruments: 16		Obs. per group = 18		
		Coefficient		<i>p</i> -value
Endogenous/ Predetermined variables	<i>G_inc</i> (-1)	0.017		0.985
	<i>AYS</i> (-1)	0.954	***	0.000
	<i>G_edu</i> (-1)	9.453	***	0.000
	<i>Ln_inc</i> (-1)	0.297	**	0.049
Regional Characteristics	<i>capital</i>	0.586	***	0.000
	<i>ter_sec</i>	2.960	***	0.002
	<i>high_hc</i>	1.043	***	0.000
	<i>low_hc</i>	- 0.186	**	0.013
Post-crisis time dummies	<i>Y2008</i>	0.112	***	0.000
	<i>Y2009</i>	0.009		0.741
	<i>Y2010</i>	0.006		0.825
	<i>Y2011</i>	- 0.014		0.603
	<i>Y2012</i>	- 0.067	**	0.015
Arellano – Bond Test for AR(1) in first differences:		Pr > z = 0.000		
Arellano – Bond Test for AR(2) in first differences:		Pr > z = 0.154		
Sargan test for overid. restrictions:		chi2 (3) = 5.91 Prob. > chi2 = 0.116		
Difference-in-Hansen test		chi2 (3) = 5.08 Prob. > chi2 = 0.166		

Authors' calculations

***, ** and * indicate statistical significance at the 1%, 5% and 10%, respectively

Additional findings of this regression analysis include a positive correlation between tertiary sector of production and population density with higher levels of education. At the same time, there is a positive correlation between groups of municipalities characterized by spatial and educational proximity in terms of human capital endowments, statistically significant in both cases. An interesting finding is the fact that the only time dummy that has been found to be statistically significant is the year 2012. This result reveals the persistent nature of human capital variable, which remains almost unaffected during periods characterized by time-varying socio-economic disturbances.

Finally, it is important to point out that the Sargan/Hansen test for over-identification does not reject the null hypothesis in any of the previous regressions, whilst the Arellano/Bond test also provides very satisfactory results, meaning that the identification of instruments is valid in all cases.

Concluding Remarks

Throughout the last decade, there has been a growing awareness regarding the relationship between education and income inequality. Given the fact that regional economies have been experiencing a transformation towards a knowledge-based structure, human capital empowerment has been considered as one of the most important tools for policy implementation. The efforts of the EU2020 agenda to promote regional development through the smart and inclusive growth paradigm, have brought the notions of education and regional disparities in the center of policy-making processes, for exploring new ways of strengthening European cohesion. Under this context, the investigation of the links between education and income inequality constitutes an intriguing field of research, not only in terms of theory, but also for policy-making processes.

This study offers an attempt to explore, the interactions arising between education and income inequality for the case of Greece. Data coming from a panel dataset for the Greek municipalities, covering the period 1994–2012, have been used for the analysis, focusing on the distribution of income and education at a municipal level. Furthermore, a structural DSEM model has been developed to investigate the links between income disparities and education, as well as the ways they have been affecting each other.

The empirical evidence indicates that there is an underlying one-way interaction between education and income inequality, which is largely influenced by regional specificities and time-dependent socio-economic disturbances, such as the 2008 economic crisis. The revealed effect illustrates that higher educational levels in period $t-1$ result to an increase of income inequality within municipalities in period t . Nonetheless, a reverse effect relationship between educational level and income inequality is not revealed. Evidence also supports the existence of a Kuznets-type relationship between income and its inequality component.

Regarding regional specificities, capital municipalities, related to higher population densities, as well as educational proximity between municipalities, constitute additional parameters affecting income inequality. Moreover, local economic structure constitutes another key regional externality that affects income disparities. Estimated results regarding the time post-crisis dummies, used to capture the potential effects of the 2008 economic crisis on the development of income inequalities, indicate that there has

been a reduction in inequality, during this period. Finally, Sargan/Hansen and Arellano/Bond tests, performed to evaluate the model, show extremely satisfactory values.

In terms of policy implications, the findings indicate that the still on-going recession period in Greece has delayed the development of a knowledge-based economic structure within the country. Thus, human capital empowerment policies for strengthening the educational level might not yield positive results, in terms of social inclusion, measured through income inequality, as expected. Investment on education should be accompanied by efforts to promote a knowledge-based structure of the Greek economy, in order to reinforce economic activity related to highly-skilled people, and thus, knowledge to be considered as a key driver of future economic growth. Under this context, smart growth policies, following skills' empowerment, could be considered as a crucial and effective tool for building inclusive societies, where people would be able to anticipate and manage changes.

In general, the above analysis highlights the importance of incorporating regional specificities, such as population density, educational proximity and local labor market structure, while investigating the potential effects of implementing skills' empowerment policies for achieving inclusive growth. The effectiveness of that kind of policies varies between different economic environments, depending on the extent to which these environments have integrated a knowledge-based structure in their overall economy. Human capital empowerment policies in many cases may not yield the expected results regarding social cohesion aspects, not due to ineffectiveness, but because they are implemented on areas still not being able to take full advantage of their strengths. As a result, future research studies should focus on sub-regional levels, helping policy-makers to effectively capture local specificities, enabling them to effectively act on reducing regional disparities through the implementation of targeted place-based policies, tailored to local particularities.

Acknowledgements The authors would like to thank the editor and the two anonymous referees for their insightful comments.

References

- Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies*, 58(2), 277 Available at: <http://restud.oxfordjournals.org/content/58/2/277.short>. Accessed 28 Sept 2015.
- Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, 68(1), 29–51 Available at: <http://www.sciencedirect.com/science/article/pii/030440769401642D>. Accessed 3 Jan 2016.
- Artelaris, P., & Petrakos, G. (2016). Intraregional spatial inequalities and regional income level in the European Union: Beyond the inverted-U hypothesis. *International Regional Science Review*, 39(3), 291–317.
- Atkinson, A. B., & Bourguignon, F. (Eds.). (2014). *Handbook of income distribution SET* (Vol. 2A-2B). Amsterdam: Elsevier.
- Bachtler, J. (2010). Place-based policy and regional development in Europe. *Horizons*, 10(44), 54–58.
- Bachtler, J., & Mendez, C. (2016). *EU cohesion policy and European integration: The dynamics of EU budget and regional policy reform*. London: Routledge.
- Bachtler, J., & Turok, I. (2013). *The coherence of EU regional policy: Contrasting perspectives on the structural funds*. London: Routledge.

- Ballas, D., Clarke, G. P., & Wiemers, E. (2005). Building a dynamic spatial microsimulation model for Ireland. *Population, Space and Place*, 11(3), 157–172. <https://doi.org/10.1002/psp.359>.
- Ballas, D., Dorling, D., & Hennig, B. (2014). *The social atlas of Europe*. Bristol: Policy Press.
- Ballas, D., Dorling, D., & Hennig, B. (2017a). *The human atlas of Europe: A continent united in diversity*. Bristol: Policy Press.
- Ballas, D., Dorling, D., & Hennig, B. (2017b). Analysing the regional geography of poverty, austerity and inequality in Europe: A human cartographic perspective. *Regional Studies*, 51(1), 174–185.
- Barca, F. (2009). Agenda for a reformed cohesion policy; a place-based approach to meeting European Union challenges and expectations. European Communities.
- Bartels, R. (1982). The rank version of von Neumann's ratio test for randomness. *Journal of the American Statistical Association*, 77(377), 40–46.
- Baum, C. F. (2013). Dynamic panel data estimators. *Applied Econometrics*, EC823, 1–50.
- Becker, G. S., & Chiswick, B. R. (1966). Education and the distribution of earnings. *The American Economic Review*, 56(1/2), 358–369.
- Becker, S. O., Egger, P. H., & Ehrlich, M. V. (2016). Effects of EU regional policy: 1989–2013 (no. 1118). University of Warwick, Department of Economics.
- Bernhard, S. (2010). *Die Konstruktion von Inklusion: europäische Sozialpolitik aus soziologischer Perspektive* (vol. 943). Campus Verlag.
- Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87(1), 115–143 Available at: <http://www.sciencedirect.com/science/article/pii/S0304407698000098>. Accessed 11 Feb 2015.
- Bourguignon, F., & Morrisson, C. (1998). Inequality and development: The role of dualism. *Journal of Development Economics*, 57(2), 233–257 Available at: <http://www.sciencedirect.com/science/article/pii/S0304387898000893>. Accessed 19 Nov 2015.
- Cecchi, D. (2000). Does educational achievement help to explain income inequality? Departmental working papers. Available at: <http://ideas.repec.org/p/mil/wpdepa/2000-11.html>. Accessed 31 July 2015.
- Chiswick, B. R. (1971). Earnings inequality and economic development. *The Quarterly Journal of Economics*, 85(1), 21–39 Available at: <http://econpapers.repec.org/RePEc:oup:qjecon:v:85:y:1971:i:1:p:21-39>. Accessed 2 Feb 2016.
- Davies, P. (1999). What is evidence-based education? *British Journal of Educational Studies*, 47(2), 108–121.
- De la Fuente, A., & Ciccone, A. (2002). Human capital in a global and knowledge based economy. Institute for Economic Analysis.
- De la Fuente, A., & Doménech, R. (2006). Human Capital in Growth Regressions: How much difference does data quality make? *Journal of the European Economic Association*, 4(1), 1–36. <https://doi.org/10.1162/jeea.2006.4.1.1>.
- Doran, J., & Jordan, D. (2013). Decomposing European NUTS2 regional inequality from 1980 to 2009: National and European policy implications. *Journal of Economic Studies*, 40(1), 22–38.
- Elias, A. (2008). Introduction: Whatever happened to the Europe of the regions? Revisiting the regional dimension of European politics. *Regional & Federal Studies*, 18(5), 483–492.
- EU Parliament. (2007). Regional disparities and cohesion: What strategies for the future, IP/B/REGI/IC/2006-201, p. iv.
- European Commission. (2008). Commission staff working document (2008) accompanying the green paper on territorial cohesion, p. 6.
- European Commission. (2010). Europe 2020: A strategy for smart, sustainable and inclusive growth.
- Fabrizi E. and Trivisano C. (2016). Small area estimation of the Gini concentration coefficient. *Computational Statistics & Data Analysis*, 99, 223–234.
- Fenton, A. (2013). Small-area measures of income poverty, CASE - social policy in a cold climate working paper, Centre for analysis of social Exclusion, LSE.
- Fingleton, B. (Ed.). (2013). *European regional growth*. New York: Springer Science & Business Media.
- Florida, R., & Mellander, C. (2014). The geography of inequality: Difference and determinants of wage and income inequality across US metros. *Regional Studies*. <https://doi.org/10.1080/00343404.2014.884275>.
- Garcilazo, E. (2011). The evolution of place-based policies and the resurgence of geography in the process of economic development. *Local Economy*, 26(6–7), 459–466.
- Gianelle, C., D. Kyriakou, C. Cohen and M. Przeor (eds) (2016), *Implementing smart specialisation: A handbook*, Brussels: European Commission, EUR 28053 EN, <https://doi.org/10.2791/53569>.
- Gottschalk, J. (2001). *An introduction into the SVAR methodology: Identification, interpretation and limitations of SVAR models (No. 1072)*. Kiel working paper.

- Gregorio, J. D., & Lee, J.-W. (2002). Education and income inequality: New evidence from cross-country data. *Review of Income and Wealth*, 48(3), 395–416 Available at: <http://doi.wiley.com/10.1111/1475-4991.00060>. Accessed 2 Feb 2016.
- Hadjimichalis, C. (2011). Uneven geographical development and socio-spatial justice and solidarity: European regions after the 2009 financial crisis. *European Urban and Regional Studies*, 18(3), 254–274.
- Hadjimichalis, C., & Hudson, R. (2014). Contemporary crisis across Europe and the crisis of regional development theories. *Regional Studies*, 48, 208–218.
- Hansen, L. P. (1982). Large sample properties of generalized method of moments estimators. *Econometrica*, 50, 1029–1054.
- Harris, R. D., & Tzavalis, E. (1999). Inference for unit roots in dynamic panels where the time dimension is fixed. *Journal of Econometrics*, 91(2), 201–226.
- Haughton, J. H., & Khandker, S. R. (2009). *Handbook on poverty and inequality*. Washington, DC: World Bank Publications.
- Hennig, B. D., Ballas, D., & Dorling, D. (2015). In focus: Europe's uneven development. *Political Insight*, 6(3), 20–21.
- Holmes, T. J. (2010). Structural, experimentalist, and descriptive approaches to empirical work in regional economics. *Journal of Regional Science*, 50(1), 5–22 Available at: <http://doi.wiley.com/10.1111/j.1467-9787.2009.00637.x>. Accessed 2 Feb 2016.
- Holtz-Eakin, D., Newey, W., & Rosen, H. S. (1988). Estimating vector autoregressions with panel data. *Econometrica*, 56, 1371–1395.
- Hsiao, C., & Anderson, T. W. (1981). Estimation of dynamic models with error components. *Journal of the American Statistical Association*, 76, 598 Available at: <http://repository.ust.hk/ir/Record/1783.1-32016>. Accessed 2 Feb 2016.
- Kaplanoglou, G., & Rapanos, V. T. (2015). Evolutions in consumption inequality and poverty in Greece: The impact of the crisis and austerity policies.
- Katsimi M., Moutis T., Pagoulatos G., & Sotiropoulos, D. (2015). Growing inequalities and their impacts on Greece, country report for Greece. GINI Growing Inequalities Impacts.
- Kramar, H. (2016). Regional convergence and economic development in the EU: The relation between national growth and regional disparities within the old and the new member states. *International Journal of Latest Trends in Finance and Economic Sciences*, 6(1), 1052–1062.
- Krueger, A. B., & Lindahl, M. (2000). Education for growth: Why and for whom? Retrieved from <http://www.nber.org/papers/w7591>.
- Lee, N., Sissons, P., & Jones, K. (2015). The geography of wage inequality in British cities. *Regional Studies*, *Regional Studies*. <https://doi.org/10.1080/00343404.2015.1053859>.
- Leventi, C., & Matsaganis, M. (2016). Estimating the distributional impact of the Greek. *Crisis*, 2009–2014.
- Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, 22(1), 3–42. [https://doi.org/10.1016/0304-3932\(88\)90168-7](https://doi.org/10.1016/0304-3932(88)90168-7).
- Marin, A., & Psacharopoulos, G. (1976). Schooling and income distribution. *The Review of Economics and Statistics*, 58, 332–338.
- Martin, R. (2011). The local geographies of the financial crisis: From the housing bubble to economic recession and beyond. *Journal of Economic Geography*, 11, 587–618.
- Matsaganis, M., & Leventi, C. (2011). Inequality, poverty and the crisis in Greece. ETUI policy brief, European economic and employment policy (vol. 5).
- Matsaganis, M., & Leventi, C. (2014). Poverty and inequality during the Great Recession in Greece. *Political Studies Review*, 12, 209–223. <https://doi.org/10.1111/1478-9302.12050>.
- Mincer, J. A. (1974). Schooling, experience, and earnings. National Bureau of Economic Research, Inc.
- Mitrakos. (2014). Inequality, poverty and social welfare in Greece: Distributional effects of austerity, Bank of Greece, Athens, Discussion paper 174.
- Mitze, T. (2012). *Empirical Modelling in Regional Science*. Berlin: Springer Available at: <http://link.springer.com/10.1007/978-3-642-22901-5>. Accessed 2 Feb 2016.
- Mitze, T. (2014). Does regional science need an experimentalist buzz? *Regional Studies*, *Regional Science*, 1(1), 51–59.
- Mitze, T., & Stephan, A. (2013). Simultaneous-equations analysis in regional science and economic geography. Working paper series in economics and institutions of innovation. Available at: <http://ideas.repec.org/p/hhs/cesisp/0309.html>. Accessed 2 Feb 2016.
- Monastriotis, V. (2011). Making geographical sense of the Greek austerity measures: Compositional effects and long-run implications. *Cambridge Journal of Regions, Economy and Society*, rsr026.
- Niemi, M. (2007). *Public health and municipal policy making: Britain and Sweden, 1900–1940*. Aldershot: Ashgate.

- Nivière, D. (2005). Négocier une statistique européenne: le cas de la pauvreté. *Genèses*, 58(1), 28–47.
- O'Brien, P., Sykes, O., & Shaw, D. (2017). *Evolving conceptions of regional policy in Europe and their influence across different territorial scales*. Territorial Policy and Governance: Alternative Paths.
- OECD. (1996). The knowledge-based economy. *Organisation for economic co operation and development, OeD, OECD*, 2, 1–46.
- OECD. (2013). *OECD framework for statistics on the distribution of household income, consumption and wealth*. Paris: OECD Publishing. <https://doi.org/10.1787/9789264194830-en>.
- OECD. (2015). *In it together: Why less inequality benefits all*. Paris: OECD Publishing.
- Panori, A., Ballas, D., & Psycharis, Y. (2016). SimAthens: A spatial microsimulation approach to the estimation and analysis of small area income distributions and poverty rates in the city of Athens. *Computers, Environment and Urban Systems* Forthcoming.
- Paredes, D., Iturra, V., & Lufin, M. (2016). A spatial decomposition of income inequality in Chile. *Regional Studies*, 50(5), 771–789. <https://doi.org/10.1080/00343404.2014.933798>.
- Park, K. H. (1996). Educational expansion and educational inequality on income distribution. *Economics of Education Review*, 15(1), 51–58 Available at: <http://www.sciencedirect.com/science/article/pii/0272775795000003>. Accessed 31 July 2015.
- Piacentini, M. (2014). “Measuring income inequality and Poverty at the regional level in OECD countries”, *OECD Statistics working papers, 2014/03*. Paris: OECD Publishing.
- Pritchett, L. (2001). Where has all the education gone? *The world bank economic review*, 15(3), 367–391.
- Prodromidis, P.-I. (2006). *A regional analysis of declared incomes in Greece*. Centre of Planning and Economic Research: Athens.
- Psacharopoulos, G. (1982). Earnings and education in Greece, 1960–1977. *European Economic Review*, 17(3), 333–347 Available at: <http://www.sciencedirect.com/science/article/pii/S0014292182800688>. Accessed 20 Nov 2015.
- Psycharis, Y., & Pantazis, P. (2016). The geography of declared income in Greece before and during the economic crisis. *Regions Magazine*, 30(1), 4–7.
- Psycharis, Y., Kallioras, D., & Pantazis, P. (2014). Economic crisis and regional resilience: Detecting the “geographical footprint” of economic crisis in Greece. *Regional Science Policy & Practice*, 6(2), 121–141.
- Rae, G. (2011). On the periphery: The uneven development of the European Union and the effects of the economic crisis on Central–Eastern Europe. *Global Society*, 25(2), 249–266.
- Ram, R. (1990). Educational expansion and schooling inequality: International evidence and some implications. *The Review of Economics and Statistics*, 72(2), 266–274 Available at: <http://www.jstor.org/stable/2109716>.
- Rees, P., Martin, D., & Williamson, P. (2002). Census data resources in the United Kingdom. In P. Rees, D. J. Martin, & P. Williamson (Eds.), *The census data system* (pp. 1–24). Chichester: Wiley.
- Reiss, P. C., & Wolak, F. A. (2007). Chapter 64 structural econometric modeling: Rationales and examples from industrial organization. *Handbook of Econometrics*, 6, 4277–4415 Available at: <http://www.sciencedirect.com/science/article/pii/S1573441207060643>.
- Rickman, D. S. (2010). Modern macroeconomics and regional economic modeling. *Journal of Regional Science*, 50(1), 23–41 Available at: <http://doi.wiley.com/10.1111/j.1467-9787.2009.00647.x>. Accessed 2 Feb 2016.
- Rodríguez-Pose, A., & Tselios, V. (2008a). Inequalities in income and education and regional economic growth in western Europe. *The Annals of Regional Science*, 44(2), 349–375. <https://doi.org/10.1007/s00168-008-0267-2>.
- Rodríguez-Pose, A., & Tselios, V. (2008b). Education and income inequality in the regions of the European Union. Spatial Economics Research Centre (SERC), London School of Economics and Political Science, London. Retrieved from <http://eprints.lse.ac.uk/33188/1/sercdp0011.pdf>.
- Rodríguez-Pose, A., & Tselios, V. (2011). Mapping the European regional educational distribution. *European Urban and Regional Studies*, 18(4), 358–374. <https://doi.org/10.1177/0969776411399345>.
- Rodríguez-Pose, A., & Tselios, V. (2015). Toward inclusive growth: Is there regional convergence in social welfare? *International Regional Science Review*, 38(1), 30–60.
- Rodrik, D. (2007). The real exchange rate and economic growth: Theory and evidence.
- Roodman, D. (2006). How to do Xtabond2: An introduction to difference and system GMM in Stata. *SSRN Electronic Journal* Available at: <http://papers.ssrn.com/abstract=982943>. Accessed 2 Feb 2016.
- Roodman, D. (2009). A note on the theme of too many instruments. *Oxford Bulletin of Economics and Statistics*, 71(1), 135–158 Available at: <http://doi.wiley.com/10.1111/j.1468-0084.2008.00542.x>. Accessed 2 Feb 2016.
- Sargan, J. D. (1958). The estimation of economic relationships using instrumental variables. *Econometrica*, 26, 393–415.

- Smith, A. (2013). Europe and an inter-dependent world: Uneven geo-economic and geo-political developments. *European Urban and Regional Studies*, 20(1), 3–31.
- Thorbecke, E., & Charumilind, C. (2002). Economic inequality and its socioeconomic impact. *World Development*, 30(9), 1477–1495.
- Tinbergen, J. (1972). The impact of education on income distribution. *Review of Income and Wealth*, 18(3), 255–265 Available at: <http://doi.wiley.com/10.1111/j.1475-4991.1972.tb00865.x>. Accessed 2 Feb 2016.
- Tselios, V. (2014). The granger-causality between income and educational inequality: A spatial cross-regressive VAR framework. *The Annals of Regional Science*, 53(1), 221–243 Available at: <http://link.springer.com/10.1007/s00168-014-0626-0>. Accessed 2 Feb 2016.
- van Ham, M., Tammaru, T., de Vuijst, E., & Zwiers, M. (2016). Spatial segregation and socio-economic mobility in European Cities.
- Winegarden, C. R. (1979). Schooling and income distribution: Evidence from international data. *Economica*, 46, 83–87.
- Yang, J., Huang, X., & Li, X. (2009). Educational inequality and income inequality: An empirical study on China. *Frontiers of Education in China*, 4(3), 413–434.