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ABSTRACT

Public investment and regional growth and convergence:

Evidence from Greece*

This paper estimates the impact of public investment on regional economic growth and convergence at the NUTS III level in Greece. Using a new database of public expenditure per region for the period 1978-2007, it proposes a model which captures not just the impact of public investment in Greek prefectures, but also the spillover effects related to the existence of externalities from neighbouring regions. The results point to a positive long-run impact of public investment per capita on regional economic growth – but not on convergence – which also generates considerable spillover effects. However, the returns vary according to different types of public investment, with education and infrastructure spillovers having the highest impact. In general, public investment externalities seem to be more relevant for regional growth than direct public investment in each region. Finally, the impact of different types of public investment in Greece is mediated by politics and political factors, but the effect of politics disappears once we control for political-period-specific spatial-invariant variables.

JEL Classification: R11, R12, R53 and R58
Keywords: convergence, economic growth, greece, public investment, regional economics, regional policy, spatial econometrics and spillover effects

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1. Introduction

Fiscal policy, in general, and public investment, in particular, have regained attention since the onset of the Great Recession in 2008. Discretionary fiscal action and the initial implementation of stimulus packages, intended to stabilise the economy and promote economic growth and employment, have revived the interest on the macroeconomic consequences of fiscal and public policies (Krugman, 2005; Solow, 2005).

The potential returns of public investment have, however, always been hotly disputed. Starting at least with Keynes, public investment has variously been portrayed as a stabiliser of the economy (Musgrave, 1959), as a generator of economic development and growth (Hirschman, 1958: 190), and as an instrument for the redistribution of national wealth, both among income groups and across geographical areas (e.g. Oates, 1972). These views had a tremendous influence on policy, leading to the implementation of massive public works programmes both in the US and in Europe, especially during the 'New Deal' and after World War II.

The expansion of public investment in the post-war decades was followed, after the crises of the 1970s, by a period of greater introspection in which the potential returns of investment by the state became contested. While some (e.g. Aschauer, 1989a,b,c, 1990; Munnell, 1990a,b; 1992) extolled the virtues of public investment, and especially of public infrastructure, in increasing productivity and economic growth, others questioned whether these returns ever materialized (e.g. Hulten and Schwab 1991; García-Milá and McGuire, 1992; Evans and Carras, 1994; Holtz-Eakin, 1994; Holtz-Eakin and Schwartz, 1995; García-Milá et al. 1996), reflecting an increasing political scepticism in public investment that characterised governments across the developed world.

The aim of this paper is to contribute to this debate and analyse the short-/medium- and long-term returns of public investment in Greece, a country where public intervention has been much maligned of recent. We will assess whether public investment in Greek regions (prefectures or NUTS III regions) has delivered greater regional growth and convergence. During the period of analysis successive Greek governments – regardless of their political orientation – have made regional growth and convergence one of their main economic policy priorities. However, so far, there has been little research assessing the impact of these interventions.

The scarcity of research in this field is partly the result of the lack of reliable and consistent time series containing public investment data at the level of prefectures. We overcome this problem by gathering a deflation-adjusted dataset of public investment expenditure in Greece at NUTS III level for the period 1978-2007. The data were collected using different official data sources and processed together in order to generate a complete and comprehensive source of statistical data on different types of public investment for Greek prefectures over three decades, considering both the direct regional impact of intervention and the externalities it generates.

In order to achieve this aim, the paper is structured around six sections. First, this short introduction is followed by a section looking at the literature on public investment and growth. Section 3 introduces the data sources and some key stylised facts about public investment in Greece. The econometric model is presented in Section 4, which is

followed by the interpretation of results in Section 5. The paper concludes with some policy recommendations and proposals for future work.

2. Public investment, spillovers, polities and growth

2.1 Public investment, spillover effects and growth

There is much controversy in the literature about the economic returns of public policy intervention on territorial development. Two opposing camps are clearly defined.

On the one hand, there are those who tend to view public investment as a generator of economic growth and development and as a source of regional convergence. Neoclassical economics is firmly within this camp. The works of Solow (1956) or Barro (1990) have emphasised the equalising role of public capital, in general, and of investment in physical capital, in particular, as a consequence of the existence of constant or decreasing returns to scale for capital accumulation. But perhaps the greatest defender of public investment in recent decades has been Aschauer. Aschauer (1989a,b) posits that differences in the stock of physical capital – and, in particular, of public infrastructure – are the fundamental factors explaining differences in territorial levels of output and development. According to Aschauer (1989a,b), a good endowment of public infrastructure significantly contributes to a productivity rise in the private sector and to economic growth. This view has been supported by a relatively large number of studies (i.e. Munnell, 1990a,b; Berndt and Hansson, 1992; Nadiri and Mamuneas, 1994).

This positive perception of the returns of public investment is, however, far from being the norm. Many researchers have challenged Aschauer's views by demonstrating that the impact of public investment, in general, and of public infrastructure investment, in particular, has either been insignificant or negligible. Most of this literature tends to underline the lack of any clear and positive link between public capital and private output, regardless of geographical context (e.g. Sturm and de Haan, 1995; Pereira and Roca-Sagalés, 2003).

The controversy between both camps is not just the result of different theoretical standpoints. It may also reflect other factors, such as the "different sources of data upon which scholars have based their contributions", the "geographic scale at which the analyses were conducted", and, "the absence of geographical consideration" and of a more precise specification of "inter-regional economic links of public infrastructure impacts" (Mikelbank and Jackson, 2000:251). In particular, the lack of consideration of the role played by geographical spillover effects may be crucial in the inconclusive nature of the literature on the returns of investment in infrastructure (Pereira and Roca-Sagalés, 2003:239; Moreno and López-Bazo, 2007:48).

The relatively recent introduction of geographical aspects and spillovers in the analysis of the impact of public investment has often lead to results that are somewhat less polarised. By and large, studies that are more sensitive to the spatial dimension tend to highlight that public investment plays a role in the geographical distribution of economic activities and that it generates externalities which may diffuse across regional

borders (Välilä et al., 2005; Kamps, 2005; Rodríguez-Pose and Crescenzi, 2008; Kemmerling and Stephan, 2008; Ottaviano, 2008). Whether changes in the distribution of economic activity as a result of public investment are more or less beneficial for economic growth and convergence varies from one analysis to the other. Most studies tend to find some returns of public investment on output and growth, but are generally more cautious on its impact on regional convergence. Välilä et al. (2005) and the European Commission (2007), for example, show that public investment in the European Union (EU) plays a non-negligible role as a determinant of output across Europe. Similarly, a number of studies analysing the impact of investment by the European Structural Funds have found a positive – albeit to a varying degree according to the different studies – relationship between European investment and regional growth in the EU (Cappelen et al., 2003; Rodríguez-Pose and Fratesi, 2004; Puigcerver-Peñalver, 2007).

The views on the impact of public investment on regional convergence are, by contrast, less clear cut. Contrasting results abound. Most, however, report little firm evidence of a widespread convergence linked to public investment expenditure. This is the case, for example, of the Italian regions, where Danieli (2009) finds that, for the period 1980-2007, public expenditure has contributed to cross-regional convergence in labour productivity, but has had a very limited impact on convergence in GDP per capita. Progressive territorial policies have often resulted in a growing divergence between the North and the South of the country (Padovano, 2007:89-90). Lago-Peñas and Martínez-López (2009) reach the same conclusion for Spain: despite the presence of strong redistributive policies from a territorial perspective, public investment did not generate regional convergence across Spanish regions during the 1980s and 1990s. And similar results are found by Pereira and Andraz (2006) for Portugal and by Checherita et al. (2009) for the whole of the EU.

2.2. Polity and growth

One of the key shortcomings of this type of analysis is that it tends to overlook the role played by political and institutional factors. Most of the research on the returns to public investment has fundamentally concentrated on levels of investment and endowments, using other regional economic variables as controls. Yet, it is well-known that the returns of public investment are likely to be strongly mediated by local political and institutional factors. Political decisions play an important role in determining public resource allocation across space. Numerous studies have documented that public expenditure is more often the result of political considerations – pork-barrel politics – than a response to social welfare or economic efficiency needs (Yamano and Ohkawara, 2000; Johanson, 2003; Castells and Solé-Ollé, 2005; Cadot et al., 2006).

The influence of pork-barrel politics in decisions about where to locate public expenditure across countries of Europe is becoming increasingly well documented, with many studies highlighting that 'politics matter' for the allocation of public investment (e.g. Romp and de Haan, 2007; Estache, 2006). Kemmerling and Stephan (2008) have, for example, shown that in the case of France, Germany, Italy and Spain political factors play a determinant role in the regional distribution of infrastructure investment, although the impact of these factors is less important than what the authors had anticipated. Specific country evidence tends to be stronger. In the case of Italy, Golden and Picci (200: 2868) find that powerful individuals in the ruling party manage to

secure greater infrastructure investments for their localities of origin. Similarly, Castells and Solé-Ollé (2005) demonstrate that, in the case of Spanish provinces, efficiency criteria played a very limited role in the geographical distribution of government infrastructure investment, with political factors being more prominent in decisions about where to allocate infrastructure. Hence Spanish governments tend to invest more in the regions where electoral productivity is higher, with partisan alignment having an important influence on the amount of public grants awarded to municipalities (Solé-Ollé and Sorribas-Navarro, 2008). The role of pork-barrel politics and electoral considerations has been further documented in the cases of France (Cadot et al., 2006) and Sweden (Johansson, 2003), where "intergovernmental grants are used in order to win votes" (Johansson 2003:883).

The limited research on pork-barrel politics in Greece has, in contrast to the above mentioned analyses for other European countries, presented little evidence of an influence of political factors on decisions about where to allocate public investment. Lambrinidis et al. (2005:1241) have found that the percentage of votes in a prefecture in favour of the governing party at national level has not played a significant role in the regional allocation of public investment in infrastructure. We will revisit this issue in this paper.

3. Public investment in Greece

3.1 Public investment in Greece - setting the context of analysis

Public investment in Greece has been the main and arguably the most popular way to tackle both the country's backwardness relative to the EU average, as well as its strong internal territorial imbalances. Public investment programmes have been used by successive Greek governments as a way to promote convergence towards the standards of living of the EU and to reduce domestic regional asymmetries.

Between 1978 and 2007 public investment represented on average 4% of the annual GDP of the country. There were, however, important yearly fluctuations in the amount of funds devoted to public investment. As a general rule, public investment was strongest in the second half of the period considered. The main reason for this has been the considerable influx of EU Structural Funds since their reform in 1989. During the period between 2000 and 2006, transfers from the EU represented, on average, an estimated 48% of all public investment in Greece (European Commission, 2007:143). Public investment peaked in 2002, reaching 6% of GDP (Psycharis, 2008).

Whether this significant effort has paid off in terms of greater growth both at the national and at the regional level and of greater regional convergence remains unclear. Most previous studies dealing with the impact of public policy in Greece have focused on the impact of public infrastructure on economic growth at national level. These studies have paid particular attention to transportation and have generally indicated that public infrastructure investment has been an important determinant of aggregate growth (Christodoulakis and Segoura, 1993; Mamatzakis, 2007) and of the performance of private manufacturing in Greece (Rovolis and Spence, 2002).

The geographical dimension of public investment has attracted, by contrast, virtually no attention. Yet, aggregate growth and regional convergence are not necessarily complementary objectives. Aggregate growth can often be achieved by generating greater territorial inequities, especially if it leads to the agglomeration of economic activity in core areas. Hence, the main question of this paper is to estimate the contribution of public investment to regional economic growth, in order to determine whether any potential greater aggregate growth has been evenly distributed across prefectures in the country or has been accomplished at the cost of increasing regional asymmetries. In order to do this, we use a new dataset which allows us to assess to what extent different investment categories (i.e. transportation, education, health and social welfare, housing, etc.) affect regional economic growth and convergence in Greece. Our starting hypothesis is that the returns of public investment on economic growth matter, but depend on the type of public investment under consideration. Different categories of public investment may have different impacts on outputs, as they tend to pursue different aims that depend on the relationship with the territory (Moreno and López Bazo, 2007:48). In addition to the different categories of public investment, we will also consider the geographical dimension of public investment. Public investment in one region is bound to have a significant impact on neighbouring regions, generating a level of spatial dependence which has so been neglected in analyses of public investment in Greece. In this paper we will use recent advances in spatial econometrics in order to determine better the effects of public investment on regional growth in Greece.

3.2 Data sources and units of analysis

The analysis conducted in this paper rests on a new dataset of regional public investment in Greece. The variables in the dataset include all payments by different tiers of the Greek government – payments by national government at ministerial level, as well as payments by the weaker regional, prefectural, and local tiers of government – channelled through the Greek Public Investment Budget (PIB, also known as the Public Investment Programme). The PIB is a part of the Greek annual budget and requires parliamentary approval. It represents the main mechanism for providing the Greek economy with different types of public 'infrastructures', encompassing also the Structural Funding from the EU.

The PIB, managed by the Ministry of Economics and Finance, started to operate in 1952 (Law N.2212/52). Its establishment reflected a growing international trend towards putting a greater emphasis on infrastructure investment. The PIB includes expenditure on construction, machinery and physical infrastructure, as well as technical assistance explicitly related to these works. In 1989, and as a result of the influence of the European Union Community Support Programmes, the PIB was divided into two parts: the first containing projects co-financed with the European Union and the second including projects not eligible for structural assistance and consequently financed only by national funds. Another influence of the EU structural assistance is that since 1996 the PIB also encompasses investments in human capital (Law N.2601/98).

The dataset includes information on public capital investment for 51 prefectures over a period of 30 years, implying a total of 1530 observations per variable. The information included in the dataset contains only the 55% of total public investment which, during the study period, could be allocated to a specific prefecture. The remaining 45% could not be assigned to any specific region, and included national projects deemed to affect

either the entire country or subsets of geographical areas other than prefectures. The 'total' public investment used in the paper thus includes the sum of regionally identifiable public investment expenditures.

We use sectoral deflators for the different categories of infrastructure investment in order to obtain a measure of public investment at constant prices. All data is expressed in euros at 2000 prices.

Table 1 presents some descriptive statistics of the main variables used in the analysis.

Insert Table 1 around here

The territorial units used in the analysis are the prefectures (in Greek, 'nomos'). Greece is divided into 51 prefectures, which correspond to level III of the Nomenclature of Territorial Units for Statistics (NUTS) of EUROSTAT, the Statistical Office of the European Union. The average surface of a prefecture is 2,587 km^2 (ranging from a minimum of 356 km^2 to a maximum of 5,461 km^2). Prefectures have traditionally been the key spatial level for regional development policy. The regions, which, despite their still almost non-existent autonomy, today play a role in regional policy, were only created in 1986 and did not become fully functional until after 1997.

The population and wealth of the different prefectures is very unequal (see Appendix 1). Attiki, where the capital Athens is located, accounts for, with more than 4.0 million inhabitants, 36.2% of the total population of the country. Thessaloniki, with 1.1 million, represents 10.2% of the total. These marked inequalities are also reflected in the geography of production. Attiki and Thessaloniki jointly represent more than 59% of the total GDP of Greece.

Disparities in terms of GDP per capita are also significant. Voiotia and Attiki, the two wealthiest prefectures, have a GDP per capita which is respectively 3.3 and 2.75 times higher than that of Ileia and Rodopi, the two poorest. Attiki also experienced one of the highest levels of GDP per capita growth among Greek prefectures for the period 1996-2007, leading to a further polarization of the country's internal asymmetries.

4. Econometric specification and variables.

In order to assess the impact of public investment across Greek prefectures during the period 1978-2007, we adopt an econometric model based on the theoretical approach and the empirical applications described in Section 2. Our basic model is derived from the neoclassical $\beta-$convergence model proposed by Barro (1991), whereby the average regional growth rate during any given political period – determined by the terms in power of different political parties – is a function of the relative wealth of each Greek prefecture and of the level of public investment in each prefecture and in neighbouring prefectures. The model adopts the following form:

$$\frac{1}{T}\ln\left(\frac{Y_{i,t_{0+T}}}{Y_{i,t_0}}\right) = a + \beta_1 \ln(Y_{i,t_0}) + \beta_2 PublInv_{i,t_0} + \beta_3 [WPublInv_{t_o}]_i + \beta_4 x_{i,t_0} + u_{i,t_0}$$

where Y_{i,t_0} is the average GDP per head for region i at political period t_0, $PublInv_{i,t_0}$ is the public investment for region i during political period t_0 and $[WPublInv_{t_0}]_i$ is the public investment in neighbouring regions i during political period t_0. We use a spatial econometric specification as a means to test for the occurrence of regional public investment externalities and to estimate their magnitude (López-Bazo et al. 2004). The specification of the regional public investment interaction is represented by a spatial weights matrix W. In our empirical specification, W is a binary matrix equal to 1 in the case of the $k-$nearest neighbouring regions, with $k = 5, 7 \; and \; 9$, and 0 otherwise. We use different weights matrices in order to check for the sensitivity of the results. β_1 represents the coefficient on the initial regional GDP per head. This coefficient allows us to test for the presence of regional convergence in Greece. β_2 denotes the coefficient on public investment in each region, and β_3 denotes the coefficient on public investment in neighbouring regions. β_2 represents the *internal* returns to public investment, while β_3 represents the *external* returns to public investment, capturing public investment externalities across prefectures. In order to minimise the risk that β_3 captures effects other than 'true' public investment externalities, we also include a vector of regional specific characteristics x_{i,t_0}, representing some of the basic structural features of each prefecture. β_4 is the coefficient on these regional specific characteristics. u_{i,t_0} is the error term and α is the constant.

Insert Table 2 around here

The above empirical specification represents a spatial cross-regressive econometric model examining the potential impact of regional and interregional public investment on regional economic growth over different political periods. The political periods are determined by the party in office following successive Greek elections. There are two main parties in Greece, which have alternated in governance since the restoration of democracy in 1975: PASOK (also known as the Socialist Party) and New Democracy Party (also known as the Liberal Party). PASOK was the governing party between 1982-1989, 1994-1999 and 2000-2004 while New Democracy Party was in office during the periods 1978-1981, 1990-1993 and 2005-2007 (for the date of the election, party in office, and political period, see Table 2). The political periods not only mark changes in the orientation of the government, but also important milestones in Greece's European integration process: membership of the European Community in 1981, the Mediterranean Integrated Programmes in 1985, the First Community Support Framework 1989-1993, the Second Community Support Framework 1994-1999, entry into the European Monetary Union in 2000, and a large section of the Third Community Support Framework 2000-2006.

We also introduce spatial dependence among the observations for the Greek regions in each political period. Since the value of the public investment observed in each region is jointly determined with that of neighbouring regions, ignoring spatial dependence may

result in biased estimates. Spatial dependence in our empirical growth model is of the substantive type, as it is likely to be caused by technological and pecuniary externalities (Fingleton and López-Bazo, 2006). In addition, by introducing spatially lagged independent variables, we not only explore the interactions among neighbouring regions, but also minimise their effect on the residuals (Rodríguez-Pose and Crescenzi, 2008).

The analysis covers 357 observations, corresponding to 51 Greek prefectures or regions over 7 political periods (t_{0+T}) (Table 2). The limited time span of our political periods may produce, as convergence is a long-run process, biased results and misleading conclusions (Arbia et al. 2005). As a means to minimise this problem we resort to panel data analysis, in order to consider both geographical and temporal variation in growth. Panel data analysis has the additional advantage of increasing the degrees of freedom and reducing collinearity among explanatory variables, thus improving the efficiency of the econometric estimates (Hsiao 2003). This implies that an interregional externality is generated in a region and incorporated by other regions over 7 political periods. Although in our specification, spatial dependence is a substantive phenomenon, we also test for spatial dependence as a nuisance using the Moran's I test (Cliff and Ord,1981) adapted to the regression residuals.

In our econometric model, the error term is specified as $u_{i,t_0} = \omega_i + \xi_t + \varepsilon_{i,t_0}$, where ω_i is the unobservable regional specific effects, ξ_t denotes time-dummies (political-period-dummies), and ε_{i,t_0} is the disturbance term. This model allows for unobserved heterogeneity through the regional effect ω_i, capturing the combined effect of time-invariant regional omitted variables. Moreover, our model controls for all time-specific (political period-specific) spatial-invariant variables through ξ_t.

Our model thus includes both a spatial and a temporal dimension. The former dimension pertains to a set of cross-regional units of observations, while the latter pertains to periodic observations (based on political periods) of a set of variables characterising those cross-regional units over a particular time-span (Rodríguez-Pose and Tselios, 2009). The empirical model is estimated by fixed effects (FEs) in order to control for time-invariant characteristics. This estimator controls for the effects of the omitted variables that are peculiar to each region (NUTS III) and accommodates spatial heterogeneity through ω_i. It wipes out all the space-specific time-invariant variables, and also reduces the risk of obtaining biased estimation results (Baltagi, 2005). However, this reduction in bias comes at a significant cost, as it removes cross-sectional variation from the data, potentially affecting the efficiency of the parameter estimates (Higging and Williamson, 1999; Rodríguez-Pose and Tselios, 2010). The higher the cross-sectional variation, the lower the efficiency of the FEs estimator. Since the FEs estimator disregards persistent effects when used alone, it can lead to misleading results when most of the variation is cross-sectional (Partridge, 2005; Tselios, 2009). We therefore calculate the within and between variation from the data and when the cross-sectional variation is high, the model is also estimated by ordinary least squares (OLS). Pooled OLS will be consistent and efficient in cases of no individual heterogeneity. When heterogeneity exists, a trade-off between bias and precision emerges. Bearing this in mind, FEs coefficients are interpreted as time-series effects (or short/medium-run effects), as they reflect within-region time series variation, whereas the pooled OLS

coefficients reflect long-run effects (Mairesse, 1990; Durlauf and Quah, 1999; Partridge, 2005).

The suitability of the above estimators is checked using different specification tests. The p-values of Breusch and Pagan's (1980) Lagrange Multiplier (LM) statistic test the validity of the pooled OLS models, while the p-values of Hausman's (1978) statistic test the random effects (REs) estimator as an appropriate alternative to the FEs estimator.

Finally, if there is no great difference between the significance of the homoscedasticity and the heteroscedasticity consistent covariance matrix estimator (White, 1980), the determinants of regional economic growth can be considered robust to the model specification about the error term, and for the sake of brevity, we do not report the robust standard errors. Our base model is estimated by FEs, with the Breusch and Pagan's (1980) statistic showing whether the OLS is an alternative to the FEs estimator and the Hausman's (1978) statistic whether the REs estimator is an alternative to the FEs estimator. All these models are calculated with and without time-dummies (ξ_t) in order to highlight the role of the time-specific (election-specific or political-period specific) spatial-invariant variables. If these variables are statistically significant, their omission could bias the estimates in a typical time-series study (Baltagi, 2005). However, as our analysis juggles political periods and not annual time-span, depending on the variation, the magnitude and the significance of the time-dummies, they could be replaced by a dummy variable which takes the value of 1 if the governing party is New Democracy (for $t = t_0$) and 0 if the governing party is PASOK.

4.1 Independent variables

The precise independent variables included in the analysis are as follows:

Initial regional economic development ($\ln(Y_{i,t_0})$): The logarithm of the initial level of per-capita GDP is introduced in the model because, first, the level of development of a prefecture may affect its capacity to absorb public investment and to transform it into economic growth and, second, to test for conditional $\beta-$convergence.

Regional and interregional public investment ($PublInv_{i,t_0}$ and $[WPublInv_{t_0}]_i$, respectively): Regional public investment is measured by (a) the total regional public investment expenditure and (b) the per capita regional public investment expenditure. These variables are later decomposed into the following types of regional public investment expenditures: (1) total public infrastructure expenditure, which includes transport infrastructure (roads and highways, bridges, harbours and maritime signalling, airports, railway communications, and urban transportation) and other types of infrastructure (agriculture, manufacture, tourism and culture, water supply and sewage, extra works, specific infrastructures, such as stadia, related to the 2004 Olympic Games); (2) education and research public expenditure; (3) housing public expenditure; (4) health and social welfare public investment expenditure; (5) decentralised public investment expenditure; and (6) miscellaneous public investment expenditure. The same variables are calculated for the neighbouring regions in order to capture the potential spillovers linked to interregional public investment expenditure. Regional and interregional public investment expenditure enters the empirical specification in logarithms. Overall, it is expected that the geographical location of a region and

differences in public investment expenditure among prefectures will play a major and positive role in explaining growth.

Control variables (x_{i,t_0}): Based on the review of the theoretical literature and on data availability, we identify the following set of time-variant control variables:

(a) Political power: We proxy political power using two variables. First, as in the case of Lambrinidis et al. (2005), the percentage share of votes in the region in favour of the party governing at the national level. The second political power variable is the difference in the percentage share of votes in any given prefecture in favour of the governing party (PASOK or ND) relative to the main opposition party. As we expect that "governments, irrespective of their ideological preferences, attempt to influence in their favour the outcome of a forthcoming election by adopting expansionary policies and increasing public expenditures in the period preceding an election, especially if the re-election prospects for the governing party are uncertain" (Lambrinidis et al. 2005: 1233), the coefficients of both variables representing political power could be positive. The percentage share of votes in the region in favour in the governing party denotes the 'absolute' political power of the governing party relative to the main opposition party, while the difference of the percentage share of votes in a region in favour of the governing party denotes the 'relative' political power. The value of the latter variable for a particular region can be negative in those cases where the percentage share of votes in that region in favour of the governing party is lower than the percentage share of votes in the same region in favour of the main opposition party. When considering the political power variables, the number of observations is reduced to 306, because of missing data on the percentage share of votes for t_0 =1 (1978-1981).

(b) Population and population density: Population is a proxy for the size of regional markets and population density is normally used in the literature in order to denote regional agglomerations. We expect the coefficient of both variables to be positive, because, large and densely populated regions will act as a magnet for economic activities (Krugman, 1991).

(c) Other controls (Source: Cambridge Econometrics database): We also control for additional economic variables (see Tselios, 2008; Rodríguez-Pose and Tselios, 2009; Tselios, 2009; Rodríguez-Pose and Tselios, 2010). These include (1) regional gross value added (gva) investment as a share of gva which is a proxy for capital growth; (2) sectoral composition, measured by the share of agricultural gva to total regional gva (base category), the share of industrial gva to total regional gva and the share of service-sector gva to total regional gva; (3) the location quotient for the above sectors; and (4) employment measured by the number of employees in the region.

The above control variables are introduced in our model to account for differences in steady-states values across economies, because the conditional $\beta-$convergence model encompasses the structural differences among regional economies which converge to different steady-states (see Tselios, 2009).

5. Regression results

The empirical analysis exploits the panel structure of the dataset for the 51 Greek prefectures included in the analysis over the period 1978-2007 (over 7 political periods). The analysis is developed in two stages. First, we resort to a traditional neo-classical growth model which examines the impact of overall public investment on regional growth. Second, we propose a spatial cross-regressive economic model, capturing not only the impact of public investment as well as its different components in each Greek prefecture on economic growth, but also the spillover effects related to the externalities generated by public investment in neighbouring regions.[1]

5.1 Impact of public investment on growth

Tables 3 and 4 display the FEs and OLS regression results, respectively. The p-values of Breusch and Pagan's LM test fail to reject the validity of the pooled OLS estimator (apart from Regression 1). We can thus safely assume that the unobserved regional specific effects are uncorrelated with the explanatory variables. Since both cross-sectional and time-series variation of the explanatory variables are high (see Appendix 2), the FEs coefficients can be interpreted as short/medium-run effects, and the pooled OLS coefficients as long-run effects. The p-values of Hausman's test reject the GLS estimator as an appropriate alternative to the FEs estimator for Regressions 2-4, 6 and 8-12 and fail to reject it for Regressions 1, 5 and 7, showing the sensitivity of this test to the empirical specification. Overall, the theoretical interpretation of the estimators, the within and between variation in the data and the specification tests point to the FEs and OLS models as the most appropriate. Finally, as there is no much difference between the significance of the homoscedasticity and the heteroscedasticity consistent covariance matrix estimator, for the sake of brevity, we do not report the robust standard errors.[2]

Insert Tables 3 and 4 around here

The results of the analysis point towards the presence of a strong positive association between public investment per capita and regional growth across Greek prefectures in the long-run (Table 4). But, the short-run impact is positive and statistically significant only once we control for election-specific spatial-invariant variables (Table 3). Thus political period dummies play a significant role in the short-run effect of public investment per capita. The long-run connection is, however, not reproduced when public investment per capita is replaced by the overall level of public investment (Table 4: Regressions 3 and 4). These results are robust to the introduction of the political control variables, as well as to controlling for population, population density, regional

[1] We have also calculated the impact of different types of public investments per capita without spatial externalities, but we do not report them for the sake of brevity. However, the results can be provided upon request.

[2] These standard errors can be provided upon request.

gva, investment as a share of gva, sectoral composition and the location quotient for the agricultural, industrial and service sectors.[3]

The political variables also display some interesting results. While, as in Lambrinidis et al. (2005), the impact of the percentage share of votes in the region in favour of the governing party on regional growth ('absolute' political power) is not statistically significant in both the short- and the long-run (Tables 3 and 4: Regressions 5 and 6), the impact of the difference of the percentage share of votes in the region in favour of the governing party ('relative' political power) is positive and statistically significant in the short-term once we add control variables (Regressions 9 and 11), but disappears when we control for political period dummies (see Regressions 10-12).[4] Hence, it is not the overall share of the vote for the governing party which is translated into greater levels of economic growth, but how big the gap between the governing and the main opposition party is, which presumably would allow the Greek national government to have a greater leeway on decisions about public policy expenditure in those regions where it enjoys a greater 'relative' political power. 'Absolute' political power seems to matter less, as the opposition may also have substantial support at regional level. However, as the standardised coefficients for the above regressions[5] show, the influence of 'relative' political power on economic growth is trumped by that of public investment expenditure per capita, meaning that, in the case of Greece, public investment seems to have a higher impact on growth than political forces.

The coefficients of the logarithm of GDP per capita are sensitive to the empirical specification of the estimators (FEs or OLS), the inclusion of control variables and the inclusion of political-period dummies. The results therefore reject the hypothesis of conditional β-convergence across Greek prefectures during the period of analysis.

A fundamental issue encountered in exploring the association between public investment and growth is connected to the size of the units of analysis. Greek prefectures vary enormously in production and population (i.e. the prefectures of Attiki and Thessaloniki represent almost 60 per cent of the total GDP and 40 per cent of the population). It is therefore legitimate to ask whether larger regions should carry more weight than smaller ones (Tselios et al. 2012). Since our goal is to see how regional economies work with each region viewed as a separate realisation of certain underlying economic processes, each region should be weighted the same (Firebaugh, 2003). In other words, we are interested in growth in GDP per capita, and not, particularly, in growth levels of GDP. Nevertheless, we have re-estimated the analysis using growth levels of GDP, and the regression results underline the robustness of our results: total public investment (whether per capita or not) has a positive impact on growth of GDP levels which is stronger in the long-run than in the short-run (Table 5).

Insert Table 5 around here

[3] Due to the very high correlation between population, population density, employment and regional gva, we display the regression results for population density only. The rest can be provided upon request.
[4] Even if control variables are included in Regressions 5 and 6, the coefficient of the 'absolute' political power is not statistically significant in both FEs and OLS models. The results can be provided upon request.
[5] The results can be provided upon request.

The above findings are also robust to replacing political-period dummy variables with a dummy variable which takes the value of 1 if the governing party is New Democracy (for $t = t_0$) and 0 if the governing party is PASOK.[6]

5.2 Impact of different types of public investment and their externalities on growth

Taking Regressions 7 and 8 in Tables 3 and 4 as our benchmark, we proceed to examine the impact of the different types of public investment expenditure per capita considered and their externalities by means of a spatial cross-regressive neoclassical growth model, putting greater emphasis on the transport part of regional public investments. This model captures the combined effect of (total and different types of) public investment in Greek prefectures and the spillover effects related to the existence of externalities emanating from neighbouring regions. Table 6 presents the FEs regression results (short-run effects) and Table 7 the pooled OLS regression results (long-run effects), with and without political-period dummies. These results are robust to the choice of the spatial weights matrix.[7] The p-values of Breusch and Pagan's LM test are sensitive to the empirical specification (they fail to reject the validity of the pooled OLS estimator in Regressions 1, 2, 5, 9 and 10, and reject it in Regressions 3, 4, 6, 7 and 8). The p-values of Hausman's test reject the GLS estimator as an appropriate alternative to the FEs estimator in all regressions. Once again, the FEs and OLS estimators are considered as the most appropriate by the different tests.

Insert Tables 6 and 7 around here

The results of Tables 6 and 7 indicate that economic growth is affected in different ways by different types of per capita public investment expenditure and that the spillovers of certain types of public investment – and mainly investment in transport infrastructure – is crucial for regional economic growth in Greece.

Both in the short- and in the long-run three types of public investment stand out as key drivers of regional economic growth: education and research, public infrastructure and housing. In the short-run (Table 6, Regressions 7-10) education and research public expenditure per capita is always positively and significantly associated with regional growth. Prefectures with a higher level of investment in education and research tend to perform better than prefectures where investment in human capital and research is less of a concern. Investment education and research also generates positive spillovers (Regressions 7 and 9), although the coefficients are sensitive to the introduction of political-period dummies. Investment in public, mainly transport, infrastructure per capita has no significant direct effect – regions which benefit from a higher level of investment do not achieve higher levels of growth – but a discernible indirect effect via spillovers: prefectures surrounded by other prefectures where public infrastructure is a top priority (Regressions 3 and 4), and especially those which have invested heavily in transport infrastructure (Regression 5), tend to grow faster in the short-run. Investment

[6] These results can be provided upon request.

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

in housing, by contrast, has a negative association with regional growth, once political periods are controlled for (Regressions 8 and 10).

In the longer-run the results point in a similar direction. If we take into account the regressions which can be accepted according to the OLS specification tests (Table 7, Regressions 1, 2, 5, 9 and 10), education and research, public investment and housing again stand out. In the longer-run education and research continue to yield significant positive results in terms of economic growth and generate positive spillovers, although the effect is sensitive to the introduction of time dummies (Regressions 9 and 10). Public infrastructure investment not only continues to generate considerable spillovers, but, in the longer-term, also leads to greater growth (Regressions 1 and 2), a result which is reproduced when transport infrastructure investment is taken into account (Regression 5). However, both for overall public infrastructure investment and for transport public infrastructure investment the dimension of the coefficients for the variables measuring externalities is also greater than that of direct public investment (Table 7, Regressions 1, 2 and 5). This implies that while both public investments internal and external to the region generate economic returns, it is often the case that the impact of growth is greatest through the aggregate investment in neighbouring prefectures than through specific localised investments in the region. Housing investment is again detrimental for regional growth and generates negative spillover effects (Regression 10).

The decomposition of public investment into its different categories does not alter the influence of 'relative' political power on economic growth. Greek prefectures where the difference in the percentage share of votes between the governing party and the main opposition party is greatest, tend to grow faster than those where the gap between the two main parties is smaller, but this effect disappears once we control for political period dummies in the FEs models (Table 6). Finally, the regression results confirm the absence of conditional convergence in GDP per capita for Greek regions.

6. Conclusions

In this paper we have analysed the economic returns of public investment across Greek prefectures. The analysis deals with a topic which has attracted relatively little attention, despite the importance awarded both by the Greek government and the EU to public investment as a mechanism to promote greater economic growth and regional convergence. The paper has a series of novelties. The first one is the introduction of a unique and comprehensive dataset of public investment which spans over three decades. The second is related to the distinction between different types of public investment per region, including transport infrastructure, education and research, housing, health and social welfare, and decentralised public investments. Finally, the paper introduces the geographical dimension, by exploring the role of public investment externalities on the economic growth of Greek prefectures, an area of research which have been neglected by the literature until now.

The results of the analysis are very much in line with the international literature on the topic. While, on the one hand, we find that total public infrastructure expenditure per capita and, more specifically, transport infrastructure investment, have a positive and

significant impact on regional growth in Greece (Mas et al., 1996; Pereira and Roca-Sagalés, 2003; Salinas-Jiménez, 2004; Pereira and Andraz, 2006; de la Fuente, 2008; Danieli, 2009), the evidence of any effect on regional convergence is much more nuanced (Rodríguez-Pose and Fratesi, 2004; Padovano, 2007; Checherita et al., 2009; Lago-Peñas and Martínez-López, 2009). There is no clear indication that public investment has contributed to narrow the development gap across Greek prefectures. This implies that either Greek development policy was either not territorially progressive enough or that public investment may have been more efficient in more developed regions. The results thus reflect the growing consensus in the literature about the growth enhancing effect of public capital (vid. Romp and de Haan, 2007:33), but also about its limited potential to rein in processes of territorial polarisation (Vickerman et al., 1999).

Different types of public investment also seem to have different impacts on economic growth. In particular, investment in education and research has yielded the greatest direct returns, while public and transport infrastructure investment has had a more indirect effect, via geographical spillovers.

The external returns to this type of investments have clearly outweighed internal ones. This means that public (transport) infrastructure investment in one region tends to complement investment in other regions, making the influence of intervention felt well beyond the borders of the prefecture where it takes place.

Finally, some political variables, such as the difference in the percentage share of votes between the governing and the main opposition party exert a non-negligible influence on growth rates across Greek prefectures since the restoration of democracy, but this result is sensitive to the introduction of political-period-specific spatial-invariant variables.

Our research has reached the conclusion that in a country such as Greece, where public intervention is often considered to lead to spillage and wastage, public investment over the last three decades has had a moderately positive effect on regional economic growth, although its impact on reducing internal disparities has been somewhat more muted. The results also show that in certain areas, such as transport infrastructure, the benefits not necessarily come from direct intervention in specific regions, but from the spillovers that are generated as a result of multiple types of public intervention across the country. However, the results also raise a number of interesting questions regarding the potential equity, efficiency, redistributive and political effects of the allocation of public investment in Greece. Only further research on these issues will allow to determine how the returns of public investment can be maximised.

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TABLES

Table 1: Descriptive statistics of the initial database

Summary statistics						
Variables	Mean	Minimum	Maximum	Std. Deviation	Range	Coefficient of Variation
GDP per capita*	9056.400	4043.151	33520.345	2752.633	29477.193	30.4%
Population density	71.533	10.326	1039.049	129.630	1028.723	181.2%
Total Public Inv	278.806	54.214	3703.001	178.914	3648.787	64.2%
Transport	35.963	.000	3185.876	103.534	3185.876	287.9%
Productive	57.784	.000	3193.652	112.984	3193.652	195.5%
Education	18.084	.000	188.438	21.986	188.438	121.6%
Housing	2.885	.000	139.733	8.832	139.733	306.1%
Health	9.455	.000	246.032	18.955	246.032	200.5%
Decentralized	147.400	1.421	950.527	107.951	949.105	73.2%
Miscellaneous	10.024	.000	266.072	20.795	266.072	207.4%
% votes ND**	42.6	19.2	57.7	6.1	38.5	14.3%
% votes PASOK**	44.5	24.7	65.9	6.6	41.2	14.8%

Total number of observations 1530 (30 years for 51 observations per year)

* In Euro, at constant prices 2000
** ND denotes New Democracy, the Liberal Party and PASOK denotes the Socialist Party

Table 2: Political periods

Year of election	Date of election	Party in office	Political period	Length of a political period (years)	t_0	t_{0+T}
1977	20-Nov	ND	1978-1981	4	1	
1981	18-Oct	PASOK	1982-1984	3	2	1
1985	02-Jun	PASOK	1985-1989	5	3	2
1990	08-Apr	ND	1990-1993	4	4	3
1993	10-Oct	PASOK	1994-1996	3	5	4
1996	22-Sep	PASOK	1997-1999	3	6	5
2000	09-Apr	PASOK	2000-2003	4	7	6
2004	07-Mar	ND	2004-2007	4		7
2007	16-Sept	PASOK				

ND: New Democracy, Liberal Party; PASOK: Socialist Party

Table 3: Total public investment expenditure per capita (FEs estimator): dependent variable is growth of GDP per capita

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Ln of GDP per capita	0.0932	-0.2276	0.0838	-0.2252	0.0996	-0.2372	0.1067	-0.2337	-0.0350	-0.2204	-0.0061	-0.2534
	(0.036)**	(0.044)***	(0.036)**	(0.044)***	(0.038)***	(0.045)***	(0.038)***	(0.045)***	(0.043)	(0.051)***	(0.046)	(0.051)***
Ln of total public investment expenditure per capita	0.0446	0.0193			0.0525	0.0232	0.0517	0.0234	0.0412	0.0279	0.0426	0.0273
	(0.017)***	(0.016)			(0.021)**	(0.017)	(0.021)**	(0.017)	(0.020)**	(0.018)	(0.020)**	(0.017)
Ln of total public investment expenditure			0.0507	0.0138								
			(0.016)***	(0.016)								
Percentage share of votes in the region in favour of the governing party					0.0000	0.0014						
					(0.001)	(0.001)						
Difference in the percentage share of votes in the region in favour of the governing party							0.0006	0.0004	0.0013	0.0003	0.0012	0.0003
							(0.001)	(0.001)	(0.001)**	(0.001)	(0.001)**	(0.001)
Density									0.8847	-0.3214	1.3982	-1.2219
									(0.646)	(0.601)	(0.667)**	(0.677)*
Investment as a share of gva									0.3806	0.0608	0.3879	0.0624
									(0.111)***	(0.126)	(0.117)***	(0.124)
Share of agricultural gva to total regional gva									Base category	Base category		
Share of industrial gva to total regional gva									0.0857	0.0573		
									(0.141)	(0.158)		
Share of service-sector gva to total regional gva									0.5005	0.1170		
									(0.111)***	(0.181)		
Location quotient (agriculture)											0.0187	-0.0691
											(0.021)	(0.024)***
Location quotient (industry)											0.0714	-0.1240
											(0.045)	(0.056)**
Location quotient (services)											0.5012	-0.3955
											(0.134)***	(0.200)**
Political-period dummies	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES
Constant	-1.3344	2.0128	-1.5632	1.9942	-1.4915	1.9500	-1.5456	1.8457	-0.6181	1.5896	-1.1629	2.8514
	(0.327)***	(0.445)***	(0.349)***	(0.484)***	(0.409)***	(0.471)***	(0.394)***	(0.466)***	(0.419)	(0.601)***	(0.453)**	(0.705)***
LM test	4.91	0.23	0.09	1.96	0.60	2.24	0.52	2.01	0.12	1.25	0.10	1.76
	(0.0266)	(0.6316)	(0.7588)	(0.1611)	(0.4382)	(0.1346)	(0.4709)	(0.1559)	(0.7280)	(0.2635)	(0.7559)	(0.1846)
Hausman test	2.54	33.95	19.48	24.71	1.15	31.79	2.09	64.16	32.45	47.92	25.38	24.78
	(0.2803)	(0.0000)	(0.0001)	(0.0017)	(0.7653)	(0.0000)	(0.5532)	(0.0000)	(0.0000)	(0.0000)	(0.0013)	(0.0247)
Observations	357	357	357	357	306	306	306	306	306	306	306	306
R-within	0.0618	0.3586	0.0700	0.3571	0.0602	0.4086	0.0648	0.4053	0.2317	0.4082	0.2086	0.4281

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

Table 4: Total public investment expenditure per capita (OLS estimator): dependent variable is growth of GDP per capita

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Ln of GDP per capita	0.0478	-0.0244	0.0521	-0.0296	0.0665	-0.0104	0.0650	-0.0080	0.0380	-0.0467	0.0359	-0.0548
	(0.020)**	(0.020)	(0.022)**	(0.021)	(0.021)***	(0.021)	(0.021)***	(0.021)	(0.025)	(0.026)*	(0.025)	(0.026)**
Ln of total public investment expenditure per capita	0.0609	0.0430			0.0581	0.0438	0.0573	0.0432	0.0357	0.0333	0.0416	0.0320
	(0.011)***	(0.010)***			(0.012)***	(0.011)***	(0.012)***	(0.011)***	(0.013)***	(0.011)***	(0.013)***	(0.011)***
Ln of total public investment expenditure			-0.0020	-0.0054								
			(0.007)	(0.006)								
Percentage share of votes in the region in favour of the governing party					-0.0004	0.0009						
					(0.001)	(0.001)						
Difference in the percentage share of votes in the region in favour of the governing party							0.0003	0.0004	0.0005	0.0003	0.0007	0.0003
							(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Density									-0.0341	-0.0261	-0.0131	-0.0302
									(0.043)	(0.039)	(0.044)	(0.039)
Investment as a share of gva									0.2179	-0.0017	0.1942	-0.0062
									(0.077)***	(0.081)	(0.080)**	(0.081)
Share of agricultural gva to total regional gva									Base category	Base category		
Share of industrial gva to total regional gva									0.2176	0.2870		
									(0.081)***	(0.075)***		
Share of service-sector gva to total regional gva									0.2886	0.2338		
									(0.074)***	(0.076)***		
Location quotient (agriculture)											0.0419	-0.0283
											(0.017)**	(0.021)
Location quotient (industry)											0.1346	0.0003
											(0.041)***	(0.049)
Location quotient (services)											0.4496	-0.0413
											(0.126)***	(0.159)
Political-period dummies	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES
Constant	-1.1245	-0.1774	-0.3719	0.5056	-1.2390	-0.3721	-1.2340	-0.4463	-0.9989	-0.1848	-1.4354	0.2056
	(0.221)***	(0.236)	(0.197)*	(0.197)**	(0.248)***	(0.246)	(0.248)***	(0.247)*	(0.258)***	(0.270)	(0.290)***	(0.396)
Observations	357	357	357	357	306	306	306	306	306	306	306	306
R-squared	0.1007	0.3043	0.0167	0.2696	0.0977	0.3190	0.0983	0.3184	0.1709	0.3515	0.1704	0.3560

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

Table 5: Total public investment expenditure per capita (FEs and OLS estimator): dependent variable is growth of GDP level

	FEs				OLS			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln of GDP	0.1024	-0.2505	0.0954	-0.2519	0.0141	0.0043	-0.0204	-0.0266
	(0.033)***	(0.045)***	(0.033)***	(0.045)***	(0.006)**	(0.006)	(0.010)*	(0.009)***
Ln of total public investment expenditure per capita	0.0417	0.0202			0.0611	0.0399		
	(0.020)**	(0.017)			(0.013)***	(0.012)***		
Ln of total public investment expenditure			0.0435	0.0155			0.0322	0.0325
			(0.020)**	(0.017)			(0.013)**	(0.011)***
Difference in the percentage share of votes in the region in favour of the governing party	0.0006	0.0004	0.0006	0.0004	0.0006	0.0008	0.0007	0.0009
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)*	(0.000)	(0.000)**
Political-period dummies	NO	YES	NO	YES	NO	YES	NO	YES
Constant	-2.5592	4.9666	-2.6405	4.9814	-0.9697	-0.4529	-0.0461	0.0350
	(0.676)***	(0.947)***	(0.681)***	(0.960)***	(0.248)***	(0.233)*	(0.121)	(0.107)
LM test	0.30	1.08	0.00	3.39				
	(0.5840)	(0.2982)	(0.9553)	(0.0656)				
Hausman test	8.23	18.79	17.18	102.85				
	(0.0414)	(0.0009)	(0.0006)	(0.0000)				
Observations	306	306	306	306	306	306	306	306
R-within	0.0648	0.3804	0.0668	0.3790				
R-squared					0.0766	0.2832	0.0308	0.2771

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

Table 6: Total public investment and by different types and spillovers (FEs estimator): dependent variable is growth of GDP per capita

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ln of GDP per capita	0.0307	-0.2271	0.0408	-0.2336	0.0953	-0.2383	-0.1471	-0.2422	-0.1077	-0.2499
	(0.039)	(0.045)***	(0.039)	(0.045)***	(0.038)**	(0.047)***	(0.043)***	(0.046)***	(0.044)**	(0.047)***
Ln of total public investment expenditure per capita	0.0499	0.0254								
	(0.020)**	(0.017)								
W_Ln of total public investment expenditure per capita	0.2475	0.0648								
	(0.047)***	(0.046)								
Ln of total public infrastructure expenditure per capita			0.0032	0.0019			0.0066	-0.0027		
			(0.007)	(0.006)			(0.007)	(0.007)		
W_Ln of total public infrastructure expenditure per capita			0.0635	0.0368			0.0770	0.0289		
			(0.012)***	(0.016)**			(0.014)***	(0.018)		
Ln of transport public infrastructure investment expenditure per capita					0.0018	-0.0002			0.0010	-0.0005
					(0.001)	(0.001)			(0.001)	(0.001)
W_Ln of transport public infrastructure investment expenditure per capita					0.0078	0.0015			0.0053	0.0005
					(0.003)**	(0.003)			(0.003)	(0.003)
Ln of other types of public infrastructure expenditure per capita					0.0028	0.0058			0.0079	0.0014
					(0.006)	(0.005)			(0.006)	(0.006)
W_Ln of other types of public infrastructure expenditure per capita					0.0167	0.0197			0.0387	0.0048
					(0.014)	(0.017)			(0.015)***	(0.018)
Ln of education and research public expenditure per capita							0.0043	0.0030	0.0041	0.0030
							(0.001)***	(0.001)**	(0.001)***	(0.001)**
W_Ln of education and research public expenditure per capita							0.0111	-0.0004	0.0120	0.0001
							(0.002)***	(0.003)	(0.002)***	(0.003)
Ln of housing public expenditure per capita							-0.0005	-0.0018	-0.0001	-0.0018
							(0.001)	(0.001)**	(0.001)	(0.001)**
W_Ln of housing public expenditure per capita							0.0056	-0.0032	0.0060	-0.0039
							(0.001)***	(0.002)	(0.002)***	(0.003)
Ln of health and social welfare public investment expenditure per capita							-0.0005	-0.0002	-0.0006	-0.0004
							(0.001)	(0.001)	(0.001)	(0.001)
W_Ln of health and social welfare public investment expenditure per capita							-0.0041	-0.0043	-0.0043	-0.0047
							(0.002)	(0.003)	(0.003)	(0.003)*
Ln of decentralised public investment expenditure per capita							0.0313	0.0251	0.0273	0.0206
							(0.020)	(0.019)	(0.021)	(0.019)
W_Ln of decentralised public investment expenditure per capita							0.0945	0.0522	0.0826	0.0458
							(0.042)**	(0.046)	(0.044)*	(0.047)
Ln of miscellaneous public investment expenditure per capita							-0.0013	-0.0008	-0.0008	-0.0008
							(0.002)	(0.002)	(0.002)	(0.002)
W_Ln of miscellaneous public investment expenditure per capita							0.0085	0.0084	0.0098	0.0083
							(0.005)*	(0.005)	(0.005)*	(0.005)
Difference of the percentage share of votes in the region in favour of the governing party	0.0011	0.0005	0.0014	0.0005	0.0011	0.0004	0.0013	0.0006	0.0011	0.0005
	(0.001)**	(0.001)	(0.001)**	(0.001)	(0.001)*	(0.001)	(0.001)**	(0.001)	(0.001)**	(0.001)
Political-period dummies	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES
LM test	0.00	2.13	2.90	8.90	0.83	6.88	3.61	4.22	1.50	2.38
	(0.9611)	(0.1445)	(0.0886)	(0.0028)	(0.3634)	(0.0087)	(0.0574)	(0.0399)	(0.2208)	(0.1232)
Hausman test	21.61	60.11	24.98	53.00	17.11	31.83	64.31	33.92	138.72	63.78
	(0.0002)	(0.0000)	(0.0001)	(0.0000)	(0.0089)	(0.0004)	(0.0000)	(0.0129)	(0.0000)	(0.0000)
Constant	-3.9173	0.9567	-1.3579	1.5511	-1.2222	1.8936	-2.2626	0.6368	-1.8668	1.2275

	(0.586)***	(0.782)	(0.329)***	(0.490)***	(0.351)***	(0.512)***	(0.850)***	(1.031)	(0.904)**	(1.007)
Observations	306	306	306	306	306	306	306	306	306	306
R-squared	0.1577	0.4101	0.1480	0.4127	0.1116	0.4075	0.3456	0.4586	0.3090	0.4523

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

Table 7: Total public investment and by different types and spillovers (OLS estimator): dependent variable is growth of GDP per capita

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ln of GDP per capita	0.0658	-0.0053	0.0319	-0.0207	0.0508	-0.0181	-0.0015	-0.0125	0.0037	-0.0087
	(0.021)***	(0.022)	(0.024)	(0.023)	(0.023)**	(0.023)	(0.025)	(0.023)	(0.024)	(0.023)
Ln of total public investment expenditure per capita	0.0478	0.0417								
	(0.012)***	(0.011)***								
W_Ln of total public investment expenditure per capita	0.0728	0.0154								
	(0.025)***	(0.024)								
Ln of total public infrastructure expenditure per capita			-0.0002	-0.0027			-0.0027	-0.0057		
			(0.004)	(0.004)			(0.005)	(0.005)		
W_Ln of total public infrastructure expenditure per capita			0.0309	0.0093			0.0156	0.0141		
			(0.009)***	(0.010)			(0.011)	(0.012)		
Ln of transport public infrastructure investment expenditure per capita					0.0019	0.0014			0.0017	0.0013
					(0.001)*	(0.001)			(0.001)	(0.001)
W_Ln of transport public infrastructure investment expenditure per capita					0.0072	0.0015			0.0026	0.0019
					(0.003)**	(0.003)			(0.003)	(0.003)
Ln of other types of public infrastructure expenditure per capita					-0.0043	-0.0037			-0.0029	-0.0056
					(0.004)	(0.004)			(0.005)	(0.004)
W_Ln of other types of public infrastructure expenditure per capita					0.0016	0.0005			-0.0048	-0.0047
					(0.010)	(0.010)			(0.011)	(0.013)
Ln of education and research public expenditure per capita							0.0020	0.0005	0.0020	0.0006
							(0.001)*	(0.001)	(0.001)*	(0.001)
W_Ln of education and research public expenditure per capita							0.0094	-0.0009	0.0093	-0.0004
							(0.002)***	(0.003)	(0.002)***	(0.003)
Ln of housing public expenditure per capita							-0.0014	-0.0025	-0.0014	-0.0026
							(0.001)*	(0.001)***	(0.001)*	(0.001)***
W_Ln of housing public expenditure per capita							0.0045	-0.0055	0.0051	-0.0051
							(0.001)***	(0.002)**	(0.001)***	(0.002)**
Ln of health and social welfare public investment expenditure per capita							0.0009	0.0006	0.0008	0.0005
							(0.001)	(0.001)	(0.001)	(0.001)
W_Ln of health and social welfare public investment expenditure per capita							0.0010	-0.0012	0.0012	-0.0014
							(0.003)	(0.003)	(0.003)	(0.003)
Ln of decentralised public investment expenditure per capita							0.0057	0.0200	-0.0009	0.0141
							(0.014)	(0.013)	(0.014)	(0.013)
W_Ln of decentralised public investment expenditure per capita							-0.0717	-0.0048	-0.0557	0.0119
							(0.030)**	(0.030)	(0.030)*	(0.031)
Ln of miscellaneous public investment expenditure per capita							-0.0024	-0.0011	-0.0024	-0.0009
							(0.002)	(0.002)	(0.002)	(0.002)
W_Ln of miscellaneous public investment expenditure per capita							0.0031	0.0113	0.0033	0.0126
							(0.004)	(0.005)**	(0.004)	(0.005)***
Difference of the percentage share of votes in the region in favour of the governing party	0.0002	0.0004	0.0008	0.0008	0.0005	0.0007	0.0008	0.0009	0.0007	0.0008
	(0.000)	(0.000)	(0.000)*	(0.000)*	(0.000)	(0.000)	(0.000)*	(0.000)**	(0.000)	(0.000)*
Political-period dummies	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES
Constant	-2.0292	-0.6452	-0.7055	0.2026	-0.4703	0.2920	0.7751	-0.1704	0.8326	-0.1601
	(0.368)***	(0.398)	(0.207)***	(0.224)	(0.215)**	(0.220)	(0.519)	(0.508)	(0.517)	(0.517)
Observations	306	306	306	306	306	306	306	306	306	306
R-squared	0.1227	0.3194	0.0672	0.2849	0.0656	0.2874	0.1886	0.3440	0.1911	0.3459

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

Appendix 1: Selected demographic and economic indicators for the NUTS III regions of Greece

Code	*Name*	*Population*	*Surface*	*Population Density*		*GDP per capita*			
		2006		*2006*			*2006*		
NUTSIII		inh .000	km^2	inh./km^2	R	PPS €	GR=100	R	EU27=100
GR111	Evros	148,8	4,242	35.1	40	15,700	71	29	67
GR112	Xanthi	106,4	1,793	59.3	16	14,400	65	39	61
GR113	Rodopi	111,2	2,543	43.7	30	11,500	52	50	49
GR114	Drama	100,4	3,468	29	44	13,600	61	44	58
GR115	Kavala	140,1	2,111	66.4	12	15,900	72	27	67
GR121	Imathia	144,1	1,701	84.7	7	15,200	68	36	64
GR122	Thessaloniki	1,139,50	3,683	309.4	2	20,000	90	9	85
GR123	Kilkis	86,2	2,519	34.2	41	19,400	87	14	82
GR124	Pella	145,1	2,506	57.9	17	14,100	64	41	60
GR125	Pieria	128,2	1,516	84.6	8	13,700	62	43	58
GR126	Serres	188,4	3,968	47.5	27	12,200	55	48	52
GR127	Chalkidiki	100,2	3,254	30.8	43	17,500	79	21	74
GR131	*Grevena*	31,4	2,291	13.7	50	17,100	77	23	72
GR132	Kastoria	53,7	1,720	31.2	42	15,700	71	29	67
GR133	Kozani	154,3	3,516	43.9	29	19,800	89	10	84
GR134	Florina	54,2	1,924	28.2	46	15,500	70	32	66
GR141	Karditsa	116,2	2,636	44.1	28	11,900	54	49	50
GR142	Larisa	285,6	5,381	53.1	23	16,500	74	24	70
GR143	Magnisia	204	2,636	77.4	9	19,600	88	12	83
GR144	Trikala	130,7	3,384	38.6	37	13,400	60	45	57
GR211	Arta	71	1,662	42.7	32	13,200	59	46	56
GR212	Thesprotia	42,7	1,515	28.2	45	16,100	73	26	68
GR213	Ioannina	179,1	4,990	35.9	39	18,700	84	16	79
GR214	Preveza	57,3	1,036	55.3	19	15,400	69	33	65
GR221	Zakynthos	40,3	406	99.3	6	21,800	98	5	92
GR222	Kerkyra	126,8	641	197.8	3	15,900	72	27	67
GR223	Kefallinia	38	904	42	34	19,400	87	14	82
GR224	Lefkada	22,3	356	62.6	15	15,300	69	35	65
GR231	Aitoloakarnania	217,9	5,461	39.9	36	13,100	59	47	56
GR232	Achaia	340,2	3,271	104	5	16,500	74	24	70
GR233	Ileia	179,8	2,618	68.7	11	10,900	49	51	46
GR241	Voiotia	125,4	2,952	42.5	33	36,600	165	1	155
GR242	Evvoia	206,6	4,167	49.6	24	18,200	82	18	77
GR243	Evrytania	19,6	1,869	10.5	51	14,300	64	40	61
GR244	Fthiotida	166,5	4,441	37.5	38	18,300	82	17	78
GR245	Fokida	37,7	2,120	17.8	49	15,700	71	29	67
GR251	Argolida	102,5	2,154	47.6	26	17,200	77	22	73
GR252	Arkadia	88,4	4,419	20	48	21,300	96	7	90
GR253	Korinthia	146	2,290	63.8	13	23,900	108	4	101
GR254	Lakonia	92,9	3,636	25.6	47	13,900	63	42	59
GR255	Messinia	164,3	2,991	54.9	20	14,500	65	38	61
GR300	Attiki	4,046,90	3,808	1.062.70	1	30,500	137	2	129
GR411	Lesvos	106,2	2,154	49.3	25	15,100	68	37	64
GR412	Samos	42,7	778	54.9	21	15,400	69	33	65
GR413	Chios	52	904	57.5	18	17,900	81	19	76
GR421	Dodekanisos	194,7	2,714	71.7	10	21,700	98	6	92
GR422	Kyklades	110,8	2,572	43.1	31	24,600	111	3	104
GR431	Irakleio	299	2,641	113.2	4	19,800	89	10	84
GR432	Lasithi	75,4	1,823	41.4	35	20,800	94	8	88
GR433	Rethymni	80,6	1,496	53.9	22	17,800	80	20	75
GR434	Chania	150,3	2,376	63.3	14	19,500	88	13	83
GR	Greece	11,192,6	131,957	84.8		22,200	100		94

Appendix 2: Descriptive statistics of the transformed database

Variable		Mean	Std. Dev.	Min	Max	Observations
Growth of GDP per capita	overall	.067823	.0948181	-.1755181	.456404	N = 357
	between		.0342307	.0019933	.1760615	n = 51
	within		.0885352	-.1801079	.421213	T = 7
Ln of GDP per capita	overall	9.096925	.2418485	8.638805	10.35576	N = 357
	between		.1957685	8.791503	9.945979	n = 51
	within		.1442614	8.679303	9.665029	T = 7
Ln of total public investment expenditure per capita	overall	12.43332	.4519743	11.35308	13.79646	N = 357
	between		.3374544	11.74684	13.33416	n = 51
	within		.3038495	11.60626	13.44716	T = 7
Ln of total public investment expenditure per capita of the neighbouring regions	overall	12.41022	.2452241	11.70031	13.04608	N = 357
	between		.1609957	12.10848	12.76563	n = 51
	within		.1861508	11.82592	12.89375	T = 7
Ln of total public investment expenditure	overall	17.13069	.7890384	15.43434	21.57098	N = 357
	between		.7278346	15.93656	20.47478	n = 51
	within		.3190086	16.2643	18.22688	T = 7
Percentage share of votes in the region in favour of the governing party	overall	45.32539	5.863099	30.42	65.9	N = 306
	between		3.933326	37.8841	57.00155	n = 51
	within		4.377042	20.55675	64.4152	T = 6
Difference in the percentage share of votes in the region in favour of the governing party	overall	3.34771	11.28558	-31.72549	46.7	N = 306
	between		6.788575	-13.13485	24.10859	n = 51
	within		9.057317	-52.48637	37.11487	T = 6
Population	overall	201.9408	501.5664	19.45	3905.475	N = 357
	between		504.606	21.64643	3604.046	n = 51
	within		35.11547	-174.3388	503.3697	T = 7
Density	overall	.0716859	.1301283	.0104066	1.025597	N = 357
	between		.1308824	.0117607	.9464407	n = 51
	within		.0095865	-.027127	.1508427	T = 7
Regional gross value added (gva)	overall	1851.878	5323.196	110.945	56110.74	N = 306
	between		5206.049	159.9679	37101.33	n = 51
	within		1295.293	-6287.335	20861.29	T = 6
Employment	overall	77.99757	204.4363	0	1829.5	N = 357
	between		203.1201	6.040476	1452.343	n = 51
	within		35.0968	-192.012	455.1547	T = 7
Investment as a share of gva	overall	.2564266	.0706925	.1449932	.4436591	N = 306
	between		.0466981	.1787531	.3505835	n = 51
	within		.0534085	.193149	.4404795	T = 6
Share of agricultural gva to total regional gva	overall	.1634259	.0812845	.0061129	.3854895	N = 306
	between		.0681644	.0101267	.3063645	n = 51
	within		.0451326	.0564208	.3233061	T = 6
Share of industrial gva to total regional gva	overall	.2118924	.1115079	.0564368	.6709269	N = 306
	between		.1025841	.0816602	.6235168	n = 51
	within		.0456401	.0762582	.392866	T = 6
Share of service-sector gva to total regional gva	overall	.6246818	.1185916	.2571158	.8914089	N = 306
	between		.1027077	.2878322	.8481105	n = 51
	within		.0607293	.4463109	.7609797	T = 6
Location quotient (agriculture)	overall	1.799752	.8304992	.0787967	4.096764	N = 306
	between		.7574971	.1079048	3.403411	n = 51
	within		.3540249	.8172568	3.214066	T = 6
Location quotient (industry)	overall	.9672284	.5077056	.2674293	3.127595	N = 306
	between		.469741	.3742122	2.853596	n = 51
	within		.2018062	.3822788	1.833371	T = 6
Location quotient (services)	overall	.9052145	.1612705	.3675106	1.282515	N = 306

	between		.1487658	.4174971	1.229345	n = 51
	within		.0651131	.6267361	1.054203	T = 6

Note: Columns ‘minimum’ and ‘maximum’ present, respectively, the minimum and maximum values of x_{it} for the ‘overall’ line, $\bar{x}_i$ for the ‘between’ line and $x_{it} - \bar{x}_i + \bar{x}$ for the ‘within’ line (Fávero and Belfiore, 2011).