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Tobias Ketterer, Andrés Rodríguez-Pose

Utrecht University
Urban & Regional research centre Utrecht

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by

Tobias Ketterer[§] and **Andrés Rodríguez-Pose**[ɤ,*]

[§] European Commission, DG Economic and Financial Affairs, Rue de la Loi 170, B-1049 Brussels, Belgium

[ɤ] Department of Geography and Environment, London School of Economics, Houghton St, London WC2A 2AE, UK

[*] Corresponding author: a.rodriguez-pose@lse.ac.uk

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Abstract

The debate on whether institutions or geography prevail in driving economic growth has been rife (e.g. Sachs 2003 vs. Rodrik et al. 2004). Most of the empirical analyses delving into this debate have focused on world countries, whose geographical and institutional conditions differ widely. Subnational analyses considering groups of countries with, in principle, more similar institutional and geographical conditions have been limited and tended to highlight that geography is more important than institutions at subnational level. This paper aims to address whether this is the case by investigating how differences in institutional and 'first-nature' geographical conditions have affected economic growth in Europe's regions in the period 1995-2009. In the analysis we use a newly developed dataset including regional quality of government indicators and geographical charactersitics and employ 2-SLS and IV-GMM estimation techniques with a number of regional historical variables as instruments. Our results indicate that at a regional level in Europe institutions rule. Regional institutional conditions – and, particularly, government effectiveness and the fight against corruption – play an important role in shaping regional economic growth prospects. This does not imply, however, that geography is irrelevant. There is evidence of geographical factors affecting regional growth, although their impact is dwarfed by the overriding influence of institutions.

Keywords: Regional economic growth, institutions, geography, quality of government, NUTS-2 regions, Europe

JEL codes: R11, O11, O43

1. Introduction

Indicators of economic prosperity vary significantly across countries and regions. The wealthiest country in the world, Qatar (98,814 US$ per capita), is 182 times richer than the poorest, the Central African Republic (542 US$).[1] The gap between Europe's regions is considerably smaller, but still substantial. The European Union's (EU) poorest region, Severozapaden in Bulgaria, has a GDP per inhabitant which at 7,200€ (28% of the EU-28 average) is more than twelve times lower than that of its richest region, Inner London (80,400€ or 321 % of the EU-28 average).[2] With similar examples across the world and within different countries the question which arises is what drives these regional differences and what can policy makers do to narrow the gap between rich and poor territories?

Scholars have tried to explain differences in development in many different ways. In recent years an important debate has emerged opposing two factors as competitors: local institutions vs. geographical conditions. On the one hand, researchers such as Rodrik (2000), Acemoglu et al. (2001), Easterly and Levine (2003) and Rodrik et al. (2002; 2004) posit that the roots of differentials in development levels lie in institutional factors. The quality of local institutions, which is reflected in a society's formal and informal rules and norms and in its potential to generate desirable economic behaviour, is considered to be a major – if not the major – driver of economic growth and dynamism (North 1990; Hall and Jones 1999). In particular, a territory's political and legal setting, including the quality of contract enforcement, property rights, and the presence or absence of service-oriented government structures are considered key in determining the government's credibility in policy formulation, its ability to reduce uncertainty, as well as to cut down the monetary costs of economic activity.

However, not everyone supports the idea that institutions are the main driver of existing economic differences. A second strand of literature puts geography at the heart of economic development and growth. Geography – understood as 'first-nature' geography, i.e. the physical and natural geographical conditions that shape every territory – determines the presence of natural resource endowments, transport costs, and knowledge and technology diffusion, thus shaping a territory's potential for development. From this perspective, productivity and the accumulation of human capital are strongly affected by the geography of places (Diamond

[1] IMF data for 2013 expressed in PPS.

[2] Eurostat for 2011 expressed in PPS.

1997; Gallup and Sachs 2000; Sachs 2001, 2003; McArthur and Sachs 2001), meaning that geography governs the growth potential of any territory.[3]

Although this dichotomy may be somewhat artificial, institutions and first-nature geography have been pitched against one another in a lively and somewhat bitter debate. Even more balanced recent contributions indicating that both institutions and geography matter (e.g. Bosker and Garretsen 2009; Naudé 2009) cannot escape the dichotomy at the heart of this debate. Both groups of scholars have tried to stand their ground in a number of country-level studies about which factor matters most for economic growth – institutions or geography. The debate has so far produced evidence to support both camps, without yielding a clear verdict.

One of the main characteristics of this debate is that empirical analyses have generally focused on countries in the world. Similar studies at the regional level have been extremely limited – with the notable exception of Gennaioli et al. (2013). The question which remains is thus whether in settings where institutional and geographical differences tend to be significantly smaller than in a cross-country context covering most parts of the world, such as the EU, institutions or geography actually make a difference for economic development.

In this paper we contribute to the discussion by looking at the competition between institutions and geography from a sub-national perspective, taking regions in the EU as our object of study. In order to assess whether it is local institutions or geography which matters most for regional development in the EU, we use a novel dataset on quality of government measures and geographical data – including a series of historical variables employed as instruments. Our analysis focuses on European NUTS-2 regions of the EU-15[4] and covers the time period 1995 to 2009.

The reminder of the paper is structured as follows. Section 2 reviews the main arguments behind institutional and geographical factors as shapers of economic growth. Section 3 describes the empirical methodology and discusses the data, while the results are presented and interpreted in section 4. Section 5 concludes.

2. Institutions vs. Geography

[3] Sachs (2003: 3) states that geography may also have influenced institutional choices and concludes that "the logic of the geography-institutions linkage is also the logic of a direct geography-productivity linkage".

[4] We exclude those countries which joined the EU since 2004 because of their different history and significantly lower institutional quality and levels of GDP per capita. This allows us to maximise the homogeneity of our dataset as well, as a result of better data availability, as to cover a longer time period in the analysis.

Why do some regions develop faster than others? The quest for the factors behind economic development is as old as growth theory. More recently researchers and policymakers have gone beyond the traditional interest in infrastructure, human capital, and innovation to focus on two distinct types of factors: institutions and geography.

Institutions can be defined as the ‘rules of the game’ that shape human interaction and cooperative activity (North 1990). They include behavioural norms and traditions, as well as legal, moral and ethical concepts on which societies are based. As basic regulators of human interaction and economic activity, institutions matter for economic development and growth, and are crucial in determining “the social atmosphere of a particular locality” (Amin and Thrift 1995: 104). Stable and reliable institutions are essential factors in providing a sound framework for economic activities and reducing transaction costs. Most academic work on the economic impact of institutions has been concerned with formal institutions and, in particular, with property rights and the rule of law. A combination of a secure system of property rights with a transparent and well-functioning legal system is often considered to be the key recipe for economic progress (North 1990; Knack and Keefer 1995; Keefer and Shirley 2000; Acemoglu et al. 2005). Research has also tended to underline how institutions are embedded in history. The design and quality of past institutions has been reported to have a crucial impact on the effectiveness of current institutional settings (Tabellini 2010). La Porta et al. (1999), for example, analyse the determinants of government quality in different countries and document the relevance of historical factors in explaining the variation in government performance. Differences in colonisation have also been found to influence economic development (Acemoglu et al. 2001), while the impact of other types of historical variables on current economic performance has been reported in numerous analyses (e.g. Acemoglu et al. 2003; Dollar and Kraay 2003; Satyanath and Subramanian 2004). Additional empirical support for the relevance of institutions has been provided by Hall and Jones (1999), who find that a substantial part of the variation of activity across countries is explained by institutions and government policies (i.e. the social infrastructure). All this research provides a strong evidence for the relevance of institutions, as underlines that, when institutional variables are included in growth regressions, they tend to dwarf the impact of almost any other potential growth driver.

Geographical location already featured in the work of Adam Smith (1776). But in recent years the analysis of how factors such as location, access to waterways and other geographical features affect economic growth has witnessed a revival. When examining the causes of large income differentials across countries, ‘first-nature’ geography is often considered as a fundamental, deeply-rooted underlying factor of a territory’s growth potential

(Warner 2001; Rodrik et al. 2002). The implications of location and local physical conditions for transportation costs and the capacity to develop new economic activities are important and determine – to a larger or lower extent depending on the physical characteristics of a territory – the potential for growth in a given place.

Numerous physical geography factors have featured prominently in this type of research. Distance and access to navigable waters have been frequently highlighted as central determinants of economic growth (Gallup et al. 1999). Access to the coast is also a critical factor, as coastal regions tend to perform better, once other variables are taken into consideration, than countries further away from the sea (Bloom et al. 2003). Research has also concentrated on the impact of natural endowments on economic development, attaining mixed results. Several studies have reported evidence of a 'resource curse' – that is, the negative impact of large natural endowments on economic growth (Sachs 1995; Auty 2000; Gylfason 2001). Climate has also been taken into consideration. Masters and McMillan (2000), for instance, find evidence of varying economic performance depending on the temperature zone in which a country is located. In African tropical countries, for example, convergence is conditional on the achievement of economies of scale, while for those in more temperate zones convergence fundamentally depends on policy choices (Masters and McMillan 2000). Similarly it has been found that countries situated along the equator (Bloom et al. 2003) or the tropics (Sachs and Warner 1997) are more likely to have low levels of development compared to countries in more temperate climates. And higher average temperatures are considered to significantly reduce economic growth in poor countries (Dell et al. 2012).

Empirical work on the association between institutions and geography, on the one hand, and economic development, on the other, has been, however, mainly conducted at a national level. Using countries as units of analysis yields interesting results, but overlooks the important fact that both institutional and geographical conditions, while often varying significantly across regions, tend to be much more subtle and nuanced within a given country or, for that sake, a set of countries which share relatively similar historical trajectories and geographical characteristics. Differences in GDP per head – the proxy generally used for development – institutional quality, and geography across countries in the world are stark. The gap in voice and accountability, government effectiveness, or regulatory quality between those nation-states with the highest governance quality (generally Scandinavian countries or Singapore) and those at the bottom of the ranking (countries like Somalia, the Democratic Republic of Korea, or Turkmenistan) is much greater than anything seen within any individual country or group of countries with relative similar the conditions, such as those of the EU (Kaufmann et al. 2010).

Disparities in the rule of law, which are strong across the world, are much smaller in a national or even in a European context, were countries have to fulfil the so-called Copenhagen criteria in order to join the EU.[5] Similarly, international contrasts in geographical conditions – from access to the sea, to the ruggedness of the terrain, average temperature and precipitation, or the incidence of tropical diseases – are much greater at world level than anything that can be found in Europe.

The strong institutional and geographical differences across countries in the world shape our perception of whether it is institutions or physical geography which has a greater influence on levels of development. However, national geographical averages may not necessarily reflect the specific conditions which affect economic activity in different parts of a country. But, how these smaller intra-national or intra-European differences in geography and institutions impact economic development is much more poorly understood. The limited empirical research focusing on the impact of local and regional institutions and geography on sub-national economic growth performance gives partial and contrasting results. On the one hand, Tabellini (2010) finds that culture – measured by trust and respect for others – is strongly correlated with current levels of regional development in 68 regions in eight EU countries. Government structure and its institutional quality have also been associated with the effectiveness of public policies, in general, and European cohesion policies, in particular (Beugelsdijk and Eijffinger 2005; Ederveen et al. 2006; Bähr 2008; Rodríguez-Pose and Garcilazo 2015). On the other, Gennaioli et al. (2013), covering 1,569 regions in 110 countries, report that institutions – proxied by the business environment – do not account for differences in income per head. By contrast, they find that favourable geographical factors, such as access to the sea, lower average temperatures, and better natural endowments lead to higher levels of development. They argue that while "some institutions or culture may matter only at the national level, […] large income differences within countries call for explanations other than culture and institutions" (Gennaioli et al. 2013: 107-108), the reason being that "differences in institutions or culture are arguably small within countries and in any event much smaller than between countries" (Gennaioli et al. 2014: 265).

There is therefore a dearth of solid empirical evidence for a causal chain linking local and regional institutions and geography to economic development and existing results tend to be contradictory. This is a problem as, increasingly, socio-economic literature considers local

[5] The Copenhagen criteria require any country aiming to join the EU to have democratic institutions, safeguards to respect human rights, a functioning market economy, and a capability to absorb the whole EU legislation (or *Acquis Communautaire*). These conditions imply that formal institutions should be relatively homogenous across the EU.

and regional institutions and geography as essential drivers for sub-national economic activity, as well as important building-blocks for local risk and transaction cost reduction (Jütting 2003; Rodríguez-Pose and Storper 2006; Rodríguez-Pose 2013).

In brief, the existing literature seems to provide both, evidence for the relevance of institutions and geography for economic growth at a national level. Contrasting and comparing the relative importance of both factors, however, has sparked a fierce debate about which of these two forces prevails, with some authors claiming that institutions rule and other that they don't (see for instance Rodrik et al. 2004 and Sachs 2003). While Acemoglu et al. (2001), Easterly and Levine (2003), and Rodrik et al. (2004), find that the impact of institutions on national income levels dwarfs everything, with limited evidence for the role of geography, others, including Gallup et al. (1990), Gallup and Sachs (2001), Sachs and Malaney (2002), Sachs (2003), disagree with the supposed primacy of institutions, providing ample evidence of a direct effect of geography on economic growth and income.

There is also limited evidence of whether institutions and/or geography matter at all in more homogeneous contexts, such as that of Europe. And when this evidence has emerged, the results have been contradictory (Tabellini 2010 vs. Gennaioli et al. 2013). Against this controversial backdrop we aim to assess the role of institutions vs. 'first-nature' geography on development in the sub-national regional context of the first 15 members of the EU, precisely those for which geographical and institutional differences are more limited and data availability is greater. The next section lays out the conceptual framework which will be brought to the data.

3. **Methodology**

3.1 ***Conceptual framework***

To justify our empirical approach we take inspiration from Ertur and Koch (2007) and sketch out a simple conceptual framework based on an augmented Solow growth model.[6] In addition to allowing for cross-territory technological interdependence, we assume that technological progress and technology adoption are affected by institutional parameters reflecting the quality and efficiency of governments, investment- and business-oriented soft infrastructure as well as

[6] Ertur and Koch (2007) develop a growth model with Arrow-Romer externalities and spatial externalities in a setting with N world countries.

by the reliability of the judicial environment (Aron 2000). We consider the following Cobb-Douglas production function for region *i* (with *i*=1,…,N) at time *t*:

$$Y_i(t) = A_i(t) K_i^{\alpha} Q_i^{\beta} L_i^{1-\alpha-\beta} \tag{1}$$

where $K_i(t)$ denotes the stock of physical capital, $L_i(t)$ the amount of labour supply, and $Q_i(t)$ the institutional quality parameter. $A_i(t)$ represents the aggregate level of technology:

$$A_i(t) = \Omega(t) k_i^{\phi}(t) q_i^{\varphi}(t) \prod_{j \neq i}^{N} A_j^{\gamma w_{ij}}(t) \tag{2}$$

The level of aggregate technology includes several major factors. First, there is an exogenous part, which is assumed to be identical in all regions ($\Omega(t)$) and has a constant growth rate. Second, the aggregate level of technology rises with the level of capital and institutional quality per worker ($k_i(t)$ and $q_i(t)$). Hence, additional capital investments increase the level of the capital stock as well as the region's overall level of technology through knowledge spillovers. Similarly, improvements in government quality facilitate spillovers and the technological up-grading of all firms in the economy. The assumption that technology adoption is influenced by institutional factors is based on the view that technological take-up is constrained by 'social capability' (David 1998), implying that the local institutional environment plays a fundamental role in determining why certain development strategies take hold and others do not.[7] Moreover, we suppose that these knowledge spillovers are not limited to a region's borders, but that the knowledge incorporated in capital or institutional quality extends beyond the geographical boundaries of any territory. Cross-border effects, however, suffer from a decay effect and diminish with distance.[8] Including cross-border technological and institutional interdependence in the production function (1) leads to a per-capita growth model of spatial heterogeneity:

$$y_i(t) = \Omega^{\frac{1}{1-\gamma}}(t) \left(k_i^{u_{ii}}(t) \prod_{j \neq i}^{N} k_j^{u_{ij}}(t) \right) \left(q_i^{v_{ii}}(t) \prod_{j \neq i}^{N} q_j^{v_{ij}}(t) \right) \tag{3}$$

[7] The parameters ϕ and η in equation (2) describe the strength of these externalities.

[8] The parameter γ in equation (2) measures the level of spatial externalities, where what is, in theory, an identical effect for all regions, *de facto* depends on an exogenous friction term w_{ij} denoting the distance between region *i* and *j*.

with y, k, and q denoting the respective production function parameters expressed in per-capita terms.[9]

3.2 ***Specification***

In this section we evaluate the effect of savings, population growth, government quality, and location (including a set of geographical variables) on income growth. Equation (4) denotes the spatially augmented Solow equation, which can be transformed into a standard Solow specification by setting the spatial weighs equal to zero and dropping the quality of government and geography terms:

$$\ln y_i(t) - \ln y_i(t-1) = \beta_0 \ln y_i(t-1) + \beta_1 \ln(s_i) + \beta_2 \ln(n_i + g + \delta) + \beta_3 \ln(q) \qquad (4)$$
$$+ \beta_4 \ln(geo_i) + \theta_0 \sum_{j\neq i}^{i} w_{ij} \ln y_i(t-1) + \theta_1 \sum_{j\neq i}^{i} w_{ij} \ln(s_j) + \theta_2 \sum_{j\neq i}^{i} w_{ij} \ln(n_j + g + \delta)$$
$$+ \theta_3 \sum_{j\neq i}^{i} w_{ij} \ln(q) + \theta_4 \sum_{j\neq i}^{i} w_{ij} \ln(\Delta y_j) + \varepsilon_i$$

where the dependent variable denotes regional GDP per capita growth (in PPS); s represents savings and hence investment; n denotes exogenous population growth; g is technological progress; δ is the constant depreciation rate of capital. $\varepsilon_{i,t}$ represents the idiosyncratic error term.[10] The analysis is conducted at the NUTS-2 regional level and includes up to a maximum of 2,576 observations. Our dataset excludes Eastern Europe given their different recent history and the difficulties in collecting historical instrumental variables for this region. We hence focus on sub-national territories in the original fifteen members of the EU (EU-15).[11]

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[9] And with

$$u_{ii} = \alpha + \phi\left(1 + \sum_{r=1}^{\infty} \gamma^r w_{ii}^{(r)}\right), u_{ij} = \phi\left(\sum_{r=1}^{\infty} \gamma^r w_{ij}^{(r)}\right), v_{ii} = \beta + \varphi\left(1 + \sum_{r=1}^{\infty} \gamma^r w_{ii}^{(r)}\right), v_{ij} = \eta\left(\sum_{r=1}^{\infty} \gamma^r w_{ij}^{(r)}\right).$$

[10] We assume, as in Mankiw et al. (1992) that these variables (i.e. n+g+δ) are constant over time and jointly add up to a value of 5%. Annual time fixed effects are also introduced in order to control for time-specific characteristics.

[11] For countries without an adequate regional structure (i.e. Luxembourg), country-wide statistics were used. Some countries (Denmark and Greece) had to be excluded due to insufficient data availability, as was the case for a number of individual regions – Ceuta and Melilla (E), Canary Islands (E), all French overseas departments (Guadeloupe, Martinique, Guyane, Réunion), Açores (P), Madeira (P), North Eastern Scotland (UK), and the Highlands and Islands (UK).

Our main explanatory variables of interest are regional quality of government and a raft of first-nature geography variables. To assess whether institutions matter we employ a recently constructed institutional index measuring government quality at a regional NUTS-2 level (Charron et al. 2014). The institutional index – reflecting the overall quality of regional government – can be decomposed into its four constituent components: i) fight against corruption; ii) rule of law; iii) government effectiveness and bureaucracy; and iv) government accountability.[12] Amongst the 'first-nature' geography variables considered, we include terrain ruggedness, which we expect to exert a negative impact on local economic activity by increasing the costs for transport and trade. Ruggedness is computed as the log of 1 plus the difference between the minimum and maximum altitude of a region. Differences in climate across Europe's regions are controlled by the inclusion of January and July mean temperatures. A region's distance to the equator is included to indicate physical location. Several country-level studies point to a substantial impact of a territory's latitude when explaining differences in output and development (Gallup et al. 1999; Mellinger et al. 2000).[13] To account for potential nonlinearity in the correlation between economic growth and latitude, we introduce the squared value of latitude. Other geographical variables include i) a region's access to the sea, which reflects a territory's advantageous location in terms of ease of accessibility; ii) a number of regional soil characteristics;[14] iii) additional climate and weather characteristics (daily temperature ranges, precipitation, and cloudiness). Weather and soil-related attributes may influence the distribution of human activity across space and hence shape a region's development potential for economic exchange. Both factors may also shape settlement patterns. Better climates and more fertile lands have driven demographic growth and population density levels. Finally, the geographic size of a region is taken into account by introducing the territory's surface in square-kilometres.

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[12] As the 'quality of government' (QoG) index and its individual components are adjusted around zero, with positive and negative values reflecting favourable and less favourable institutional environments, respectively, we add a value of 10 in order to be able to include them in logarithms.

[13] Some studies, however, stress that distance from the equator, rather than reflecting an area's geophysical attributes, portrays economic, institutional, and other non-geophysical factors (Hall and Jones 1999; Nordhaus and Chen 2009). Hall and Jones (1999) for instance argue that a country's latitude may be used as a measure for a territory's distance to Western Europe, a factor which may have influenced the development and design of market institutions.

[14] Among others, we include soil limits to agriculture, soil class, dominant parent material, soil differentiation, depth, erosion, water capacity, mineral composition of the soil, and organic content (for greater detail, see Table A2 in the Annex).

3.3 ***Data***

The aim of this section is to highlight some of the most salient characteristics of the dataset. Eurostat's Regio database is the source for the economic and population-related variables. The institutional variables stem from a new dataset developed by Charron et al. (2014). These authors construct a 'quality of government' (QoG) index at the EU national, as well as sub-national (regional) level, by combining the World Bank's country-level 'World Governance Indicators' (WGI) (Kaufmann et al. 2009) with an EU-wide regional survey of 34,000 Europeans. According to the authors the survey, including 34,000 respondents, "constitutes the largest survey ever undertaken to measure quality of government at the sub-national level to date" (Charron et al. 2014: 72). It covers a total of 172 NUTS-1 and NUTS-2 regions. On average the survey targeted around 200 participants per region[15] and consisted of 34 quality of government-, and demography-related questions, addressing topics such as education, health care, and law enforcement – services often provided by local or regional authorities in Europe. Those consulted were asked to rate services with respect to their quality, impartiality and the presence of corruption. Answers led to the construction four composite indices of government quality, reflecting the residents' perception of i) the prevalent level of corruption; ii) the rule of law at the local level; iii) government effectiveness; and iv) the strength of democracy and electoral institutions (voice and accountability). The authors also amalgamated all four individual components into one composite index for regional quality of government. Each indicator was standardized, providing a regional distance to the national score, expressed in standard deviations. The regional distance was subsequently standardised at the EU level, using the World Bank Worldwide Governance Indicators (WGI) time series. For more detailed information on the survey, as well as on the construction of the indices see Charron et al. (2014).

The geographical variables in the analysis stem from a range of sources. Soil-related regional characteristics, including soil limits to agriculture, soil depth and differentiation were obtained from the European Soil Database. Mitchel et al. (2004) is the source for regional weather and temperature data. Finally, we use a series of regional historical variables, collected by Gilles Duraton, Giordano Mion and Andrés Rodríguez-Pose. The historical dataset was built

[15] However, aware that the "the number of respondents per region was on the smaller side (200)" (Charron et al. 2014: 7773), the country context of each region was added for robustness to the region's score, with the aim of introducing elements of the local institutional quality which were not captured by the survey. This allowed the authors of the survey to compensate for any shortcomings of the presence of outlying regions within any country with the addition of "credible and robust" country data (Charron et al. 2014: 73).

by manually digitalizing and geo-coding historical maps provided by Kishlansky et al. (2003) and the online source www.euratlas.com. The set of historical variables, used as instruments for our institutional parameters, includes several variables:

a) *Charlemagne*, depicting whether a current European region belonged to Charlemagne's empire and/or was a tributary territory to it at the time of the emperor's death;

b) *Rome*, capturing a region's affiliation to the Roman empire at the time of Julius Caesar (49 BC), as a proxy for strong exposure to the Roman state, legal and military system;

c) *Early Christianization*, indicating whether a region was Christianised in 600 AD, which aims to account for the proliferation of a certain set of morals, societal norms and ideas; and

d) *Number of kingdom changes*, a measure of early political stability/instability, reflecting the number of times a region changed kingdom between 500AD and 1000AD. This variable was constructed using different maps including the boundaries of European kingdoms in 100 year intervals. Every territory in each of the six time periods was ascribed to a kingdom using geo-coding techniques.

Please see Table A1 in Appendix for the exact definitions of each variable and of their sources. Table A2 provides the descriptive statistics.

3.4 ***Endogeneity issues***

A major challenge in economic analysis is establishing causality. While geographical aspects may be assumed to be reasonably exogenous, the identification of the direct and indirect channels through which 'first-nature' geography may affect economic performance are trickier. It has been argued that geographical factors have a notable direct effect on economic dynamism through their impact on (agricultural) productivity and production systems, morbidity and life expectancy, but also through the physical location and the availability of natural resources (Diamond 1997; McArthur and Sachs 2001; Sachs 2001; 2003). Indirect effects may be present through their sway on the distance from major markets and their influence on the development of institutions themselves.[16]

[16] Unequally distributed or ample natural resource endowments may, for example, hamper institutional development (Engerman and Sokoloff 1997; Sala-i-Martin and Subramanian 2003).

Establishing a direct causal link between a region's institutions and economic performance is more difficult, as higher income may also represent a cause rather than a consequence of better institutions. In order to address this potential reverse causality concern and to demonstrate that institutions are an independent driver of economic activity, we use instrumental variable techniques aiming at finding exogenous sources of variation for institutional quality. First, all independent variables are introduced with a one-year lag in order to minimise potential endogeneity. More importantly, two-stage least square (2SLS) estimations and heteroscedasticity-robust system 'Generalized Method of Moments' (GMM) estimators are used in the analysis. The specific estimator chosen for the IV-GMM regressions is the system GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998) in its second-step version.

For the choice of instruments we resort to the set of regional historical variables mentioned earlier. Following the new institutionalist view (North 1986; 1990), a region's historical heritage may have significantly shaped the development and design of institutions, such as the type of legal system, as well as the role played by formal and informal norms in governing societies. This type of historical variables have often been used as instruments for institutional quality (e.g. La Porta et al. 1999; 2000; Acemoglu et al. 2001; 2002; Engerman and Sokoloff 2000; 2002).

As indicated in the previous section, our preference for historical instruments goes well back in time. Past events and historical shocks are likely to have left a deep trace on territories, shaping the character of their institutions until today (Duranton et al. 2009). Hence the choice of *Charlemagne*, *Rome*, *Early Christianization*, and *Number of kingdom changes*. All instruments are regionalised. The selection of these historical variables is governed by the fact that it is highly likely that early exposure to stable and 'modern' governance – be it through the Roman or Charlemagne's Empire –, together with the influence of Christianity, as well as long periods of political stability would have determined the formation of institutional systems and their successive development across Europe. Likewise, we also argue that centuries of political instability caused by different norms and commitments under different kingdoms or tribal rule may have also shaped early institutional development and altered legal and institutional developments accordingly.

Given how deeply embedded in time these variables are, they can reasonably be considered as exogenous instruments, as they are likely to be sufficiently uncorrelated with other potential (and omitted) causes of economic dynamism. In addition, we also include past values in the IV regressions, assuming that past institutional features are linked to current ones.

4. Results

In this section we present the empirical results for 184 NUTS-2 regions in Europe during the period between 1995 and 2009. We first focus on the standard Solow growth model to which we successively add the individual institutional components and geographical variables. Section 4.1 introduces the results when estimating various empirical specifications with OLS and heteroskedasticity consistent standard errors, while section 4.2 reports the instrumental variable results using 2-SLS regressions. Section 4.3 presents the findings when using an Arellano-Bond panel data IV-GMM technique.[17] Finally, a spatially augmented growth model is presented in section 4.4, adding information of neighbouring regions to the standard Solow model.

4.1 ***Pooled OLS***

The results of the standard Solow OLS analysis (Table 1) indicate that our control variables are broadly in line with our expectations. First, and following a neoclassical perspective, initial GDP per capita levels are negatively associated with economic growth, providing evidence of conditional beta convergence and of a catching-up process of poorer regions on a European-wide scale.[18] Regional population growth rates also follow the predictions of the neoclassical Solow growth framework and display a consistently negative sign in the coefficient which is, however, not statistically significant at the usual levels. Productive capital, measured by local gross fixed capital formation, is reported to exert a positive effect on local economic performance in almost all model specifications. Measuring productive capital is however notoriously difficult and this problem may have some influence in the lack of statistical significance observed in all but one model specification.

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[17] The results including a series of soil characteristics and further weather-related climatic factors are presented in Annex Tables 4 to 8. Moreover, a model with region fixed effects is also run in order to control for all remaining unobserved sources of spatial heterogeneity. The results are reported in annex Table A8 and, by and large, confirm the alternative estimation outcomes. They highlight the existence of a statistically significant positive effect of the combined government quality variable, the fight against corruption, and government effectiveness. All time constant regressor are dropped when using the FE estimator. Finally, to account for a possible interaction between institutions and the geography, we interact the combined quality of government index with a set of geographical variables. The results, reported in Table A9 in the Annex, show significant coefficients in most specifications for the combination of institutional index and coast or regional ruggedness. This suggests that coastal areas may benefit more good institutional settings than land-locked areas. This finding, however needs to be treated with caution given the very high values for the VIF tests – which point to important multicollinearity concerns.

[18] Note that when introducing the geographical variables (Table 1, Regressions 9 to 12), the parameter estimates, although still negative, are no longer statistically significant at the usual levels.

Concerning our independent variables of interest – institutions and 'first-nature' geography – some interesting findings emerge (Table 1). First, there is a positive and highly significant (at the 1% level) association between quality of government and regional economic performance (Table 1, Column 4). Our results therefore corroborate past analyses at the national (Knack and Keefer 1997; Rodrik et al. 2002; 2004; Keefer and Shirley 2000; Dollar and Kraay 2003; Acemoglu et al. 2005) and regional (Tabellini 2010) level which have underlined the importance of institutions for economic growth. They, nevertheless, contradict recent studies which have stressed that within country institutional differences do not matter for economic performance (Gennaioli et al. 2013 and 2014). They also confirm previous country-level studies highlighting the importance of government quality (La Porta et al. 1999).

Decomposing the institutional quality index into its individual components allows us to assess which government quality factors are more important for economic growth. The results of the analysis show that all four components of the quality of government index have a positive and significant connection with economic growth. The fight against corruption, the rule of law, and government effectiveness and accountability are essential for a good regional performance in Europe. These three variables display in all cases positive parameter estimates that vary between 0.014 and 0.039 (Table 1, Columns 5-8), underlining the growth-promoting role of aspects such as the efficient and non-bureaucratic provision of public goods and services, a functioning and independent legal system, as well as low levels of local corruption.

In Columns 8 to 12 of Table 1 a set of local geographical variables is introduced. The introduction happens first without controlling for the institutional environment (Table 1, Column 9), followed by the inclusion of the composite government quality index (Column 10), and of four individual government quality aspects (Columns 11 and 12). Including the geographical variables in the Solow-type growth framework without considering government quality factors (Column 9) shows similar results to the specification with the government quality index (Column 10): most geographical variables are insignificant. Neither regional access to the sea (positive coefficient) nor local terrain ruggedness (negative coefficient), which emerge as essential elements for economic activity in most studies of the role of geography for economic growth at the national level (e.g. Gallup et al. 1990; Gallup and Sachs 2001; Sachs and Malaney 2002; Bloom et al. 2003; Sachs 2003), seem to matter for economic growth at a regional level in Europe. Other geographical factors are more significant. This is the case of the land area of a region – a result which is corroborated when additionally including the composite government quality index (Table 1, Column10) – and of a region's distance from the equator (i.e. latitude). The former variable displays a positive coefficient, while the latter is negatively associated with regional economic growth in Europe. The squared value of latitude variable is positively connected to growth, once quality of government has explicitly been controlled for. These results suggest a non-linear relationship, implying that a region's physical location is at first less favourable the further away it is located from the equator. This possibly reflects the catch-up process of some regions in Southern Europe during the period of analysis and that, beyond a certain threshold, the association becomes positive with increasing latitude.

Introducing both quality of government components and the geographical variables in the analysis (Table 1, Columns 11 and 12) simultaneously points to the fact that institutions trump 'first-nature' geography as a driver of economic growth at the European regional level. In particular, low corruption levels and high government accountability indicators prevail as the most important institutional factors, while most of the 'first-nature' geography variables are not statistical significant. The exceptions are regional latitude and January mean temperatures, meaning that a milder winter is the only climate factor to facilitate greater economic activity in Europe in recent times.

Tables A3 and A4 in the Annex report the findings when including an extended set of climate and weather-related variables, in absence and presence of regional institutional characteristics. The results show a negative effect of January precipitation and July evapotranspiration (moisture or humidity) levels and suggest a positive influence of daily January temperature ranges and winter moisture-levels. Winter and summer cloudiness are found to be statistically not significant. When including government quality in the analysis, the results remain by and large unchanged and show a statistically highly significant and positive impact of the quality of regional government (Table A4).

Our final physical geography variables include a large battery of regional soil characteristics (Tables A5 and A6). The results suggest a positive connection of less fertile soils (soil limits to agriculture), less podzolic and more ferrasolic soils (see soil class). They also provide partial evidence for a positive relationship of soil depth and subsoil water capacity with regional growth perspectives. A negative effect is reported for the topsoil available water capacity. Considering regional institutions confirms these findings and highlights, once again, the persistent and highly significant impact of the institutional variables in all model specifications (Table A6).

Table 1: Standard Solow estimation including institutional parameters. Pooled OLS

	European Union											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Initial GDP per capita	-0.006*	-0.006*	-0.005	-0.007*	-0.007*	-0.006*	-0.006	-0.008**	-0.004	-0.004	-0.005	-0.002
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Investment (gross fixed capital formation)		-0.0002	0.002	0.003	0.003*	0.003	0.002	0.002	0.002	0.002	0.001	0.003
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Population growth			-0.058	-0.031	-0.033	-0.025	-0.048	-0.007	-0.107	-0.144	-0.174	-0.272**
			(0.085)	(0.080)	(0.080)	(0.081)	(0.081)	(0.078)	(0.100)	(0.099)	(0.105)	(0.116)
Institutional quality Index (QoG)				0.025***						0.047***		
				(0.007)						(0.011)		
Fight against corruption					0.029***						0.046*	0.053**
					(0.007)						(0.025)	(0.025)
Rule of law						0.024***					-0.004	-0.011
						(0.007)					(0.024)	(0.024)
Government effectiveness							0.014**				-0.007	-0.008
							(0.006)				(0.014)	(0.013)
Government accountability								0.039***			0.039**	0.040**
								(0.010)			(0.016)	(0.016)
Coast									0.001	0.002	0.001	-0.001
									(0.001)	(0.0013)	(0.001)	(0.001)
Regional Ruggedness									-0.001	-0.001	-0.001	0.000
									(0.001)	(0.001)	(0.001)	(0.001)
Area									0.000*	0.000**	0.000	0.000
									(0.000)	(0.000)	(0.000)	(0.000)
Latitude									-0.0001	-0.001***	-0.006**	-0.008***
									(0.0002)	(0.0002)	(0.003)	(0.003)
Latitude squared											0.0001**	0.0001***
											(0.00002)	(0.000)
Mean Temperature - July												-0.001
												(0.0004)
Mean Temperature - January												0.001***
												(0.0004)
Constant	-0.006	-0.011	-0.013	-0.056*	-0.056*	-0.059*	-0.040	-0.076**	-0.013	-0.099***	-0.006	-0.013
	(0.034)	(0.034)	(0.035)	(0.033)	(0.033)	(0.035)	(0.034)	(0.034)	(0.033)	(0.038)	(0.065)	-0.072
Observations	2576	2515	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331
R-squared	0.591	0.562	0.570	0.570	0.571	0.570	0.570	0.571	0.613	0.618	0.618	0.620
Mean VIF	1.00	1.00	1.07	1.08	1.11	1.08	1.06	1.11	1.30	1.46	61.53	60.89
Heterogeneity (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Standard errors are heteroskedasticity-consistent and reported in parentheses below all coefficients. *, **, *** respectively denote the 10%, 5%, 1% significance levels. The t-statistics are shown in parentheses. Constant and time dummies are not reported. It is worth noting that most mean VIFs are below 6 (apart from regressions (11) and (13) indicating some multicollinearity issues).

4.2 ***Two-stage least squares estimations***

Addressing endogeneity concerns by means of the two-stage least square regressions (Table 2) allows us to jump from the simple associations detected between our institutional variables and regional economic performance in the OLS analysis to determining the direction of causality and, therefore, impact. As mentioned in the methodological section, we employ an instrumental variable technique using lagged values and historical data on past regional affiliations to kingdoms, empires and to early Christianization.[19]

Table A7 in the Annex reports the first-stage regression results. The general validity and significance of the instruments, introduced is indicated by the first-stage F-tests of jointly insignificant instruments, which are rejected in all first-stage regressions. In addition, the F-test statistic at the bottom of Table A3 displays values that are far larger than ten.[20] The Anderson-Rubin test results for each specification (Table 2) further reinforce the validity of the instruments, as the p-values reject the null hypothesis of joint insignificance at the 1% threshold level in all specifications.

Overall, the 2-SLS results reported in Table 2 support the findings presented in Table 1. The instrumental variable regressions point to a significant negative impact of initial GDP per capita levels in most specifications, with statistically significant coefficients at the 5 or 10% threshold, and which are, in terms of magnitude, similar to the OLS results. The results also indicate a highly persistent and negative impact of regional population growth rates on per capita economic performance. Furthermore, the regression results also highlight the importance of investments in productive capacity, with parameter estimates that are significant at the 1% level.[21]

More importantly, the results of the IV analysis underline the relevance of institutions, in general, and quality of government, in particular, for regional economic growth in Europe (Table 2). Both the composite government quality index and its individual components display positive parameter estimates which are statistically significant at the 1% threshold level (Table 2, Columns 4 to 8). These results also hold when controlling for geographical

[19] The first-stage results involving the use of initial values and a selection of historical variables as instruments are presented in Table A7.

[20] Table A7 also includes the Angrist-Prischke (AP) under-identification test scores under the null that a particular endogenous regressor in question is unidentified. The AP first-stage F-statistic displays favourable results, as the test values are relatively large.

[21] The last two model specifications (Columns 11 and 12) represent an exception, as they report positive, but statistically insignificant coefficients for initial GDP per capital levels, and statistically insignificant coefficients for investment and population growth.

regional characteristics (Table 2, Column 10), suggesting that the effect of geography cannot offset the impact of the local institutional environment on GDP per capita growth.

The results for the individual components of the institutional composite index (Table 2, Columns 5 to 8) are in line with the previously reported OLS findings. All parameter estimates for all coefficients remain positive and statistically highly significant. The magnitude of the coefficients is also slightly larger than in the OLS analysis, further reinforcing the crucial role of low levels of local corruption, government effectiveness, the rule of law, and government accountability for the local economic growth and competitiveness prospects in Europe's NUTS-2 regions.

Model specifications (9) to (12) in Table 2 examine and contrast the impact of sub-national local institutions when controlling for the geography of places. When examining the effect of geography on economic per capita growth rates in isolation (Table 2, Column 9), all geographical components turn out to be statistically insignificant, indicating that, at least in the case of European regions for the period of analysis, 'first-nature' geography has no influence on economic performance. These results stand when government quality is introduced in the analysis (Table 2, Column 10). The coefficients for all physical geographical variables remain insignificant, with the only exception of latitude.

Decomposing the results for the institutional composite index into its individual components and controlling for 'first-nature' geography (Table 2, Columns 11 to 13) further corroborates that institutions trump physical geography as a factor behind regional economic growth in Europe. Low levels of corruption emerge as a fundamental driver of economic growth (Table 2, Columns 11-13), while there is no sign of impact of any of the 'first-nature' geographical variables on regional growth.[22]

[22] These results, however, should be taken with a pinch of salt as multi-correlation concerns may be present in the results of Table 2, Columns 11-13.

Table 2: Standard Solow estimation including institutional parameters. Two stage least squares

	European Union												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Initial GDP per capita	-0.010***	-0.009***	-0.005	-0.007**	-0.009**	-0.005	-0.006*	-0.006	-0.006	-0.005	0.078	0.087	0.113
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.097)	(0.102)	(0.112)
Investment (gross fixed capital formation)		0.005*	0.010***	0.016***	0.018***	0.016***	0.016***	0.014***	0.010***	0.014***	-0.051	-0.060	0.0001
		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.066)	(0.069)	(0.031)
Population growth			-0.291**	-0.305**	-0.313**	-0.349***	-0.329***	-0.358***	-0.289*	-0.474***	-8.477	-8.424	-7.865
			(0.130)	(0.126)	(0.127)	(0.128)	(0.124)	(0.128)	(0.149)	(0.153)	(6.219)	(6.301)	(5.265)
Institutional quality Index (QoG)				0.063***						0.083***			
				(0.012)						(0.015)			
Fight against corruption					0.071***						0.450**	0.435**	0.492**
					(0.012)						(0.198)	(0.197)	(0.206)
Rule of law						0.044***					-0.825	-0.831	-0.734*
						(0.013)					(0.519)	(0.532)	(0.416)
Government effectiveness							0.062***				0.614	0.638	0.483
							(0.011)				(0.441)	(0.459)	(0.308)
Government accountability								0.043***			-0.024	-0.019	-0.105
								(0.014)			(0.101)	(0.101)	(0.099)
Coast									-0.0002	0.0002	0.009	0.008	-0.006
									(0.002)	(0.002)	(0.007)	(0.007)	(0.006)
Regional Ruggedness									-0.0001	-0.00002	-0.001	0.000	0.005
									(0.001)	(0.001)	(0.001)	(0.001)	(0.004)
Area									0.000	0.000	0.000	0.000	0.000
									(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Latitude									0.0001	-0.001**	-0.048	-0.049	-0.043
									(0.0002)	(0.0002)	(0.038)	(0.039)	(0.031)
Latitude squared											0.0004	0.0004	0.0004
											(0.0003)	(0.0003)	(0.0003)
												0.001	-0.002
												(0.001)	(0.002)
Mean Temperature - January													0.008
													(0.006)
Constant	0.034	0.027	0.0141	-0.103***	-0.103***	-0.083**	-0.116***	-0.069*	0.019	-0.146***	0.379	0.248	0.018
	(0.027)	(0.028)	(0.029)	(0.038)	(0.036)	(0.039)	(0.039)	(0.038)	(0.031)	(0.045)	(0.254)	(0.239)	(0.236)
Observations	1840	1779	1595	1411	1411	1411	1410	1411	1595	1411	1410	1410	1410
R-squared	0.664	0.642	0.636	0.665	0.667	0.664	0.661	0.666	0.636	0.666	0.602	0.652	0.176
Anderson Rubin (Chi-statistic)	14.00	17.45	24.15	75.46	80.05	55.28	89.22	56.09	21.92	85.22	88.47	88.91	90.56
Anderson Rubin (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Endogeneity	0.000	0.000	0.000	0.000	0.000	0.009	0.000	0.019	0.000	0.000	0.000	0.000	0.000
Hansen-J	0.000	0.000	0.000	0.355	0.203	0.306	0.683	0.153	0.003	0.283	0.382	0.702	0.678
Mean VIF	1.00	1.07	1.20	1.21	1.27	1.21	1.15	1.31	1.62	1.82	49.81	2624.62	2190.43
Heterogeneity (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Standard errors are in parentheses below all coefficients. *, **, *** respectively denote the 10%, 5%, 1% significance levels. Apart from the introduced historic variables, past values were used as instruments. Constant and time dummies are not reported. It is worth noting that most VIFs apart from regression (11) to (13) are below 6.

*4.3 **IV-GMM estimations***

In order to further account for potential endogeneity concerns and to control for unobserved heterogeneity, we conduct a third type of econometric estimations. In this case we resort to the use of a dynamic panel data approach, by means of a system-GMM estimation technique (Bond et al. 2001). The regression results of the Arellano-Bond system-GMM estimator are displayed in Table 3 and remain in line with the the findings of the OLS and 2-SLS regression approaches. The system-GMM regressions confirm the postive and highly significant role of low levels of corruption and of government accountability in promoting local economic performance (Table 3, Columns 5 and 8). The rule of law and government effectiveness have, by contrast, no significant impact on regional economic growth (Table 3, Columns 6 and 7).

Some slight differences with respect to previous tables emerge when considering ‘first-nature’ geographical variables. In particular, access to the sea appears to have a positive influence on economic performance (Table 3, Column 9), a fact which is confirmed when the quality of government index is introduced in the model (Table 3, Column 10). Most other coefficients for the different geographical factors considered remain insignificant at the usual threshold levels. The only exception is, once again, latitude, whose coefficient displays a weak statistical significance (Table 3, Column 9), although this significance is not robust to controlling for government quality (Table 3, Column 10).

In Table 3, Columns 11 to 17 we contrast the relevance of a region’s physical geography with the sway on economic growth of individual insitutional factors. The results of this type of analysis further stress the relevance of institutional factors over economic growth. Low corruption, rule of law, and government accountability (Table 3, Columns 11, 12, 14, 15 and 16) have a strong impact on European regional growth. Geography variables have, by contrast, and a much lower influence on regional economic performance. Only access to the coast and latitude display some sort of connection to growth, although the positive coefficients of a coastal location for growth do not survive the introduction of temperature variables and of the square of the latitude (Table 3, Columns 15 and 16). The IV-GMM analysis further confirms the positive influence of milder winter climates (January temperatures) on regional economic growth (Table 3, Columns 15 and 16).

Table 3: Standard Solow estimation including institutional parameters. IV-GMM: Arellano-Bond (two-step)

	European Union									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Initial GDP per capita	-0.011	0.017	0.008	0.006	-0.007	0.015*	0.011	-0.001	0.013	0.006
	(0.021)	(0.013)	(0.013)	(0.008)	(0.009)	(0.008)	(0.007)	(0.008)	(0.009)	(0.008)
Investment (gross fixed capital formation)		-0.003	-0.002	0.005	0.011***	0.008***	0.008***	0.010***	-0.001	0.008**
		(0.004)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
Population growth			0.016	-0.025	0.045	-0.162	-0.293	-0.217	-0.291	-0.239
			(0.241)	(0.206)	(0.201)	(0.172)	(0.198)	(0.166)	(0.264)	(0.228)
Institutional quality Index (QoG)				0.004						0.0213
				(0.014)						(0.022)
Fight against corruption					0.068***					
					(0.015)					
Rule of law						0.019				
						(0.013)				
Government effectiveness							-0.006			
							(0.017)			
Government accountability								0.079***		
								(0.017)		
Coast									0.003*	0.004**
									(0.002)	(0.002)
Regional Ruggedness									-0.00002	-0.001
									(0.001)	(0.001)
Latitude									-0.0004*	-0.0003
									(0.0002)	(0.0003)
Latitude-squared										
Mean Temperature - July										
Mean Temperature - January										
Observations	2576	2515	2331	2331	2331	2331	2331	2331	2331	2331
Annual time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AR(5)	0.009	0.009	0.005	0.005	0.006	0.005	0.005	0.004	0.005	0.005
AR(6)	0.639	0.401	0.215	0.167	0.150	0.150	0.144	0.094	0.207	0.148
Hansen J	0.00	0.00	0.00	0.13	0.14	0.21	0.20	0.20	0.20	0.20
Number of regions	184	184	184	184	184	184	184	184	184	184
Number of instruments	51	88	120	154	154	154	154	154	123	156

Notes: Standard errors are heteroskedasticity consistent and are reported in parentheses below all coefficients. *, **, *** respectively denote the 10%, 5%, 1% significance levels.

Table 3 (continued): Standard Solow estimation including institutional parameters. IV-GMM: Arellano-Bond (two-step)

	European Union					
	(11)	(12)	(13)	(14)	(15)	(16)
Initial GDP per capita	0.001	0.013	0.016**	0.002	0.007	0.019
	(0.008)	(0.009)	(0.008)	(0.009)	(0.011)	(0.012)
Investment (gross fixed capital formation)	0.011***	0.011***	0.009***	0.008**	0.017**	0.016**
	(0.004)	(0.003)	(0.003)	(0.003)	(0.007)	(0.006)
Population growth	-0.415**	-0.426**	-0.630***	-0.559***	-1.118***	-1.204***
	(0.201)	(0.201)	(0.235)	(0.195)	(0.349)	(0.359)
Institutional quality Index (QoG)						
Fight against corruption	0.131***				0.152***	
	(0.022)				(0.027)	
Rule of law		0.053***				
		(0.018)				
Government effectiveness			0.017			
			(0.022)			
Government accountability				0.121***		0.099***
				(0.025)		(0.031)
Coast	0.006***	0.005***	0.005**	0.006***	-0.004	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)
Regional Ruggedness	-0.0004	-0.001	-0.001	-0.001	-0.0001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Latitude	-0.001***	-0.001**	-0.0004	-0.001***	-0.019**	-0.006
	(0.0003)	(0.0002)	(0.0003)	(0.0003)	(0.008)	(0.008)
Latitude-squared					0.0002**	0.0001
					(0.0001)	(0.0001)
Mean Temperature - July					-0.002	-0.001
					(0.001)	(0.001)
Mean Temperature - January					0.003***	0.003***
					(0.001)	(0.001)
Observations	2331	2331	2331	2331	2331	2331
Annual time dummies	Yes	Yes	Yes	Yes	Yes	Yes
AR(5)	0.007	0.005	0.005	0.004	0.008	0.004
AR(6)	0.156	0.128	0.140	0.080	0.119	0.058
Hansen J	0.20	0.17	0.12	0.10	0.11	0.99
Number of regions	184	184	184	184	184	184
Number of instruments	157	157	157	158	158	158

Notes: Standard errors are heteroskedasticity consistent and reported in parentheses below all coefficients. *, **, *** respectively denote the 10%, 5%, 1% significance levels.

4.4 *Spatially augmented growth model*

In Table 4 we estimate the spatially augmented Solow model using OLS, 2SLS and IV-GMM methods. First, previous results are largely confirmed when introducing spatial dependency. A region's own past GDP per capita levels is negatively connected, in the OLS and IV-GMM findings, with current economic growth rates, pointing to a catching-up of the poorer regions in Europe over the considered time horizon. Regional physical capital has a positive and statistically highly significant impact on local economic growth for the OLS and IV-GMM estimations. Regional population growth rates shows negative coefficients in all specifications, but are not always statistically significant. The institutional quality variable displays positive and statistically significant coefficients when using OLS or IV-GMM, even when adding geographical variables, underlining once more the importance of government quality for economic growth.

Second and turning to the effect of cross-border spill-overs, neighbouring GDP per capita levels appear to be detrimental to local economic growth rates. This may point, under certain conditions, to higher growth in regions that are surrounded by poorer areas, and an associated catching up process. In addition, the coefficients for regional investment in neighbouring areas show negative signs, which are however only significant when using OLS or IV-GMM, suggesting lower growth in regions surrounded by important investments in physical capital. Neighbouring population growth rates show in most specifications positive coefficients, which are however not statistically significant at the usual thresholds.[23] Economic growth in surrounding areas, by contrast, positively and significantly affects economic growth, highlighting the presence of important growth spillovers. Finally, government quality in neighbouring regions is in most specifications statistically insignificant at the usual levels, apart from the OLS and IV-GMM specifications that include geographical variables where the spatially lagged government quality variable shows a negative sign.

[23] The 2SLS results display negative coefficients. However and given the rather high values for the VIF tests and rather low levels for the Hansen J tests, these results need to be interpreted with some caution.

Table 4: Spatially augmented Solow estimation: Institutional parameters and NUTS-2 regional economic growth in NUTS-2 regions.

European Union									
	OLS			2SLS			IV GMM		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Initial GDP per capita	-0.008	-0.006	-0.006	0.015*	0.021	0.026*	-0.008	-0.006	-0.006
	(0.006)	(0.004)	(0.004)	(0.008)	(0.015)	(0.015)	(0.006)	(0.004)	(0.004)
Investment	0.017***	0.018***	0.017***	-0.004	-0.006	-0.001	0.017***	0.018***	0.017***
	(0.006)	(0.005)	(0.005)	(0.023)	(0.023)	(0.022)	(0.006)	(0.005)	(0.005)
Population growth	-0.666**	-0.374	-0.351	-5.455*	-5.409	-4.343	-0.666**	-0.374	-0.351
	(0.321)	(0.274)	(0.254)	(3.304)	(3.751)	(4.518)	(0.321)	(0.274)	(0.254)
Institutional quality index (QoG)	-	0.028***	0.050***	-	-0.016	-0.008	-	0.028***	0.050***
	-	(0.008)	(0.013)	-	(0.032)	(0.041)	-	(0.008)	(0.013)
Spatially weighed initial GDP per capita	-0.009***	-0.010***	-0.008***	-0.012	-0.015	-0.020*	-0.009***	-0.010***	-0.008***
	(0.003)	(0.002)	(0.002)	(0.010)	(0.012)	(0.010)	(0.003)	(0.002)	(0.002)
Spatially weighed investment	-0.034**	-0.034***	-0.030***	-0.016	-0.025	-0.047	-0.034**	-0.034***	-0.030***
	(0.015)	(0.011)	(0.011)	(0.065)	(0.068)	(0.060)	(0.015)	(0.011)	(0.011)
Spatially weighed population growth	0.003	0.002	0.001	0.031	0.030	0.023	0.003	0.002	0.001
	(0.002)	(0.002)	(0.002)	(0.019)	(0.022)	(0.027)	(0.002)	(0.002)	(0.002)
Spatially weighed economic growth	1.279***	1.482***	1.490***	4.628***	5.137***	5.101***	1.279***	1.482***	1.490***
	(0.189)	(0.193)	(0.192)	(0.647)	(1.189)	(1.268)	(0.189)	(0.193)	(0.192)
Spatially weighed institutional quality index	-	-0.002	-0.003**	-	-0.001	-0.005	-	-0.002	-0.003**
	-	(0.001)	(0.001)	-	(0.013)	(0.015)	-	(0.001)	(0.001)
Coast	-	-	0.003***	-	-	-0.002	-	-	0.003***
	-	-	(0.001)	-	-	(0.003)	-	-	(0.001)
Regional Ruggedness	-	-	0.001	-	-	-0.001	-	-	0.001
	-	-	(0.0004)	-	-	(0.001)	-	-	(0.0004)
Area	-	-	-0.0003	-	-	-0.0003	-	-	-0.0003
	-	-	(0.0002)	-	-	(0.0004)	-	-	(0.0002)
Observations	2318	2318	2318	1403	1403	1403	2318	2318	2318
R-squared	0.860	0.862	0.863	0.830	0.121	0.169	-	-	-
Mean VIF	5.43	5.08	4.85	144.53	136.15	149.25	-	-	-
Endogeneity	-	-	-	0.000	0.000	0.000	-	-	-
AR(5)	-	-	-	-	-	-	0.002	0.001	0.001
AR(6)	-	-	-	-	-	-	0.181	0.195	0.220
Hansen J	-	-	-	0.830	0.749	0.556	0.725	1.000	1.000
Heterogeneity (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Standard errors are heteroskedasticity consistent and are reported in parentheses below all coefficients. *, **, *** respectively denote the 10%, 5%, 1% significance levels. The t-statistics are shown in parentheses.

5. Conclusions

In this paper we have revisited the geography vs. institutions controversy by analysing whether it is 'first-nature' geography or institutions which has had a greater influence over regional growth in 184 regions of the 15 original member states of the European Union. The paper provides several novelties. It is the first paper which has tackled this controversy directly at subnational level. Previous analyses focused on the national scale, where contrasts in geographical dimensions and institutional conditions are far greater than at the European level. It is also one of a handful of papers which has delved in detail and using advanced econometric techniques on the role of institutions and/or physical geography for economic growth across regions in Europe. The analysis has also been concerned with economic growth, rather than with levels of economic development as was the case of past studies (Tabellini 2010; Gennaioli et al. 2013).

On the whole, the results of the analysis underline the importance of local institutional conditions for economic development in Europe. Regional government quality emerges as a fundamental driver of economic performance across the EU. In particular, low corruption and government accountability are crucial factors behind regional economic growth in Europe. These findings are robust to changes in the model specification and to the use of different estimation techniques (OLS, 2-SLS, IV-GMM, and spatial models), while the IV analyses demonstrate that the causality runs from institutions to economic performance and not vice versa. The results also underline that, in contrast to past studies which have stressed that "institutions may be important at the national, but not at the regional level" (Gennaioli et al. 2013: 137), regional institutions, proxied by government quality are fundamental elements in the European growth equation. This result vindicates the work of social scientists who have for decades stressed the importance of the quality of local institutions for economic development across different parts of Europe (e.g. Banfield 1958; Trigilia 1992; Putnam 1993), as well as that of more recent cross-regional research focusing on culture and institutions (e.g. Tabellini 2010; Rodríguez-Pose and di Cataldo 2015).

'First-nature' geography exerts a much weaker influence on regional economic growth. While latitude, milder winters and, in some cases, access to the sea are relevant in determining the development potential of regions in Europe, all the other geographical factors considered are irrelevant for growth. This absence of physical geographical determinism in a continent where geographical extremes are to a large extent absent, implies that institutions and government quality are much better predictors of regional economic performance.

Overall, the results highlight that at a regional level in Europe institutions rule over ‘first-nature’ geography. Tackling issues such as corruption or government accountability is therefore essential in order to address existing development bottlenecks. This gives regional policy a power to change economic development in Europe, which would have not existed had physical geographical conditions trumped the influence of institutional quality over economic growth. Hence, regional development policies can make a significant difference to address economic growth problems in Europe, provided they take how institutions shape economic performance seriously.

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Annex

Table A1: description of variables

Variable	Exact definition	Source
GDP per capita	Total regional GDP PPS per inhabitant	Eurostat
Gross fixed capital formation (in % of GDP)	Gross fixed capital formation consists of resident producers´ acquisitions, less disposals, of fixed tangible or intangible assets	Eurostat
Population growth rate	Annual growth rate of the total regional population	Eurostat
Government quality index	Regional quality of government index constructed combining the following four indicators	Charron et al. (2014)
Corruption index	Measure of corruption in the public school and health care system, and other public services	Charron et al. (2014)
Rule of law index	Index measuring the residents' perception of the objectivity and confidence in the police and in regional law enforcement.	Charron et al. (2014)
Efficiency index	Index evaluating the quality of the civil service, the quality of policy formulation and implementation, as well as the government's credibility.	Charron et al. (2014)
Voice & accountability index	Extent of citizens' participation in participating in election and the political, as well as freedom of expression, and of the media.	Charron et al. (2014)
Romanization	Dummy variable indicating whether a region belonged to the Roman empire at the time of Caesar (49 BC).	Mion, Duranton, Rodriguez-Pose
Charlemagne's Empire	Indicator variable taking the value 1 if a region was part of the Charlemagne empire and/ or represented a tributary territory to the latter at the time of the emperor's death	Mion, Duranton, Rodriguez-Pose
Early Christianization	Dummy variable taking the value 1 if a region was Christianized by around 600 AD.	Mion, Duranton, Rodriguez-Pose
Number of Kingdom Changes	Variable thus measures the number of time a NUTS-2 region has experienced a different ruler (i.e. kingdom)	Mion, Duranton, Rodriguez-Pose
Latitude	Latitude of the centroid of a region	Eurostat
Coast	Equals 1 if a region borders the sea	ESPON project 2.1.1
Terrain Ruggedness	Log of 1 plus the variable slope. The slope variable has been measured as the difference between the max and min of altitude in meters	Mion, Duranton, Rodriguez-Pose
Area	Surface in square kms	Eurostat
Temperature mean - July	Mean temperature in July of each year between 1971 and 2000, in °Celsius	Mitchell et al (2004)
Temperature mean - Jan	Mean temperature in January of each year between 1971 and 2000, in °Celsius.	Mitchell et al (2004)
Precipitation mean - Jan	Mean January precipitation (in mm) 1971-2000	Mitchell et al (2004)
Precipitation mean - Jul	Mean July precipitation (in mm) 1971-2000	Mitchell et al (2004)
Cloudiness mean - Jan	Mean cloudiness in January measure on an annual basis between 1971 and 2000; in % of time.	Mitchell et al (2004)
Cloudiness mean - Jul	Mean July cloudiness (in \% time) 1971-2000	Mitchell et al (2004)
Mean January diurnal temperature range - Jan	Mean January diurnal temper. range (in °C) 1971-2000	Mitchell et al (2004)
Mean July diurnal temperature range - July	Mean July diurnal temper. range (in °C) 1971-2000	Mitchell et al (2004)
Mean January potent evapotranspiration - Jan	Mean January potent evapotranspiration (in hPa) 1971-2000	Mitchell et al (2004)
Mean January potent evapotranspiration - July	Mean July potent evapotranspiration (in hPa) 1971-2000	Mitchell et al (2004)
Soil limits to agriculture	Soil limits to agriculture. 1=no limits, 2=gravelly, 3=stony, etc.(1)	European Soil Database

		(ESDB)
Subsoil water capacity	Subsoil water capacity. 1=very low, 2=low, etc.[1]	European Soil Database (ESDB)
Topsoil water capacity	Topsoil water capacity. 1=very low, 2=low, etc.[1]	European Soil Database (ESDB)
Soil erosion	Soil erosion. 1=very weak, 2=weak, etc.[1]	European Soil Database (ESDB)
Subsoil mineralogy	Subsoil mineralogy. 1=KQ, 2=KX [2]	European Soil Database (ESDB)
Topsoil mineralogy	Topsoil mineralogy. 1=KQ, 2=KX [2]	European Soil Database (ESDB)
Soil organic content	Soil organic content. 1=high, 2=medium, etc.[1]	European Soil Database (ESDB)
Dominant parent material	Dominant parent material. 1=consol.-clastic-sediment. rocks, etc.[1]	European Soil Database (ESDB)
Class of soil	Class of soil. 1=podzol, 2=cambisol, 3=ferralsol, etc.[1]	European Soil Database (ESDB)
Soil differentiation	Soil differentiation. 0=differentiation, 1=low, etc. [1]	European Soil Database (ESDB)
Soil depth	Soil depth. 0=shallow, 1=moderate, etc.[1]	European Soil Database (ESDB)

Notes: The dataset spans the time period 1995 to 2009 and includes 254 EU regions. (1) The complete list is available upon request. (2)KQ stands for minerals and quartz, while KX denotes minerals and oxides and hydroxides.

Table A2: Summary statistics

Variable	Mean	Std. Dev.	Min	Max
GDP per capita[(i)]	22332.92	7315.63	8600.00	81400.00
Gross fixed capital formation (in % of GDP). [(i)]	0.19	0.07	-0.10	0.53
Population growth rate [(i) (ii)]	0.05	0.01	0.02	0.09
Government quality index[(i) (iii)]	10.66	0.64	7.44	11.62
Corruption index[(i) (iii)]	10.64	0.68	7.33	11.80
Rule of law index[(i) (iii)]	10.64	0.62	7.62	13.36
Efficiency index[(i) (iii)]	10.68	0.79	7.27	12.02
Accountability index[(i) (iii)]	10.56	0.62	2.99	13.11
Romanization	0	0	0	1
Charlemagne's Empire	1	0	0	1
Early Christianization	1	0	0	1
Number of Kingdom Changes	1	1	0	4
Latitude	49.44	5.50	37.24	66.40
Latitude (squared)	2474.54	548.84	1386.89	4408.50
Coast	0.50	0.50	0	1
Terrain Ruggedness	5.38	1.66	0.00	7.82
Area	15792.08	20992.45	161.40	154311.90
Temperature mean - July	18.03	2.59	10.79	25.22
Temperature mean - Jan	2.29	3.77	-12.90	11.21
Precipitation mean - Jan	69.25	28.29	29.70	216.59
Precipitation mean - Jul	63.77	29.24	4.62	181.01
Cloudiness mean - Jan	77.02	9.34	50.48	88.71
Cloudiness mean - Jul	58.44	13.73	22.18	79.45
Mean January diurnal temperature range - Jan	5.78	1.19	3.95	9.94
Mean July diurnal temperature range - July	10.01	1.56	6.69	16.21
Mean January potent evapotranspiration - Jan	10.99	7.19	0.00	34.58
Mean January potent evapotranspiration - July	105.04	21.53	74.47	160.81
Soil limits to agriculture	2.41	2.55	0	12
Subsoil water capacity	3.65	1.11	1	6
Topsoil water capacity	2.74	0.65	1	4
Soil erosion	3.54	0.63	2	5
Subsoil mineralogy	2.27	0.56	1	4
Topsoil mineralogy	2.43	0.76	1	6
Soil organic content	2.92	0.61	2	4
Dominant parent material	4.06	1.68	0	7
Class of soil	2.24	2.20	1	9
Soil differentiation	1.00	0.50	0	2
Soil depth	1.09	0.89	0	3

Notes: (i): The variables marked with (i) were introduced in the regression analysis taking the natural logarithms. (ii): Following Mankiw et al. (1995) the population growth rate has been modified by adding a value of 0.05 to take into account technological progress and capital depreciation. (iii): The regional institutional parameters are measured against the national mean values. A value of 10 indicates no deviation from the national mean.

Table A3: Standard Solow-Swan-type growth framework. NUTS-2 regional economic growth, 1995-2009 – geographical attributes. Pooled OLS

	European Union														
	(1)	(2)	(3)	(4)	(6)	(7)	(8)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Initial GDP per capita	-0.006*	-0.006*	-0.005	-0.004	-0.006*	-0.005	-0.004	-0.001	-0.005	-0.003	-0.003	-0.003	-0.003	0.001	0.0002
	(0.003	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)
Investment (gross fixed capital formation)		-0.0002	0.002	0.003	0.003	0.002	0.003	0.003*	0.002	0.0009	0.003	0.001	0.002	0.005**	0.005**
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Population growth			-0.058	-0.077	-0.067	-0.049	-0.122	-0.159	-0.072	-0.146	-0.158	-0.085	-0.125	-0.320**	-0.314**
			(0.085)	(0.091)	(0.080)	(0.087)	(0.104)	(0.103)	(0.091)	(0.104)	(0.109)	(0.099)	(0.100)	(0.131)	(0.126)
Coast				0.002									-0.0004		-0.0002
				(0.001)									(0.001)		(0.002)
Regional Ruggedness					-0.0004								-0.001*		-0.0003
					(0.0004)								(0.001		(0.001)
Area						0.000							0.000		0.000
						(0.000)							(0.000)		(0.000)
Temperature (mean) - July							-0.0002							0.002	0.0003
							(0.0004)							(0.002)	(0.002)
Temperature (mean) - January							0.0003							0.001	0.001
							(0.0003)							(0.001)	(0.001)
Precipitation (mean) - July								0.00002						-0.00001	-0.00001
								(0.00003)						(0.00004)	(0.00004)
Precipitation (mean) - January								-0.0001***						-0.00002	0.00001
								(0.00002)						(0.00004)	(0.0001)
Cloudiness (mean) - July									-0.0001					0.0001	0.0001
									(0.0001)					(0.0002)	(0.0003)
Cloudiness (mean) - January									0.00004					-0.001	-0.001
									(0.0001)					(0.001)	(0.001)
Diurnal temperature range (mean) - January										0.002***				0.002*	0.002
										(0.001)				(0.001)	(0.001)
Diurnal temperature range (mean) - July										0.0003				0.001	0.002*
										(0.001)				(0.001)	(0.001)
Evapotranspiration (mean) - January											0.001**			0.0004	0.0002
											(0.0003)			(0.0004)	(0.001)
Evapotranspiration (mean) - July											-0.0002*			-0.001*	-0.001
											(0.0001)			(0.001)	(0.001)
Latitude												-0.004***	-0.006**		-0.005
												(0.001)	(0.002)		(0.008)
Latitude (squared)												0.00004***	0.0001**		0.0001
												(0.000)	(0.000)		(0.0001)
Constant	-0.006	-0.011	-0.013	-0.019	-0.004	-0.020	-0.021	-0.043	-0.007	-0.041	-0.019	0.065	0.118*	0.094	0.130
	(0.034)	(0.034)	(0.035)	(0.036)	(0.034)	(0.035)	(0.038)	(0.038)	(0.040)	(0.036)	(0.037)	(0.040)	(0.061)	(0.108)	(0.297)
Observations	2576	2515	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331
R-squared	0.628	0.600	0.609	0.609	0.609	0.609	0.609	0.611	0.609	0.611	0.610	0.611	0.612	0.616	0.617
Heterogeneity (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Standard errors are in parentheses below all coefficients. *, **, *** respectively denote the 10%, 5%, 1% significance levels. The t-statistics are shown in parentheses. Time dummies are not reported.

Table A4: Standard Solow-Swan-type growth framework. NUTS-2 regional economic growth, 1995-2009 – geographical attributes controlling for institutions. Pooled OLS

	European Union															
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Initial GDP per capita	-0.006*	-0.006*	-0.005	-0.007*	-0.006	-0.007*	-0.006*	-0.005	-0.002	-0.006	-0.005	-0.004	-0.003	-0.004	0.0001	-0.001
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Investment (gross fixed capital formation)		-0.0001	0.002	0.003	0.003*	0.003*	0.002	0.003	0.005**	0.001	0.001	0.001	0.0002	0.001	0.004*	0.004*
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Population growth			-0.058	-0.030	-0.053	-0.037	-0.023	-0.144	-0.172*	-0.064	-0.129	-0.182*	-0.122	-0.172*	-0.316**	-0.304**
			(0.085)	(0.080)	(0.085)	(0.081)	(0.081)	(0.097)	(0.093)	(0.087)	(0.100)	(0.108)	(0.100)	(0.101)	(0.130)	(0.121)
Quality of government index				0.025***	0.027***	0.024***	0.025***	0.048***	0.042***	0.044***	0.034***	0.053***	0.052***	0.054***	0.043***	0.043***
				(0.007)	(0.007)	(0.008)	(0.007)	(0.010)	(0.007)	(0.012)	(0.008)	(0.012)	(0.011)	(0.011)	(0.013)	(0.012)
Coast					0.002									0.0002		-0.001
					(0.001)									(0.001)		(0.002)
Regional Ruggedness						-0.0002								-0.001*		-0.0004
						(0.0004)								(0.001)		(0.001)
Area							0.000							0.000		0.000
							(0.000)							(0.000)		(0.000)
Temperature (mean) - July								0.001							0.001	-0.001
								(0.0004)							(0.002)	(0.002)
Temperature (mean) - January								0.0004							0.001	0.001
								(0.0003)							(0.001)	(0.001)
Precipitation (mean) - July									0.00003						0.00001	0.000
									(0.00002)						(0.00003)	(0.00004
Precipitation (mean) - January									-0.0001***						-0.0001	-0.00001
									(0.00002)						(0.00004)	(0.00004
Cloudiness (mean) - July										-0.0001					0.0001	-0.00003
										(0.0001)					(0.0002)	(0.0003
Cloudiness (mean) - January										-0.0001					-0.001	0.0001
										(0.0001)					(0.001)	(0.001)
Diurnal temperature range (mean) - Jan											0.002***				0.002**	0.002*
											(0.001)				(0.001)	(0.001)
Diurnal temperature range (mean) - July											0.0003				0.0003	0.0004
											(0.001)				(0.001)	(0.001)
Evapotranspiration (mean) - January												0.001**			0.0003	-0.001
												(0.0002)			(0.0004)	(0.001)
Evapotranspiration (mean) - July												-0.0001			-0.001	0.0001
												(0.0001)			(0.001)	(0.001)
Latitude													-0.006***	-0.007***		-0.010
													(0.0013)	(0.0023)		(0.008)
Latitude (squared)													0.0001***	0.0001***		0.0001
													(0.00001)	(0.00002)		(0.0001)
Constant	-0.006	-0.011	-0.013	-0.056*	-0.066*	-0.049	-0.062*	-0.136***	-0.131***	-0.093**	-0.106***	-0.147***	0.001	0.051	-0.102	0.103
	(0.034	(0.034	(0.035	(0.033	(0.034	(0.032	(0.033	(0.044	(0.038	(0.045	(0.035	(0.048	(0.036	(0.058	(0.114)	(0.284)
Observations	2576	2515	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331
R-squared	0.628	0.600	0.609	0.610	0.611	0.610	0.611	0.613	0.614	0.612	0.614	0.614	0.615	0.616	0.618	0.619
Heterogeneity (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Standard errors are in parentheses below all coefficients. *, **, *** respectively denote the 10%, 5%, 1% significance levels. The t-statistics are shown in parentheses. Time dummies are not reported.

Table A5: Standard Solow-Swan-type growth framework. NUTS-2 regional economic growth, 1995-2009 – soil characteristics. Pooled OLS

	European Union													
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(14)	(15)	(16)
Initial GDP per capita	-0.006*	-0.005	-0.006	-0.005	-0.006*	-0.005	-0.005	-0.005	-0.006*	-0.005	-0.005	-0.005	-0.008**	-0.008**
	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
Investment (gross fixed capital formation)	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	-0.00003	0.002
	(0.002	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Population growth	-0.075	-0.059	-0.049	-0.062	-0.042	-0.047	-0.068	-0.061	-0.053	-0.059	-0.061	-0.048	-0.086	-0.044
	(0.080	(0.087)	(0.086)	(0.086)	(0.084)	(0.084)	(0.088)	(0.088)	(0.084)	(0.085)	(0.085)	(0.085)	(0.087)	(0.084)
Soil limits to agriculture	0.001***												0.001***	
	(0.0002)												(0.0002)	
Subsoil water capacity		0.0001											0.002**	
		(0.001)											(0.001)	
Topsoil water capacity			-0.002**										-0.002*	
			(0.001)										(0.001)	
Soil erosion				-0.0004									0.00002	
				(0.001)									(0.001)	
Subsoil mineralogy					-0.002								0.0004	0.00004
					(0.001)								(0.001)	(0.001)
Topsoil mineralogy						-0.001							-0.001	-0.0003
						(0.001)							(0.001)	(0.001)
Soil organic content							-0.001						-0.001	-0.0002
							(0.001)						(0.001)	(0.001)
Dominant parent material								-0.0001					-0.00001	0.0004
								(0.0004)					(0.001)	(0.0004)
Class of soil									0.001***				0.001***	0.001***
									(0.0003)				(0.0003)	(0.0003)
Soil differentiation										-0.0003			0.0004	-0.001
										(0.0011)			(0.001)	(0.001)
Soil depth											0.001		0.001	0.001*
											(0.001)		(0.001)	(0.001)
Temperature zone												-0.002		
												(0.002)		
Constant	-0.006	-0.013	-0.002	-0.012	-0.003	-0.009	-0.008	-0.012	-0.005	-0.012	-0.011	-0.0124	0.009	0.007
	(0.037)	(0.035)	(0.035)	(0.035)	(0.034)	(0.035)	(0.034)	(0.035)	(0.033)	(0.034)	(0.037)	(0.036)	(0.037)	(0.035)
Observations	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331
R-squared	0.611	0.609	0.610	0.609	0.609	0.609	0.609	0.609	0.612	0.609	0.609	0.609	0.616	0.613
Heterogeneity (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Standard errors are in parentheses below all coefficients. *, **, *** respectively denote the 10%, 5%, 1% significance levels. The t-statistics are shown in parentheses. Time dummies are not reported.

Table A6: Standard Solow-Swan-type growth framework. NUTS-2 regional economic growth, 1995-2009 – soil characteristics controlling for institutions. Pooled OLS

	European Union													
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(14)	(15)	(16)
Initial GDP per capita	-0.007*	-0.007*	-0.007*	-0.007*	-0.007**	-0.007*	-0.007*	-0.007*	-0.007**	-0.007*	-0.007*	-0.007*	-0.009**	-0.009**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Investment (gross fixed capital formation)	0.002	0.002	0.002	0.003	0.002	0.003	0.003	0.003	0.003	0.003	0.002	0.003	0.0004	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Population growth	-0.050	-0.038	-0.027	-0.037	-0.021	-0.025	-0.041	-0.047	-0.031	-0.033	-0.033	-0.029	-0.086	-0.041
	(0.078)	(0.081)	(0.081)	(0.081)	(0.079)	(0.079)	(0.082)	(0.083)	(0.079)	(0.079)	(0.079)	(0.080)	(0.084)	(0.079)
Quality of government index	0.022***	0.028***	0.022***	0.027***	0.024***	0.025***	0.026***	0.029***	0.021***	0.026***	0.028***	0.025***	0.024***	0.025***
	(0.007)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.007)	(0.008)	(0.008)
Soil limits to agriculture	0.001***												0.001***	
	(0.0002)												(0.0002)	
Subsoil water capacity		0.001											0.002**	
		(0.001)											(0.001)	
Topsoil water capacity			-0.002*										-0.002**	
			(0.001)										(0.001)	
Soil erosion				-0.001									0.00003	
				(0.001)									(0.001)	
Subsoil mineralogy					-0.001								0.001	0.0003
					(0.001)								(0.001)	(0.001)
Topsoil mineralogy						-0.0003							-0.001	-0.0002
						(0.001)							(0.001)	(0.001)
Soil organic content							-0.001						-0.001	-0.0004
							(0.001)						(0.001)	(0.001)
Dominant parent material								-0.0004					-0.0002	0.0001
								(0.0004)					(0.001)	(0.0004)
Class of soil									0.001***				0.001***	0.001***
									(0.0003)				(0.0003)	(0.0003)
Soil differentiation										-0.0004			0.001	-0.001
										(0.001)			(0.001)	(0.001)
Soil depth											0.001		0.001	0.002**
											(0.001)		(0.001)	(0.001)
Temperature zone												-0.0004		
												(0.002)		
Constant	-0.0432	-0.063*	-0.042	-0.057*	-0.047	-0.053	-0.051	-0.059*	-0.041	-0.054*	-0.058*	-0.055	-0.035	-0.036
	(0.034)	(0.033)	(0.032)	(0.033)	(0.032)	(0.034)	(0.032)	(0.033)	(0.032)	(0.032)	(0.033)	(0.034)	(0.035)	(0.032)
Observations	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331
R-squared	0.612	0.610	0.611	0.610	0.610	0.610	0.610	0.611	0.613	0.610	0.611	0.610	0.617	0.614
Heterogeneity (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Standard errors are in parentheses below all coefficients. *, **, *** respectively denote the 10%, 5%, 1% significance levels. The t-statistics are shown in parentheses. Time dummies are not reported.

Table A7: Regional institutional parameters and economic growth in European NUTS-2 regions. First stage

	Government quality	Corruption	Rule of law	Government effectiveness	Government accountability
	(1)	(2)	(3)	(4)	(5)
Past GDP per capita	-0.004*	0.005**	-0.005*	-0.002	0.010
	-0.002	-0.002	-0.003	-0.003	-0.008
Past Investment	-0.004***	0.009***	-0.006***	-0.011***	0.001
	-0.001	-0.001	-0.002	-0.002	-0.005
Past population growth	-0.014	0.036	0.119	-0.213	0.077
	-0.087	-0.084	-0.094	-0.163	-0.141
Past values - Institutional quality index	1.124***				
	-0.009				
Roman Empire	-0.003**	-0.001	-0.014***	-0.002	-0.029***
	-0.001	-0.002	-0.003	-0.002	-0.006
Charlemagne's empire	0.004***	0.001	0.009***	0.003	0.013***
	-0.001	-0.001	-0.002	-0.002	-0.003
Early Christianity	-0.001	0.001	-0.009***	0.005***	-0.016***
	-0.001	-0.001	-0.001	-0.002	-0.004
Changes in kingdom affiliation	-0.003***	-0.002***	-0.003***	-0.004***	-0.005***
	-0.001	-0.001	-0.001	-0.001	-0.002
Past corruption		1.042***			
		-0.016			
Past rule of law levels			1.119***		
			-0.045		
Past government effectiveness				1.078***	
				-0.014	
Past government accountability					0.582***
					-0.164
Constant	-0.279***	-0.159***	-0.252**	-0.194***	0.908***
	-0.027	-0.037	-0.101	-0.045	-0.332
Observations	1411	1411	1411	1410	1411
F-statistic of joint significance	2937.88	1622.08	782.86	1222.91	201.03
F-statistic (p-value)	0.000	0.000	0.000	0.000	0.000
AP Chi-sq. (p-value)	3818.79	8810.71	3910.63	8438.86	1120.33
AP F-statistic	3818.79	1742.16	773.26	1668.62	221.52

Notes: Standard errors are in parentheses below all coefficients. *, **, *** respectively denote the 10%, 5%, 1% significance levels. The first-stage regression results displayed above only report the first-stage regressions for the specifications (4) to (8) presented in table 2.

Table A8: Institutional parameters and NUTS-2 regional economic growth. FE estimations.

	European Union	
	(1)	(2)
Initial GDP per capita	-0.193***	-0.212***
	(0.015)	(0.015)
Investment (gross fixed capital formation)	-0.006**	-0.006**
	-(0.003	(0.003)
Population growth	-0.907***	-0.825***
	(0.156)	(0.155)
Institutional quality Index (QoG)	0.185***	
	(0.048)	
Fight against corruption		0.339***
		(0.072)
Rule of law		-0.027
		(0.050)
Government effectiveness		0.259***
		(0.024)
Government accountability		-0.0002
		(0.036)
Coast	*dropped*	*dropped*
Regional Ruggedness	*dropped*	*dropped*
Area	*dropped*	*dropped*
Latitude	*dropped*	*dropped*
Latitude squared		*dropped*
Mean Temperature - July		*dropped*
Mean Temperature - January		*dropped*
Constant	2.432***	2.065***
	(0.131)	(0.156)
Observations	2331	2331
R-squared	0.679	0.694
Number of NUTS-2 regions	184	184
Heterogeneity (p-value)	0.000	0.000

Notes: Standard errors are heteroskedasticity-consistent and are reported in parentheses below all coefficients. *, **, *** respectively denote the 10%, 5%, 1% significance levels. The t-statistics are shown in parentheses. Constant and time dummies are not reported.

Table A9: Interaction terms: Institutional parameters and the geography of places

	European Union								
	OLS			2SLS			IV GMM		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Initial GDP per capita	-0.026***	-0.033***	-0.030***	-0.026***	-0.033***	-0.030***	0.008	0.002	0.006
	(0.007)	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)	(0.009)	(0.009)	(0.008)
Investment	0.029***	0.024***	0.025***	0.029***	0.024***	0.025***	0.007**	0.009**	0.003
	(0.007)	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)	(0.003)	(0.004)	(0.003)
Population growth	-0.678**	-0.473	-0.412	-0.678**	-0.473	-0.412	-0.062	-0.158	-0.185
	(0.337)	(0.289)	(0.300)	(0.337)	(0.289)	(0.300)	(0.239)	(0.214)	(0.249)
Institutional quality index (QoG)	-0.145	-0.514*	0.563*	-0.145	-0.514*	0.563*	0.096	0.406***	-0.556***
	(0.104)	(0.292)	(0.292)	(0.104)	(0.292)	(0.292)	(0.065)	(0.128)	(0.207)
Institutional quality index * Coast	0.281**			0.281**			-0.110		
	(0.129)			(0.129)			(0.075)		
Institutional quality index * Ruggedness		0.095**			0.095**			-0.062***	
		(0.047)			(0.047)			(0.018)	
Institutional quality index * Latitude			-0.011			-0.011			0.014***
			(0.007)			(0.007)			(0.005)
Coast	-0.661**			-0.661**			0.264		
	(0.301)			(0.301)			(0.178)		
Regional Ruggedness		-0.226**			-0.226**			0.147***	
		(0.111)			(0.111)			(0.044)	
Latitude			0.027			0.027			-0.033***
			(0.017)			(0.017)			(0.012)
Observations	1411	1411	1411	1411	1411	1411	2331	2331	2331
R-squared	0.089	0.089	0.084	0.181	0.183	0.166	---	---	---
Mean VIF	652.35	425.85	626.80	2032.46	1030.68	1220.58	---	---	---
Endogeneity	---	---	---	0.0003	0.0006	0.0003	0.000	---	---
AR(5)	---	---	---	---	---	---	0.005	0.005	0.005
AR(6)	---	---	---	---	---	---	0.178	0.170	0.117
Hansen J	---	---	---	0.4426	0.6222	0.5809	0.10	0.09	0.09
Heterogeneity (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Standard errors are heteroskedasticity consistent and are reported in parentheses below all coefficients. *, **, *** respectively denote the 10%, 5%, 1% significance levels. The t-statistics are shown in parentheses.