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Abstract

Understanding the forces driving regional growth in the EU is a major challenge for theory and policy. The opening of national borders, together with the rapid technological and scientific progress, has exposed regional economies to an extremely competitive, free-market, integrated economic environment, affecting their patterns of development. EU regions should, thus, be understood not only as national, geographic and administrative sub-divisions, but also as integral parts of the EU economic space. The paper develops a generalized econometric model for the investigation of the determinants of regional economic growth in 249 EU NUTS II regions, for the period 1990-2003. The model provides critical insight with important implications for theory and policy.

Key-Words

regional economic growth, EU regions.

JEL

R10, R11, R15

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1. Introduction

The detection of the forces underpinning regional economic growth in the European Union (EU) constitutes an important issue for both academics and policy-makers. The opening of national borders, together with the rapid technological and scientific progress, has created an extremely competitive, free-market, integrated economic environment (Jutila, 2001; Christiaans, 2002). Competition, in such an economic environment, is likely to have a stronger effect at the regional level than at the national one since regional economies are more vulnerable and interact more closely (Malmberg et al, 1996; Fatás, 1997). EU regions should, thus, be understood not only as national, geographic and administrative sub-divisions, but also as integral parts of the EU economic space (Castells and Hall, 1994; Scott and Storper, 2003).

The issue of regional economic growth has attracted increasing attention, especially after the creation of the Single European Market (SEM) and the European Monetary Union (EMU). Empirical research, however, has been mainly focused on the convergence-divergence debate (Barro and Sala-i-Martin, 1991; Armstrong, 1995; Quah, 1996; Lopez-Bazo et al, 1999; Puga, 1999; Esteban, 2000; Cuadrado-Roura, 2001; Römisch, 2003; Petrakos et al, 2004 and 2005a, *inter alia*). This seems rather natural, since, despite the long-run implementation of the EU regional policy (Hurst et al, 2000), the existing regional disparities raise concerns regarding EU cohesion[1] (Begg, 2003; Dluhosch, 2006), especially after the EU eastwards enlargement (Petrakos, 2000; Hallet, 2002). Yet, the processes underlying regional economic growth are poorly understood and inadequately conceptualized (Artelaris et al, 2006).

The paper develops a generalized econometric model for the investigation of the determinants of regional economic growth in the EU. The model concerns 249 EU[2] Nomenclature of Territorial Units for Statistics (NUTS) II regions[3] (Table 1) for the period 1990-2003, and provides critical insight with important implications for theory and policy. The dataset used consists of data taken from the EUROPEAN REGIONAL (CAMBRIDGE ECONOMETRICS), REGIO (EUROSTAT) and COMEXT (EUROSTAT) databases.

---------------- Insert Table 1 around here---

The next section of the paper discusses EU regional economic growth, providing the theoretical framework(s) and some empirical results. The third section detects

[1] Article 158 of the Amsterdam Treaty states that the EU must “promote overall harmonious development […] reducing disparities between the levels of development of the various regions and the backwardness of the least favoured regions”.
[2] Regions of Bulgaria and Romania are excluded due to the lack of statistical data.
[3] NUTS II is the most appropriate spatial level for modelling and analyzing European datasets as it allows the consideration of phenomena at meso-levels i.e. it is neither too large nor too small. From a policy viewpoint, it is the spatial unit adopted by the EU for the allocation of Structural Funds (Canova, 2001; Arbia et al, 2005).

econometrically the determinants of regional econometric growth in the EU. The last section of the paper concludes.

2. Regional Economic Growth in the European Union: Theoretical Framework(s) and Some Empirical Results

Neoclassical growth theory, theory of endogenous growth, cumulative causation theory and new economic geography are the main strands in conventional economic growth theorization[4]; a generalized theory of economic growth is missing.

The main assumptions of neoclassical growth theory (Solow, 1956; Swan, 1956; Cass, 1965; Koopmans, 1965) are constant returns to scale, diminishing marginal productivity of capital, exogenously determined technical progress and substitutability between capital and labor. As a result, an increase in capital investment increases economic growth only in the short-run; because the ratio of capital to labor goes up and the marginal productivity of the additional units of capital is assumed to decline, the economy eventually moves back to its long-term growth path. This indicates that poor countries tend to grow faster than the rich ones, since they present higher marginal productivity of capital, moving towards their steady-state. Convergence would be absolute (unconditional), when economies have a common steady-state (homogeneous economies in terms of technology, savings rate, population growth rate and depreciation rate), or conditional, when economies have different steady-states (heterogeneous economies). A steady-state is reached when output per worker and capital per worker are constant (this means that output, capital and labor are all growing at the same rate). The transition of an economy to a more superior steady-state requires the increase of labor supply and the improvement in labor and capital productivity. Productivity, however, is independent from the capital investment, being dependent on the exogenously-determined technological progress.

Endogenous growth theory (Romer, 1986 and 1990; Lucas, 1988; Rebelo, 1990) supports that improvements in productivity can be linked to a faster pace of innovation and extra investment in human capital. The development of an innovative, knowledge-driven, economy can generate positive externalities and spill-over effects that an economy is able to develop and maintain. Hence, policies, designed from both the public and the private sector, are deemed to play a substantial role in advancing growth on a long-term horizon. Poor countries may achieve higher rates of economic growth by investing in factors that promote knowledge and innovation. Convergence, however, is ambiguous as the rich countries can implement easily the same (or better) sets of policies.

Cumulative causation theory (Veblen, 1915; Myrdal, 1957; Kaldor, 1970) stresses the fact that interregional interactions are related to the process of economic growth.

[4] Whereas the first two theories of economic growth are considered to be country-oriented, the other two are considered to be region-oriented.

Initial conditions are of extreme importance since they determine regional economic growth process in a self-sustained and incremental way. Divergence, thus, is the most possible outcome as the centrifugal forces that spread economic growth from the richest to the poorest regions are probably not in a position to bring the economic system into a state of balance if policies are not come into play.

New economic geography (Krugman, 1991; Fujita and Krugman, 1995; Fujita et al, 1999; Fujita and Krugman, 2004; Fujita and Mori, 2005) asserts that the process of economic growth is unbalanced, favoring the initially advanced regions. The emphasis is not given on the economic system itself but on the economic actors through a formalized system of assumptions concerning increasing returns to scale, imperfect competition and non-zero transport costs. Under these assumptions, economic activities tend to agglomerate in specific regions and choose locations with a large local demand, resulting in a self-sustained process. The spatial distribution of economic activities can be explained by centripetal (backward and forward linkages of firms and economies of scale) and centrifugal (transport costs and anti-economies of scale) forces. This is an indirect explanation of the regional economic growth patterns.

A substantial volume of empirical studies concerning the EU regional economic growth process has been carried out, varying widely with respect to spatial and temporal scales, databases and methodologies used (Combes and Overman, 2004); many of these studies have multi-theoretical basis.

Fagerberg et al (1997) explored the determinants of economic growth during the period 1980-1990 for a sample of 64 regions, coming from Germany, Italy, France and Spain, and argued that differences across regions in innovation, diffusion of technology and unemployment may explain differences in regional economic growth. Paci and Pigliaru (1997) analyzed 109 EU regions, coming from the EU-15 (the old EU member-states) except the Netherlands, Austria, Finland and Sweden, during the period 1980-1990 and concluded that the shift of employment from low to high productive sectors was an important economic growth parameter. Magrini (1998) analyzed the economic growth process of 122 EU-15 Functional Urban Regions (FUR) during the period 1979-1990 and found that research and development (R & D) activities influenced positively the level of economic growth. He also found that regions characterized by a higher degree of sectoral specialization exhibited higher growth rates than regions with a more diverse industrial structure (in other words, intra-regional dynamic spillovers appeared to have been more successful than inter-regional ones in fostering regional economic growth). Tondl (1999) analyzed 38 Objective-1 EU regions[5], coming from Greece, Spain, and Italy, during the period 1975-1994 and found that the stock of public investment and the level of education proved to be factors promoted economic growth. Paci and Pigliaru (2001) studied 131 EU-15 regions during the period 1978-1997 and found that performance was depended on technological catch-up and the

[5] These are the EU regions that have per capita Gross Domestic Product (GDP) levels below 75% of the respective EU average economy.

propensity to innovate. Badinger and Tondl (2002) investigated the growth factors of 128 EU regions, coming from the EMU countries except Austria and Greece, during the period 1993-2000 and supported that physical and human capital, innovation, diffusion of technology and openness to trade were crucial determinants of growth. Baugelsdijk and Noorderhaven (2004) studied 54 EU-15 regions for the year 1990 and found that regions with entrepreneurial culture (proxied by the number of self-employment to total employment) exhibited higher performance. Tondl and Vuksic (2006) examined 36 EU regions, coming from Czech Republic, Slovakia, Slovenia, Hungary and Poland, during the period 1995-2000 and found that foreign direct investment (FDI) and market access were significant factors for growth, whereas secondary education attainment had no effect. Sterlacchini (2006) analyzed the growth performance of 151 developed (non-Objective 1) EU regions, coming from the EU-15 countries except Greece, Portugal, Denmark, Luxemburg and Ireland, during the period 1995-2002 and found a positive impact of human capital and R & D activities on economic growth. Petrakos and Kallioras (2007) examined 106 EU-10 (the new EU member-states) regions for the period 1991-2000 and found that market access, specialization in capital-intensive sectors, diversification and economies of scale at the firm level had a positive impact on industrial growth. Rodriguez-Pose and Crescenzi (2006) examined the process of economic growth for the EU regions for the period 1995-2003 and concluded that R & D expenditure, market access, knowledge-spillovers and education were the major growth factors.

de la Fuente (2002) analyzed regional growth process in Spain for the period 1964-1991 and found that technological diffusion, human capital and employment level were the main growth determinants. Gustavsson and Persson (2003) analyzed regional growth in Sweden during the period 1911-1993 and supported that net migration flows had a negative impact. Lundberg (2003) analyzed, also, regional growth in Sweden for the period 1981-1990 and concluded that human capital had a positive impact on growth, whereas the impact of unemployment was negative. Audretsch and Keilbach (2004) examined regional growth in Germany during the period 1992-2000 and found that entrepreneurship and R & D intensity had a positive impact on growth. Baici and Casalone (2005) investigated regional growth in Italy for the period 1980-2001 and concluded that human capital was the major growth determinant. Iara (2005) examined regional growth in Hungary during the period 1994-2001 and supported that investment per capita, FDI density and exports had a positive impact on growth, whereas employment in agricultural sector had a negative impact. Petrakos and Kallioras (2005) examined regional-industrial growth in Greece for the period 1981-2000 and concluded that the small size of industrial firms, the lack of capital-intensive sectors, the small market size and the inter-industry trade activity had a negative impact.

3. Determinants of Regional Economic Growth in the European Union: Econometric Investigation.

The determinants (initial conditions) of economic growth are econometrically investigated for 249 EU NUTS II regions, during the period 1990-2003. The econometric model takes the form: $Y_{r_{t0\_t1}} = a_0 + \sum_{j=1}^{n}(a_j X_{jr_{t0}}) + \varepsilon_{r_{t0}}$, where $Y_{r_{t0\_t1}}$ is the dependent variable of economic growth in per capita Gross Value Added (GVA)[6] terms, in constant prices (prices of the year 1995), a_0 is the constant term, $\sum_{j=1}^{n} X_{jr_{t0}}$ is a set of growth determinants, a_j is a set of the estimators of growth determinants, $\varepsilon_{r_{t0}} \sim N(0,\sigma^2)$ is the disturbance term (with 0 mean and constant variance), r denotes regions, j =[1, n] denotes independent variables (1st, …, nth), t_0 is the base year (1990), and $t_0\_t_1$ is the time period covered by the dependent variable (1990-2003). The model is estimated with the Generalized Least Squares (GLS) method, providing for heteroskedasticity consistent standard errors with the use of the White heteroskedasticity test (White, 1980). The variables included in the model provide empirical answers, regarding the economic growth determinants, to questions stemming from the various strands of conventional economic growth theories.

Is the causal relation between level of development and regional economic growth linear or non-linear? The Baumol-type equation (Baumol, 1986) – the definition of convergence as the requirement of a negative, linear, relationship between the growth rate of a variable and its initial condition – rules out the possibility that there might exist groups of regions that form convergence clubs (Chatterje, 1992; Friedman, 1992; Quah, 1993). Thus, in order to uncover possible convergence clubs, the logarithm of the per capita GVA gap between each region and the leader (the richest) EU region (this is the region of Bruxelles-Brussel) is included in the model ($LOG(PCGVAGAP90)$) in the monad, the quadratic and the cubic power.

Is investment in higher education paying off for regions? Can it be a feasible development strategy? Do the qualitative characteristics of labor force matter for regional economic growth? Human capital, proxied by the percentage of the tertiary education graduates to the total population, is included in the model ($HUMCAP90$) in order to capture the effects of endogenous growth. Human capital refers primarily to workers' acquisition of skills and know-how through education, training and experience. The high presence of human capital in a region prevents diminishing returns of physical capital accumulation and allows the absorption or the creation of new technologies (Nelson and

[6] GVA is obtained by deducting intermediate consumption from GDP.

Phelps, 1966; Barro and Lee, 1993). Thus, a positive and statistically significant influence of human capital on regional performance is expected.

Is specialization contributing to regional economic growth? Are there limits to specialization? Can excess specialization be a problem rather than an advantage? Are there types of specialization that contribute more to regional economic growth than others? Although specialization is the basis for economic interaction, since it allows comparative advantages to be exploited more intensively, recent studies have shown that highly specialized regions have had an inferior performance (Molle, 1997; Traistaru et al, 2003; Petrakos et al, 2005a). This is the outcome of specialization in "wrong" sectors (mainly labor-intensive sectors not associated with increasing returns to scale activities) (Grossman and Helpman, 1990) and/or the vulnerability of highly specialized regions to asymmetric, industry-specific, shocks (Acemoglu and Ziliboti, 1997). The product of the level of specialization times the level of dissimilarity to the EU-15 average economy (this is the most developed part of the EU economy) is included in the model ($SPEC90 * DISSIM90$) in the monad and the quadratic power. The hypothesis tested is that the level and the type of specialization matter for regional economic growth. Specialization has a positive impact on regional economic growth. Excess specialization, however, may have an adverse impact, depending on the type of specialization. Specialization and dissimilarity are measured at the level of five Nomenclature of Classification of Economic Activities (NACE) 1-digit sectors (agriculture, manufacturing, construction, market services, non-market services), in GVA terms, by the Theil Index of Specialization and the Index of Structural Dissimilarity, respectively. The Theil Index of Specialization (Theil, 1972) is estimated by the formula: $THEIL_r = \sum_{i=1}^{n}((e_{ri}/e_r)\log(e_r/e_{ri}))$, where e_{ri} is employment in sector i and region r and e_r is employment in region r. The Theil Index takes values in the interval [0, 1], after its division with its theoretical maximum $\log(n)$, from complete absolute regional specialization to complete absolute regional diversification (notion inverse to specialization). The advantage of the Theil Index is that it allows for international comparisons since it provides absolute and not relative (to national averages) values. The Index of Structural Dissimilarity (Jackson and Petrakos, 2001) is estimated by the formula: $ISD_r = \sum_{i=1}^{n}(r_i - eu_i)^2$, where r and eu stand for the region under consideration and the EU-15 average economy, respectively, and i stands for sectors. The Index of Structural Dissimilarity takes values higher than 0, from complete structural similarity to infinitely structural dissimilarity to the EU-15 average economy.

Does location matter for regional economic growth? Is a central and accessible location, with respect to the EU market, a factor contributing to better economic growth performance? Theoretical and empirical research (Niebuhr and Stiller, 2002; Topaloglou et al, 2005; Niebuhr, 2006) acknowledge that more accessible regions, having a greater market potential are more likely to experience higher levels of economic growth. The parameter of geography, however, has no special meaning when the level of economic integration (i.e. the levels of interaction) of the EU regions is small (Monfort and Ypersele, 2003; Topaloglou et al, 2005). Economic integration may have differentiated effects on regional economic growth (Petrakos and Christodoulakis, 2000; Resmini and Traistaru, 2003; Niebuhr, 2006). Regions with a relatively central and accessible location are expected to benefit from the process of economic integration, which takes mainly the form of intra-industry trade. Relatively peripheral regions are expected to experience adverse effects, as the process of economic integration takes the form of inter-industry trade, depriving their economies from capital and knowledge-intensive sectors. Economic integration ($ECINT90$) and the product of economic integration times geographic position ($GRAV90 * ECINT90$) are included in the model in order to test for a possible non-linear impact of economic integration on regional economic growth, depending on the geographic position of each region with respect to the EU market. Geographic position is proxied by a Gravity Index (Evenett and Keller, 2002) provided by the formula: $GRAV_r = \sum_{j=1}^{n} \frac{p_r * p_j}{d_{rj}}$, where p_r stands for population in region r, p_j stands for population in region j and d_{rj} is the distance between the centroids of regions r and j. Gravity Index takes values greater than 0, from a less to a more central place in the EU market. The level of economic integration is estimated, in GVA terms, by an Index of Economic Integration (Petrakos et al, 2005b) under the formula: $IEI_r = \sum_{i=1}^{n} ((INTRAEUTR_i / TOTALTR_i) * LQ_{ir})$, where $INTRAEUTR_i$ is the trade activity (exports and imports) of each region r in the sector i with the EU-15 economy (the most integrated part of the enlarged EU), $TOTALTR_i$ is the trade activity (exports and imports) of each region r in the sector i with the non-EU-15 economy and LQ_{ir} is the location quotient of each sector i in each region r. Index of Economic Integration takes values greater than 0, from no to infinitely levels of economic integration with the EU-15 economy. The ratio $\frac{INTRAEUTR_i}{TOTALTR_i}$ is multiplied by the LQ_{ir} since there are no trade data at the regional-sectoral level. Location quotient is estimated by the formula: $LQ_{ir} = ((p_{ir} / p_r)/(p_i / p))$, where p is the product (output) of each sector i in each region r.

Is transport infrastructure contributing to a better regional economic growth performance? Transport infrastructure (and infrastructure in general) is considered as one of main development policies, aiming to reduce transport costs and expand connectivity and interaction. There is a reservation, however, whether the positive effects of this parameter on regional performance, allowing weaker regions to experience net losses from the expansion of infrastructure (Vickerman, 1991; Vickerman et al, 1999). Transport infrastructure is possible to have positive impact only in advanced regions, allowing them to expand their influence to new remote markets and attract new activities. Less advanced regions, in contrast, may loose the protection provided by distance and experience leakages to the advanced regions. The product of transport infrastructure, proxied by the percentage of national roads to total area, times the level of development, in per capita GVA terms, is included in the model ($TRANINF90 * PCGVA90$) in the monad and the quadratic power in order to test for a possible non-linear impact of transport infrastructure on regional economic growth, depending on the level of regional development.

Is investment activity and capital accumulation an important driver of regional economic growth? The logarithm of the level of investment per capita (both foreign and domestic investments) is included in the model ($LOG(PCINV90)$) since the positive impact of investment on regional economic growth is widely acknowledged (de Long and Summers, 1991; Firebaugh, 1996; Borensztein et al, 1998). Even though skepticism exists regarding the role of regional multipliers and the ability of investment to mobilize local resources in structurally weak regions, the impact of this variable on regional economic growth is expected to be positive.

Can the public sector be an engine of economic growth at the regional level? Does its expansion have a positive or a negative impact? The role of public sector in regional economic growth has not evaluated yet since no clear-cut causal connection has been detected (Atkinson, 1995; Slemrod, 1995; Agell et al, 1997), especially at the regional level. The ratio of the public GVA to private GVA is included in the model ($PUBPRIGVA90$) in order to provide an empirical answer on this intense debate.

Are agglomeration economies one of the drivers of regional economic growth? Are there limits to their effects? There is strong theoretical and empirical support about the role of urban size and density of activities on growth (Ciccone, 2002; Davies and Weinstein, 2003; Petrakos et al, 2004). More densely populated regions are assumed to enjoy external economies of scale and, as result, higher levels of economic growth. After some density threshold, however, these positive effects vanish and even become negative. The logarithm of population density ($LOG(POPDEN90)$) and the product of the logarithm of population density times the logarithm of population ($LOG(POPDEN90) * LOG(POP90)$) are included in the model in order to check for possible non-linear impact of population density, depending the level of population.

Are national characteristics affecting regional economic growth? Dummy variables are also included in the model ($DUMAUT$, $DUMBEL$, $DUMCYP$, $DUMCZE$, $DUMDEN$, $DUMESP$, $DUMEST$, $DUMFIN$, $DUMFRA$, $DUMGER$, $DUMHUN$, $DUMIRL$, $DUMITA$, $DUMLAT$, $DUMLIT$, $DUMLUX$, $DUMMAL$,

$DUMNED$, $DUMPOL$, $DUMPOR$, $DUMSLK$, $DUMSLV$, $DUMSWE$, $DUMUK$) in order to capture the impact of the national characteristics on regional economic growth since the latter may be significant (Viesti, 2001). The constant of the model (C) acts as the dummy variable for Greece ($DUMGRE$).

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The statistically significant results for the $LOG(PCGVAGAP90)$, $LOG(PCGVAGAP90)^\wedge 2$, $LOG(PCGVAGAP90)^\wedge 3$ variables indicate that the impact of development (income gap from the leading region) on regional economic growth is not linear. If a_1, a_2 and a_3 are the estimators of the $LOG(PCGVAGAP90)$, $LOG(PCGVAGAP90)^\wedge 2$ and $LOG(PCGVAGAP90)^\wedge 3$ variables, respectively, and $LOG(PCGVA90) = \omega$, the model takes the form $Y_{r_{t0\_t1}} = a_0 + a_1\omega + a_2\omega^2 + a_3\omega^3 + \dots$. The first derivative of the third-degree polynomial function takes the form $\frac{\partial Y_{r_{t0\_t1}}}{\partial \omega} = a_1 + 2a_2\omega + 3a_3\omega^2$. The first derivate is positive when

$$\omega < \frac{-2a_2 - \sqrt{(2a_2)^2 - 4(3a_3a_1)}}{2(3a_3)} \Rightarrow PCGVAGAP90 < 10^{\frac{-2a_2 - \sqrt{(2a_2)^2 - 4(3a_3a_1)}}{2(3a_3)}}$$ or

$$\omega > \frac{-2a_2 + \sqrt{(2a_2)^2 - 4(3a_3a_1)}}{2(3a_3)} \Rightarrow PCGVAGAP90 > 10^{\frac{-2a_2 + \sqrt{(2a_2)^2 - 4(3a_3a_1)}}{2(3a_3)}},$$ since

$(2a_2)^2 - 4(3a_3a_1) > 0$ and $3a_3 > 0$. The variable of regional development has a positive impact on the variable of regional economic growth when PCGVAGAP90 $\in$ (1,278, 12,067] (this stands for all regions except Hamburg, Inner London, Darmstadt, Oberbayern, Bremen, Luxemburg, Wien, Stuttgart and Ile de France – these regions form one convergence club, converging to the leader) and a negative impact when $PCGVAGAP90$ $\in$ [12,067, 39,806] (this stands for all other regions – these regions form another convergence club – diverging from the leader).

---------------- Insert Map 1 around here--

The estimator (a_4) of the $HUMCAP90$ variable is positive and statistically significant, being in line with endogenous growth theories. Regions with higher presence of human capital (higher shares of population with tertiary education) exhibit higher levels of economic growth.

The results for the $SPEC90*DISSIM90$ and the $(SPEC90*DISSIM90)^2$ variables indicate the non-linear impact of economic structure on regional economic growth. If a_5 and a_6 are the estimators of the $SPEC90*DISSIM90$ and the $(SPEC90*DISSIM90)^2$ variables, respectively, the model takes the form $Y_{r_{t0\_t1}} = a_0 + ... + a_5 SPEC90DISSIM90 + a_6(SPEC90DISSIM90)^2 + ...$. The first derivative of the second-degree polynomial function takes the forms $\frac{\partial Y_{r_{t0\_t1}}}{\partial SPEC90} = a_5 DISSIM90 + 2a_6 SPEC90(DISSIM90)^2$ and $\frac{\partial Y_{r_{t0\_t1}}}{\partial DISSIM90} = a_5 SPEC90 + 2a_6 DISSIM90(SPEC90)^2$. The first derivative is positive when $SPEC90$ is smaller than $\frac{-a_5}{2a_6 DISSIM90}$ and $DISSIM90$ is smaller than $\frac{-a_5}{2a_6 SPEC90}$, since $a_6 < 0$. This indicates that up to a critical level specialization has a positive impact, whereas beyond that level specialization has an adverse effect, depending on the level of structural dissimilarity to the EU-15 average economy. The variable of economic structure has a positive impact on the variable of regional economic growth when SPEC90*DISSIM90 ∈ [0.259, 166.449), and a negative impact when SPEC90*DISSIM90 ∈ [169.499, 1,949.111].

---------------- Insert Map 2 around here--

The statistically significant results for the $GRAV90*ECINT90$ and the $ECINT90$ variables indicate that the impact of regional economic integration on regional economic growth depends on geography. If a_7 and a_8 are the estimators of the $GRAV90*ECINT90$ and the $ECINT90$ variables, respectively, the model takes the form $Y_{r_{t0\_t1}} = a_0 + ... + a_7 GRAV90ECINT90 + a_8 ECINT90 + ...$. The first derivative of the equation takes the forms $\frac{\partial Y_{r_{t0\_t1}}}{\partial GRAV90} = a_7 ECINT90$ and $\frac{\partial Y_{r_{t0\_t1}}}{\partial ECINT90} = a_7 GRAV90 + a_8$. The first derivative is positive when $GRAV90 > \frac{-a_8}{a_7}$, since $a_7 > 0$. The variable of regional economic integration has a negative impact on the variable of regional economic growth when GRAV90 ∈ [0.001, 174.543), and a positive impact when GRAV90 ∈ [174.543, 728.410].

----------------- Insert Map 3 around here---

The results for the $TRANINFR90 * PCGVA90$ and the $(TRANINFR90 * PCGVA90)^2$ variables indicate that the impact of transport infrastructure, proxied by the percentage of national roads to total area, on regional economic growth is not linear, but it depends on the level of regional development. If a_9 and a_{10} are the estimators of the $TRANINFR90 * PCGVA90$ and the $(TRANINFR90 * PCGVA90)^2$ variables, respectively, the model takes the form $Y_{r_{t0\_t1}} = a_0 + ... + a_9 TRANINFR90 PCGVA90 + a_{10}(TRANINFR90 PCGVA90)^2 + ...$. The first derivative of the equation takes the forms $\frac{\partial Y_{r_{t0\_t1}}}{\partial TRANINFR90} = a_9 PCGVA90 + 2a_{10} TRANINFR90 (PCGVA90)^2$ and $\frac{\partial Y_{r_{t0\_t1}}}{\partial PCGVA90} = a_9 TRANINFR90 + 2a_{10} PCGVA90 (TRANINFR90)^2$. The first derivative is positive when $TRANINFR90 > \frac{-a_9}{2a_{10} PCGVA90}$, since $a_{10} > 0$. This indicates that the impact of transport infrastructure on regional economic growth is positive, but not statistically significant, only when transport infrastructure surpasses a critical threshold, depending on its level of development. The variable of transport infrastructure has a positive impact on the variable of regional economic growth when TRANINFR90*PCGVA90 $\in$ [72,800.000, 422,394.700] and a negative impact when TRANINFR90 $\in$ [54,354.000, 72,800.000).

---------------- Insert Map 4 around here--

The estimator (a_{11}) for the $LOG(PCINV90)$ variable verifies the positive and statistically significant impact of investment (public and private) on regional economic growth. Higher investment activity contributes to a better regional economic growth performance.

The estimator (a_{12}) for the $PUBPRI90$ variable is negative and statistically significant. This is an empirical contribution to the theoretical debate concerning the role of public sector on economic activity. Regions that have strong private sector are the ones with better economic growth performance, whereas regions that are mainly based on the public sector have worst records. Of course, this is an issue that needs further investigation.

The results for the $LOG(POPDEN90)$ and the $LOG(POPDEN90)*LOG(POP90)$ variables verify the non-linear impact of agglomeration economies on regional economic growth. If a_{13} and a_{14} are the coefficients for the $LOG(POPDEN90)$ and the $LOG(POPDEN90)*LOG(POP90)$ variables, respectively, and $LOG(POPDEN90)=k$ and $LOG(POP90)=z$, the model takes the form $Y_{r_{t0\_t1}} = a_o + ... + a_{13}k + a_{14}kz + ...$. The first derivative of the equation takes the forms $\frac{\partial Y_{r_{t0\_t1}}}{\partial k} = a_{13} + a_{14}z$ and $\frac{\partial Y_{r_{t0\_t1}}}{\partial z} = a_{14}k$. The first derivative is positive when $z < \frac{-a_{13}}{a_{14}} \Rightarrow \mathrm{POP90} < 10^{\frac{-\alpha_{13}}{\alpha_{14}}}$ and $k < 0 \Rightarrow POPDEN < 1$, since $a_{14} < 0$. This indicates that the positive impact of the variable of agglomeration economies on regional economic growth vanishes when the level of population is taken into consideration (emergence of agglomeration diseconomies).

The results for the dummy variables ($DUMAUT$, $DUMBEL$, $DUMCYP$, $DUMCZE$, $DUMDEN$, $DUMESP$, $DUMEST$, $DUMFIN$, $DUMFRA$, $DUMGER$, $DUMHUN$, $DUMIRL$, $DUMITA$, $DUMLAT$, $DUMLIT$, $DUMLUX$, $DUMMAL$, $DUMNED$, $DUMPOL$, $DUMPOR$, $DUMSLK$, $DUMSLV$, $DUMSWE$, $DUMUK$ and C), indicate the different, and in some cases statistically significant, impact of the national factor on the level of regional economic growth.

4. Conclusions

Regional economic growth is a complex process that cannot be attributed to a single driver or explained by a single theory. In contrast, many theoretical approaches contribute to its understanding. The theoretical propositions seem to be complementary and not contradictory. Among the factors that affect regional economic growth are, together with the national factor, the development level of regions, their capacity to invest in human and physical capital, their economic structure, their geographic position with respect to the EU market and their potential to exploit the positive externalities of agglomeration economies. The impact of these factors is not always conditional; for some of them is non-linear, and this raises questions for a whole set of empirical research based on linearity assumptions.

References

Acemoglu D. and Zilibotti F. (1997), Was Prometheus Unbound by Chance? Risk, Diversification and Growth, *Journal of Political Economy*, 105(4), 709-751.

Agell J., Lindh T. and Ohlsson H. (1997), Growth and the Public Sector: A Critical Review Essay, *European Journal of Political Economy*, 13, 33-52.

Aiginger K. (2000), Country Profiles in European Manufacturing, *Research Report conducted for Eurostat*.

Arbia G., de Dominicis L. and Piras G. (2005), Regional Growth and Regional Inequality in Transition Countries: a Spatial Econometric Approach, *ERSA Congress*, Amsterdam, 23-27 August.

Armstrong H. (1995), Convergence among Regions of the EU, 1950-95, *Papers in Regional Science*, 74(2), 143-152.

Artelaris P., Arvanitidis P. and Petrakos G. (2006), Theoretical and Methodological Study on Dynamic Growth Regions and Factors Explaining their Growth Performance, *DYNREG Working Paper*, 2.

Atkinson A. B. (1995), The Welfare State and Economic Performance, *National Tax Journal*, 47, 171-198.

Audretsch D. B. and Keilbach M. (2004), Entrepreneurship Capital – Determinants and Impact on Regional Economic Performance, *Max-Planck Institute of Economics Discussion Paper*, n. 3704.

Badinger H. and Tondl G. (2002), Trade, Human Capital and Innovation: The Engines of European Regional Growth in the 90s, *IEF Working Paper*, 42.

Baici E. and Casalone G. (2005), Has Human Capital Accounted for Regional Growth in Italy? A Panel Analysis on the 1980-2001 Period, *ERSA Congress*, Amsterdam, 23-27 August.

Barro R. J. and Lee J.-W. (1993), Sources of Economic Growth, *Carnegie-Rochester Conference Series on Public Policy*, 40, 1-46.

Barro R. J. and Sala–i–Martin X. X. (1992), Convergence, *The Journal of Political Economy*, 100(2), 223–251.

Baugelsdijk S. and Noorderhaven N. (2004), Entrepreneurial Attitude and Economic Growth: A Cross-Section of 54 Regions, *Annals of Regional Science*, 38(2), 199-218.

Baumol W. J. (1986), Productivity Growth, Convergence and Welfare: What the Long-Run Data Show, *American Economic Review*, 76, 1072-1085.

Begg I. (2003), Complementing EMU: Rethinking Cohesion Policy, *Oxford Review of Economic Policy*, 19(1), 161-179.

Benito J. M. and Ezcurra R. (2004), Spatial Disparities in Productivity and Industry-Mix: The Case of the European Union, *ERSA Congress*, Porto, 25-29 August.

Borensztein E., De Gregorio J. and Lee J. W. (1998), How Does Foreign Direct Investment Affect Economic Growth, *Journal of International Economics*, 45, 115-135.

CAMBRIDGE ECONOMETRICS (2007), *EUROPEAN REGIONAL Database*.

Campos N. F. και Coricelli F. (2002), Growth in Transition: What We Know, What We Don't and What We Should, *Journal of Economic Literature*, 40(3), 793–836.

Canova F. (2001), Are EU Policies Fostering Growth and Reducing Regional Inequalities? *CREI Working Paper*, n. 8.

Cass D. (1965), Optimum Growth in an Aggregative Model of Capital Accumulation, *Review of Economic Studies*, 32, 233-240.

Castells M. and Hall P. (1994), *Technopoles of the World: The Making of the 21st Century*, New York: Routledge.

Chatterji M. (1992), Convergence Clubs and Endogenous Growth, *Oxford Review of Economic Policy*, 8, 57-69.

Christiaans T. (2002), Regional Competition for the Location of New Facilities, *The Annals of Regional Science*, 45, 645-661.

Ciccone A. (2002), Agglomeration Effects in Europe, *European Economic Review*, 46, 213–227.

Combes P. P. and Overman H. (2004), The Spatial Distribution of Economic Activities in the European Union in Henderson V. and Thisse J. F. (eds): *Handbook of Urban and Regional Economics*, Amsterdam: North Holland, 2845-2910.

Cuadrado-Roura J. (2001), Regional Convergence in the EU: From Hypothesis to the Actual Trends, *Annals of Regional Science*, 35, 333–356.

Davies D. R. and Weinstein D. E. (2003), Market Access, Economic Geography and Comparative Advantage: An Empirical Test, *Journal of International Economics*, 59, 1-23.

de la Fuente A. (2002), On the Sources of Convergence: A Close Look at the Spanish Regions, *European Economic Review*, 46(3), 569-599.

de Long J. and Summers L. (1991), Equipment Investment and Economic Growth, *Quarterly Journal of Economics*, 106(2), 445-502.

Dluhosch B. (2006), Integration, Fragmentation and the Geography of Welfare, *Scandinavian Journal of Economics*, 108(3), 459-479.

Esteban J. (2000), Regional Convergence in Europe and the Industry Mix: A Shift-Share Analysis, *Regional Science and Urban Economics*, 30, 353-364.

EUROSTAT (2007), *COMEXT Database*.

EUROSTAT (2007), *REGIO Database*.

Evenett S. and Keller W. (2002), On Theories Explaining the Success of the Gravity Equation, *Journal of Political Economy*, 110, 281-316.

Fagerberg J., Verspagen B. and Caniëls M. (1997), Technology, Growth and Unemployment across European Regions, *Regional Studies*, 31(5), 457-466.

Fatás A. (1997), EMU: Countries or Regions? Lessons from the EMS Experience, *European Economic Review*, 41, 743-751.

Firebaugh G. (1996), Growth Effects of Foreign and Direct Investment, *American Journal of Sociology*, 98(1), 105-130.

Friedman M. (1992), Do Old Fallacies Ever Die? *Journal of Economic Literature*, 30(4), 2129-2132.

Fujita M. and Krugman P. R. (1995), When is the Economy Monocentric? von Thünen and Chamberlain Unified, *Regional Science and Urban Economics*, 25, 505–528.

Fujita M. and Krugman P. R. (2004), The New Economic Geography: Past, Present and the Future, *Papers in Regional Science*, 83, 139-164.

Fujita M., Krugman P. R. and Venables A. J. (1999), *The Spatial Economy: Cities, Regions and International Trade*, Cambridge Mass.: MIT Press.

Fujita M. and Mori T. (2005), Frontiers of the New Economic Geography, *Papers in Regional Science*, 84(3), 377-405.

Grossman G. M. and Helpman E. (1990), Comparative Advantage and Long-Run Growth, *American Economic Review*, 80, 796–815.

Hallet M. (2002), Income Convergence and Regional Policies in Europe: Results and Future Challenges, *42nd ERSA Congress "From Industry to Advanced Services"*, Dortmund, 27–31 August.

Hurst C., Thisse J. and Vanhoudt P. (2000), What Diagnosis for Europe's Ailing Regions? *EIB Papers*, 5(1), 9–29.

Iara A. (2005), Regional Growth in Hungary: The Impact of Economic Integration, *ERSA Congress*, Amsterdam, 23-27 August.

Jackson M. and Petrakos G. (2001), Industrial Performance under Transition: The Impact of Structure and Geography in Petrakos G. and Totev S. (eds): *The Development of the Balkan Region*, Aldershot: Ashgate, 141-174.

Jutila S. T. (2001), Interregional Competition for Sources of Economic Growth in Roy J. and Schulz W. (eds): *Theories of Regional Competition*, Baden-Baden: Nomos, 58-79.

Kaldor N. (1970), The Case for Regional Policies, *Scottish Journal of Political Economy*, 17, 337-348.

Koopmans T. C. (1965), On the Concept of Optimal Economic Growth, *Pontificae Academiae Scientiarum Scripta Varia*, 28, 225-300.

Krugman P. R. (1991), Increasing Returns and Economic Geography, *Journal of Political Economy*, 99, 183–199.

Lopez-Bazo E., Vaya E., Mora A. and Surinach J. (1999), Regional Economic Dynamics and Convergence in the European Union, *Annals of Regional Science* 33, 343-370.

Lucas R. (1988), On the Mechanics of Economic Development, *Journal of Monetary Economics*, 22, 3-42.

Lundberg J. (2003), On the Determinants of Average Income Growth and Net Migration at the Municipal Level in Sweden, *Review of Regional Studies*, 32(2), 229-253.

Magrini S. (1998), The Determinants of Regional Growth: An Empirical Analysis, *ERSA Congress*, Vienna, 28 August – 1 September.

Malmberg A., Solvell O. and Zander I. (1996), Spatial Clustering, Local Accumulation of Knowledge and Firm Competitiveness, *Geographiska Annaler*, 78(2), 85-97.

Molle W. T. M. (1997), The Regional Economic Structure of the European Union, An Analysis of Long-Term Developments, *Zeitschrift für Wirtschafts und Sozialwissenschaften*, 5, 13-32.

Monfort P. and Ypersele T. (2003), Integration, Regional Agglomeration and International Trade, *CEPR Discussion Paper*, 3752.

Myrdal G. (1957), *Economic Theory and Underdeveloped Regions*, London: Hutchinson.

Nelson R. and Phelps E. (1966), Investment in Humans, Technological Diffusion and Economic Growth, *American Economic Review*, 56, 69-75.

Niebuhr A. (2006), Market Access and Regional Disparities: New Economic Geography in Europe, *Annals of Regional Science*, 40, 313-334.

Niebuhr A. and Stiller S. (2002), Integration Effects in Border Regions: A Survey of Economic Theory and Empirical Studies, *HWWA Discussion Paper*, 179.

Nijkamp P., Rietveld P. and Salomon I. (1990), Barriers in Spatial Interactions and Communications: A Conceptual Exploration, *The Annals of Regional Science*, 24, 237-252.

Paci R. and Pigliaru F. (1997), European Regional Growth: Do Sectors Matter? *CRENoS Working Paper*, 3.

Paci R. and Pigliaru F. (2001), Technological Diffusion, Spatial Spillovers and Regional Convergence in Europe, *CRENoS Working Paper*, 1.

Petrakos G. (2000), The Spatial Impact of East-West Integration in Europe in Petrakos G., Maier G. and Gorzelak G. (eds): *Integration and Transition in Europe*, London: Routledge, 38-68.

Petrakos G. and Christodoulakis N. (2000), Greece and the Balkans: The Challenge of Integration, in Petrakos G., Maier G. and Gorzelak G. (eds): *Integration and Transition in Europe: The Economic Geography of Interaction*, London: Routledge, 269-294.

Petrakos G., Fotopoulos G. and Kallioras D. (2005a), Peripherality and Integration: Industrial Growth and Decline in the Greek Regions, *University of Thessaly Discussion Paper Series*, 11(15), 281-302.

Petrakos G. and Kallioras (2007), Integration and Structural Change: Pre-Accession Experience in the Regions of the EU New Member-States in Getimis P. and Kafkalas G. (eds): *Overcoming Fragmentation: The Changing Geography and the Prospects for Spatial Cohesion in Southeast Europe*, Aldershot: Ashgate, *forthcoming*.

Petrakos G., Psycharis Y. and Kallioras D. (2004), Regional Inequalities in the EU Accession Countries: Evolution and Challenges in Bradley J., Petrakos G. and Traistaru I. (eds): *Integration, Growth and Cohesion in an Enlarged European Union*, New York: Springer, 45-64.

Petrakos G, Rodriguez-Pose A. and Rovolis A. (2005b), Growth, Integration and Regional Disparities in the European Union, *Environment and Planning A*, 37(10), 1837-1855.

Puga D. (1999), The Rise and the Fall of Regional Inequalities, *European Economic Review*, 43(2), 303–334.

Quah D. (1993) Galton's Fallacy and Tests of the Convergence Hypothesis, *Scandinavian Journal of Economics*, 95, 427-443.

Quah D. (1996), Regional Convergence Clusters across Europe, *European Economic Review*, 40, 951–958.

Rebelo S. (1990), Long Run Policy Analysis and Long Run Growth, *NBER Working Paper*, 3325.

Rodriguez-Pose A. & Crescenzi R. (2006), R & D, Spillovers, Innovation Systems and the Genesis of Regional Growth in Europe, *BEER Research Paper*, 5.

Romer P. M. (1986), Increasing Returns and Long Run Growth, *Journal of Political Economy*, 94(2), 1002-1037.

Romer P. M. (1990), Endogenous Technological Change, *Journal of Political Economy*, 98(5), 71-102.

Scott A. J. and Storper M. (2003), Regions, Globalization, Development, *Regional Studies*, 37(6-7), 607-620.

Slemrod J. (1995), What do Cross-Country Studies Teach about Government Involvement, Prosperity and Economic Growth? *Brookings Papers on Economic Activity*, 2, 373-431.

Solow R. M. (1956), A Contribution to the Theory of Economic Growth, *Quarterly Journal of Economics*, 70, 65-94.

Sterlacchini A. (2006), Innovation, Knowledge and Regional Economic Performances: Regularities and Differences in the EU, *Università Politechnica Delle Marche Quaderno di Ricerca*, 260.

Swan T. W. (1956), Economic Growth and Capital Accumulation, *Economic Record*, 32, 334–361.

Resmini L. and Traistaru L. (2003), Spatial Implications of Economic Integration in EU Accession Countries in Traistaru I., Nijkamp P. and Resmini L. (eds): *The Emerging Economic Geography in EU Accession Countries*, Aldershot: Ashgate Publishing, 3-24.

Römisch R. (2003), Regional Disparities within Accession Countries in Tumpel-Gugerell G. and Mooslechner P. (eds): *Economic Convergence and Divergence in Europe: Growth and Regional Development in an Enlarged Europe*, Aldershot: Edward Elgar, 183-208.

Theil H. (1972) *Statistical Decomposition Analysis: With Applications in the Social and Administrative Sciences,* Amsterdam: North-Holland.

Tondl G. (1999), What Determined the Uneven Growth of Europe's Southern Regions? An Empirical Study with Panel Data, *Vienna University Working Paper*, 4.

Tondl G. and Vuksic G. (2004), What Makes Regions in Eastern Europe Catching Up? *IEF Working Paper*, 51.

Topaloglou E., Kallioras D., Manetos P. and Petrakos G. (2005), Towards a Border Regions Typology in the Enlarged EU, *Journal of Borderland Studies,* 20(2), 67-89.

Traistaru I., Nijkamp P. and Longhi S. (2003), Specialization of Regions and Concentration of Industries in EU Accession Countries in Traistaru I., Nijkamp P. and Resmini L (eds): *The Emerging Economic Geography in EU Accession Countries,* Aldershot: Ashgate Publishing, 331-371.

Veblen T. (1915). Imperial Germany and the Industrial Revolution, London: Macmillan.

Vickerman R. (1991), *Infrastructure and Regional Development*, London: Pion.

Vickerman R., Spiekermann K. and Wegener M. (1999), Accessibility and Economic Development in Europe, *Regional Studies*, 33(1), 1-15.

Viesti G. (2000), Economic Policies and Local Development: Some Reflections, *European Planning Studies*, 32, 707-720.

Weinhold D. and Rauch J. E. (1999), Openness, Specialization and Productivity Growth in Less Developed Countries, *Canadian Journal of Economics*, 32(4), 1009-1027.

White H. (1980), A Heteroskedasticity-Consistent Covariance Matrix and a Direct Test for Heteroskedasticity, *Econometrica,* 48, 817-838.

Appendix

Table 1: The 249 NUTS II EU regions considered in the paper

BELGIUM (11): Bruxelles-Brussel, Antwerpen, Limburg, Oost-Vlaanderen, Vlaams Brabant, West-Vlaanderen, Brabant Wallon, Hainaut, Liége, Luxemburg, Namur

DENMARK (3): Hovedstadsreg, Øst for Storebaelt, Vest for Storebaelt

GERMANY (40): Stuttgart, Karlsruhe, Freiburg, Tübingen, Oberbayern, Niederbayern, Oberpfalz, Oberfranken, Mittelfranken, Unterfranken, Schwaben, Berlin, Bradenburg, Bremen, Hamburg, Darmstadt, Giessen, Kassel, Mecklenburg-Vorpommern, Braunschweig, Hannover, Lüneburg, Weser-Ems, Düsseldorf, Köln, Münster, Detmold, Arnsberg, Koblenz, Trier, Rheinhessen-Pfalz, Saarland, Chemnitz, Dresden, Leipzig, Dessau, Halle, Magdeburg, Schleswig-Holstein, Thüringen

GREECE (13): Anatoliki Makedonia, Kentriki Makedonia, Dytiki Makedonia, Thessalia, Ipeiros, Ionia Nisia, Dytiki Ellada, Sterea Ellada, Peloponnisos, Attiki, Voreio Aigaio, Notio Aigaio, Kriti

SPAIN (18): Galicia, Asturias, Cantabria, País Vasco, Navarra, Rioja, Aragón, Madrid, Castilla-León, Castilla-la Mancha, Extremadura, Cataluña, Comunidad Valenciana, Baleares, Andalucia, Murcia, Ceuta y Melilla, Canarias

FRANCE (22): Île de France, Champagne-Ardenne, Picardie, Haute-Normandie, Centre, Basse-Normandie, Bourgogne, Nord-Pas de Calais, Lorraine, Alsace, Franche-Comté, Pays de la Loire, Bretagne, Poitou-Charentes, Aquitaine, Midi-Pyrénées, Limousin, Rhône-Alpes, Auvergne, Languedoc-Rouss., Provence-Alpes-Côte-d'Azur, Corse

IRELAND (2): Border, Southern and Eastern

ITALY (20): Piemonte, Valle d'Aosta, Liguria, Lombardia, Trentino-Alto Adige, Veneto, Friuli-Venezia Giulia, Emilia-Romagna, Toscana, Umbria, Marche, Lazio, Abruzzo, Molise, Campania, Puglia, Basilicata, Calambria, Sicilia, Sardegna

THE NETHERLANDS (12): Groningen, Friesland, Drenthe, Overijssel, Gelderland, Flevoland, Utrecht, Noord-Holland, Zuid-Holland, Zeeland, Noord-Brabant, Limburg

LUXEMBURG (1): Luxemburg

AUSTRIA (9): Burgenland, Niederösterreich, Wien, Kärnten, Steiermark, Oberösterreich, Salzburg, Tirol, Vorarlberg

PORTUGAL (7): Norte, Centro, Lisboa e Valle do Tejo, Alentejo, Algarve, Acores, Madeira

FINLAND (5): Itä-Suomi, Etelä-Suomi, Länsi-Suomi, Pohjos-Suomi, Åland

SWEDEN (8): Stockholm, Östra Mellansverige, Sydsverige, Norra Mellansverige, Övre Norrland, Smaland med oarna, Västsverige

THE UNITED KINGDOM (37): Tees Valley and Durham, Northumberland and Tyne and Wear, Cumbria, Cheshire, Greater Manchester, Lancashire, Merseyside, East Riding, North Yorkshire, South Yorkshire, West Yorkshire, Derbyshire, Leicestershire, Lincolnshire, Hereford, Worcestershire and Warwickshire, Shropshire, West Midlands, East Anglia, Bedfordshire, Essex, Inner London, Outer London, Berkshire, Buckinghamshire and

Oxfordshire, Surrey, Hampshire and Isle of Wight, Kent, Gloucester, Wiltshire and North Somerset, Dorset and Somerset, Cornwall, Devon, West Wales, East Wales, North East Scotland, Eastern Scotland, South West Scotland, Highlands and Islands, Northern Ireland

CYPRUS (1): Cyprus

MALTA (1): Malta

CZECH REPUBLIC (8): Praha, Strední Cechy, Jihozápad, Severozápad, Severovýchod, Jihovýchod, Strední Morava, Moravskoslezko

HUNGARY (7): Közép-Magyarország, Közép-Dunántúl, Nyugat-Dunántúl, Dél-Dunántúl, Észak-Magyarország, Észak-Alföld, Dél-Alföld

POLAND (16): Dolnoslaskie, Kujawsko-Pomorskie, Lubelskie, Lubuskie, Lódzkie, Malopolskie, Mazowieckie, Opolskie, Podkarpackie, Podlaskie, Pomorskie, Slaskie, Swietokrzyskie, Warminsko-Mazurskie, Wielkopolskie, Zachodniopomorskie

SLOVAKIA (4): Bratislavský, Západné Slovensko, Stredné Slovensko, Východné Slovensko

ESTONIA (1): Estonia

LITHUANIA (1): Lithuania

LATVIA (1): Latvia

SLOVENIA (1): Slovenia

Sources: Names from EUROPEAN REGIONAL (CAMBRIDGE ECONOMETRICS) and REGIO (EUROSTAT) databases / Authors' elaboration

Table 2: A generalized model of regional economic growth in the EU, Period 1990-2003

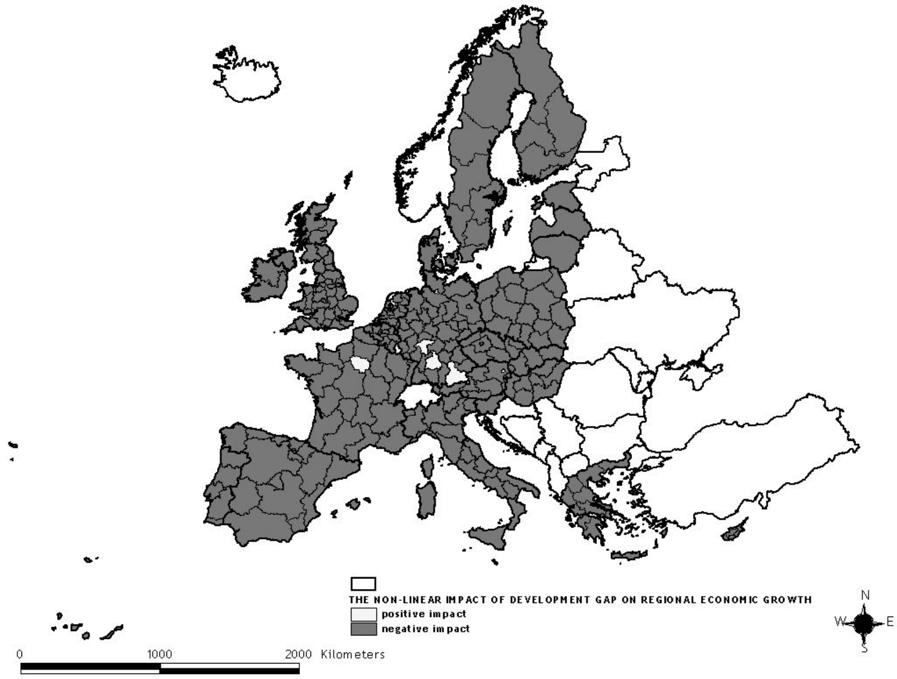
Dependent Variable: Y90_03
Method: Least Squares
Included observations: 249
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	Beta Coeff.	t-Statistic	Prob.
C (DUMGRE)	-3.150144	1.280930		-2.459264	0.0147**
LOG(PCGVAGAP90)	2.337216	0.975008	3.357	2.397125	0.0174**
(LOG(PCGVAGAP90))^2	-0.507697	0.208524	-6.983	-2.434725	0.0157**
(LOG(PCGVAGAP90))^3	0.028225	0.011017	4.331	2.562067	0.0111**
HUMCAP90	0.063533	0.007380	0.836	8.609051	0.0000***
SPEC90*DISSIM90	0.000255	0.000255	0.063	0.998368	0.3192
(SPEC90*DISSIM90)^2	-7.66E-07	4.43E-07	-1.712	-1.730042	0.0851*
GRAV90*ECINT90	0.001010	0.000354	0.183	2.850244	0.0048**
ECINT90	-0.328339	0.090263	-0.209	-3.637588	0.0003***
TRANINFR90*PCGVA90	-2.28E-06	1.37E-06	-0.479	-1.661447	0.0981*
(TRANINFR90*PCGVA90)^2	4.13E-12	4.24E-12	0.209	0.973278	0.3315
LOG(PCINV90)	0.465990	0.151355	0.872	3.078791	0.0024***
PUBPRIGVA90	-0.742930	0.294008	-0.130	-2.526900	0.0122**
LOG(POPDEN90)	0.323660	0.112045	1.344	2.888662	0.0043***
LOG(POPDEN90)*LOG(POP90)	-0.018175	0.007091	-1.153	-2.563028	0.0111**
DUMAUT	0.098164	0.161816	0.031	0.606640	0.5447
DUMBEL	-0.257744	0.117940	-0.158	-2.185390	0.0300**
DUMCYP	-0.135142	0.079390	-0.021	-1.702256	0.0902*
DUMCZE	-0.055224	0.255439	-0.090	-0.216190	0.8290
DUMDEN	-0.035626	0.176618	-0.026	-0.201712	0.8403
DUMESP	-0.343242	0.334182	-0.179	-1.027112	0.3055
DUMEST	-0.298669	0.090024	-0.045	-3.317661	0.0011***
DUMFIN	-0.051582	0.185993	-0.014	-0.277332	0.7818
DUMFRA	-0.305217	0.122715	-0.225	-2.487206	0.0137**
DUMGER	-0.343368	0.123025	-0.354	-2.791046	0.0057***
DUMHUN	0.353279	0.221353	0.149	1.595996	0.1120
DUMIRL	1.212027	0.143856	0.271	8.425267	0.0000***
DUMITA	-0.174667	0.124151	-0.134	-1.406888	0.1609
DUMLAT	2.350717	1.364344	0.063	1.722965	0.0864*
DUMLIT	-0.800442	0.384414	-0.122	-2.082241	0.0385**
DUMLUX	-0.056004	0.146031	-0.023	-0.383511	0.7017
DUMMAL	-0.360479	0.126277	-0.088	-2.854667	0.0047***
DUMNED	-0.305154	0.137900	-0.189	-2.212866	0.0280**
DUMPOL	0.304607	0.166850	0.156	1.825627	0.0693*
DUMPOR	-0.028092	0.090000	-0.030	-0.312132	0.7552
DUMSLK	0.321324	0.214872	0.099	1.495416	0.1363
DUMSLV	-0.439502	0.200201	-0.066	-2.195304	0.0292**
DUMSWE	-0.486964	0.151494	-0.217	-3.214414	0.0015***
DUMUK	0.003528	0.112767	0.029	0.031283	0.9751
F-STATISTIC	14.47502				0.0000***
R^2 ADJUSTED	0.673706				

*** statistically significant at 1% level, ** statistically significant at 5% level, * statistically significant at 1% level

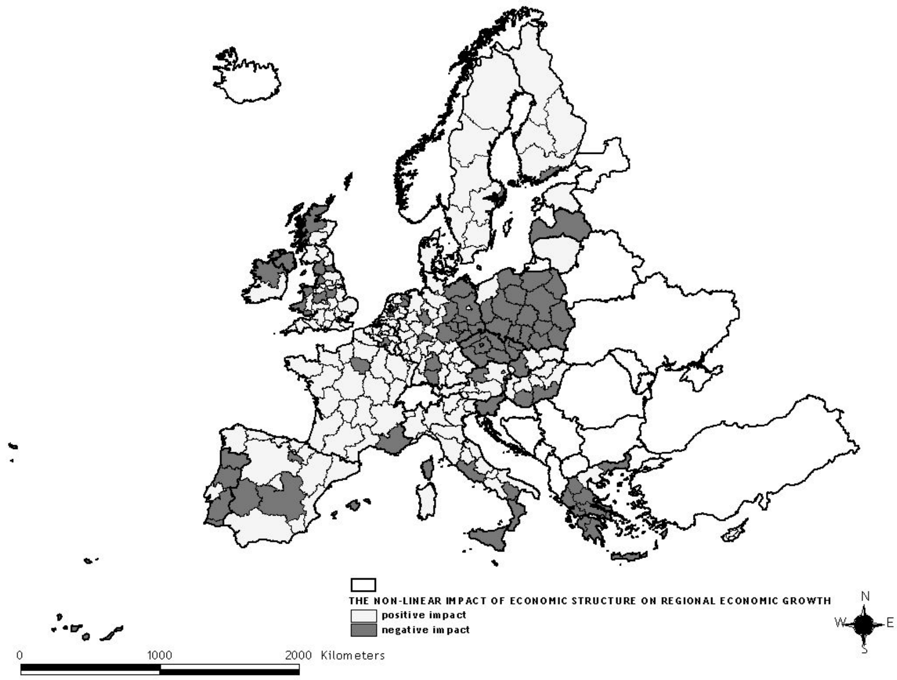
Sources: Data from EUROPEAN REGIONAL (CAMBRIDGE ECONOMETRICS), REGIO (EUROSTAT) and COMEXT (EUROSTAT) databases / Authors' elaboration

Map 1: The non-linear impact of regional development (development gap) on regional economic growth, Standard errors taken into consideration, Period 1990-2003



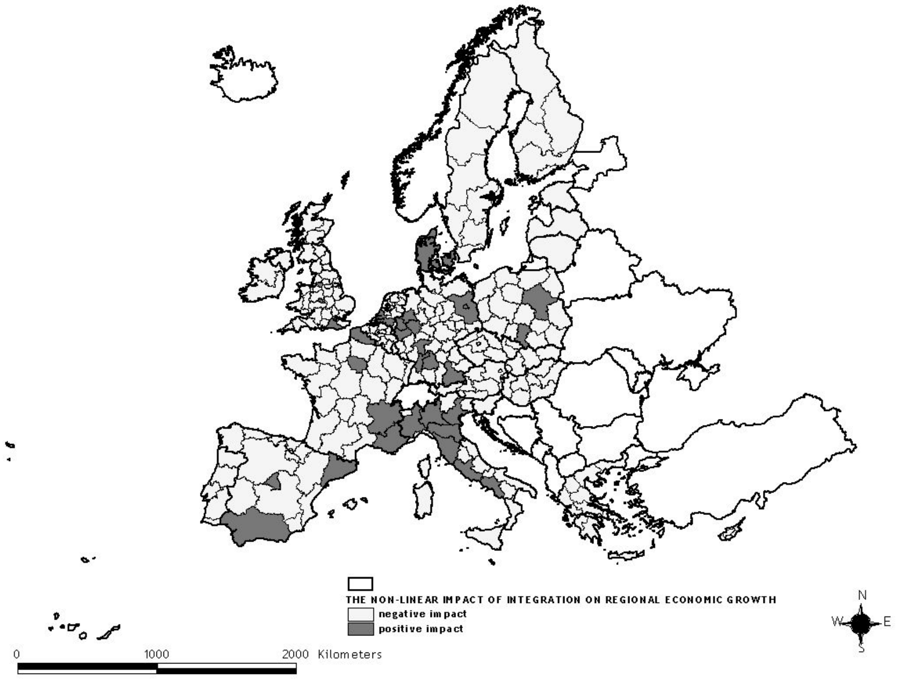
Sources: Data from EUROPEAN REGIONAL (CAMBRIDGE ECONOMETRICS) database / Authors' elaboration

Map 2: The non-linear impact of regional economic structure on regional economic growth, Standard errors taken into consideration, Period 1990-2003



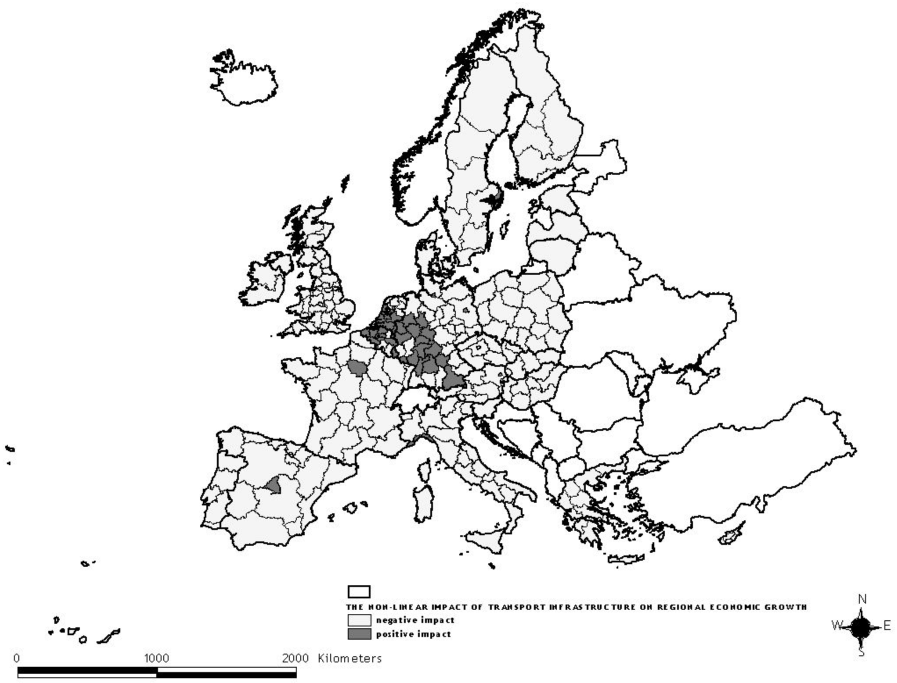
Sources: Data from EUROPEAN REGIONAL (CAMBRIDGE ECONOMETRICS) database / Authors' elaboration

Map 3: The non-linear impact of regional economic integration on regional economic growth, Standard errors taken into consideration, Period 1990-2003



Sources: Data from EUROPEAN REGIONAL (CAMBRIDGE ECONOMETRICS) database / Authors' elaboration

Map 4: The non-linear impact of regional transport infrastructure on regional economic growth, Standard errors taken into consideration, Period 1990-2003



Sources: Data from EUROSTAT (REGIO) database / Authors' elaboration