

# Does Space Matter? Empirics on Convergence in EU Regions \*

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## Abstract

In this paper we investigated the per-capita income convergence process among extended EU regions during the period 1995-2004. Starting from neo-classical analysis we have further applied spatial econometric tools to explore the role of spatial heterogeneity and spatial spillovers in regional convergence process. Since spatial spillovers appeared as a fundamental element in explaining regional growth, we tried to model neighboring relations using the gravity approach, in order to take into account economic and social agglomeration. Results confirm that the binary choice, commonly used to construct contiguity matrix for spatial econometric analysis, is an excessive simplification. This, in turn, confirms that spillovers diffusion process is easier in agglomerated areas, with important implications for policy analysis. The rest of the paper is organized as follows: after the general introduction, a paragraph is devoted the matter of convergence and cohesion in enlarged europe; follows an introduction to neo-classical analysis and a brief part explaining used data and methodology. In the end we show our results and finally conclusions are taken together with some policy implications.

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## 1 Introduction

The aim of this paper is to investigate the convergence process in European Union at regional level. Regions are in fact the main objective of European Cohesion Policy, both because they represent an intermediate political level between states and local administrations and because they're the main funds receivers. Moreover a convergence process is expected to take place in Europe since efforts have been done in order to remove barriers to national goods and services markets and labor and capital mobility should also have boosted the catching-up.

So, classical regression tests are the natural starting point of such an analysis, even if standard  $\beta$ -convergence test has been criticized since it is not a sufficient evidence to allow global disparities reduction over time, that is the real focus of a cohesion-oriented policy; and that's why some others newer methodologies have been proposed (i.e. Quah, 1993) [18]. Anyway authors are convinced that classical regression test has still some explaining power, even if some notations are needed. In particular, standard  $\beta$ -convergence test does not account for spatial matters, whose importance in regional growth process has been underlined also at theoretical level as in Krugman (1991) [13]. Spatial econometric tools enable to consider spatial relations and/or spatial interactions in the standard convergence equation, so that to give a clearer estimation of the speed of the convergence process. We have found that a convergence process exist, as it was supposed to, and that is mainly characterized by spillover diffusion; then we tried to consider agglomeration factors in diffusion process. Emerging results, even without contributing to the debate on social disparities reduction, are much more interesting than the ones obtained with standard  $\beta$ -test, and some important implication may be extracted about the role played by geography in conditioning economic convergence dynamics. In the rest of the paper we first introduce an analysis of regional convergence and territorial cohesion in European Countries (paragraph 2). Then neo-classical convergence hypothesis, together with some results of previous studies in Europe at regional level (paragraph 3) are briefly shown. After a brief presentation of the data and of the spatial econometric tools used for empirical analysis (paragraph 4) we present our results (paragraph 5). In the final part we will try to extract some policy implications.

## 2 Regional Convergence and Territorial Cohesion

The role and the importance of disequilibria among European regions are clearly stated in the EU Treaty where territorial cohesion is introduced along with economic and social cohesion (art.174). Furthermore, the Treaty clarifies that a "*particular attention shall be paid to rural areas... and regions*

*which suffer from severe and permanent natural or demographic handicaps such as the northernmost regions with very low population density and island, cross-border and mountain regions” (art.174).*

The emphasis on disparities is largely discussed in the sequence of reports on cohesion among regions and countries published by the EU Commission. Most of them are widely used as basis to cohesion policies.

The latest evidence provides a contradictory picture of the phenomenon. On one side economic cohesion among countries has improved due to relevant performance of the so-called “cohesion countries” (countries with per capita GDP lower than 90% of European average) like Ireland and Spain that reached the top levels of European ranking. On the other side, cohesion among regions globally improved since eight regions over 78 overcome the 75% of per capita GDP (EU-27).

Despite the low number of regions involved by a significant improvement, the fourth relation on social cohesion states that *“The lagging regions in the EU-15, which were major recipients of support under cohesion policy during the period 2000–2006, showed a significant increase in GDP per head relative to the rest of the EU between 1995 and 2004. In 1995, 50 regions with a total of 71 million inhabitants had a GDP per head below 75% of the EU-15 average. In 2004, in nearly one in four of these regions home to almost 10 million, GDP per head had risen above the 75% threshold.”*

Territorial cohesion exhibited an evidence of an increasing number of poles of development. Most of these poles are concentrated in large urban areas, in EU-15 regions as well as in the enlargement countries. A symmetric phenomenon of decreasing economic activities in rural areas emerged.

Until the nineties the core of the European growth was concentrated in the middle of EU-15 (Munich, Hamburg, Paris, London and Milan). Afterwards, the new comers of European economic growth emerged in Scandinavian countries, Spain and Ireland and in the capital towns of the enlargement countries.

The polarisation of the economic development has largely been characterized by increasing diseconomies of agglomeration, due to increasing congestion costs and pressure on housing markets and network services, and subsequent suburbanisation.

Despite an increasing optimistic view about economic convergence among EU regions, the analysis of EU policy-makers about territorial cohesion is focused on the potential problems arising from growth polarisation. Large capital towns (or better capital regions) often became strong economic growth attractors but, at the same time, increasing problems in surrounding regions and deprivation in rural areas offset the economies of agglomeration generated by increasing growth rates. Their core-peripheral dynamics is often characterized by relevant economic growth and loss of population at the core of capital region and less moderate economic growth and increasing population at the periphery of capital region (urban sprawling).

In some countries economic growth is characterized by a bi-modal (or tri-modal) distribution of regional growth rates with a leading town/region (usually the capital town region) and strong secondary poles (like Milan and Naples in Italy, Barcelona in Spain, Frankfurt and Munich), where economic growth is even higher than in the capital town. Usually, most of the economic growth is concentrated in the capital town region and less distributed in the rest of the country.

Moreover, most of the economic potential is concentrated, according to EU analysis, in cross-border cooperation due to relaxation of constraints to economic exchanges from physical and administrative point of view. Cross-border areas are certainly in some cases consolidated areas of spillover effects in economic growth and in other cases, where the physical context is an obstacle, are marginal areas due to lack of infrastructure (i.e. mountain areas).

Territorial and economic differences in EU regions are also clearly due to different development patterns among European regions. Looking at the latest years (1995/2005), there have been at least three different situations:

1. in some regions high growth rates in per capita GDP have been obtained along with increase in productivity and in employment rates: ie. the case of Ireland;
2. in some other regions, relatively high growth rates in per capita GDP have been obtained along with increase in productivity and strong decline in employment rates;
3. in other regions, most of them in highly industrialised countries, lower (or negative) per capita GDP growth rate are accompanied by low productivity growth rate and by moderate employment rate growth.

The current economic crisis will certainly re-depict the current situation, since some of the new member states might be interested by structural crisis. Nevertheless, the underlying fundamentals of economic structure will strongly influence the recovering phase and the productivity patterns will be crucial.

The empirical evidence and most of the analysis of territorial cohesion are openly oriented to discuss how space may matters in the dynamics of convergence among European regions. Some very practical questions may arise. Are agglomerative factors crucial to explain increasing economic convergence? Is increasing economic convergence widely justified by current cohesion policies? Is there any additional room to stimulate spillover effects by supporting specific cooperation policies? Are spillover effects still relevant in a de-materialized economy in which geographical proximity may reduce its importance?

### 3 Neo-classical Convergence Hypothesis

Convergence, as well known, is the most important neoclassical growth model prediction (Solow, 1956) [23]: under simple hypothesis of perfect market competition, constant returns to scale production function and homogeneous agents, it is shown that all economies with similar characteristics follow a growth path toward a common and stable steady-state per-capita capital and income level. Barro and Sala-i-Martin (1991) [6] suggested to test for that regressing annual average growth rate of per-capita income on a constant and initial income level: a negative and statistically significant coefficient can be taken as a convergence evidence, although it is not sufficient to allow disparities reduction over time (Barro & Sala-i-Martin, 1995) [7](Quah, 1993) [18]. The hypothesis has been tested in the absolute and conditional form: while the sooner applies to the case of similar structural characteristics between economies, the latter applies in the case economic structures differ.

Because of the lack of conditioning variables to be considered in standard regression at regional level, researchers interest focused on country level, while country dummy have been generally considered in regional analysis in order to catch some effects due to economic, social and cultural characteristics. Some studies on European regions have confirmed the role of country dummy in conditioning convergence process that, in any case, has been shown to exist (Brauningen & Niebuhr, 2005) [9] (Fisher & Stirbock, 2004) [11]. Martin (1998) [14] showed also that country dummy may have more explaining power than conditioning variables. Such studies, among the others, underlined that the assumption of homogeneous economic characteristics does not hold in general and neither in European case. Within such a framework, neo-classical analysis seems to be partial, and this leaves the field open to further studies investigating the nature of heterogeneity and the type of relations between regions. The first has been partly explored trough the use of panel data techniques. After a seminal work by Islam (1995) [12] panel data approach has been used to investigate convergence at regional level: applying the within transformation to dependent and explanatory variables (as in the case of a Fixed Effects Estimator) enables to estimate the speed of convergence after regional specific effects have been detected. The main problem arising here is that economies are supposed to converge toward different steady states , and that's why convergence coefficient estimated with FE differs a lot from standard OLS coefficient obtained with cross-section approach. This has been found also at regional level in Europe by Tondl (1998) [24]. So, in the end, panel data techniques do not help better understanding convergence process, but clearly make regional heterogeneity to emerge, even if nothing can be said about the nature of heterogeneity.

The second has been explored trough the use of spatial econometric

tools. Rey and Montouri (1999) [21] firstly examined convergence matters under the spatial econometric point of view and some interesting results emerge when one or more terms of the standard convergence equation are supposed to follow a spatial autoregressive process. There are two ways that help to detect the role of space in regional convergence analysis: spatial relation and spatial interaction. A spatial relation emerge in the case that income distribution is not characterized by spatial randomness, and so the income level in one region is strictly related to income level in neighboring regions. In this case, part of regional heterogeneity could be explained by geographical location, since we can assume differences between two regions are lower when lower is the distance separating them. Spatial interaction refers to a case where effects of regional economic activity spill over the regional border affecting neighboring economies. As well as for intra-firms spillover diffusion (the case where benefits of an investment cannot be closed inside investor firm's walls but extend also to other firms nearly located), there's in fact no reason to suppose benefits in terms of growth are closed inside regional borders. Investigating the role of space in those two aspect will help reaching interesting insights on EU regional convergence debate.

## 4 Data and Methodology

The dataset is composed of 250 regions belonging to 25 member states (actually Romania and Bulgaria regions have been excluded): data on income are available starting from 1995 and ending on 2004. The unit measure is the per-capita Gross Domestic Product in Purchising Power Standard, at 1995 price level, so that to avoid possible biases coming from inflation or life-cost phenomena. Eurostat also provided European map at NUTSII administrative level, that has been used to extract information on geographical location of each region (those last were necessary to compute contiguity). In order to account for spatial relation and spatial interaction effects in convergence equation we used spatial econometric: this can be defined as a set of tools to deal with spatial effects in linear regression model. Spatial effects appear in linear regression model when one or more explicative variable, the dependent variable or the error term follow a spatial autoregressive (generally first order) process. This means that each observation is linked to neighboring observations. In order to define neighboring a spatial weight matrix  $W$  is used, that is a squared positive matrix in which observations appears both in row and column and a non-zero element identifies contiguity between two observations. Generally self-contiguity is excluded so that each element in principal diagonal is zero, and the matrix is used in the row-standardized form. So, given a random vector  $z$ , of dimension  $n$ , its spatially lagged value  $Wz$ , with  $W$  an  $n \times n$  positive matrix, can be interpreted as the neighboring average of  $z$ . This have some important implication in convergence analysis.

Let's consider standard convergence equation in [1]:

$$\frac{1}{T} \log \left( \frac{y_{t+T}}{y_t} \right) = \alpha + \beta \log(y_t) + \epsilon \quad (1)$$

and assume  $\epsilon \sim iid(0, \sigma_\epsilon^2)$ . Here  $\alpha$  and  $\beta$  can be estimated via OLS as long as errors are not correlated with explicative variables: what we expect is a negative and statistically significant coefficient.

The simplest way to account for spatial relation is to include in [1] a spatially lagged initial income level, so that the model became the one in [2]:

$$\frac{1}{T} \log \left( \frac{y_{t+T}}{y_t} \right) = \alpha + \beta \log(y_t) + \gamma W \log(y_t) + \epsilon \quad (2)$$

given convergence, if income would be randomly distributed across space we should note a  $\beta$  coefficient still significant but not the same for  $\gamma$ . By contrast, a significant  $\gamma$  (expected negative), confirms the presence of geographical patterns of income and so growth rate is explained not only by initial income level but also by initial income level in surrounding areas. This formulation goes under the name of spatial cross-regressive model. Notice that, as long as error terms in [2] are still independent and identically distributed, coefficients can be estimated using OLS. At the same way spatial spillover effects can be estimated assuming that the dependent variable or the error term follow a spatial autoregressive process (Anselin L., 1988b) [3]. About first case, generally dependent variable is supposed to follow not a complete spatial autoregressive process but a mixed regressive autoregressive process, so that a spatially lagged dependent variable is added on the right-hand side of the standard regression model. The resulting model is commonly called Spatial Lag Model (hereafter SL), and in the case of the convergence equation it looks like in [3]:

$$\frac{1}{T} \log \left( \frac{y_{t+T}}{y_t} \right) = \rho W \frac{1}{T} \log \left( \frac{y_{t+T}}{y_t} \right) + \alpha + \beta \log(y_t) + \epsilon \quad (3)$$

with  $\rho$  the coefficient that measures the importance of spatial spillover effects. Notice that the presence of a spatially lagged dependent variable in right-hand side of [3] prevents the use of OLS as estimation method. Instead parameters may be estimated via Maximum Likelihood. Once we move the spatially lagged dependent variable in left-hand side we can reorganize everything to reach the reduced form of this model in [4]:

$$\frac{1}{T} \log \left( \frac{y_{t+T}}{y_t} \right) = (1 - \rho W)^{-1} \alpha + (1 - \rho W)^{-1} \beta \log(y_t) + (1 - \rho W)^{-1} \epsilon \quad (4)$$

that is a non-linear model in  $\alpha$ ,  $\rho$  and  $\beta$ . In the second case described above, error terms are supposed to follow a spatial autoregressive process like

in [5], so that an higher than expected growth rate in one region generates an higher than expected growth in neighboring regions.

$$\epsilon = \lambda W \epsilon + \mu \quad (5)$$

With  $\mu \sim iid(0, \sigma_\mu^2)$ ; substituting [5] in [1] we have that

$$\frac{1}{T} \log \left( \frac{y_{t+T}}{y_t} \right) = \alpha + \beta \log(y_t) + (1 - \rho W)^{-1} \mu \quad (6)$$

and so, multiplying both sides of [6] for  $(1 - \rho W)$  and reorganizing everything we get the so called Spatial Error Model (hereafter SE), that is the one in [7]

$$\frac{1}{T} \log \left( \frac{y_{t+T}}{y_t} \right) = constant + \beta \log(y_t) + \lambda W \frac{1}{T} \log \left( \frac{y_{t+T}}{y_t} \right) + \delta W \log(y_t) + \mu \quad (7)$$

with  $constant = (1 - \lambda W)\alpha$  and a linear constraint on coefficients  $\delta = -\lambda\beta$ .

As well as for SL model also in SE model the lack of independence assumption made about the error term prevents the use of OLS, and Maximum Likelihood Method has to be used. Notice that in SE model both a spatially lagged growth rate and a spatially lagged initial income level are present, so that spatial relations and spatial interactions are considered together.

## 5 Empirical Results

In this section we provide empirical results of convergence analysis using spatial econometric approach. Spatial analysis starts from statistical evidence of spatial correlation for the considered variable: a statistical measure to see whether GDP is spatially correlated is the Moran Index in [8] (Moran, 1950) [15]: it measures the probability that regions with high (low) value of GDP are located near regions with high (low) values of GDP.

$$I_t = \frac{n}{\sum_{i=1}^n \sum_{j=1}^n w_{ij}} \cdot \frac{\sum_{i=1}^n \sum_{j=1}^n w_{ij} (x_{it} - \bar{x}_t)(x_{jt} - \bar{x}_t)}{\sum_{i=1}^n (x_{it} - \bar{x}_t)^2} \quad (8)$$

Where  $w_{ij}$  is the generic element of  $W$  matrix defined in previous section,  $x_{it}$  the natural logarithm of per-capita income at time  $t$  in region  $i$ , and  $n$  the number of regions. An higher than expected index

$$I > E(I) = -1/(n - 1)$$

means that the probability for observations to be spatially auto-correlated is higher than the one obtained if observations will be randomly distributed

Year	I
1995	0.5184
1996	0.5011
1997	0.4884
1998	0.4817
1999	0.4597
2000	0.4534
2001	0.4484
2002	0.4256
2003	0.4158
2004	0.4081
E(I)	-0.004

Table 1: Moran Index for GDP

across space. Table 1 reports  $I$  index values for GDP in each year: as expected, Moran's  $I$  is always significantly higher than its expected value.

In order to analyze what consequences this may have for standard convergence analysis, we start from results of standard OLS estimation in table 2.

As expected, convergence coefficient is negative and significant. Even if null hypothesis of normality of errors cannot be rejected, there's no trace of heteroschedasticity; instead Moran's  $I$  on regression residuals shows spatial autocorrelation in error terms. Common practice is to compare results of LM indicators for the SL and SE specification in order to select the model that best fits spatial connections. Following Anselin (1988a) [2] the one achieving the higher values should indicate the best model (given the higher significance), but in the case both are significant the robust version should better identify the correct model (it is not easy to have both robust tests highly significant) (Anselin & Rey, 1991) [5]. In our case the SL model is the best choice, and in order to find the contiguity matrix that best expresses spatial spillovers we estimated different models with different  $W$  matrices and selected the one with the higher Akaike Information Criterion and Log-Likelihood (Akaike, 1981) [1]. Notice that contiguity matrices have been not constructed using physical contiguity information but considering neighbors all regions within a certain distance (distance-based contiguity) or all  $k$ -nearest regions ( $k$ -nearest contiguity). In table 3 results of all those estimation have been reported: left column indicates the way  $W$  matrix have been constructed, while on the right side other two columns indicate the average number of neighbors and the number of regions with no neighbors.

Note that all models show an higher likelihood if compared with the standard OLS regression model: here the matrix constructed selecting as neighbors the 9 nearest regions seems to be the best choice. Following this choice SL and SE model have been estimated and results are resumed in

Dep Var: Annual Average Growth Rate	
<b>Constant</b>	0.204 *** (11.33)
<b>Initial Income</b>	-0.0168 *** (-8.89)
<i>R-squared(adjusted)</i>	0.65625
<i>F-statistic</i>	79.02 ***
<i>Log-likelihood</i>	750.034
<i>Akaike Information Criterion</i>	-1496.07
<b>Diagnostic for Normality of Errors</b>	
<i>Jarque-Bera Test</i>	17.78 ***
<b>Diagnostic for Heteroskedasticity</b>	
<i>Breusch-Pagan Test</i>	0.2625
<b>Diagnostic for Spatial Dependence</b>	
<i>Moran's I on Regression Residuals</i>	0.2656
<i>LM lag</i>	98.71 ***
<i>LM error</i>	90.67 ***
<i>Robust LM lag</i>	11.50 ***
<i>Robust LM error</i>	3.46 *
t-statistic in brackets. Significance: *** 99%, ** 95%, * 90%	

Table 2: OLS Estimation of Convergence Equation

SL model estimated via Maximum Likelihood				
matrix	AIC	Log-Likelihood	Av. Neigh	No Neigh
WK3	-1545.4	776.69	3	0
WK4	-1544.3	776.14	4	0
WK5	-1546.8	777.42	5	0
WK6	-1546.8	779.39	6	0
WK7	-1550.4	779.21	7	0
WK8	-1552	780.02	8	0
WK9	-1553.9	780.94	9	0
WK10	-1552.6	780.31	10	0
WK20	-1541	774.05	20	0
WK50	-1523	756.05	50	0
WK100	-1506.3	757.16	100	0
WD2	-1520.1	764.02	0,314583	24
WD3	-1523	765.49	14.54	9
WD4	-1521.4	764.69	23.02	9
WD5	-1530	768.97	32.51	4
WD10	-1505.7	756.69	90.02	3
WD20	-1492.3	750.15	190.31	1
WDMAX	-1493.5	750.55	241.37	0

Table 3: Optimal Contiguity matrix selection

table 4

	SL	SE
<b>Constant</b>	.092 *** (4.75)	.1030 *** (3.82)
<b>Initinc</b>	-.008 *** (-4.33)	-.007 ** (-2.33)
<b>Lagged Initinc</b>		-.002 (.63)
<b>Rho/Lambda</b>	.6507 *** (9.72)	.6336 *** (8.51)
<i>Likelihood Ratio</i>	61.81 ***	50.45 ***
<i>Wald statistic</i>	94.49 ***	72.44 ***
<i>Log-Likelihood</i>	780.94	781.14
<i>AIC</i>	-1553.9	-1552.3
<i>LM-test</i>	.048	.107
z-statistic in brackets. Significance: *** 99%, ** 95%, * 90%		

Table 4: Spatial Lag and Spatial Error models: ML estimation

Wald statistic confirms that SL model is a better choice. Convergence coefficient is still significant in both cases, as well as the coefficient that measures spillover effects, but the coefficient of lagged initial income in SE model is not significant (even if of the expected sign). This has some important implications if we compare those results with the ones obtained estimating Spatial Cross-Regressive model (in table 5).

OLS Estimation	
<b>Constant</b>	0.259 *** (11.32)
<b>Initinc</b>	-.007 ** (-2.32)
<b>Lagged Initinc</b>	-.014 *** (-3.45)
<i>R-squared (adjusted)</i>	.2707
<i>F-statistic</i>	47.02
t-statistic in brackets. Significance *** 99%, ** 95%, * 90%	

Table 5: Spatial Cross-Regressive Model

It's easy to see that a spatially lagged initial income alone is significant, attributing importance to spatial relation, but modeling spatial interaction is a more correct way to account for spatial matters in classical convergence regression.

We can then briefly conclude that spatial spillover diffusion theory helps to explain regional growth in Europe: in table 4, the convergence coefficient of the SL model (that can be interpreted as the speed of the convergence process) turned to be much more lower than in the standard case in table 2.

Once we know that regional growth is characterized by spillover diffusion, accounting for contiguity in  $W$  matrix simply with 1 or 0 may appear as a simplification, as long as it is the empirical counterpart of the assumption that spillover diffusion process is the same in all areas. On the contrary, diffusion is supposed to be easier in agglomerated areas and faster if regions are separated by small distances. That's why a gravity formulation for the element of  $W$  matrix should represent a better specification. In particular, we supposed spillover diffusion depends positively on the size cross-product and negatively on distance: size can reflect economic agglomeration (in this case we used GDP) or social agglomeration (in this case we used the population). Coming out matrices are reported in table 6 together with the name identifying the model.

Model	Gravity Formulation	Model	Gravity Formulation
1/D	$\frac{W_{ij}}{d_{ij}}$	1/D2	$\frac{W_{ij}}{d_{ij}^2}$
GG/D	$\frac{GDP_i \times GDP_j}{d_{ij}}$	GG/D2	$\frac{GDP_i \times GDP_j}{d_{ij}^2}$
G2G2/D2	$\frac{GDP_i^2 \times GDP_j^2}{d_{ij}^2}$	G2G2/D	$\frac{GDP_i^2 \times GDP_j^2}{d_{ij}}$
PP/D	$\frac{POP_i \times POP_j}{d_{ij}}$	PP/D2	$\frac{POP_i \times POP_j}{d_{ij}^2}$
P2P2/D2	$\frac{POP_i^2 \times POP_j^2}{d_{ij}^2}$	P2P2/D	$\frac{POP_i^2 \times POP_j^2}{d_{ij}}$

Table 6: Gravity Structures

Applying these matrices to spatial lag model we obtained different estimated values of parameters, but in all cases slopes were of the expected sign and significant. Given consistency of all models we selected the most efficient using Akaike Information Criteria (AIC) and Log-Likelihood criteria (LL).

Notice also that those specifications account for distance in physical sense, not considering the stock of transportation and communication infrastructure that also play an important role (Toral, 2005) [25]. Finally note that  $\rho$  coefficient in PP/D model is lower than the standard SpLag, indicating that binary choice for contiguity matrix overestimates spillover diffusion.

## 6 Conclusions

In this work we have examined convergence in EU regions starting from classical regression framework and also using spatial econometric tools. The

Model	constant (z)	beta (z)	rho (z)	AIC	LL	W (p-value)	LM (p-value)
1/D	.091 *** (4.86)	-.0078 *** (-4.34)	.63 *** (9.86)	-1558.4	783.20	97.3 (.000)	.352 (.55)
1/D2	.098 *** (5.34)	-.0083 *** (-4.66)	.56 *** (9.31)	-1557.2	782.6	86.75 (.000)	3.79 (.051)
GG/D	.093 *** (4.93)	-.008 *** (-4.41)	.62 *** (9.59)	-1556.3	782.17	92.04 (.000)	.369 (.54)
GG/D2	.10 *** (5.46)	-.008 *** (-4.76)	.56 *** (9.05)	-1554.9	781.44	81.85 (.000)	3.91 (.047)
G2G2/D2	.10 *** (5.65)	-.009 *** (-4.93)	.54 *** (8.66)	-1551.1	779.56	75.05 (.000)	3.94 (.047)
G2G2/D	.098 *** (5.14)	-.008 *** (-4.58)	.60 *** (9.05)	-1552.2	780.07	81.99 (.000)	.072 (.39)
PP/D	.096 *** (5.17)	-.008 *** (-4.62)	.62 *** (9.81)	-1562.4	785.18	96.34 (.000)	.941 (.332)
PP/D2	.10 *** (5.46)	-.008 *** (-4.76)	.56 *** (9.04)	-1554.9	781.44	81.85 (.000)	3.91 (.047)
P2P2/D2	.11 *** (6.05)	-.009 *** (-5.28)	.54 *** (9.17)	-1561.3	784.64	81.17 (.000)	4.31 (.0379)
P2P2/D	.11 *** (5.74)	-.009 *** (-5.11)	.57 *** (9.31)	-1560.6	784.29	86.66 (.000)	2.67 (.102)
SpLag	.092 *** (4.75)	-.008 *** (-4.32)	.65 *** (9.72)	-1553.9	780.94	94.49 (.000)	.048 (.826)

Table 7: Spatial Lag Models Estimated Using Gravity Structures

linear regression approach to convergence has been fully criticized both under the theoretical and empirical point of view: theoretically because it is derived by neoclassical growth model, whose assumption (in particular the CRS production function and the uniqueness and stability of the steady state) seem to be quite unrealistic and simplistic; empirically because standard convergence evidence is not sufficient to allow disparities reduction over time. And that's why some others more recent approaches emerged focusing on the long-run tendency of income distribution (Quah, 1993b) [18]. Our opinion is that the econometric approach has still some explaining power: accounting for spillover diffusion in regional growth gives a clearer evidence of income convergence and results are also coherent with many statements of New Economic Geography (Ottaviano & Thisse, 2004) [17]. We have found evidence of convergence in EU regions during the period 1995-2004 and the speed of this process has been estimated around 2% a year. Since errors were spatially autocorrelated, some kind of spatial process should have been considered, and the spatial lag model, accounting for benefits in term of growth one region receives from neighbors, resulted the best choice. Those relations have been considered using a contiguity matrix made of elements 0 characterizing non-contiguity and 1 characterizing contiguity. This

binary choice appeared an excessive simplification: applying the gravity approach (Newton, 1687) [16] (Zipf, 1946) [26] (Sen & Smith, 1995) [22] to contiguity matrix elements enabled to consider spillover diffusion process to be higher in socially and/or economically agglomerated areas. With this last formulation the model seems to be better specified. We can than conclude that a convergence process exists in European regions, but standard tests are not sufficient since regions are not islands and economies are not closed. Instead they compete and at the same time cooperate, so that each economy is strictly related to his neighbors. These relations are stronger in agglomerated areas, where regions continuously benefits of each-other growth. Policy-makers should account for that when programming policy actions at regional level trying to boost growth in some particular areas, so that benefits can extend to all others regions. Moreover a further effort is necessary to investigate, at local level, what makes the spillover diffusion faster, so that investments could be concentrated in strategic sectors.

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