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Structural change, productivity growth and Structural Funds in European regions

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Abstract

In the present paper structural and within components of the productivity growth are examined. The regions that manage to pull out of poverty and improve their living standards, in facts, need to be able to diversify away from agriculture and other traditional sectors. In the first step, an exploratory analysis leads to observe that structural and within variation are strictly clustered with respect to their geographical location. The estimation of the factors that influence within and structural change is then performed through a spatial econometric model able to explicitly include spatial spillover effects. Empirical estimation shows that structural change is promoted by high skilled human capital and agglomeration and from their respective spillovers, denoting the existence of Jacobian externalities across industries. The initial presence of low productivity sectors as well as the proximity to big market does not have any impact and institutions and Structural Funds discourage within change but they do not have a decisive role in promoting the structural variation. Finally, structural change is a key factor in order to cushion the fall of productivity between 2008 and 2009.

1. Introduction

Since the mid of nineties, the interest upon the empirical study of the economic convergence of European regions has grown considerably. This is due to two main factors: the first regards the findings related, among others, to the empirical studies of Barro and Sala-i-Martin (1991) and the second the key contribution, in term of budget and policies, of the European Union to the economic convergence¹. Regarding this last point, a number of empirical studies demonstrate that Structural

¹ The largest amount of regional policy funding (more than 80%) is dedicated to the regions falling under the Convergence objective. This objective covers Europe's poorest regions whose per capita gross domestic product (GDP) is less than 75% of the EU average. The Convergence objective aims to allow the regions affected to catch up with the EU's more prosperous regions, thereby reducing economic disparity within the European Union.

Funds devoted to convergence, have a limited or even insignificant impact on the Gross Domestic Product per capita of the assisted and more in general on their economic performances areas (Rodriguez-Pose and Fratesi, 2004; Ederveen et al., 2006; Dall’erba and Le Gallo, 2007, 2008; and Mohl and Hagen, 2010). At this regard Boldrin and Canova (2001) sustain that the contribution of regional and structural policies is mostly redistributinal. Recent findings show that Structural Funds are conditional effective, such as, they affect regional economies under certain specific conditions, e.g. institutional quality (Ederveen et al. 2006 and Montresor et al. 2013).

My study faces the regional growth under a different point of view. It focuses on labor productivity because it is recognized as a key factor to guarantee a stable and solid regional development (Krugman, 1992). In particular, productivity growth is split into two parts: the “within” growth regards the change inside individual sectors and the “structural” growth the reallocations across different sectors. At this regard, the ability of the regions to diversify away from traditional sectors – i.e., to modify their economic structure – and the speed with which labor and other resources move to modern economic activities are the fundamental factors that differentiates successful regions from unsuccessful ones. The investigation continues looking at the geographical patterns of the “within” and the “structural” variation, analysing the factors that affect the two components of the labor productivity growth and then drawing some insights about the relationship with the recent financial crisis.

The paper is divided into five further sections. In the next the decomposition of labor productivity and an exploratory spatial analysis are performed. In the third the spatial econometric technique is presented. The fourth regards the model and the data used. The fifth looks at the empirical results while in the last some conclusions and policy implications are presented.

2. Productivity growth decomposition and exploratory spatial data analysis

According to McMillan and Rodrik (2011), labor productivity growth can be achieved through the growth within economic sectors or through labor mobility across sectors, from low-productivity to high-productivity sectors, increasing overall labor productivity in the economy. This can be expressed using the following decomposition:

$$\Delta Y_t = \sum_{i=1}^N \theta_{i,T-t} \Delta y_{i,t} + \sum_{i=1}^N \Delta y_{i,t} \theta_{i,t} \quad (1)$$

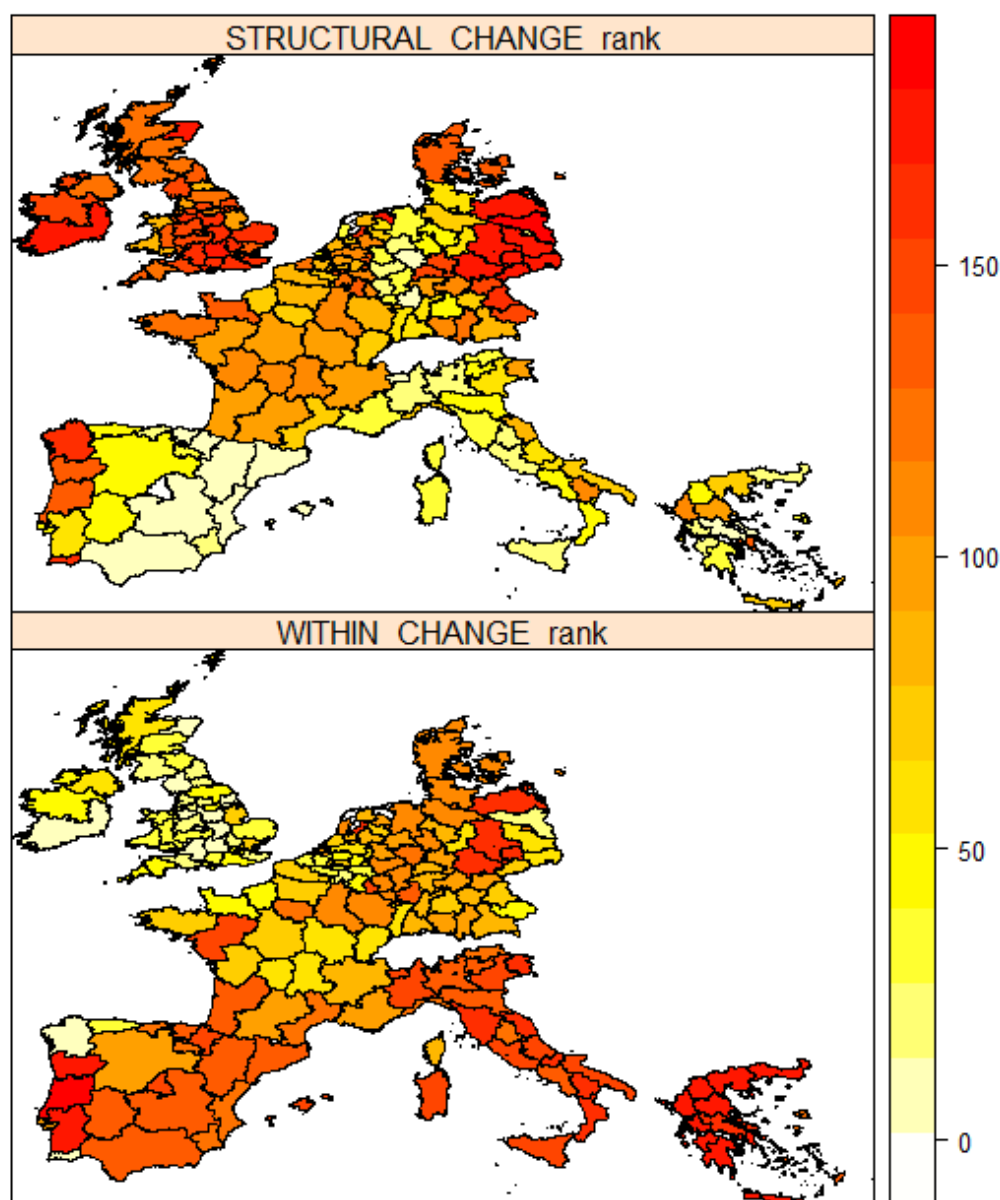
where Y_t and $y_{i,t}$ refer to economy-wide and sectoral labor productivity levels, respectively, and $\theta_{i,t}$ is the share of employment in sector n of which there are N . The Δ operator denotes the change in productivity or employment shares between $T-t$ and T . The first term in the decomposition, the “within” component of productivity growth, denotes the variation of productivity due exclusively to

a change inside individual sectors (employment is kept unaltered). The second term, the “structural change” term, captures the productivity effect of labor reallocations across different sectors. It captures the productivity effect of labour reallocations across different sectors (i.e., the inner product of productivity levels at the end of the time period with the change in employment shares across sectors). A positive correlation between changes in employment shares and productivity levels means that structural change will increase economy-wide productivity growth. The identification of the regions whose productivity growth is characterized from “structural” variation allows determining the sustainability of their economy in the long run.

The decomposition is performed upon the average productivity growth of 180 NUTS 2 regions in the time-span 1989-2006. Five sectors from Cambridge Econometrics database 2012 are used: agriculture, manufactory, construction, market services and non market services.

Figure 1 shows the choropleth maps of the structural and within variations. The regions are ranked from the lighter to the darker in function to the weight of each component of the productivity growth. It is immediately visible the tendency to form clusters of regions with higher structural change in the continental Europe, with three cohesion countries - Spain, Italy and Greece - characterized essentially from the only within variation. The within and structural changes are rather homogeneous within countries. Only Germany shows a different behavior in its eastern and western part. Former DDR regions and the ones bordering former communist countries have had a strong shift to the more productive sectors at the cost of the more developed western regions. This process is very important because it is able to guarantee a catch-up between the clusters of eastern poorer and western richer regions within the same country. In the other countries, in particular in the Spain, Italy and Greece, the homogeneous spatial patterns of the two components of the productivity growth show that the existing productivity gap between the lagging and the developed region still exists. With respect to the European perspective, the Mediterranean countries are falling the catching up with continental countries.

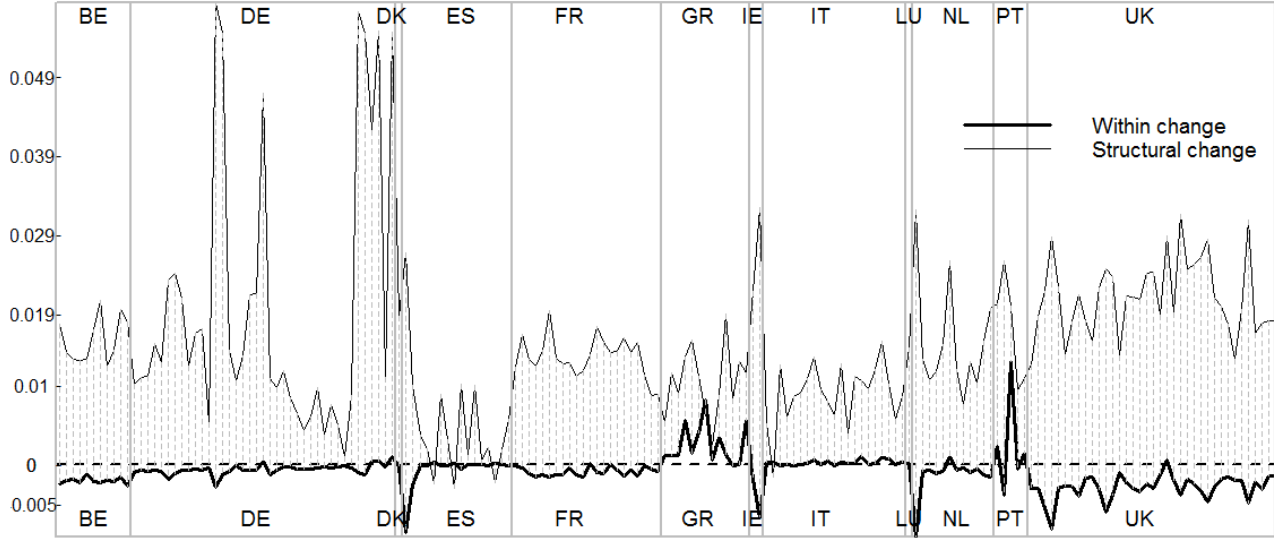
Figure 1: Choropleth maps of the decomposition of productivity growth, 1989-2006



In figure 2 there is the decomposition of productivity growth by region. The darker light denotes within change and the lighter the structural change. The higher contribution to average productivity growth is due to structural change. It overcomes the within change, generally negative, in almost all regions. Structural change is not homogeneous within the following countries: France, Italy, Belgium, Denmark and partially in Great Britain, and within variation has a positive contribution to the productivity growth only in Portugal and Greece. The little productivity growth of Italy is characterized from a small positive contribution of within growth and from a predominant role of structural change. In the case of Spain, the contribution of the two components of productivity growth is very differentiated. In some regions they have the same sign and in others the reverse. In Belgium, and even more Great Britain, there is a strong negative role of within component, showing that the

inner gain of productivity moves in the opposite direction with respect to the overall productivity growth, due only to structural change. Finally, in Germany the mentioned catching-up process of the lagging regions is evident and due mainly to the intersectoral productivity change.

Figure 2: Decomposition of productivity growth by region, 1989-2006



The spatial autocorrelation is examined through the Moran's I defined as:

$$I = \frac{n}{S_0} \frac{\sum_i \sum_j w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{\sum_i (x_i - \bar{x})^2} \quad (2)$$

where \bar{x} is the mean of the x variable, w_{ij} are the elements of the weight matrix, and S_0 is the sum of the elements of the weight matrix: $S_0 = \sum_i \sum_j w_{ij}$.

Moran's I is similar but not equivalent to a correlation coefficient. It varies from -1 to +1. In the absence of autocorrelation and regardless of the specified weight matrix, the expectation of Moran's I statistic is $-1/(n-1)$, which tends to zero as the sample size increases.

In the study a queen row standardized spatial weight matrix is used. The choice of the Queen spatial weight matrix comes from the intuitive idea according to which, without knowing the exact spatial linkage and interactions among regions², the most simple and foregone relation is due to geography: a region is considered a neighbor if it exhibits at least a shared border or vertex. We tested other spatial weight matrices weights matrix obtaining similar results.

² The concept of proximity can assume various definitions, e.g. cultural, economic, institutional, geographical, etc. Still, each definition could refers to different and distinct concepts. For example, cultural proximity could be due to common language, common habits, common religion, etc.

Table 1 shows the existence of a clear positive spatial pattern: regions with similar values of the variables are located in neighbor regions. This is a statistical confirmation of the visual results in table 1.

Table 1: spatial autocorrelation

Variable	Moran's I	p-value
Growth 89-06	0.528	< 0.001
Within	0.415	< 0.001
Structural	0.546	< 0.001

3. Spatial econometric technique adopted

After the identification of the paths of within and structural growth of European regions, it is useful to assess what are the conditions that affect them. To reach this aim, I perform a cross-section regression where a set of variables are correlated, respectively, with structural and within variation. At this regard, it is conceivable that the growth of productivity, and of its two components, depends upon the own region as well as neighboring region characteristics and upon the spatial connectivity structure among them.

In this paper I test the possibility to use a very general spatial model called spatial Durbin in which both dependent and independent variables are lagged with respect to the averaged values of the neighbors.

The spatial Durbin model is specified as follows:

$$y = \rho W y + \alpha + X \varphi_1 - W X \varphi_2 + z \quad (3)$$

where y is a $N \times 1$ vector of the dependent variable, α is an $N \times 1$ vector of constant terms and X is an $N \times K$ matrix of explanatory variables. The matrix W is an $N \times N$ non-stochastic, non-negative spatial weight matrix. If observation region i is related to observation j , then $W_{ij} > 0$. Otherwise, $W_{ij} = 0$, and the diagonal elements W_{ii} , by convention, are set to zero. The parameters ρ , φ_1 and φ_2 are to be estimated. The spatial autoregressive parameter ρ , that varies between -1 and 1, indicates the level of spatial interaction between regions. Finally, $z \sim N(0, \sigma^2 I)$ is an $N \times 1$ vector of well-behaved error terms. This model can be justified from a set of theoretical and empirical considerations that I briefly resume in the following lines.

Spatial Durbin model, can be easily derived from a spatial error model³ where $\varepsilon = \rho W \varepsilon + v$, and $v \sim N(0, \sigma^2 I)$ is a $N \times 1$. The presence of residual spatial dependence, and its modelling as a spatial error model, as noted by Fingleton and López-Bazo (2006) and LeSage and Fischer (2008), may reflect the

³ In appendix A there is the derivation of spatial Durbin from spatial error model.

omission of one or more spatially autocorrelated variables. This points out the problem of biased and inconsistent estimation of the coefficients for the remaining variables because it is unlikely that X and v are uncorrelated.

Spatial heterogeneity can be dealt with the use of regional (or country) dummies. According to LeSage and Pace (p. 29, 2009a), the vector of dummies can be treated as a spatially structured random effect vector, falling in the case of spatial error model that leads to the more convenient spatial Durbin model for the reasoning expressed above.

An intuitive justification to spatial Durbin is related to the spatial context to which it refers. In a growth process, it is not possible, mainly in Europe, to ignore the spatial spillovers and agglomeration (or congestion) effects. At this regard, the characteristics of the surrounding regions (Wx), with respect to the one of interest, should be determinant ($\phi_2 > 0$), detrimental ($\phi_2 < 0$) or irrelevant ($\phi_2 = 0$). In the last case spatial Durbin is simplified to spatial lag model. The same could be said about the spatial lag of the dependent variable (Wy): the role of the structural or within change of the neighbor regions is measured from the parameter ρ , which determines the strength of the spatial multiplier $(I - \rho W)^{-1}$.

The spatial multipliers is the key in determining the marginal effects of the regression model:

$$\frac{\partial y_i}{\partial x_{ij}} = (I - \rho W)^{-1} (I\phi_1 + W\phi_2) \quad (4)$$

Estimated effects do not depend only from ϕ_1 , but also from the sign and magnitude of ρ and ϕ_2 . The matrix of partial derivatives has the following scalar summary measures (LeSage and Pace, 2009a, 2009b):

- (a) the *average direct effect* constructed as an average of the diagonal elements of $(I - \rho W)^{-1} (I\phi_1 + W\phi_2)$, such as the average response of the dependent to the independent variable, like in typical regression models,
- (b) the *average indirect effect* constructed as an average of the off-diagonal elements of $(I - \rho W)^{-1} (I\phi_1 + W\phi_2)$, where the off-diagonal row elements are summed up first, and then an average of these sums is taken,
- (c) the *average total effect* is the sum of the direct and indirect impacts.

The *indirect effect* estimates corresponds to the spatial spillovers and should be interpreted in two distinct ways. The first interpretation reflects how a change in the value of a variable of all regions by some constant would impact the dependent variable in a typical region (*indirect effect to an observation*). According to the second, the indirect effect measures the cumulative impact of a change in the initial level of a variable in a region averaged over all other regions (*indirect effect from an observation*) (Fischer *et al.* 2009).

In the case of a spatial lag model, the interpretation is the same, but the characteristics of the neighboring regions do not account for the determination of the indirect effects, i.e. $\varphi_2 = 0$.

The choice of the spatial Durbin model can follow a general-to-specific or a specific-to-general approach. In the former case, a Lagrange Multiplier test is performed on OLS estimates. In the latter, a LR and Wald test is done to investigate whether this model can be simplified to the spatial lag model, i.e., $H_0: \varphi_2 = 0$, or whether it can be simplified to the spatial error model, $H_0: \varphi_1 + \rho\varphi_2 = 0$ (Mur and Angulo, 2006).

4. The economic model

In the paragraph I explain the economic model that I adopt to determine what are the conditioning variables that affect structural and within change. The model, which takes the form of equation (3), is as follows:

$$g_i = f\left(\text{agglom}, \text{agglom}^2, \ln(gva_{89}), \ln(hrs_{89}), \ln(agri_{89}), \ln(mkp_{89}), \ln(kru_{89}), \ln(funds), qli\right) \quad (5)$$

The main source of data is Cambridge Econometrics database 2012. For human capital (*hrs*) we use Eurostat's region database, for Structural Funds some Reports of the European Commission (1995, 1997, 1999, and 2006), and for the institutional quality indicator (*qli*) data from Charron et al. (2013). The variables to be included in the model are defined in the base year 1989 and their description is in the following matrix (Table 2).

Table 2: The variables used in the analysis

Variable	Description
g_i	either within change or structural change as in equation (1)
$\log(gva/emp \ 1989)$	(log of) Gross Value Added per employee
agglom	population density (persons/km ²), as a proxy for agglomeration economies
$\log(hrs)$	(log of) human resources in science and technology core over population
$\log(agri)$	(log of) share of employment in agriculture over total employment
$\log(mkp)$	(log of) market potential
$\log(kru)$	(log of) the level of specialization of regional employment
$\log(funds)$	(log of) the Structural Funds for Objective 1, 2 and 5b over gross value added
qli	institutional quality indicator

4.1 Gross Value Added per employee

The Gross Value Added per employee is a control variable included in the cross-section type growth regression models. A negative and significant coefficients means that poorer regions tend to growth to the levels of the more developed.

4.2 Agglomeration and economies of scale

The degree of agglomeration of the regional economy is proxied by the population density, as customary in the literature. In addition, the presence of local economies of scale or diseconomy due to congestion processes is proxied by the square of the variable.

4.3 Human capital

The high quality of human capital is a key driver for the long-term growth of productivity and income. It guarantees a higher level of growth through the activity of research and development that can turn into new, commercially viable products and services. Highly skilled human capital can also absorb and adapt the existing external knowledge to the needs of the local firms, a process identified by the literature as a basic requirement for economic dynamism (Cohen and Levinthal 1990; Maurseth and Verspagen 1999). In the context of structural and within change, the role of the human capital cannot be ignored because it is conceivable that its presence facilitate the process of shifting of the regional economies to a more productive structure.

4.4 Low productivity sector (agriculture)

The weight of agricultural sector is the proxy of the strength of the traditional sector (Dell'Erba and Le Gallo, 2008), or, in other terms, the amount of human resources excluded from productive employment. The choice of this variable allows observing the capacity of a region to moves away from a typically low productive sector. The absence of statistical significance of the parameter lets to infer that the presence of a traditional sector is not an obstacle to the structural or within change. A positive correlation means that, *ceteris paribus*, a higher weight of agriculture is a factor that facilitate the structural or within change. On the contrary, a negative value would show that the traditional sector is an obstacle for structural change or for the gain of productivity due only to the inner variation.

4.5 Market potential

Market potential in region i is defined as:

$$mkp_i = \sum_k^N \frac{X_k}{\text{dist}_{i,k}}$$

where X_k is the employment in region k and $\text{dist}_{i,k}$ is the distance between the centroids of region i and k defined in kilometers.

The proximity to big markets is one of the factors that should help firms to quickly and easily sell their products. Accordingly, regions' structural and/or within change could be determined from their privileged position in term of proximity to attractive markets. A region with a strong economic

structure, with a high capacity to export, should take advantage from the big markets of the surrounding regions in term of higher possibility of selling its products. This could determine a shift toward the more productive sectors in order to increase the opportunity to sell more rentable products. At the opposite, a weak region should suffer from the attractively and high potential neighbor regions because bigger markets could mean higher working opportunities and better expected incomes with the consequence that skilled workers would find convenient to emigrate. In this case a negative effect on structural change would be observed. In the meantime, regions would specialize upon the sectors where they have a comparative advantage, and a positive sign with respect to within variation is expected. If the two mentioned effects, in an average regions, compensate each other, or the geographical position with respect to the market is not an important factor in order to determine structural or within change, then the parameter associated to the market potential is not significantly different from zero.

4.6 Krugman Index

The Krugman specialisation index to measure the specialisation of local employment, according to Midelfart-Knarvik et al. (2002) is defined as follows:

$$K = \sum_{i=1}^N |g_{ij} - g_j| \quad \text{where } g_{ij} = \frac{X_{ij}}{\sum_{j=1}^M X_{ij}} \quad \text{and } g_j = \frac{X_j}{\sum_{j=1}^M X_j}$$

Where X_{ij} and X_j represent, respectively, the employment in branch j in region i and the national employment in branch j . The range of the index is between zero (sectoral structures are identical to the rest of the EU) and two (for totally different structures). The Krugman Index has been calculated on the data for employment in NUTS 2 regions, for the following sectors: agriculture, manufactory, construction, market services and non-market services. The Krugman index is expected to be negative when correlated with the structural change. This reflects the idea according to which more specialized regions should meet more difficulties in modifying their economic structure. On the contrary, when related to within change, a positive sign is expected because a higher degree of specialization should lead to an increasing probability of inner sectoral improvement.

4.7 Structural Funds

According to the endogenous growth theory, public policies have an important role in the determination of growth rates in the long run. Barro (1990) predicts that policies financing new public infrastructures increase the marginal product of private capital, hence fostering capital accumulation and growth. At this regard, the role and the strength of European Cohesion Policy in fostering structural and within change is investigated. In the former case, public investments would represent

a way to effectively improve regional competitiveness. In the latter case the European Cohesion Policy would not reach its aim to make regions more competitive because it would not have been able to stimulate the shift to more productive sectors.

In this work I consider only the regionally targeted Objectives, such as 1, 2 and 5b⁴ for the programming period 1989-1993 and 1994-1999, and Objectives 1 and 2 for the third period, 2000-2006 because Objective 5b was included in Objective 2.

4.8 Institutional quality

Institutions are a not negligible factor when dealing with economic growth. At the contrary, they could play a fundamental role in promoting growth (OECD, 2009). In order to account for institutions, I refer to the Quality of Government Composite Index developed by Charron et al. (2013), a composite indicator that combines data for both the national and regional levels. This indicator is constructed to account only for formal institutions, such as aspects related to constitutions, laws, charters and regulations (Amin, 1999). Informal institutions, which comprise traditions, group routines, social norms and conventions, and informal networks (Rodríguez-Pose and Storper, 2006) are intentionally neglected, probably for the difficulty in measuring them. In this study, it was assumed that the EUqogIndex remains stable (or changes very slowly) over time (Ederveen et al., 2006).

5. Results of the analysis

5.1 The determinants of within and structural change

In this paragraph I adopt the spatial econometric approach specified in paragraph 3 to test the economic model described in paragraph 4. The first preliminary step consists in the individuation of the right spatial model. The results of this selection are in table 2. In the specific-to-general approach the robust version of the Lagrange Multiplier test shows that the spatial error model is the best choice for both within and structural change models. Nevertheless, as described in paragraph 3 and more in detail in Appendix A, the spatial error model could hide the presence of omitted variables leading to

⁴ The objectives are the following:

- Objective 1: promoting the development and structural adjustment of the regions whose development is lagging behind (regions with GDP per capita lower than 75% of the Community average);
- Objective 2: converting the regions seriously affected by industrial decline (high unemployment and low employment growth);
- Objective 3: combating long-term unemployment;
- Objective 4: facilitating the occupational integration of young people;
- Objective 5a: speeding up the adjustment of agricultural structures;
- Objective 5b: promoting the development of rural areas.

Objectives 1, 2 and 5b are regionally targeted; Objective 1 and other Objectives are mutually exclusive.

bias results. The Wald and Likelihood-ratio (LR) tests in the general-to-specific approach, in the case of within model, show a clear preference for spatial lag model, and in the case of structural change for Spatial Durbin. In light of these results, the choice is for Spatial Durbin when dealing with structural change and spatial lag with within change. Spatial lag model has the advantage to include global spatial externalities (Anselin, 2002), a high probable situation in presence spillover effects.

Table 2: test for the correct identification of the spatial model

Within change				Structural change		
Specific-to-general: OLS vs. Spatial lag, Spatial Error and Spatial Durbin						
Test	Value	Df	P-value	Value	Df	P-value
LM err	7.02	1	0.008	18.46	1	< 0.001
LM lag	11.19	1	< 0.001	29.97	1	< 0.001
Robust LM err	1.04	1	0.307	0.71	1	0.398
Robust LM lag	5.21	1	0.022	6.23	1	0.012
Spatial Durbin	12.23	2	0.002	24.69	2	< 0.001
General-to-specific: Spatial Durbin vs. Spatial lag and Spatial Error						
Test	Value	Df	P-value	Value	Df	P-value
Wald lag	15.50	9	0.078	21.66	9	0.010
LR lag	14.40	9	0.108	20.36	9	0.016
Wald err	17.62	9	0.040	22.36	9	0.008
LR err	17.63	9	0.040	23.28	9	0.005

Estimation results of the model (5) are in table 4. These estimates are not useful in order to interpret the model because the partial derivatives shown in equation (4) are not directly observable in this table. The parameters ρ are positive and strongly significant. This is expected because Moran's I in table 1 shows a positive and significant spatial autocorrelation. The positive ρ implies that a positive (negative) indirect effect has a positive (negative) impact on surrounding regions' within (structural) change which, in turn, has a positive (negative) impact on within (structural) change of the study region. This process is analogous in both spatial lag and spatial Durbin model.

Wald test is equal to 11.543 for within model and 12.377 for structural change model with a *p-value* < 0.001. The models are highly significant. Lagrange Multiplier test for spatial autocorrelation in the residuals is 0.742 for within model and 6.044 structural change model. In the former case the residuals are spatially autocorrelated with a probability lower than 5% while in the former the probability is less than 0.01%. Finally, Braush Pagan test for heteroskedasticity in highly significant in both models (the value is 27.47, with 9 degree of freedoms for within model and 50.30 with 18 degree of freedom for structural change model).

Table 3: estimation results

	Within change	Structural change
Variable	Estimate	Estimate
Intercept	0.0183 ** (0.0068)	0.1912 *** (0.0421)
log(gva/emp 1989)	-0.0020 ** (0.0007)	-0.0272 *** (0.0030)
agglom	-0.0002 (0.0005)	-0.0042 ** (0.0017)
agglom ²	0.0000 (0.0001)	0.0006 ** (0.0003)
log(hrs)	0.0009 (0.0006)	0.0087 ** (0.0029)
log(agr)	0.0000 (0.0002)	-0.0004 (0.0009)
log(mkp)	0.0017 ** (0.0007)	-0.0027 ** (0.0015)
log(krg)	-0.0002 (0.0002)	-0.001 (0.0027)
log(fnds)	-0.0001 * (0.0001)	0.0003 (0.0003)
qli	-0.0009 *** (0.0003)	0.0027 * (0.0014)
W×log(gva/ emp 1989)		0.0066 (0.0051)
W×agglom		0.0005 (0.0040)
W×agglom ²		0.0006 (0.0008)
W×log(hrs)		0.0063 (0.0040)
W×log(agr)		-0.0001 (0.0015)
W×log(mkp)		0.0035 * (0.0019)
W×log(krg)		-0.0046 (0.0049)
W×log(funds)		0.0007 (0.0005)
W×qli		-0.0026 (0.0016)
ρ	0.287 ***	0.309 ***
Wald test	11.543 ***	12.377 ***
AIC	-1747.2	-1308.8
LM test sp. autocorr	0.742	6.044 **
Breush Pagan test	27.47 (df = 9) ***	50.30 (df = 18) ***

Significance * 10%; ** 05%; *** 1%. Standard errors in brackets.

The results, as in equation (4), are in table 3. They are obtained by simulating parameters using the ML multivariate normal parameter distribution with a series of 500 simulated draws. The comparison of the two models shows very different results.

The coefficient of the Gross Value Added per employee is significant and negative in both within change model and structural change model. The growth of the poorer regions to the level of the more developed is then guaranteed.

The parameters associated to the variable denoting agglomeration is significant only in the structural change model. The signs denote an upward convex curvature of the parameter that shows that its impact increases at increasing rates. In our knowledge, there are not direct empirical and/or theoretical evidences of the role of population density on structural change. Nevertheless, it can be recalled the study of Ciccone and Hall (1996) who find that average labour productivity is significantly greater where agglomeration is higher. Agglomeration also increases innovative output (Carlino et al., 2002; Sedgley and Elmslie, 2004; Andersson et al., 2005) that can play a role in favoring structural change. This is confirmed by the positive direct, indirect and total effect of human capital. This measure of the accumulation of skills at the local level is a strong driver for structural change. The significant indirect impact shows that it creates spatial spillovers that, through the feedback effect due to the positive parameter ρ , indirectly increase the rate of structural change on the objective region. The mentioned process could be referred to the Jacobian externalities (Jacobs, 1969) according to which knowledge may spill over between complementary rather than similar industries as ideas developed by one industry can be applied in other industries. The exchange of complementary knowledge across different firms and economic agents facilitates innovation. Therefore, a diversified regional production structure leads to increasing returns and to “diversification” externalities.

The presence of a low productive sector (agriculture) has no effects on both within and structural change. It does not prevent or facilitates the shift to more productive sectors as well as the intra-industry productivity gain. The parameter of the Krugman index, as expected, has a positive impact when correlated to within change, but is statistically not significant in structural change model. A stronger specialization in a certain sector makes convenient to improve the performances of that sector, without shifting to others, although potentially more profitable. The estimates of the market potential is negative in both models but it is significant at only 10% level in structural change model. The weak statistical significance shows that, on average, a region does not take specific advantages, in terms of structural or within change, from its geographical position with respect to big markets.

The impact of the Structural Funds is negative for the within change model and positive for the structural variation model. The significance is low but it is conceivable that an impact would exist because the total effect (direct effect + indirect effect) is significant at 10% level for within change

model and at 5% level for structural change model. The positive sign of the coefficient associated to the Structural Funds in the structural change model leads to think that these funds promote the modernization of the regional economic structures. Nevertheless, this is happening indirectly, via indirect effect, and then involving the whole economy through the feedback effects. The negative coefficient associate to the Structural Funds in the within change model is justified from the fact that Cohesion Policy aims at improving the regional economic performances thus it is linked with the shift to more productive sectors rather than to the inner improvement of existing sectors, discouraging this last aspect.

Finally, the institutional quality indicator shows a negative direct, indirect and total effect in the within change model. This is not counterintuitive because, if a sustainable economy is characterize from a shift to more efficient structure, then the institution should work in that direction, “penalizing” the maintenance of the actual structure. This process reflects on the positive sign of the direct effect for structural change model. Nevertheless, the 10% significance level is not enough to affirm that institutions have a determinant and clear role in increasing the probability of a shift to a more effective sectoral structure. In any case, a further investigation is needed to include, as fare as possible, data on informal institutions.

Table 3: Direct, indirect and total impact estimates

Variable	Within change			Structural change		
	Direct	Indirect	Total	Direct	Indirect	Total
log(gva/emp 1989)	-0.0020 **	-0.0007 *	-0.0028 **	-0.0274 ***	-0.0025	-0.0299 ***
agglom	-0.0002	-0.0001	-0.0003	-0.0043 **	-0.0011	-0.0054
agglom ²	0.0000	0.0000	0.0000	0.0007 **	0.0012	0.0019
log(hrs)	0.0009	0.0003	0.0013	0.0094 ***	0.0122 **	0.0217 ***
log(agr)	0.0000	0.0000	0.0000	-0.0004	-0.0003	-0.0008
log(krg)	0.0017 **	0.0006	0.0023 **	-0.0014	0.0067	0.0081
log(mkp)	-0.0002	-0.0001	-0.0002	-0.0024 *	0.0036	0.0012
log(funds)	-0.0001 *	-0.0001	-0.0002 *	0.0003	0.0011 *	0.0014 **
qli	-0.0009 ***	-0.0003 **	-0.0013 ***	0.0026 *	-0.0025	0.0001

Significance * 10%; ** 05%; *** 1%.

5.1 Structural change and the crisis: what a relation?

This section briefly looks at the relationship between the structural change happened from 1989 to 2006 and the reaction to the crisis of 2008. The intention is to observe if a progress in productivity due to a shift to a more sustainable and performing economic structure can cushion the fall of productivity between 2008 and 2009. The model is constructed as a typical cross section growth regression, such as regressing the logarithm of the initial Gross Value Added per employee and the structural change on the labour productivity growth between 2008 and 2009. The model that better

fit the data according to Lagrange Multiplier, Wald and Likelihood-ratio tests is the spatial lag model. Table 4 shows the results. The estimated ρ is equal to 0.82 and it is strongly significant. Spatial autocorrelation on the residuals is not detected from Lagrange Multiplier test and Wald test confirms the whole significance of the model. The fundamental point is the positive and significant direct, indirect and total impact of structural change on growth. This means that the regions that have a better response to the crisis are the ones that have shown the highest rates of structural change. Furthermore, the indirect impact tells us that a variation in the value of structural change of all regions by some constant positively affects the productivity growth of the study region or, alternatively, what is the cumulative amount of the variation in the level of structural change in a region averaged over all other regions. The significant total impact, finally, denotes that, although structural change is more concentrated in some regions, it is able to affect positively all European regions via the spatial spillovers. In a sense, regions neighboring to others with strong structural change need to adjust their economic structure to the surrounding competitor regions to be able to sustain international competition. If we multiply this scheme for all European regions, a virtuous process of sustainable growth takes place.

Table 4: Direct, indirect and total impact estimates

Variable	Estimate	Direct	indirect	Total
Intercept	-0.0165 (0.0111)			
log(gva/emp 2008)	0.0043 (0.0030)	0.0059	0.0187	0.0246
Structural change	0.3588 *** (0.0698)	0.4903 ***	1.5391 ***	2.0294***
ρ	0.8231 ***			
AIC	-1125.6			
Wald test	572 ***			
LM sp. Autocorr.	7.1094 ***			

Significance * 10%; ** 05%; *** 1%. Standard errors in brackets.

6. Conclusions

In the present paper structural and within components of the productivity growth are examined. In the first step an analysis of the distribution of these two components is conducted. Then the estimation of the factors that influence within and structural change is performed. Finally, some insights on the relation between structural change and the reaction to actual crisis are drawn.

The empirical analysis is performed using a spatial model that have been identified following both a general-to-specific and a specific-to-general strategy. The chosen model, able to explicitly includes

spatial spillover effects stemming from the neighboring regions, seems to be the best candidate in explaining the European regional within and structural change.

Results show that structural and within variation are strictly related to their geographical location. Regions with high and low values are very clustered and in some cases they have a rather strict correspondence with the respective national borders. In any case, this phenomenon needs to be further analysed. Another finding regard the positive contribution of structural change to economic growth in contrast with the negative impact of the within variation.

Beside the exploratory analysis, the empirical estimation of the factors that impact upon the within and structural change leads to some clear conclusions. Structural change is promoted by high skilled human capital and agglomeration and from their respective spillovers. This is the sign of the existence of Jacobian externalities across industries, while no evidence of MAR (Marshall-Arrow-Romer) externalities within the same industry is found. The dimension of the agricultural sector is not an obstacle to within or structural change and this implies that it is not necessary to intervene in order to resize the weight of low productive sectors. The proximity to big market upon both within and structural change has a null effect and a strong specialization is a key determinant for the gain of productivity within the same industry. Institutions and Structural Funds discourage within change but they do not have a decisive role in promoting the structural variation.

These synthesized aspects are a precious departure point to implement policies able to favor a sustainable development. The key role of structural change, in fact, is demonstrated also from its role in supporting the productivity growth during the recent crisis.

Policy makers, in the light of these results, should plan strategies that privilege the transmission of knowledge among sectors, reshaping Cohesion Policy in such a way to stimulate innovative and profitable sectors, avoiding rent seeking. This process should also be encouraged by efficient institutions. Local institutions, in fact, are one of the main determinant to setting up the right conditions to foster the endogenous and exogenous factors that determine structural change and then a sustainable productivity growth.

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Appendix A: Derivation of Spatial Durbin model from spatial error model

A standard regression form is defined as:

$$y = \mathbf{X}\beta + \varepsilon \quad (1a)$$

where y is a $N \times 1$ vector of the dependent variable, and \mathbf{X} is an $N \times K$ matrix of explanatory variables and ε is a disturbance term.

In the case in which ε and \mathbf{X} have zero covariance and ε follows a spatial autoregressive process, the spatial structure of the error terms is defined as:

$$\varepsilon = \rho W \varepsilon + v \quad (2a)$$

$$\varepsilon = (I - \rho W)^{-1} v \quad (3a)$$

where ρ is the spatial auto-regressive parameter and $v \sim N(0, \sigma^2 I)$.

Substituting (3a) in (1a), leads to the following form of (1a):

$$y = \alpha + \mathbf{X}\varphi + (I - \rho W)^{-1} v \quad (4a)$$

The high probability that x and v are correlated leads to the following specification:

$$v = X\eta + z \quad (5a)$$

where $z \sim N(0, \sigma^2 I)$

that is, ε depends linearly on X plus a disturbance term z where the scalar parameter η and the variance of the disturbance term z determine the strength of the relation between x and $\varepsilon = (I - \rho W)^{-1}$.

Putting together (4a) and (5a) we have:

$$gy = \alpha + \mathbf{X}\varphi + (I - \rho W)^{-1} (\mathbf{X}\eta + z) \quad (6a)$$

or

$$(I - \rho W) y = \alpha + (I - \rho W) \mathbf{X}\varphi + (\mathbf{X}\eta + z) \quad (7a)$$

that can be rewritten as follows:

$$y = \rho W y + \alpha + \mathbf{X}(\beta + \eta) - \rho W \mathbf{X}\varphi + z \quad (8a)$$

Model (8a) contains k nonlinear constraints on the parameters, the so-called common factor constraints

$$\rho = (\beta + \eta) = -\rho\beta = -\rho\varphi$$

If the constraints are not satisfied, we have the following unconstrained form:

$$y = \rho W y + \alpha + \mathbf{X}\varphi_1 - W \mathbf{X}\varphi_2 + z \quad (9a)$$

known as spatial Durbin model.