TECHNOLOGY CATCHING-UP AND REGULATION IN EUROPEAN REGIONS

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Resumen: En este trabajo se analizan los efectos de la intensidad de la regulación en el mercado de bienes, en el de crédito y en el mercado de trabajo sobre el crecimiento de la productividad total de los factores (PTF) para 121 regiones europeas. Se estima un modelo de catch-up tecnológico para el periodo 1995-2007 en el que se introducen los indicadores nacionales de regulación en el mercado de bienes, crédito y del mercado de trabajo. Además se controla por las dotaciones regionales de activos intangibles (capital humano y capital tecnológico) que afectan positivamente al crecimiento de las productividades regionales. Las bases de datos utilizadas son: para la PTF, capital humano y tecnológico la BD.EURS (NACE Rev1) y EUROSTAT; para los indicadores de regulación en los mercados Fraser Institute y OCDE. Se utiliza un modelo SLX (spatial lag of X) para captar la existencia de dependencia espacial en los datos regionales. Nuestros resultados muestran evidencia de que las regulaciones que frenan la competitividad en dichos mercados explican parte de las divergencias observadas en el crecimiento de la PTF en las regiones europeas.

Palabras Clave: TFP, Regulación, Capital Humano, Capital tecnológico, Instituciones, Catch-up, Regiones europeas.

Abstract: This paper analyzes the effects of the intensity of regulations in the goods, credit and labour markets on the growth of total factor productivity (TFP) for 121 European regions. A technological catch-up model for the period 1995-2007 is estimated where national regulatory indicators are introduced into the goods, credit and labour markets and which is controlled by the regional endowments of intangible assets (human and technological capital) that positively affect the growth of regional productivity. The databases used are: BD.EURS (NACE Rev1) and Eurostat for TFP and human and technological capital; and Fraser Institute and OECD for regulation indicators of markets. We use the spatial lag of X (SLX) model to capture possible spatial interactions across spatial units. Our results show that regulations that hinder competitiveness in both markets explain part of the observed differences in TFP growth between European regions.

Keywords: TFP, Regulation, Human Capital, Technology Capital, Institutions, Catch-up, European Regions.

JEL Classification: O47; R11; R38; O52; C23

1. Introduction

The main objective of this study is to analyze how much of regional productivity disparities in Europe are caused by differences among the institutional arrangements that regulate labour and product markets and are not simply a response to an accumulation issues in regional infrastructure, human and technological capital. In other words, we maintain that the impact of differences in market regulations reduces European regions TFP growth and it may contribute to creating or sustaining the divergence or persistence of disparities among regions.

Competition -and the policies affecting it- has been found to be an important determinant of productivity growth since the *Wealth of Nations*. More recent papers have directly addressed the influence of institutions on macroeconomic variables including productivity. Hall and Jones (1999), Acemoglu et al. (2001), Aghion and Griffith (2005) show that institutions are a major determinant of wealth and long-term growth. Countries that had better political and economic institutions in the past are richer today. On the other hand, substantial levels of regulations may have a negative impact on firms' investment decisions (Alesina et al., 2005), the technology adopted and innovation (Aghion et al., 2005) and a positive impact of policies towards liberalization on growth and productivity. Other studies have focused more directly on the relationship between the institutions of labour markets and products and TFP. Nicoletti and Scarpetta (2003), Scarpetta and Tressel (2002, 2004), Kent and Simon (2007) are just a few examples[1].

This paper contributes to the literature by investigating the effects of regulation on the TFP growth in 121 European regions. While there are numerous studies on the impact of institutions in the goods and labour markets on productivity at the country level (OECD, EU), this is not the case at the regional level. Take for example the effect that current institutions in the labour market have on regional disparities in unemployment rates[2]. According to Elhorst (2003), there is a lack of studies that integrate research on national and regional factors for European countries. In this paper, in addition to the effects of national labour, credit and product market institutions, we also take into account regional characteristics and especially the spatial dependence.

In European regions in the period 1995-2007, there is a wide dispersion in productivity. Productivity convergence between north and south European economies remains a priority in the economic policy of the EU. The EU's cohesion policy has been unable to allow south European regions to catch up with their more advanced neighbours[3]. There is almost unanimous agreement in the debate that institutional and economic conditions that regulate labour markets and products have a significant effect on the convergence process.

During said period, the process of economic integration in the UE led to reforms in the regulatory framework, moving towards a greater liberalization in product, credit and labour markets that were subject to greater competition. Although in general regulations have become less restrictive, it has occurred to different degrees, to different extents and with differential impacts across the EU regions.

[1] See Crafts (2006).
[2] Niebuhr (2002), Caroleo and Coppola (2006), Kosfeld and Dreger (2006), Herwartz and Niebuhr (2009 and 2011).
[3] Escribá and Murgui (2013).

More specifically, this paper estimates a model of technological catch-up for the period 1995-2007 where national regulatory OECD indicators relating to the goods market (product market regulations, PMR) and labour market (employment protection and legislation, EPL) and Fraser Institute indicators are introduced. We control for regional endowments of intangible assets (human capital and technological capital) that positively affect the growth of regional productivity. The databases used are: BD.EURS (NACE Rev1), EUROSTAT, OECD indicators of regulation in the markets and Fraser Institute. We find evidence that the regulations that hinder competitiveness in both markets explain part of the observed differences in TFP growth in European regions. We find some evidence that lower levels of regulation are associated with higher TFP growth. Lower levels of regulation in the product market and in particular the absence of barriers to trade and Investment has a greater positive effect on productivity growth. Further liberalization in the labour market in general and only one of its components (hiring and firing regulation), and less business regulation in general have an important effect on the growth of TFP. These results remain unchanged when we control for region-specific variables in the region and surrounding areas.

The 121 regions (NUTS2) considered are from nine countries: Germany, Austria, Belgium, Spain, France, Holland, Italy, Portugal and Sweden. The Brussels region is considered a leader, with the highest level of TFP in both 1995 and 2007. The different regions are at different distances from the productivity frontier. While in most northern regions TFP has grown more than Brussels, this is not the case with the Portuguese, Spanish and Italian regions. They show that, behind regional disparities in TFP dynamics, there are domestic factors that affect regions of the same country. This also influences the effectiveness of regional EU policy[4]. The significance of these national factors (regulatory framework, both in the goods and factor markets) on the productivity of European regions is at the heart of this study.

The rest of paper is organized as follows. Section 2 describes the TFP measures and the synthetic regulation indicators. Section 3 presents an empirical model and discusses the econometric specification. Section 4 reports on estimates of the macroeconomic impact of regulations on productivity growth across regions of 9 European countries. Section 5 offers some concluding comments.

2. Data description.

2.1.-The TFP Measures

TFP.-The database used is BD.EURS (NACE Rev1)[5] for all variables involved in the elaboration levels and growth rates of regional TFP. This database, in year 2000 Euros, is compiled by the Budget General Directorate of the Spanish Ministry of Economic and Financial Affairs. The data provided by BD.EURS are mainly based on information supplied by REGIO, the EUROSTAT

[4] As Geppert, Gornig & Stephan (2003) point out, the single market and monetary union have neither managed to diminish the importance of domestic factors in the growth of regional TFP.

[5] This European regional database is available on the following web page: http://www.sepg.pap.minhap.gob.es/sitios/sepg/es-ES/Presupuestos/Documentacion/Paginas/BasededatosBDEURS.aspx

regional database, thus ensuring its compatibility with AMECO and EU-KLEMS, which is why it starts in 1995. The lack of homogeneous data for the remainder of the European regions, especially for data relating to the GFCF, determined the complete set of regions that were included in this database. The availability of capital stock data at NUTS2 level in Escribá and Murgui (2014a)[6] makes it possible to use a standard procedure to estimate TFP in each region for the period 1995-2007. The regions included are from nine countries: Germany, Austria, Belgium, Spain, France, Holland, Italy, Portugal and Sweden. The TFP series of European regions used in this paper were obtained from the GVA series in PPS (Purchasing Power Standards), employment, capital income share and labour income share by Escribá and Murgui (2014b). Appendix A includes a brief explanation of how to get the levels and rates of growth of regional TFP as well as a table with its values and the variables involved. Figure 1 shows the regional disparities in the levels and rates of productivity growth. The point located on the right represents the Brussels region.

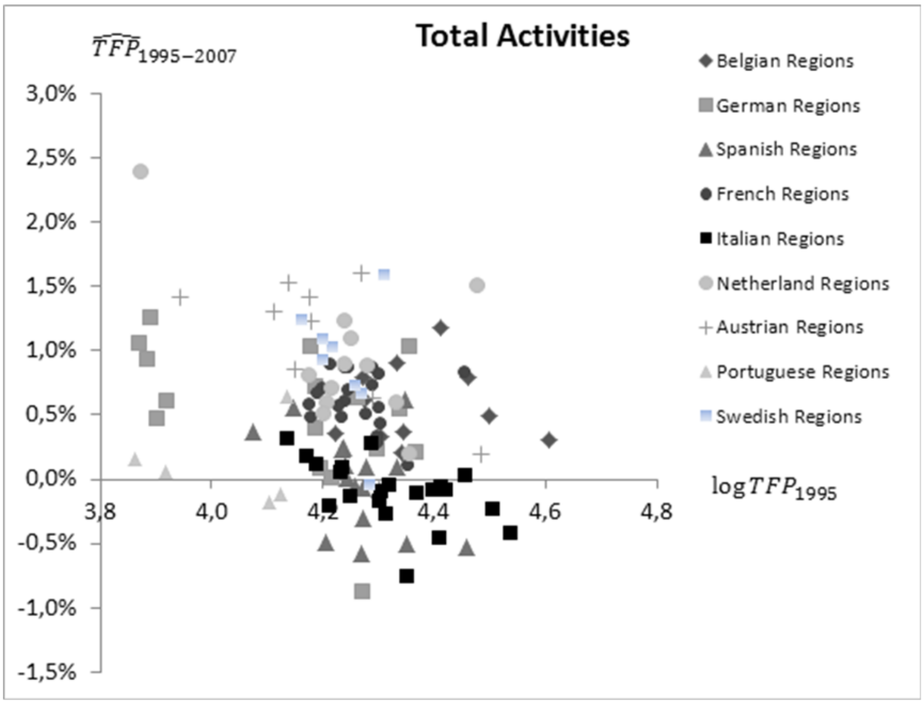

Figure 1: Productivity differences and convergence

It can be seen in the graph that regions within the same country can be grouped into specific areas of the diagram. It might indicate the importance of national factors in the behaviour of regional TFP.

Technology gap. The technology gap or the distance from the technological frontier that captures the potential for technology transfer is defined as the difference between region TFP and the technological frontier in the initial year. There are several ways to measure the technology gap. In our study, we mirror the approach of existing literature (Nicoletti and Scarpetta, 2003; Griffith et al., 2004; Kent and Simon (2007) and Buccirossi et al., 2013) and

[6] In Escribá and Murgui (2014a) the methodology used in the construction of capital stock series is explained. There are still some discrepancies between these and Cambridge Econometrics. The series are included in the BD.EURS.

use the TFP level to calculate the distance to the technological frontier. The technology leader is defined as the region with the highest value for the TFP level in 1995 and the technology gap as $\ln TFP_{ij,t} - \ln TFP_{L,t}$.

2.2.-Regional Control Variables.

For region-specific explanatory variables, EUROSTAT is used: the regional technological capital is drawn from the number of patents (Patent applications to the EPO by priority year and NUTS3, aggregated to NUTS2) in relation to the GVA (the BD.EURS database) in 1995; human capital has been approximated by the percentage of population aged 25-64 with tertiary education (levels 5 and 6) attainment NUTS 2 regions from EUROSTAT ISCED97.

2.3.-National Regulation Indicators.

Two sources are used for the 1995 national regulation indicators:

- **OECD**. The synthetic indicators **EPL** (employment protection and legislation) and **PMR** (product market regulation) are used to characterize rigidity in the labour and product markets, respectively. The latter is subdivided into: **STATEC** (state control), **BE** (barriers to entrepreneurship) and **BTI** (barriers to trade and investment). The indicators represent the stringency of regulatory policy on a scale from 0 to 6 with higher numbers being associated with policies that are more restrictive to competition[7]. The OECD's indicators are based on self assessment questionnaires that are filled in by national administrations in each country. Responses are ranked and aggregated so that assessments can be benchmarked to enable comparisons.

- **Fraser Institute**. The economic freedom index to: the credit market (**CMR**: credit market regulations), the labour market (**LMR**: labour market regulations) and the business (**BR**: business regulations) the aggregated three synthetic regulation indicators. A component of CMR is specifically addressed: private industry credit (**PSC**). Further disaggregation is considered in the regulation of the labour market: **HIRE** (hiring regulations and minimum wage), **HFR** (hiring and firing regulation), **CC** (centralized collective bargaining), **HOURRE** (hours regulations) and **CONSPR** (conscription). Components of business regulations were also considered: **BC** (bureaucracy costs), **START** (starting a business), **EXPRAY** (extra payments / bribes / favouritism). Like all the ratings in the index, these are values out of 10; ten (10) is the highest possible rating and zero (0) is the lowest. The higher the rating, the greater the degree of economic freedom[8].

Table 1A shows objective measures of goods market regulation compiled by the OECD in the first four columns while the next column shows objective measures of employment protection constructed by OECD to measure the cost implications of regulatory provisions for employers. The last two columns of Table 1A and Table 1B show scores for the Fraser

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[7] For more details see Nicoletti, G., S. Scarpetta and O. Boylaud (1999), Conway, Janot and Nicoletti (2005), Nicoletti, G., and F. Pryor (2006).

[8] For more details see Block (1993).

Institute's Economic Freedom Index. Its components include subjective survey assessments of aspects of institutions and policy such as credit, business and labour regulations. According to both the Fraser Institute and the OECD, the countries with the least restrictions on competition in the product market are the Netherlands and Sweden. This is not the case with the labour market regulation indicators, where discrepancies (note the case of Portugal) between the OECD and the Fraser Institute can be observed.

3.-The Empirical Model and Econometric Specification

This paper uses cross-section data regressions with TFP growth as the dependent variable. We examine the effects of product, credit and labour market regulations on TFP growth in 121 EU regions between 1995 and 2007. Aghion and Schankerman (2004) and Aghion and Griffith (2005) provide a theoretical framework to explain this link.

Similar to the approach used by Buccirossi et al. (2013), we proceed to directly test the relationship between country-specific measures of regulation and regional TFP growth:

$$\widehat{TFP}_{ij,t} = \eta_{ij,t} + \tau_{ij,t} REG_{j,t} + \varepsilon_{ij,t} \qquad (1)$$

Where $\widehat{TFP}_{ij,t}$ is TFP growth in a region *i* in a country *j* and $REG_{j,t}$ is one of our indicators of regulation in a country *j*. However, the TFP growth is affected by other region characteristics and the technological and organizational transfer from the technology-frontier. The general specification we use for our regression analysis is a modified version of that used in Griffith, Redding and Van Reenan (2004), Nicoletti and Scarpetta (2003)[9] and Aghion and Howit (1998, 2006) and is based on a 'catch-up' theory of TFP growth[10]. This theory suggests that, all things being equal, regions further from the technological frontier will experience more rapid TFP growth, given their greater opportunity to adopt more advanced productive practices than those regions at the frontier. TFP growth in a given region at time *t* will be a function of TFP growth in the region technological leader and the technology gap for each region, which is the difference between the logged levels of TFP in region *i* and the technological leader (L):

$$\widehat{TFP}_{ij,t} = \eta\widehat{TFP}_{L,t} + \beta ln\left(\frac{TFP_{ij,t}}{TFP_{L,t}}\right) + \psi\, REG_{j,t} + \varphi\, X_{ij,t} + \varepsilon_{ij,t} \qquad (2)$$

where $X_{ij,t}$ are regional-specific control variables (human capital and R&D) included in the catch-up equation to account for the possible role of regional-specific factors. Our empirical analysis seeks to adapt the TFP equation proposed by Buccirossi et al (2013)[11] to the conditions of the European regions belonging to the 9 countries. European regions are denoted by i = 1,…, 121 and countries by j = 1,..9. The presence of the term, $\eta\widehat{TFP}_{L,t}$, allows the contemporaneous rate of TFP growth in the frontier to have a direct effect on TFP growth in non-frontier regions. For non-frontier regions, relative TFP, $\beta ln\left(\frac{TFP_{ij,t}}{TFP_{L,t}}\right)$, is negative; the more negative the relative TFP, the further a region lies behind the frontier and the greater its potential for technology transfer. Therefore, with technology transfer, the estimated

[9] Nicolleti and Scarpetta (2003) replace the role of R&D in the Griffith, Redding and Van Reenan approach with their measures of product market regulation.
[10] See Bernard &Jones 1996, Harrigan, 1999, and Scarpetta & Tressel, 2002 and Annex 1.
[11] Buccirossi et al (2013) estimate the impact of competition policy and some of its components on total factor productivity growth using a sample of 22 industries in 12 OECD countries over the period 1995-2005.

coefficient on relative TFP should be negative. This coefficient of the TFP gap (β) measures the speed of (conditional) convergence to the long-run steady state level for TFP. In the presence of technological convergence, the technology gap between each region and the leader converges to a constant value. This would imply that the vector of variables $(X_{ij,t})$ only translates into differences in TFP levels but not into permanent differences in TFP growth rates.

Our analysis uses European region data and this spatial data typically violates the assumption that each observation is independent of other observations made using the OLS methods. The quality of estimates and inferences are affected if non-spatial regression models are used. Non-spatial regression specifications that exclude spillovers from a model specification lead to estimates that suffer from omitted variables bias. When comparing model specifications we use likelihood ratio or Lagrange multiplier statistics as is the case with most of the spatial econometric literature. Specifically, we are comparing the OLS model against the SAR, SEM and SLX models for cross sectional data which may capture possible spatial interactions across spatial units.[12]

A spatial autoregressive model (SAR) can be expressed as:

$$y = \rho W y + X\phi + \varepsilon$$
$$\varepsilon \sim N(0, \sigma^2 I_n) \tag{3}$$

y denotes a vector of outcomes, X the explanatory variable matrix and ϕ a vector of parameters. W is known $n \times n$ spatial weight matrices, usually containing contiguity relations or functions of distance. A first-order contiguity matrix has zeros on the main diagonal, rows that contain zeros in positions associated with non-contiguous observational units and ones in positions reflecting neighbouring units that are (first-order) contiguous.

We could drop the assumption that y is affected by the spatial lag of y and instead assume a SAR-type spatial autocorrelation in the error process. If u denotes the vector of residuals, this gives:

the spatial error model (SEM):

$$y = X\phi + u$$
$$u = \lambda W u + \varepsilon \qquad \varepsilon \sim N(0, \sigma^2 I_n) \tag{4}$$

[12] We use the acronyms most commonly used in the spatial econometrics literature to refer to the model specifications (see LeSage and Pace, 2009)

Table 1A. National Indicators on Regulation in 1995

	Product Market Regulation	*State control*	*Barriers to entrepreneurship*	*Barriers to Trade and Investment*	***Employment protection and legislation***	***Credit market regulations***	*Private sector credit*
Belgium	**2.25**	3.04	3.00	0.71	**2.48**	**9.47**	8.41
Germany	**2.17**	2.57	2.79	1.16	**2.57**	**6.98**	5.93
Spain	**2.37**	3.65	3.09	0.36	**2.96**	**8.45**	7.36
France	**2.33**	3.32	3.13	0.54	**2.84**	**9.46**	8.37
Italy	**2.35**	3.82	2.57	0.65	**3.06**	**7.18**	6.55
Netherlands	**1.81**	2.97	2.19	0.27	**2.77**	**8.85**	6.54
Austria	**2.11**	3.11	2.45	0.76	**2.38**	**6.82**	7.47
Portugal	**2.55**	4.04	2.76	0.86	**3.53**	**6.59**	7.78
Sweden	**1.88**	2.19	2.82	0.62	**2.49**	**7.81**	5.43

Source: OECD and Fraser Institute

Table 1B. National Indicators on Regulation in 1995

	Labour market regulations	*Hiring regulations and minimum wage*	*Hiring and firing regulations*	*Centralized collective bargaining*	*Hours regulations*	*Conscription*	***Business regulations***	*Bureaucracy costs*	*Starting a business*	*Extra payments /bribes/favouritism*
Belgium	**4.93**	3.87	3.77	4.49	2.55	10.00	**5.40**	6.49	4.60	5.11
Germany	**3.56**	3.38	3.94	4.49	2.97	3.00	**6.37**	6.47	4.97	7.68
Spain	**4.07**	5.78	2.62	5.18	3.75	3.00	**5.58**	6.37	5.32	5.06
France	**3.35**	2.55	4.16	4.49	2.58	3.00	**5.50**	6.30	3.43	6.76
Italy	**3.49**	3.40	2.62	4.49	3.95	3.00	**3.91**	4.71	4.10	2.91
Netherlands	**4.09**	4.52	3.38	4.49	5.08	3.00	**7.79**	7.37	7.53	8.46
Austria	**4.28**	4.58	4.82	4.49	4.50	3.00	**5.90**	6.52	3.72	7.48
Portugal	**4.64**	6.42	3.40	5.18	5.22	3.00	**5.21**	5.53	4.32	5.79
Sweden	**3.03**	1.83	3.93	4.49	1.90	3.00	**7.55**	8.28	5.08	9.29

Source: Fraser Institute

Next, drop the assumption that a spatial autocorrelation in the error process and instead assume that y is affected by spatial lags of the explanatory variables, this gives:

the spatial lag of X model (SLX):

$$y = X\phi + WX\theta + \varepsilon$$
$$\varepsilon \sim N(0, \sigma^2 I_n) \tag{5}$$

This model allows for local spillovers to neighbouring observations through spatial lag terms for the explanatory variables. A spatial lag consists of a matrix product such as W X, which forms a linear combination of values from the matrix X, reflecting neighbouring region values. The direct effects are the coefficient estimates of the non-spatial variables $\left(\frac{\partial y}{\partial X^k} = \phi\right)$ and the spillover effects (or indirect effects) are those associated with the spatially lagged explanatory variables $\left(\frac{\partial y}{\partial X^k} = W\theta\right)$. The coefficient θ reflects average or typical spillovers, where averaging takes place across all observations (regions).

As discussed in the next section the spatial lag of X model describes the spatial dependence structure adequately, so based on equation (2), the basic empirical specification we consider can be written as:

$$\widehat{TFP}_{ij,\tau} = \eta\widehat{TFP}_{L,\tau} + \beta ln\left(\frac{TFP_{ij,0}}{TFP_{L,0}}\right) + \psi\, ln\, REG_{j,0} + \alpha_1\, ln\, R\&D_{ij,0} + \alpha_2 ln\, HUMAN_{ij,0} +$$
$$+\theta_1\, W\, ln\, R\&D_{ij,0} + \theta_2 W\, ln\, HUMAN_{ij,0} + \varepsilon_{ij} \tag{6}$$

where $\widehat{TFP}_{ij,\tau}$ denotes TFP growth rate for the period 1995-2007, $\widehat{TFP}_{L,\tau}$ the growth of the TFP in the leading region, $ln\left(\frac{TFP_{ij,0}}{TFP_{L,0}}\right)$ the technology gap in 1995, $R\&D$ and $HUMAN$ two important control variables -the human capital (the percentage of population 25 or over having higher education) in 1995 and technological capital (number of patents in relation to GVA) in 1995- and REG denotes the national measures of product, credit and labour-market regulation in initial period. $W\, HUMAN_{ij}$ and $W\, R\&D_{ij}$ denote the spillovers effects or neighbouring region values[13].

For non-frontier regions, if there is technology transfer, the estimated coefficient on relative TFP (β) should be negative.[14] Worker education ($HUMAN$) own region is expected to transmit strongly positive externalities and to be a means of absorbing new technologies. Regional technological capital ($R\&D$), is also expected to have a positive effect.

Table 2 summarises the descriptive statistics of the series used in the estimation.

[13] We use Akaike's and Schwarz's Bayesian to compare model with spatial lag in different exogenous variables.
[14] We establish the robustness of our results with alternative measurements of the gap technology variable, using for example, the average TFP level of 9 European countries included in the sample in defining the location of the frontier.

Table 2. Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
$\widehat{TFP}_{ij}$	121	0.005	0.006	-0.009	0.024
$ln\frac{TFP_{ij}}{TFP_{ij}}$	121	-0.357	0.138	-0.743	0.000
$ln\,R\&D$	121	0.703	1.209	-3.528	2.632
$ln\,HUM$	121	-1.733	0.444	-2.813	-0.939
Variables in logarithms					
Product Market Regulation (PMR)	121	0.794	0.093	0.594	0.938
State control (STATE)	121	1.161	0.165	0.785	1.397
Barriers to entrepreneurship (BE)	121	1.020	0.112	0.786	1.141
Barriers to trade and investment (BTI)	121	-0.531	0.417	-1.323	0.146
Employment protection and legislation (EPL)	121	1.022	0.096	0.867	1.261
Credit market regulations (CR)	121	2.085	0.131	1.886	2.248
Private sector credit (PSC)	121	1.954	0.139	1.692	2.129
Labour market regulations (LMR)	121	1.331	0.135	1.109	1.595
Hiring regulations and minimum wage (HIRE)	121	1.293	0.330	0.604	1.859
Hiring and firing regulations (HFR)	121	1.242	0.207	0.963	1.573
Centralized collective bargaining (CC)	121	1.528	0.055	1.502	1.645
Hours regulations (HOURRE)	121	1.209	0.285	0.642	1.652
Conscription (CONS)	121	1.208	0.348	1.099	2.303
Business regulations (BR)	121	1.724	0.206	1.364	2.053
Bureaucracy costs (BC)	121	1.829	0.152	1.550	2.114
Starting a business (START)	121	1.520	0.224	1.233	2.019
Extra payments/bribes/favouritism (EXTPAY)	121	1.760	0.369	1.068	2.229

Source: own elaboration

4. Estimation of the TFP's catch-up model.

Table 3 presents the results of estimating a cross-section regression model where the average TFP growth 1995-2007 in a region is the endogenous variable and the growth of the TFP in the leading region, the technology gap in 1995, the human capital in 1995, the research and development in 1995 and the measure of product market regulation in initial period, are the exogenous variables. The purpose of this estimation is selecting the appropriate spatial regression model. We estimate equation (2), in the first instance, using an ordinary least squares regression (column [1]). The estimates do not suffer from non-normality and heteroskedasticity as can be observed in the lower part of Table 3. Spatial tests were performed on the residuals of the OLS thus were used for the test the spatial weights matrix W which is specified as a row-normalized binary contiguity matrix, with elements $w_{ij} = 1$ if two spatial units share a common border, and zero otherwise[15]. Lagrange Multiplier tests for spatial error (LM ERR) and spatial lag (LM LAG) are obtained. As can be seen, the null hypothesis of absence of spatial dependence is rejected by SEM.

[15] See Anselin (1988) and Anselin et al. (1996).

In Table 3 columns [2] and [3], the modelling strategy for specifying a spatial econometric model is used. The commonly adopted procedure is to test the OLS model against the SAR and SEM models for an exogenously specified spatial weights matrix W. Tests (likelihood ratio) in the lower part of Table 3 in these columns show the null hypothesis ($\rho = 0$) and ($\lambda = 0$) in equation (3) and (4) are accepted, respectively. Column [4] contains the estimation results when the SLX model is considered. The LR test suggests the preference for the spatial lag of X model.[16]

Tables 4 and 5 contain the estimation results explaining growth of regional TFP for the SLX model (equation (6)) using the row-normalized binary contiguity matrix. Objective measures of regulations are inserted into cross-region growth regressions. In table 4, OECD regulation indicators and Fraser Institute regulation indicators in Table 5, are introduced.

In Table 4, both the PMR (and its disaggregated components) and EPL variables enter our regressions in levels, so the interpretation of a significant negative relationship between a regulatory variable and regional TFP growth is that deregulation in countries in product and labour markets causes an increase in the regional growth rate of TFP. All estimates show that the SLX model is appropriate as can be observed in LR test where ($H_0: \theta = 0$ is rejected). The first column contains the estimation results using product market regulation as a regulation index, the components of PMR are considered in column [2] and employment protection legislation in column [3] and both PMR and EPL variables in column [4]. The coefficients of the technology gap have a negative and significant effect in all cases, which demonstrates a TFP convergence (conditional) process in the 121 European regions with a rate around 2% annually. As for the control variables, both the direct effects of regional human capital and regional technological capital are positive and statistically significant. That is, during the period from 1995 to 2007, regional technological capital and regional human capital had a positive impact on the TFP growth in regional economies. A one-point increase in the percentage of population aged 25 or over with higher education increases TFP growth by about 0.4 points; a one-point increase in the number of patents in relation to GVA increases European regions TFP growth by about 0.1 points. Secondly, indirect (other-region, spillover, θ)[17] impacts of human and technological capital are statistically significant. While technological capital in neighbouring regions has a positive effect on regional TFP growth (same magnitude as direct effect) the human capital in adjacent regions has a negative one[18].

The coefficients of regulation have a negative and significant effect when the aggregate indicators are introduced. Only the coefficient of barriers to trade and investment is statistically significant and negative when the disaggregate indicators of PMR are introduced. A one-point increase in the PMR reduces TFP growth by about [1.2 to 1.3] points; a one-point increase in the EPL reduces TFP growth by about [0.9 to 1.1] points.

The results obtained when Fraser Institute Regulation Indicators are introduced do not change –as is the case in for OECD indicators- in regard to the technology gap, regional human

[16] LeSage (2014) argues that only two specifications SDM and SDEM (this specification collapse to the SLX when λ=0, page 11) need considered by regional science practitioners.

[17] LeSage and Pace (2009) argue that spillovers in the context of (cross-sectional) spatial regression models should be interpreted as comparative static changes that will arise in the dependent variable as the relationship under study moves to a new steady-state equilibrium.

[18] This curious result suggests the existence of competition and mobility of skilled labour between neighbouring regions.

and technological capital (own-region and other-region) which remained significant, as can be seen in Table 5. The coefficients of the technology gap have a negative and significant effect, however, there are differences, albeit small, in the magnitude of the coefficients (columns [5] to [8]) when the explanatory variables capturing the components of labour market regulation and business regulation are included. In these columns, the coefficient of R&D is positive but not statistically significant.

The coefficients of regulation have a positive and significant effect when the aggregate indicators are introduced (columns [1], [3] and [6]). Only the coefficient of hiring and firing regulations[19] (component of LMR) and bureaucracy costs (component of BR, the correlation between BR and BC is close to unity, see Annex 2) are statistically significant and positive.[20]

A one-point increase in more freedom in the credit market regulation (or private sector credit) increases TFP growth by about 0.9 (0.8) points; a one-point increase in more freedom in the labour market regulation (or hiring and firing regulations) increases TFP growth by about 0.74 (0.75) points; a one-point increase in more freedom in the business regulation (or bureaucracy costs) increases TFP growth by about 0.9 (1.8) points.

5. Conclusions

This paper provides new evidence on regional productivity performance. Although in the period under consideration catching-up productivity between European regions has had an effect, major differences persist in both productivity levels and growth rates. The allocation of human and technological capital differs between European regions, but so is the regulatory burden of their markets. Besides the influence of regional factors specifically related to the provision of both human and technological capital, factors related to the regulation of markets have played an important role in TFP growth. Using data from 121 EU regions over the period 1995-2007 and a spatial lag of X model, we explore the effects of product, credit and labour market regulations on aggregate TFP growth. The different regulatory level of markets has significant effects that are both quantitatively important and statistically significant with regard to regional TFP growth.

We find some evidence indicating that lower levels of regulation are associated with higher TFP growth. Lower levels of regulation in the product market and in particular the absence of barriers to trade and investment has a larger positive effect on productivity growth. And further liberalization of the labour market in general and only one of its components (hiring and firing regulation), and fewer business regulations in general have an important effect on the growth of European regions TFP. These results remain unchanged when we control for region-specific variables in the region and surrounding areas.

[19] Also Scarpetta and Tressel (2002) find evidence to suggest that where strict employment protection legislation raises the costs of hiring and firing workers and hence of labour adjustment in response to technical changes, this can reduce incentives to innovate, and hence productivity growth.

[20] When LMR's components are introduced into the regression (column [4]) the statistical VIF (variance inflation factor that shows us how much the variance of the coefficient estimate is being inflated by multicollinearity) increases considerably. When it is estimated each component separately, only HFR is statistically significant.

Table 3. Estimation Results (PMR Index). Selecting a Spatial regression model

Dependent variable	$\widehat{TFP}_{ij,1995-2007}$			
ESTIMATION	**OLS** **[1]**	**SEM** **[2]**	**SAR** **[3]**	**SLX** **[4]**
$ln\left(\frac{TFP_{ij}}{TFP_L}\right)$	-0.0178*** (0.0028)	-0.0120*** (0.0028)	-0.0113*** (0.0027)	-0.0195*** (0.0028)
$ln\,R\&D$	0.0018*** (0.0004)	0.0015*** (0.0004)	0.0014*** (0.0004)	0.0009* (0.0005)
$ln\,HUM$	0.0013 (0.0009)	0.0000 (0.0012)	0.0002 (0.0010)	0.0044*** (0.0014)
W $ln\,R\&D$				0.0014** (0.0006)
W $ln\,HUM$				-0.0048*** (0.0018)
$\widehat{TFP}_{L,1995-2007}$	0.0112*** (0.0045)	0.0117*** (0.0045)	0.0092** (0.0042)	0.0057 (0.0046)
PMR	-0.0150*** (0.0050)	-0.0137*** (0.0048)	-0.0118*** (0.0045)	-0.0133*** (0.0051)
λ		0.1476 (0.113)		
ρ			0.1045 (0.1005)	
LM Error	14.2088			
p-value	(0.0002)			
LM Lag	1.9804			
p-value	(0.1593)			
LR Test SEM vs. OLS ($\lambda = 0$)		1.692(0.193)		
LR Test SAR vs. OLS ($\rho = 0$)			1.082(0.298)	
LR Test SLX vs. OLS ($\theta = 0$)				10.640(0.004)
R^2	0.50	0.48	0.47	0.53
Sample Size	121	121	121	121
Shapiro-Wilk Test	[0.0982]			[0.1725]
Breusch-Pagan	[0.0131]			[0.0203]
VIF	1.47			2.84

Note for Table 3: Standard errors are presented in brackets. A spatial error model (SEM) is estimated in [2], a spatial autoregressive model in [3] and a spatial lag of X model in [4]. * values significant at 10%, ** 5% and *** 1%. LM ERR and LM LAG stands for the Lagrange Multiplier test respectively for residual spatial autocorrelation and spatially lagged endogenous variable. The null hypothesis for Shapiro-Wilk test is that the data are normally distributed. Breusch-Pagan/Cook-Weisberg tests the null hypothesis that the error variances are all equal versus the alternative that the error variances are a multiplicative function of one or more variables. The variance inflation factor (VIF) quantifies the severity of multicollinearity in an ordinary least squares regression analysis.

Table 4. Estimation Results. OECD Regulation Indicators.

Dependent variable	$\widehat{TFP}_{ij,1995-2007}$			
ESTIMATION: The spatial lag of X model (SLX)				
	[1]	**[2]**	**[3]**	**[4]**
$ln\left(\frac{TFP_{ij}}{TFP_L}\right)$	-0.0195***	-0.0229***	-0.0199***	-0.0184***
	(0.0028)	(0.0031)	(0.0029)	(0.0029)
$ln\, R\&D$	0.0009*	0.0012***	0.0010**	0.0008
	(0.0005)	(0.0005)	(0.0005)	(0.0005)
$ln\, HUM$	0.0044***	0.0041***	0.0037***	0.0035***
	(0.0014)	(0.0016)	(0.0015)	(0.0015)
W $ln\, R\&D$	0.0014**	0.0019***	0.0013**	0.0010*
	(0.0006)	(0.0006)	(0.0006)	(0.0006)
W $ln\, HUM$	-0.0048***	-0.0057***	-0.0043***	-0.0046***
	(0.0018)	(0.0019)	(0.0018)	(0.0018)
$\widehat{TFP}_{L,1995-2007}$	0.0057	-0.0072	0.0065	0.0146**
	(0.0046)	(0.0067)	(0.0065)	(0.0072)
PMR	-0.0133***			-0.0124***
	(0.0051)			(0.005)
$STATEC$		-0.0034		
		(0.0047)		
BE		0.0008		
		(0.0041)		
BTI		-0.0033***		
		(0.0011)		
EPL			-0.0114**	-0.0097*
			(0.0006)	(0.0060)
LR Test SLX vs. OLS ($\theta = 0$)	10.64	15.81	10.95	11.81
p-value	0.0049	0.0004	0.0034	0.002
R^2	0.51	0.55	0.52	0.54
Sample Size	121	121	121	121
Shapiro-Wilk Test	[0.1725]	[0.2248]	[0.0117]	[0.1456]
Breusch-Pagan	[0.0203]	[0.3576]	[0.0124]	[0.0229]
VIF	2.84	3.26	3.14	3.00

Note for Table 4: Standard errors are presented in brackets. * values significant at 10%, ** 5% and ***1%. See note for table 3 for information about tests.

Table 5. Estimation Results. Fraser Institute Regulation Indices.

Dependent variable	$\widehat{TFP}_{ij,1995-2007}$			ESTIMATION: The spatial lag of X model (SLX)					
	[1]	**[2]**	**[3]**	**[4]**	**[5]**	**[6]**	**[7]**	**[8]**	**[9]**
$ln\left(\frac{TFP_{ij}}{TFP_L}\right)$	-0.0241***	-0.0231***	-0.0221***	-0.0181***	-0.0168***	-0.0164***	-0.0178***	-0.0165***	-0.0201***
	(0.0028)	(0.0027)	(0.0027)	(0.0032)	(0.0031)	(0.0032)	(0.0032)	(0.0028)	(0.0030)
$ln\ R\&D$	0.0013***	0.0013***	0.0013***	0.0008	0.0007	0.0009*	0.0010**	0.0009*	0.0012***
	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)
$ln\ HUM$	0.0041***	0.0047***	0.0046***	0.0060***	0.0040***	0.0032***	0.0019	0.0021	0.0024**
	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)	(0.0014)
$W_{ln}\ R\&D$	0.0018***	0.0019***	0.0019***	0.0013**	0.0012**	0.0016***	0.0015***	0.0015***	0.0017***
	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0006)	(0.0005)	(0.0005)	(0.0005)	(0.0005)
$W_{ln}\ HUM$	-0.0055***	-0.0044***	-0.0050***	-0.0036***	-0.0039***	-0.0062***	-0.0068***	-0.0069***	-0.0074***
	(0.0018)	(0.0017)	(0.0017)	(0.0018)	(0.0018)	(0.0018)	(0.0018)	(0.0017)	(0.0017)
$\widehat{TFP}_{L,1995-2007}$	0.0290***	-0.0219***	-0.0161***	-0.0108***	-0.0118***	-0.0246***	-0.0495***	-0.0444***	-0.0571***
	(0.0083)	(0.0059)	(0.0049)	(0.0346)	(0.0335)	(0.0064)	(0.0115)	(0.0089)	(0.0101)
Credit Market Reg	0.0097***								0.0097***
	(0.0031)								(0.0029)
PSC		0.0084***							
		(0.0026)							
Labor Market R			0.0074***						0.0087***
			(0.0027)						(0.0027)
HIRE				-0.0169***					
				(0.0052)					
HFR				0.01093***	0.0075***				
				(0.0025)	(0.0024)				
CC				0.0559***					
				(0.0210)					
HOURRE				0.0193***					
				(0.0051)					
CONSPR				0.0068***					
				(0.0020)					
Business Reg						0.0094***			0.0062***
						(0.0028)			(0.0025)
BC							0.0248***	0.0180***	
							(0.0025)	(0.0039)	
START							-0.0022		
							(0.0018)		
EXTPAY							-0.0025		
							(0.0028)		

LR Test SLX vs. OLS ($\theta = 0$)	15.23	13.98	15.10	6.10	7.07	16.04	17.59	18.93	22.89
p-value	[0.0005]	[0.0009]	[0.0005]	[0.0473]	[0.0292]	[0.0003]	[0.0002]	[0.0001]	[0.0000]
R^2	0.54	0.54	0.53	0.60	0.54	0.55	0.59	0.58	0.61
Sample Size	121	121	121	121	121	121	121	121	121
Shapiro-Wilk Test	[0.0239]	[0.0121]	[0.2321]	[0.0933]	[0.0144]	[0.3535]	[0.0426]	[0.2162]	[0.2684]
Breusch-Pagan	[0.1811]	[0.0948]	[0.0257]	[0.0789]	[0.0770]	[0.0370]	[0.1507]	[0.1270]	[0.1398]
VIF	2.76	2.66	2.67	8.59 (Multicol)	2.98	3.12	4.96 (Multicol)	3.19	2.72

Note for Table 5: Standard errors are presented in brackets. * values significant at 10%, ** 5% and *** 1%. See note for table 3 for information about tests.

Our results also have significant implications for policy. They suggest that countries should prioritize reforming their business regulations when designing growth policies. During this period, the process of economic integration in the UE led to reforms in the regulatory framework that led to a greater liberalization in product, credit and labour markets subject to greater competition. Although, in general, regulation has become less restrictive, it has occurred at different degrees, to different extents and with differential impacts across the EU regions. The effectiveness of regional development policies in the EU is heavily influenced by government policies. The harmonization of government regulatory policies will determine the future competitiveness of the European economy and its regions.

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Annex 1. TFP *Estimation Procedure*

This paper includes a procedure to estimate TFP for each European regions belonging to different countries. The procedure is the most commonly used in literature: following Solow using a Cobb-Douglas function with two factors, capital and labour. Constant returns, neutrality in the sense of Hicks and perfect competition are assumed, α_{ij} and $1-\alpha_{ij}$ are used as shares for capital and for labour, respectively, that are different in each region. The information on α_{ij} is extracted directly from the accounts available from the BD.EURS database. The TFP growth rate is calculated as the difference between the output growth rate and the growth in the levels of Divisia inputs. To determine the relative levels of TFP in each region, the methodology in Bernard and Jones (1996), Harrigan (1999) and more specifically in this literature on regulation, Scarpetta and Tressel (2002), is used.

Total Factor Productivity. Levels ant growth rates.

		Growth rates average values 1995-2007					
Region	**TFP 1995**	**TFP**	**GVA**	**L**	**K**	**Contrib. of L**	**Contrib. of K**
Région de Bruxellest	100	0.003	0.018	0.008	0.032	0.005	0.010
Prov. Antwerpen	90	0.005	0.023	0.012	0.031	0.008	0.010
Prov. Limburg	72	0.006	0.023	0.012	0.028	0.008	0.009
Prov. Oost-Vlaanderen	76	0.009	0.026	0.010	0.030	0.007	0.010
Prov. Vlaams Brabant	86	0.008	0.029	0.017	0.030	0.011	0.010
Prov. West-Vlaanderen	72	0.008	0.024	0.009	0.031	0.006	0.010
Prov. Brabant Wallon	82	0.012	0.036	0.021	0.032	0.014	0.010
Prov. Hainaut	77	0.002	0.015	0.008	0.022	0.006	0.007
Prov. Liège	77	0.004	0.016	0.008	0.022	0.005	0.007
Prov. Luxembourg	68	0.004	0.019	0.010	0.028	0.007	0.009
Prov. Namur	74	0.003	0.022	0.012	0.034	0.008	0.011
Baden-Württemberg	71	0.006	0.019	0.006	0.023	0.004	0.008
Bayern	65	0.010	0.022	0.006	0.023	0.004	0.008
Berlin	72	-0.009	0.002	0.005	0.022	0.003	0.008
Brandenburg	49	0.010	0.018	0.003	0.019	0.002	0.007
Bremen	78	0.010	0.018	-0.001	0.023	0.000	0.008
Hamburg	79	0.002	0.015	0.005	0.028	0.003	0.010
Hessen	77	0.005	0.016	0.004	0.024	0.002	0.009
Mecklenburg-Vorpom	50	0.005	0.012	0.000	0.019	0.000	0.007
Niedersachsen	66	0.004	0.015	0.005	0.022	0.003	0.008
Nordrhein-Westfalen	74	0.002	0.014	0.006	0.022	0.004	0.008
Rheinland-Pfalz	66	0.001	0.013	0.006	0.022	0.004	0.008

Region	TFP 1995	Growth rates average values 1995-2007					
		TFP	GVA	L	K	Contrib. of L	Contrib. of K
Sachsen	50	0.006	0.015	0.003	0.018	0.002	0.007
Saarland	66	0.007	0.018	0.004	0.021	0.003	0.007
Sachsen-Anhalt	49	0.013	0.015	-0.004	0.015	-0.003	0.005
Schleswig-Holstein	68	0.000	0.010	0.002	0.023	0.001	0.008
Thüringen	48	0.011	0.019	0.003	0.018	0.002	0.007
Galicia	63	0.006	0.029	0.014	0.039	0.009	0.015
Asturias	69	0.003	0.027	0.021	0.030	0.013	0.011
Cantabria	72	0.001	0.038	0.038	0.034	0.024	0.013
Basque Country	77	0.006	0.036	0.034	0.023	0.021	0.008
Navarra	78	-0.005	0.037	0.042	0.041	0.026	0.015
La Rioja	74	-0.001	0.035	0.033	0.040	0.020	0.015
Aragon	72	-0.001	0.033	0.032	0.037	0.020	0.014
Madrid	86	-0.005	0.040	0.045	0.047	0.028	0.018
Castile-and-Leon	70	0.000	0.026	0.021	0.033	0.013	0.012
Castile-la Mancha	67	-0.005	0.033	0.037	0.040	0.023	0.015
Extremadura	59	0.004	0.032	0.025	0.032	0.016	0.012
Catalonia	76	0.001	0.036	0.037	0.034	0.023	0.013
Valencian	69	0.001	0.039	0.035	0.042	0.022	0.016
Balearic Islands	69	0.003	0.044	0.043	0.038	0.027	0.014
Andalusia	72	-0.003	0.038	0.040	0.042	0.025	0.016
Murcia	71	-0.001	0.046	0.044	0.052	0.027	0.020
Canary Islands	71	-0.006	0.040	0.045	0.047	0.028	0.018
Île de France	86	0.008	0.023	0.009	0.023	0.006	0.008
Champagne-Ardenne	74	0.009	0.018	0.003	0.020	0.002	0.007
Picardie	73	0.003	0.013	0.005	0.017	0.003	0.006
Haute-Normandie	73	0.008	0.018	0.007	0.017	0.004	0.006
Centre	72	0.005	0.016	0.007	0.019	0.004	0.007
Basse-Normandie	69	0.005	0.015	0.006	0.017	0.004	0.006
Bourgogne	69	0.006	0.017	0.005	0.020	0.003	0.007
Nord - Pas-de-Calais	73	0.006	0.019	0.010	0.019	0.006	0.007
Lorraine	73	0.003	0.012	0.004	0.018	0.002	0.007
Alsace	77	0.001	0.015	0.009	0.022	0.006	0.008
Franche-Comté	69	0.006	0.016	0.006	0.017	0.004	0.006
Pays de la Loire	69	0.009	0.026	0.015	0.022	0.009	0.008
Bretagne	67	0.009	0.027	0.014	0.024	0.009	0.009
Poitou-Charentes	67	0.007	0.022	0.010	0.022	0.007	0.008
Aquitaine	70	0.009	0.025	0.011	0.024	0.007	0.009

Region	TFP 1995	Growth rates average values 1995-2007					
		TFP	GVA	L	K	Contrib. of L	Contrib. of K
Rhône-Alpes	65	0.006	0.017	0.006	0.020	0.004	0.007
Auvergne	73	0.009	0.025	0.012	0.022	0.008	0.008
Languedoc-Roussillon	66	0.007	0.019	0.006	0.022	0.004	0.008
Alpes-Côte d'Azur	66	0.007	0.027	0.018	0.024	0.011	0.009
Corse	74	0.005	0.023	0.016	0.023	0.010	0.009
Piemonte	65	0.005	0.030	0.023	0.028	0.014	0.010
Valle d'Aosta	82	-0.005	0.010	0.011	0.020	0.007	0.008
Liguria	77	-0.007	0.004	0.009	0.014	0.006	0.005
Lombardia	86	0.000	0.014	0.007	0.022	0.004	0.009
Bolzano-Bozen	93	-0.004	0.014	0.014	0.024	0.009	0.009
Prov. Trento	74	-0.001	0.017	0.015	0.022	0.009	0.009
Veneto	75	0.000	0.017	0.014	0.023	0.009	0.009
Friuli-Venezia Giulia	81	-0.001	0.017	0.014	0.023	0.009	0.009
Emilia-Romagna	79	-0.001	0.015	0.012	0.022	0.007	0.009
Toscana	82	0.000	0.016	0.013	0.022	0.008	0.009
Umbria	83	-0.001	0.016	0.012	0.023	0.007	0.009
Marche	74	-0.002	0.015	0.015	0.019	0.009	0.008
Lazio	73	0.003	0.021	0.016	0.022	0.010	0.009
Abruzzo	90	-0.002	0.017	0.016	0.022	0.010	0.009
Molise	75	-0.002	0.012	0.008	0.024	0.005	0.009
Campania	66	0.001	0.013	0.006	0.020	0.004	0.008
Puglia	69	0.001	0.015	0.009	0.022	0.006	0.009
Basilicata	69	0.001	0.012	0.005	0.021	0.003	0.008
Calabria	62	0.003	0.016	0.010	0.017	0.006	0.007
Sicilia	65	0.002	0.013	0.005	0.021	0.003	0.008
Sardegna	70	-0.001	0.012	0.009	0.018	0.006	0.007
Groningen	67	-0.002	0.014	0.012	0.022	0.007	0.009
Friesland (NL)	88	0.016	0.028	0.005	0.026	0.003	0.009
Drenthe	67	0.006	0.025	0.014	0.028	0.009	0.010
Overijssel	67	0.005	0.020	0.009	0.027	0.006	0.009
Gelderland	68	0.007	0.027	0.014	0.030	0.009	0.010
Flevoland	65	0.008	0.027	0.014	0.028	0.009	0.010
Utrecht	48	0.025	0.057	0.029	0.040	0.019	0.014
Noord-Holland	78	0.002	0.032	0.028	0.034	0.018	0.012
Zuid-Holland	76	0.006	0.029	0.019	0.030	0.013	0.010
Zeeland	72	0.009	0.029	0.014	0.030	0.009	0.010
Noord-Brabant	70	0.011	0.024	0.006	0.025	0.004	0.009
Limburg (NL)	69	0.009	0.030	0.017	0.027	0.011	0.009

Region	TFP 1995	Growth rates average values 1995-2007					
		TFP	GVA	L	K	Contrib. of L	Contrib. of K
Niederösterreich	52	0.014	0.027	0.005	0.026	0.003	0.009
Vienna	63	0.016	0.028	0.007	0.023	0.005	0.008
Kärnten	89	0.002	0.018	0.009	0.030	0.006	0.010
Steiermark	63	0.009	0.023	0.008	0.026	0.005	0.009
Oberösterreich	61	0.013	0.026	0.009	0.020	0.006	0.007
Salzburg	65	0.014	0.029	0.012	0.020	0.008	0.007
Tirol	73	0.006	0.025	0.012	0.031	0.008	0.011
Vorarlberg	65	0.012	0.030	0.012	0.029	0.008	0.010
Norte	72	0.016	0.030	0.009	0.024	0.006	0.008
Algarve	50	0.001	0.021	0.008	0.046	0.005	0.015
Centro (PT)	62	-0.001	0.038	0.027	0.062	0.018	0.020
Lisbon	48	0.002	0.025	0.010	0.050	0.007	0.016
Alentejo	63	0.006	0.026	0.011	0.035	0.007	0.012
Stockholm	60	-0.001	0.025	0.016	0.046	0.011	0.015
Östra Mellansverige	74	0.017	0.035	0.011	0.033	0.007	0.011
Småland med öarna	67	0.010	0.026	0.007	0.033	0.004	0.011
Sydsverige	64	0.013	0.027	0.004	0.032	0.003	0.011
Västsverige	68	0.011	0.030	0.010	0.036	0.007	0.012
Norra Mellansverige	67	0.012	0.031	0.011	0.035	0.007	0.012
Mellersta Norrland	72	0.007	0.019	0.001	0.030	0.001	0.010
Övre Norrland	72	0.000	0.011	0.001	0.032	0.000	0.011

Source: BD.EURS and own elaboration.

Annex 2. Correlation matrix

Table A.2.1. Correlation matrix of the regulation indices. Variables in logarithms

	PMR	STATEC	BE	BTI	**EPL**	**CMR**	PSC	**LMR**	HIRE	HFR	CC	HOURRE	CONS	**BR**	BC	START	EXTPAY
PMR	1																
STATEC	0,718	1															
BE	0,616	0,079	1														
BTI	0,280	0,278	0,155	1													
EPL	0,569	0,792	0,058	0,277	1												
CMR	-0,061	0,013	0,423	0,581	0,074	1											
PSC	0,519	0,519	0,482	0,203	0,153	0,607	1										
LMR	0,071	0,238	0,123	0,125	0,086	0,088	0,426	1									
HIRE	0,208	0,492	0,202	0,286	0,304	0,180	0,194	0,775	1								
HFR	0,323	0,604	0,080	0,378	0,683	0,127	0,188	0,042	0,420	1							
CC	0,436	0,453	0,351	0,328	0,509	0,025	0,186	0,357	0,696	0,502	1						
HOURRE	0,014	0,535	0,672	0,324	0,432	0,382	0,036	0,445	0,772	0,411	0,312	1					
CONS	0,055	0,096	0,221	0,140	0,374	0,396	0,401	0,620	0,058	0,130	0,149	0,304	1				
BR	-0,771	0,757	0,157	0,237	0,543	0,227	0,255	0,055	0,053	0,518	0,046	0,144	0,058	1			
BC	0,702	0,764	0,040	0,254	0,625	0,372	0,125	0,055	0,150	0,550	0,029	0,342	0,087	0,954	1		
START	0,636	0,308	0,480	0,474	0,077	0,026	0,490	0,294	0,409	0,306	0,219	0,355	0,008	0,587	0,458	1	
EXTPAY	0,625	0,750	0,019	0,038	0,574	0,199	0,109	0,043	0,191	0,750	0,138	0,259	0,111	0,937	0,905	0,283	1