
# Technology Catching-up and Regulation in European Regions

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**Resumen:** *(máximo 300 palabras)*

**:** En este trabajo se analizan los efectos de la intensidad de la regulación en el mercado de bienes y en el mercado de trabajo sobre el crecimiento de la productividad total de los factores para un panel de 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 (PMR) y del mercado de trabajo (EPL) y donde 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 utilizada son: BD.EURS (NACE Rev1), EUROSTAT, Fraser Institute y OCDE para los indicadores de regulación en los mercados. Encontramos evidencia de que las regulaciones que frenan la competitividad en ambos 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 regulation in the goods market and the labor market on the growth of total factor productivity for a panel of 121 European regions. IT is estimated a model of technological catch-up for the period 1995-2007 in which national regulatory indicators are introduced in the goods market (PMR) and labor market (EPL) and which is controlled by the regional endowments intangible assets (human and technological capital) that positively affect the growth of regional productivity. The databases used are: BD.EURS (NACE Rev1), Eurostat, Fraser institute and OECD indicators of regulation in the markets. We find evidence that the regulations that hinder competitiveness in both markets explain part of the observed differences in TFP growth in European regions.
**Keywords:** TFP, Regulation, Human Capital, Technology Capital, Institutions, Catch-up, European Regions.
**Clasificación JEL:** 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 labor and product markets and not only a response to a problem of accumulation in regional infrastructure, human and technological capital. In other words, we maintain that the impact of differences in markets regulation reduces European regions TFP growth and it may contribute to creating or sustaining the divergence or persistence of disparities among regions.

Competition -and 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, the existence of substantial degree of regulation may have a negative impact on firms' decisions concerning investments (Alesina et al., 2005), technology adoption and innovation (Aghion et al., 2005) and a positive impact of policies towards liberalization on growth and productivity. Other studies have focused more directly the relationship between the institutions of labor markets and products and TFP. Nicoletti and Scarpetta (2003), Scarpetta and Tressel (2002, 2004), Kent and Simon (2007) are examples.

This paper contributes to the literature by investigating the total factor productivity (TFP) growth impact of regulation in 121 European regions. While there are numerous studies on the impact of existing institutions in the goods and labor markets on productivity at the country level (OECD, UE), this does not happen at the regional level. That is not the case of the effect of existing institutions in the labor market on regional disparities in unemployment rates[1]. According to Elhorst (2003)[2] 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 labor and products markets institutions, we also take characteristics of regions into account.

In the period 1995-2007 is observed in European regions a wide dispersion in productivity. Productivity convergence between north and south European economies remains a priority issue in the economic policy of the UE. The UE's cohesion policy has been unable to do European regions to catch up with their more advanced neighbors. There is almost unanimous agreement in the debate that institutional and economic conditions that regulate labor markets and products have important effects on the convergence process.

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[1] Niebuhr (2002), Caroleo and Coppola (2006), Herwartz and Niebuhr (2011).

[2] Elhorst, J.P. (2003), The mystery of regional unemployment differentials: Theoretical and empirical explanations, *Journal of Economic Surveys*, 17, 709-748.

During this period, the process itself economic integration in the UE led to reforms in the regulatory framework in the direction of greater liberalization in product markets, credit and labor in markets subject to greater competition. Although, in general, regulation has become less restrictive, this has occurred at different degrees, to different extent and with differential impacts across the EU regions.

More specifically in this paper is estimated a model of technological catch-up for the period 1995-2007 in which national regulatory indicators OECD relating to the goods market (PMR) and labor market (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 of trade and investment has a larger positive effect on productivity growth. Also further liberalization in the labor market in general and only one of its components (Hiring and firing regulation), and less Business regulation in general has an important effect on the growth of TFP. These results remain unchanged when we control for region-specific variables in the region and surrounding itself.

The 121 regions (NUTS2) considered are from nine countries: Germany, Austria, Belgium, Spain, France, Holland, Italy, Portugal and Sweden. The Brussels region is the region that is considered a leader, which is showing the highest level of TFP in both 1995 and in 2007. The different regions are at different distances from the productivity frontier. While in most northern regions TFP has grown more than Brussels, not so with the Portuguese, Spanish and Italian regions. They show that, behind regional disparities in the dynamics of TFP, there are domestic factors that affect regions of the same country. This also influences the effectiveness of regional policy of the EU[3]. The importance of these national factors (regulatory framework, both in the goods and factor markets) on the productivity performance of European regions is the aim to study in this paper.

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 estimates of the macroeconomic impact of regulation on productivity growth across regions of 9 European countries. Section 5 offers some concluding comments.

[3] 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.

## 2. Data description.

### 2.1.-The TFP Measures

**TFP.**-The database used is BD.EURS (NACE Rev1)[4] for all variables involved in the elaboration levels and growth rates of TFP regional. 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 regional database, so ensuring its compatibility with AMECO and EU-KLEMS, which is why it commences 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 NUTS 2 level in Escribá and Murgui (2014a)[5] 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 labor income share by Escribá and Murgui (2014b). Appendix A includes a brief explanation of how to get the levels and rates of growth of TFP regional 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 are illustrated. The point located on the right represents the Brussels region.

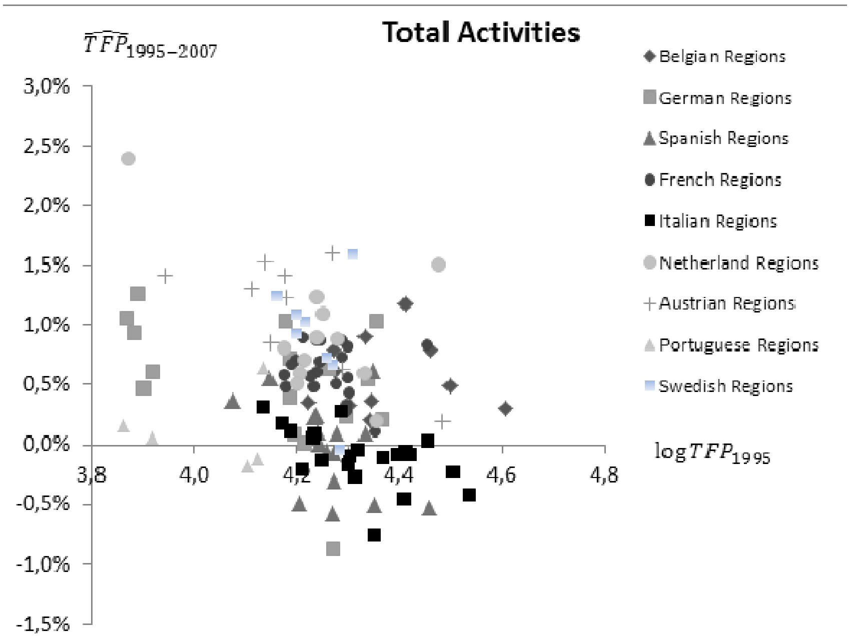


Figure 1: Productivity differences…

[4] 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

[5] In Escribá and Murgui (2014a) the methodology used in the construction of capital stock series is explained. These series remain some discrepancies with Cambridge Econometrics. The series are included in the BD.EURS.

It can be seen in the graph as the regions within the same country can be grouped into specific areas of the diagram. Which points to the importance of national factors in the regional behavior of TFP.

**Technology gap.** The technology gap or the distance from the technological frontier which captures the potential for technology transfer, is defined as the difference between region TFP and the technological frontier in initial year. There are several ways which can potentially be used to measure the technology gap. In our study, we follow the existing literature[6] (Nicoletti and Scarpetta, 2003; Griffith et al., 2004 or Buccirossi et al., 2013) and use the TFP level to compute 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 catch up as $\ln TFP_{i,f,t} - \ln TFP_{i,t}$.

## 2.2.-Regional Control Variables.

For region-specific explanatory variables was used EUROSTAT as a basic source: the regional **technological capital** was drawn from the number of patents (Patent applications to the EPO by priority year and NUTS 3, transformed to NUTS2, EUROSTAT) in relation to the GVA (the BD.EURS) 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 Indicators of Regulation.

Regarding national indicators of regulation in 1995 have used two basic sources:

- **OECD**. The synthetic indicators **EPL** (Employment Protection and Legislation) and **PMR** (Product Market Regulation), are used to characterize rigidities in the labor 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 whit higher numbers being associated with policies that are more restrictive to competition[7].
- **Fraser Institute**. The economic freedom index to: the credit market (**CMR**: credit market Regulations), the labor market (**LMR**: labor market Regulations) and the Business (**BR**: business Regulations) the big three synthetic indicators for regulation are used. A component of CMR is specifically addressed: private industry credit (**PSC**). Further disaggregation is considered in the regulation of the labor market: **HIRE** (Hiring Regulations and minimum wage), **HFR** (Hiring and firing regulation), **CC** (centralized collective bargaining), **HOURRE** (Hours Regulations) and **CONSPR** (Conscription). Also considered components of Business Regulations: **BC** (Bureaucracy costs), **START** (Starting a Business), **EXPRAY** (Extra payments / bribes / favoritism). Like all the ratings in the

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[6] Griffith, Redding and Van Reenan (2004), Nicoletti and Scarpetta (2003), Kent and Simon (2007), Buccirossi et al (2013).

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

index, these are values out of 10; 10 is the highest possible rating and zero (0) is the lowest. A higher rating indicates a greater degree of economic freedom[8].

Table 1A reports objective measures of product-market regulation compiled by the OECD in the first four columns and the next column presents 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 reports scores for Economic Freedom Index of the Fraser Institute. Both according to the Fraser Institute and the OECD countries with fewer restrictions on competition in the product market are the Netherlands and Sweden. Not so with the indicators of labor market regulation, including discrepancies between the OECD and the Fraser Institute are observed.

[8] For more details see Block, W.E (1993): *Economic Freedom. Toward a Theory of Measurement.* Backgrond Economic Freedom Publications. Fraser Institut.

**Table 1A. National Indicators on Regulation in 1995**

| | ***Product Market Regulation*** | *State control* | *Barriers of entreperneurship* | *Barriers of 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**

| | ***Labor market regulations*** | *Hiring regulations and minium wage* | *Hiring and firing regulations* | *Centralized collective bargaining* | *Hours regulations* | *Conscription* | ***Business regulations*** | *Bureaucracy costs* | *Starting a business* | *Extra payments /bribes/favoritism* |
|---|---|---|---|---|---|---|---|---|---|---|
| **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

## 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 and labour market regulation on TFP growth in 121 UE regions during 1995-2007. Aghion and Schankerman (2004) and Aghion and Griffith (2005) provide a theoretical framework for explaining this link.

Similar to the approach of Buccirossi et al. (2013) so we proceed to directly test the relationship between measures country-specific 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 $REG_{j,t}$ is one of our indicators of regulation in country *j*. However, the growth rates of TFP are affected by other region characteristics and the technological and organizational transfer from technology-frontier. The general specification we use for our regression analysis is a modified version of that in Griffith, Redding and Van Reenan (2002, 2004) and 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, other things equal, regions further from the technological frontier will experience more rapid TFP growth, given their opportunities to adopt more advanced productive practices of 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 technological '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) include 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 owned by 9 countries. Let us denote the European regions 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 is relative TFP, the further a region lies behind the frontier, and the greater the potential for technology transfer. Therefore, with technology transfer, the estimated coefficient on relative TFP should be negative. This coefficient of the TFP gap $(\beta)$ 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 implies that the vector of variables $(X_{ij,t})$ translate only into differences in TFP levels but not into permanent differences in growth rates of TFP.

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[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, 1998, and Scarpetta & Tressel, 2002 and Anexo 1.

[11] Buccirossi et al (2013) estimate the impact of competition policy and some of its components on total factor productivity (TFP) growth using a sample of 22 industries in 12 OECD countries over the period 1995-2005.

Our analysis uses European regions data and this spatial data typically violates the assumption that each observation is independent of other observations made by 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. We use on comparing model specifications likelihood ratio or Lagrange multiplier statistics as most of the spatial econometrics 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]

Formally, a spatial autoregressive model (SAR) can be written as:

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

$y$ denotes a vector of outcomes, $X$ the matrix of explanatory variables and $\phi$ 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 noncontiguous observational units and ones in positions reflecting neighboring 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):

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

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):

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

This model allow for local spillovers to neighboring 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 neighboring 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

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

explanatory variables $\left(\frac{\partial y}{\partial X^{k}} = W\theta\right)$. The coefficient $\theta$ reflects average or typical spillovers, where averaging takes place over 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:

$$\widehat{TFP}_{ij,x} = \eta \widehat{TFP}_{L,x} + \beta \ln\left(\frac{TFP_{ij,0}}{TFP_{L,0}}\right) + \psi \ln REG_{j,0} + \alpha_1 \ln R\&D_{ij,0} + \alpha_2 \ln HUMAN_{ij,0} +$$

$$+\theta_1 W \ln R\&D_{ij,0} + \theta_2 W \ln HUMAN_{ij,0} + \varepsilon_{ij} \qquad (6)$$

where $\widehat{TFP}_{ij,x}$ denotes TFP growth rate in the period 1995-2007, $\widehat{TFP}_{L,x}$ 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 and labor-market regulation in initial period. $W\,HUMAN_{ij}$ and $W\,R\&D_{ij}$ denote the spillovers effects or neighboring region values[13].

For non-frontier regions, relative TFP $\beta \ln\left(\frac{TFP_{ij,t}}{TFP_{L,t}}\right)$ is negative. If there is technology transfer, the estimated coefficient on relative TFP 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 summarise the descriptive statistics of the series used in the estimation.

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[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 to the use of alternative measures 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 |
|---|---|---|---|---|---|
| $TFP_{i}$ | 121 | 0.005 | 0.006 | -0.009 | 0.024 |
| $ln\frac{TFP_{ij}}{TFP_{lj}}$ | 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 |
| **Varibles 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 of entrepeneurship (BE) | 121 | 1.020 | 0.112 | 0.786 | 1.141 |
| Barriers of 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 |
| **Labor market regulations (LMR)** | 121 | 1.331 | 0.135 | 1.109 | 1.595 |
| Hiring regulations and minium 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/favoritism (EXTPAY) | 121 | 1.760 | 0.369 | 1.068 | 2.229 |

## 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 first instance, using an ordinary least squares regression (column [1]). The estimates don't 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 for SEM.

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

In Table 3 columns [2] and [3] the modeling strategy for specifying a spatial econometric model is followed. 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. In column [4] are presented the estimation results when SLX model is considered. LR Test suggests the preference for the spatial lag of X model.[16]

Tables 4 and 5 reports the estimation results explaining growth of regional TFP for the SLX model (equation (6)) using the row-normalized binary contiguity matrix. Objective measures of regulation are inserted into cross-region growth regressions. In table 4 OCDE 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 labor markets causes an increase in the growth rate regional of TFP. In all estimates agree that the SLX model is appropriate as can be observed in LR test $(H_0: \theta = 0$ is rejected). The first column reports 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 has 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 regards the variables of control, both direct effects of regional human capital and also regional technological capital are positive and statistically significant. That is, during the period 1995 to 2007, own 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 high education increases TFP growth by about 0.4 point; a one-point increase in number of patents in relation GVA increases European regions TFP growth by about 0.1 point. Secondly, indirect (other-region, spillover, $\theta$)[17] impacts of human and technological capital are statistically significant. While technological capital in other region has a positive effect in own regional TFP growth (same magnitude than direct effect) the human capital in other region has a negative effect.

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

The results obtained for Fraser Institute Regulation Indicators did not change – as was the case in for OCDE indicators - in regard to the technology gap, regional human and technological capital (own-region and other-region) which remained significant, as can be observed in Table 5. The coefficients of the technology gap has 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 Labor Market Regulation and Business Regulation are included. In these columns the coefficient of

[16] LeSage (2014) argues that only two specifications SDM and SDEM (this specification collapse to the SLX when $\lambda$=0, pag. 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.

own R&D is positive but not statistically significant. The coefficients of regulation have a positive and significant effect when the aggregate indicators are introduced. Only the coefficient of Hiring and firing regulations (component of LMR) and Bureaucracy costs (component of BR) are statistically significant and positive.

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) point; a one-point increase in more freedom in the Labor Market Regulation (or Hiring and firing regulations) increases TFP growth by about 0.74 (0.75) point; a one-point increase in more freedom in the Business Regulation (or Bureaucracy costs) increases TFP growth by about 0.9 (1.8) point.

**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]** |
| $ln\left(\frac{TFP_{ij}}{TFP_{L}}\right)_{1995}$ | -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) | | |
| $\rho$ | | | 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. Shapiro-Wilk test utilizes the population is normally distributed as the null-hypothesis. 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. OCDE Regulation Indicators.**

| **Dependent variable** | $\widehat{TFP}_{U,1995-2007}$ | | | |
|---|---|---|---|---|
| ESTIMATION: The Spatial lag of X model (SLX) | | | | |
| | **[1]** | **[2]** | **[3]** | **[4]** |
| $ln\left(\frac{TFP_U}{TFP_L}\right)_{1995}$ | -0.0195*** (0.0028) | -0.0229*** (0.0031) | -0.0199*** (0.0029) | -0.0184*** (0.0029) |
| $ln\ R\&D$ | 0.0009* (0.0005) | 0.0012*** (0.0005) | 0.0010** (0.0005) | 0.0008 (0.0005) |
| $ln\ HUM$ | 0.0044*** (0.0014) | 0.0041*** (0.0016) | 0.0037*** (0.0015) | 0.0035*** (0.0015) |
| W $ln\ R\&D$ | 0.0014** (0.0006) | 0.0019*** (0.0006) | 0.0013** (0.0006) | 0.0010* (0.0006) |
| W $ln\ HUM$ | -0.0048*** (0.0018) | -0.0057*** (0.0019) | -0.0043*** (0.0018) | -0.0046*** (0.0018) |
| $\widehat{TFP}_{L,1995-2007}$ | 0.0057 (0.0046) | -0.0072 (0.0067) | 0.0065 (0.0065) | 0.0146** (0.0072) |
| **PMR** | -0.0133*** (0.0051) | | | -0.0124*** (0.005) |
| $STATEC$ | | -0.0034 (0.0047) | | |
| BE | | 0.0008 (0.0041) | | |
| RTI | | -0.0033*** (0.0011) | | |
| **EPL** | | | -0.0114** (0.0006) | -0.0097* (0.0060) |
| LR Test SLX vs. OLS ($\theta = 0$) p-value | 10.64 0.0049 | 15.81 0.0004 | 10.95 0.0034 | 11.81 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 Indicators.**

| **Dependent variable** | $TFP_{i,1995-2007}$ | | | | ESTIMATION: The Spatial lag of X model (SLX) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **[1]** | **[2]** | **[3]** | **[4]** | **[5]** | **[6]** | **[7]** | **[8]** | **[9]** |
| $\ln\left(\frac{TFP_{Li}}{TFP_{L}}\right)_{1995}$ | -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) |
| $TFP_{i,1995-2007}$ | -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 | 15.23 | 13.98 | 15.10 | 6.10 | 7.07 | 16.04 | 17.59 | 18.93 | 22.89 |
| ($\theta = 0$) | [0.0005] | [0.0009] | [0.0005] | [0.0473] | [0.0292] | [0.0003] | [0.0002] | [0.0001] | [0.0000] |
| p-value | 0.54 | 0.54 | 0.53 | 0.60 | 0.54 | 0.55 | 0.59 | 0.58 | 0.61 |
| $R^2$ | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 | 121 |
| Sample Size | [0.0239] | [0.0121] | [0.2321] | [0.0933] | [0.0144] | [0.3535] | [0.0426] | [0.2162] | [0.2684] |
| Shapiro-Wilk Test | [0.1811] | [0.0948] | [0.0257] | [0.0789] | [0.0770] | [0.0370] | [0.1507] | [0.1270] | [0.1398] |
| Breusch-Pagan | 2.76 | 2.66 | 2.67 | 8.59 (Multicol) | 2.98 | 3.12 | 4.96 (Multicol) | 3.19 | 2.72 |
| VIF | | | | | | | | | |

**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.

## 5. Conclusions

This paper provides new evidence on regional productivity performance. Although in the period considered there has been an effect of catching-out productivity between European regions, major differences persist in both productivity levels and growth rates. 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. The TFP growth of regions within a country is greatly affected by national factors. Using data covering 121 UE regions over the period 1995-2007, we explore the effects of product and labor market regulations on aggregate TFP growth. Our results imply that good competition policy has a strong impact on TFP growth. The coefficients for the aggregate PRM and EPL are negative and statistically significant.

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 of trade and investment has a larger positive effect on productivity growth. Also further liberalization in the labor market in general and most of its components (especially the absence of centralized collective bargaining), has an important effect on the growth of TFP. These results remain unchanged when we control for region-specific variables in the region and surrounding itself.

So far the effectiveness of regional development policies in the EU is heavily influenced by the government policies.

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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 common in the 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 $\alpha_{ij}$ and $1-\alpha_{ij}$ are used as shares for capital and for labour respectively, that are different in each region. The information on $\alpha_{ij}$ is extracted directly from the accounts available in 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),and Harrigan (1997)- and more specifically in this literature on regulation Scarpetta and Tressel (2002)- is used.

### Total Factor Productivity. Levels ant growth rates.

| Region | TFP 1995 | Growth rates average values 1995-2007 | | | | | |
|---|---|---|---|---|---|---|---|
| | | 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 |
| País Vasco | *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 |
| Aragón | *72* | -0.001 | 0.033 | 0.032 | 0.037 | 0.020 | 0.014 |
| Comunidad Madrid | *86* | -0.005 | 0.040 | 0.045 | 0.047 | 0.028 | 0.018 |
| Castilla y León | *70* | 0.000 | 0.026 | 0.021 | 0.033 | 0.013 | 0.012 |
| Castilla-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 |
| Cataluña | *76* | 0.001 | 0.036 | 0.037 | 0.034 | 0.023 | 0.013 |
| Comunidad Valenciana | *69* | 0.001 | 0.039 | 0.035 | 0.042 | 0.022 | 0.016 |
| Illes Balears | *69* | 0.003 | 0.044 | 0.043 | 0.038 | 0.027 | 0.014 |
| Andalucía | *72* | -0.003 | 0.038 | 0.040 | 0.042 | 0.025 | 0.016 |
| Región de Murcia | *71* | -0.001 | 0.046 | 0.044 | 0.052 | 0.027 | 0.020 |
| Canarias | *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 |
| Wien | *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 |
| Lisboa | *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 |