EVALUATING REGIONAL POLICIES TO IMPROVE TFP IN A CONTEXT OF LOW PRODUCTIVITY GROWTH: THE CASE OF SPAIN*

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Abstract

This paper develops a framework to analyze the potential of different variables that increase total factor productivity (TFP) growth in regions with poor productivity performance. It takes an industry level approach for a set of countries used as benchmark. The information comes from the EU KLEMS database. Once this influence is measured, the difference in the scores of each variable in Spain and its 17 regions with respect to the benchmark is used to test their potential to increase productivity growth. Results show that it is important to increase firm's size; reduce the weight of temporal workers in the labor market; increase R&D expenditure; encompass wages to productivity growth; increase the percentage of investment devoted to ICT assets as well as the use of new technologies by individuals and improve the endowments of Internet infrastructures.

Keywords: total factor productivity, ICT investment, institutions

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1. Introduction

Since the beginning of the Great Recession that began in 2007, the need to increase the growth rate of developed economies has been brought to light, with productivity gains essential to achieve this goal. However, studies show that this is not an easy task, given that Europe, in general, has a problem of slow productivity growth, particularly in services, when compared with the U.S.[1] This reality is specially worrying in some countries like Spain. From 1995 until the beginning of the crisis, GDP growth in Spain was strong and sustained, based on a more intense use of production factors in terms of both labour and capital, which led to total factor productivity (TFP) hardly increasing. Most of the Spanish regions shared this pattern although with different intensity.

What can be done to improve the productivity of these economies? Which aspects should economic policy measures focus on? The paper proposes a methodology to evaluate how a set of selected variables has contributed to productivity growth. The usual strategy followed in the study of TFP growth determinants is to make econometric estimates of TFP growth (or level) as the dependent variable for the countries analyzed, and a set of independent variables thought to play a significant role. As labour productivity and TFP growth have proved to be very sluggish in Spain and its regions, it does not seem advisable to rely only on their performance. A better strategy would be to study the determinants of TFP growth within a broader set of countries with, in general, higher productivity growth. We take this alternative route by making use of the information provided by the EU KLEMS database.

To be specific, the classification of 24 sectors of the market economy in 10 European countries (Austria, Denmark, Finland, France, Germany, Italy, Netherlands, Spain, Sweden and the UK) and in the US is used over the period 1998-2007. The analysis is carried out in two stages. Firstly, we make use of a regression framework to estimate the main determinants of TFP growth for the benchmark countries. In the second stage we make use of the coefficients previously estimated to measure the impact that the selected variables would have on improving TFP growth in Spanish regions. The main contribution of this work is to provide a consistent framework for measuring the relative importance of different determinants of TFP growth, based on a large sample of countries and explicitly considering the sectorial dimension. To the traditional determinants highlighted by the literature we have added three variables related to the functioning of institutions (labour market, organization of firms as reflected in their size, and regulations), together with a wider set of variables capturing the extension and use of ICT by firms and households. The framework allows computing the distance of the laggard regions to the benchmark and proposes measures to

[1] See Timmer *et al.* (2010) and Mas and Steherer (eds.) (2012) for a review.

calculate TPF growth in the case that the regions were to converge to the levels observed in each variable.

The paper is organized as follows. Section 2 reviews the literature on measuring the determinants of productivity. Section 3 presents the patterns of growth in Spain and its regions over the period 2000-2007. Section 4 describes the methodological approach and definitions of variables. The influence of each variable is quantified in section 5, while a simulation is carried out in section 6 measuring how TFP would be affected if the regions converged to the European average in each determinant. Finally, the last section presents the main results.

2. Determinants of productivity: literature review

Isaksson (2007) provides a comprehensive literature review on TFP determinants based on macro, sectorial and micro studies. He summarizes the determinants of TFP in four groups. The first one includes variables related to the creation, transmission and absorption of knowledge. The creation of knowledge is related to R&D and ICT investment, while its transfer is related to trade and foreign direct investment (FDI).

The second group of determinants concerns factor supply and efficient allocation. The focus here is on human capital (e.g. schooling, health and training) and physical infrastructure (e.g. roads and electricity) rather than physical capital (machinery and equipment) since the latter is always included in the production function. Efficient allocation of resources is dealt with under two headings: namely, structural change (allocation of resources to the most productive sectors) and the financial system, since a good financial system is able to allocate savings to investments with the highest returns, and high-quality investment implies a higher probability of TFP growth.

The third group of determinants is related to institutions, integration and geography. Among institutions, a distinction is made between political (e.g. autocracy versus democracy) and economic institutions (e.g. property rights and regulations), whereas in the case of integration the focus is on trade (FDI is covered under “knowledge transmission”). Geography concentrates on the location of countries and, in particular, the effects of being located in the tropics or in Africa.

The final group is concerned with the role of competition, the social dimension and the environment for productivity growth. A long-held view argues that competition is the main

determinant of productivity growth, while most recently it has been argued that environmental regulation deters it.

The great majority of papers reviewed by Isaksson (2007) are based on aggregated macro data for either individual or different sets of countries. Only a few of them rely on data disaggregated by industries as proposed here. Griffith, Redding and van Reenen (2004) use a panel of industries across 12 OECD countries. They accept the common view that R&D has two faces: the conventional role of stimulating innovation as well as enhancing technology transfer (absorptive capacity). Their theoretical rationale is based on models of endogenous innovation and growth (such as Romer [1990] and Aghion and Howitt [1992]). They find R&D to be statistically and economically important in both technological catch-up and innovation. Cameron, Proudman and Redding (2005) analyse productivity growth in a panel of 14 UK manufacturing industries since 1970. They distinguish, as do Griffith *et al.* (2004), between innovation and technology transfer as a source of productivity growth for a country behind the technological frontier, led by the US in all sectors. They also examine the role played by R&D, international trade and human capital. While R&D increases the rate of innovation, international trade enhances the speed of technology transfer. Human capital affects output through private rates of return, captured by the index of labour quality.

Timmer, Inklaar, O´Mahony and van Ark (2010, chapter 6) use a regression analysis to gauge statistically the importance of certain potential determinants of TFP growth, based on a technology gap model similar to Griffith *et al.* (2004). They also use relative levels of TFP but instead of assuming that the US is the leader in all industries they consider that each individual industry —in the set of countries covered by the EU KLEMS database— is led by a specific country. Among the many possible TFP determinants, they focus on whether ICT use and the use of skilled labour generates externalities and whether regulatory barriers to entry hamper productivity growth. The ICT variable is defined as the share of capital compensation in gross output and skilled labour refers to university-educated workers. They do not find evidence of positive externalities in the use of ICT or evidence that a larger share of highly-skilled workers has an impact on TFP growth. Both results indicate that the impact of ICT and higher-educated workers is well captured in the growth accounting exercise.
In what follows we will take a similar route to that of Timmer *et al.* (2010), but instead of concentrating on the technological gap we will focus more on ICT and some institutional settings that are potentially important when explaining the poor performance of TFP in Spain.

3. Evolution of total factor productivity: Spain and its region in the European context

The total factor productivity (TFP) figures come from the EU KLEMS database, calculated making use of growth accounting methodology for each sector of the economy. In the calculation it is assumed that there is a production function in which the value added (*y*) of a sector *i* at a given moment in time *t* can be expressed as:

$$y_{it} = y_{it}(PK_{it}^{ICT}, PK_{it}^{Non-ICT}, HW_{it}, HK_{it}, TFP_{it}) \quad [1]$$

where PK^{ICT} and $PK^{Non\text{-}ICT}$ are productive ICT capital (hardware, software and communications) and Non-ICT (other assets, excluding dwellings), respectively. HW is hours worked and HK is a measure of the skills of the workforce or human capital. TFP measures the levels of efficiency in how factors of production are used, after deducting the impact of improvements in workers' skills and corrections in the measurement of different forms of capital. A detailed explanation on how TFP growth is computed in the EU KLEMS database can be found in Timmer *et al.* (2010, chapter 3).

As we can see from the data in table 1, growth in labour productivity in the market economy is considerably lower in Spain than in the other European countries analysed in the period 2000-2007. While labour productivity grew by 1.45% in the whole of Europe[2], 1.56% in Germany, and 2.40% in the US, it was a mere 0.87% in Spain. On average, in the European countries labour productivity growth was mainly based on capital deepening (0.77 percentage points [pp], with similar contributions being made by ICT [0.36 pp] and non ICT capital [0.41 pp] and TFP [0.61 pp]). Meanwhile, changes in the contribution of skilled labour were lower (0.20 pp). In Spain, the pattern of productivity growth was very different. The most characteristic feature is the negative contribution of TFP (-0.42 pp). Furthermore, the contribution of capital per hour worked was higher in Spain but it should be noted that this capital contribution is mainly due to non ICT capital, which contributes 0.64 pp while that of ICT capital is lower (0.21 pp). Finally, improvements in the composition of the workforce play a major role in Spain and are more than twice that of European countries as a whole. Therefore, two facts stand out regarding how productivity has progressed in Spain. First, the negative behaviour of TFP during the period analysed, and secondly, the minor role of ICT capital, compared with the rest of Europe.

[2] For the 10 countries for which information is available (see footnote table 1).

Table 1. Growth Accounting

A similar pattern was shared by all the Spanish regions. Labour productivity growth was very slow and even negative in three regions, while only two improved at a rate (slightly) higher than the European average. Thirteen out of seventeen regions presented negative TFP growth, while in the remaining four it was lower than in the European countries. Capital accumulation was very intense, and in all the regions the contribution of non-ICT capital was higher than the ICT capital contribution. Finally, the improvements in the qualification of the labour force were generalized to all the regions and the contributions to labour productivity growth were always higher than for the set of European countries considered.

4. Policy variables to improve TFP: methodology and definitions

This section examines the determinants of efficiency improvements (TFP growth) from a large selection of potential explanatory variables. The analysis is performed in two stages. The first one estimates the determinants of TFP by means of a regression model using the maximum feasible level of industry disaggregation for 10 European countries and the United States. The second stage evaluates the potential of the variables found in the first stage to be most relevant in improving TFP in each of the Spanish regions.

Therefore, the strategy we propose specifies a regression model where the dependent variable is the TFP growth of each sector of the market economy provided by the EU KLEMS database. The explanatory variables for TFP growth that have been selected are the following.

Unit labour costs growth. Unit labour costs can be considered an indicator of the level of regional competitiveness. When labour costs grow at a higher pace than productivity —that is, when unit labour costs increase— it means a threat to the competitiveness of the economy if other costs are not reduced in compensation. The information for this variable comes from EU KLEMS. Data for the Spanish regions is elaborated using Regional Accounts (INE —the Spanish Statistics Institute—).

Temporality: One of the main characteristics of the Spanish labour market is its duality. That is, two groups of workers coexist: one group which enjoys a high degree of protection against adverse situations while the other has virtually no protection. The high temporality of Spanish workers mainly affects the youngest people who also happen to be the best trained, undermining the possibility of exploiting their human capital. Temporality has a negative

impact on investment in human capital and productivity as it reduces the incentives for firms and workers to provide and receive training and hinders the process of acquiring experience in the workplace. As an indicator of temporality the percentage of temporary workers in the total workforce in each sector is used. The data is obtained from Eurostat *Labour Force Statistics*. Given that the statistical breakdown is not available for all manufacturing, the same level of temporality is assigned to all manufacturing industries. In the United States information on temporary workers does not exist, because the US Federal legislation does not distinguish between different types of labor contracts in relation to the duration. That is to say, it can be assumed that, generally, any labor contract can be considered permanent. Therefore, to be able to include the United States in the sample one assumes that the temporality variable is 0% in all the sectors. The information for the Spanish regions is taken from the Labour Force Survey (INE).

Firms' size: The size of companies, largely the result of institutional environment and regulation, can have a positive effect on productivity. This is because large companies are better able to develop and exploit the benefits of innovation, devote more resources to R&D, exploit economies of scale and penetrate foreign markets (Pagano and Schivari 2003). However, it is also true that smaller companies, especially the young and most dynamic ones, may promote aggregate growth through increased competition, new product development, incorporation of new talent, new types of capital or the adoption of new organizational strategies. Unfortunately, as well as limitations on the indicators available of firm size for the countries studied, there are also limitations on the required sectorial breakdown. For example, statistics do not allow to build indicators of the average size of the sector or the average percentage of value added (or sales) represented by large firms. The indicator used is the percentage of companies with 10 or more workers out of all companies. Data for Europe is taken from Eurostat Business Demography Indicators, whereas for the US, the OECD's Structural Business Statistics are used. The DIRCE (from INE) is used for Spanish regions.

Investment in ICT. The calculation of TFP explicitly takes into account capital linked with new information technologies and communication. However, it is important to assess not only the rate at which it accumulates, but also the composition of aggregated capital. Thus, an additional variable is introduced: the percentage that ICT investment represents over total investment. The data is obtained from the EU KLEMS database. For the Spanish regions, data is taken from BBVA Foundation-Ivie.

Related to ICT, two dummy variables are included which measure whether the sector is producing ICT or is an intensive user of ICT. Dahl, Kongsted and Sorensen (2011) use also a dummy variable for ICT-intensity but distinguishing between ICT-intensive and ICT-non intensive sectors instead of ICT-producers and ICT-intensive as we do here.

Spillover effects coming from physical and human capital. A high intensity in the use of these two factors of production can generate further effects than those coming from its direct use in each firm or sector (*spillover effects*). The generation of spillovers parts from the idea that the investment in physical or human capital by companies generates increases in its stock of knowledge. But, as well, this increase of the knowledge level is a public good that can be profitable for the rest of companies and sectors. That is to say, the increase of knowledge acquired, derivative of the installed capital stock, spills over to the rest of the economy. Therefore, these assumptions imply that productivity growth will not only come from the capitalization of each company or sector, but also from the capital stock (physical and human) aggregate of the economy (Romer 1986; Lucas 1988; Barro and Sala-i-Martin 2004, among others). Aggregated physical capital is taken from the STAN database (OECD) and BBVA Foundation-Ivie for Spanish regions, and as an indicator of aggregated human capital the percentage of population (25-64 years) with tertiary education over total population (source OECD and Spanish Labour Force Survey –INE—) is used.

Infrastructure and Internet use: Two variables that approximate the endowments of Internet infrastructure of firms and their use by individuals are included. Specifically, broadband Internet subscribers (as percentage of total population) are considered an indicator of the endowments in this type of infrastructure, and the percentage of individuals who use Internet as a variable that approximates the use of new technologies. Data is taken from the World Bank for the international sample and from the INE for Spanish regions.

Expenditure on R&D. R&D investment has been widely used as a determinant of TFP growth thanks to its capacity to stimulate innovation and also to enhance technology transfer. Although Eurostat has disaggregated data by sector, it is not used as it is somewhat incomplete, reducing the sample to approximately half the observations. The sectorial data is available for most sectors and countries only in recent years of the sample. For this reason, aggregated expenditure on R&D as a percentage of total investment (Eurostat and OECD) in each country is included in the estimation. For Spanish regions, data is obtained from the INE. The technological capital stock by branch of activity provided by EU KLEMS is not considered, given that the latest data available is 2003 and the sectorial availability is limited.

For example, it does not provide a breakdown of the services market by branch of activity, and only the total is available.

Regulatory variables in services: It has been argued that the main cause for slow productivity growth in the EU compared to a much higher rate in the United States stems almost exclusively from low competition in the service sectors. In order to capture the characteristics that hinder competition in various service sub-sectors, we have considered the three indicators on regulatory barriers included in the OECD database *Indicators of Product Market Regulation*. The indicators are constructed from questionnaires completed by national authorities in three separate years: 1998, 2003 and 2008. Given that only these three periods are available, the remaining sample years are interpolated. The indices are bounded between 0 and 6, the higher values meaning higher level of restrictions on competition. The indicators included are: 1. Sector specific administrative burdens (administrative burdens in road transport and retail distribution sectors); 2. Barrier to entry in network sectors (measures various kinds of entry barriers in network sectors —based on detailed data for seven network sectors—, as well as the degree of vertical integration in energy, rail transport and telecommunication sector); and 3. *Barrier to entry in services* (measures barriers to entry in retail trade and professional services).

As seen in section 2, a broader set of potential explanatory variables exists. Additional variables are not included due to lack of sufficient information for different countries and for sectorial breakdown. For example, infrastructure endowments are a variable which has a potential effect on TFP and should therefore be included in the estimates. However, capital stock in infrastructure is available only for the Spanish economy. In relation to other variables that have been excluded, it should be mentioned that indicators cannot be obtained from Eurostat *Labour Force Statistics* regarding the skills of company directors. Something similar occurs with variables on entrepreneurship. There are some studies that have included other variables among the determinants of TFP, such as foreign direct investment and the degree of openness.

This paper does not include either for the following reasons. Although the OECD publishes data on sectorial foreign direct investment, the sectorial breakdown since 1998 is only available for investment flows, and is only available for *stock* for recent years. The relevant variable for productivity analysis should be accumulated investment stock, rather than just the investment made in a given year. The sectorial trade balance is not included either, as it

is only available for those sectors that produce tradable goods, and is therefore not available for services.

5. Determinants of Total Factor Productivity (TFP) Growth

Table 2 shows the results of the estimates. The dependent variable in all equations is *TFP* growth. These are estimated using panel data techniques (random effects) in which the individual is defined by sector and country. They also include time and country dummy variables (country effects), in order to capture *shocks* and specific characteristics of countries, or of years, not covered by other explanatory variables. The table includes several regressions in which additional variables are added sequentially as they do not have sectorial variability (only across countries and over time). In total, more than 1,600 observations are available, with R^2 around 0.63.

Column [1] indicates that there exist a negative relationship between unit labour cost and TFP. When labour costs increase at a faster rate than productivity —thus increasing unit labour costs— wages and prices experience an upward pressure with a loss of competitiveness. The rise in inflation reduces the real value of all fixed nominal incomes (salaries, pensions, unemployment benefits, nominal savings rates, …). If workers have enough power to translate the rise of inflation into higher wages —as it has in fact happened in Spain— real wages will go up with negative effects on employment. Furthermore, the increase in unit labour costs would be detrimental for competitiveness since it would push up the price of our exports while reducing at the same time the price of imports.

The results also indicate that there is a negative relationship between temporary work and TFP, since it shows a statistically significant negative coefficient although not always statistically significant. However, the non-significance of the coefficient is driven by the assumption of temporality made for the US. All the estimations have been re-run (not shown) excluding this country from the sample. In this case, temporality always shows a negative and statistically significant coefficient. Therefore, as mentioned, and as can be seen in the literature (see Dolado and Stucchi, 2008, among others), the existence of high level of temporality in the Spanish economy is an obstacle for TFP growth. This effect is due to the fact that higher temporality reduces (especially when the rate of conversion from temporary to permanent jobs is low) the effort by workers and the probability of acquiring more human capital. It also reduces the incentive for companies to invest in training.

The results shown also confirm the positive relationship between firm size and TFP growth, since the coefficient accompanying the variable that measures the proportion of firms with

over 10 employees is positive and significant. Therefore, in those sectors where the ratio of micro-firms is smaller, major efficiency gains are observed.

Columns [1] and [2] show the coefficients of the weight of the investment in ICT on total investment, and of the dummy variables that measure if the sector is intensive in the production and/or the use of ICT. The coefficients of the dummy variables measure the differences in TFP growth that exist in average between the ICT producing (or users) and non-producing sectors (or non-users). The results show that ICT producing sectors grow systematically at a greater pace than the non-producing ones. That is to say, ICT producing sectors have an advantage in terms of TFP that ranges between 4.3 and 4.5 percentage points. Nevertheless, evidence that the ICT intensive user sectors have greater productivity than non-intensive users is not obtained, since the coefficient is not significant.

The variable that measures the importance of the ICT investment on total investment is not significant. Apparently, this result contradicts the conclusions reached by abundant studies that find evidence in this sense (see Isaksson, 2007). This is due to the high sample correlation between this variable and the dummy variables that measure if a sector is an intensive ICT user o producer. If these dummies are eliminated, the weight of the ICT investment is highly significant (equations [3] and [4]). Therefore, if the multicolinearlity problem between the variables is corrected, the results show that TFP growth is greater in those sectors in which the investment is more focused on this type of assets. In the rest of the equations of table 2, the weight of ICT investment is included solely, eliminating the two dummy variables.

The first set of variables that are included without industry variability are the physical and the human capital spillover. Both are positive, although not always significant. The physical capital spillover effects are not significant when country dummies are included, possibly due to multicollinearity. However, when these are excluded, the coefficients are significant. As for the percentage of university on the total of population, the situation is just the opposite. It is significant when the country dummy variables are included, but not when they are excluded. The R&D investment also shows a positive and significant sign, implying that an increase in R&D expenditure fosters TFP growth.

Equations [9] and [10] include the variables related to the different regulatory barriers in services. Among the three variables included, only the third (*Barriers to entry in services*) is

significant[3]. The evidence therefore suggests that in a European context there are indeed barriers in the sectors of retail trade and professional services which mean that competition does not generate enough pressure on these sectors to improve their efficiency, with negative effects on the aggregate. This result is in contrast with Inklaar *et al.* (2008) who find that, in post and telecommunications, lower barriers are strongly related to higher TFP growth, while for other service sectors no evidence could be found. The last two sets of estimates include variables related to the endowments of Internet infrastructure of companies and their use by individuals. Once again, the significance of the variables can be seen when country effects are eliminated. The use of Internet by individuals is statistically significant, whereas the endowment is only significant marginally. This illustrates that indicators of Internet use, and to a lower extend, its endowments, have a role to play in explaining TFP growth.

6. Policy variables to improve TFP growth in Spain and its regions

In this section, the distance between Spain in relation to the average of the European countries considered in the analysis is evaluated in each of the explanatory variables, so as to then calculate its potential to accelerate TFP growth.

Table 3 shows the average value of each variable for Spain, its regions as well as the average of the European countries taken as benchmark over the period of analysis. In relation to European countries, the Spanish economy stands out for its unit labour costs growth rates, always positive and higher in all regions than in Europe, while the US presented a negative sign. Spanish temporality rate is significantly higher than in Europe. Whereas in Europe only 10.7% of workers are temporary, in Spain this percentage is more than twice higher, 26.1%, and for some regions it goes beyond 30%. The proportion of firms with 10 or more employees is below the European average: 6.1% in Spain, and 7.0% in Europe, to be compared with 25.1% in the US. Only two regions (Murcia and Navarre) have a similar share than the European average. The weight of ICT investment over total investment is also lower in Spain (16.3%) than in Europe (21.7%). No one single Spanish region reaches this European score. The endowments of physical capital per inhabitant are lower in Spain and again no single region is more capitalized than the European average. On the contrary, the percentage of population with higher education is slightly higher than in the average of the European countries under consideration, but way behind the United States.

[3] The non-significance of the Specific administrative burdens and Barrier to entry in network sectors is not due to a possible problem in the high correlation between the three indicators of regulatory barriers. The estimates were repeated for each one separately. The only significant variable was the Barriers to entry in services variable (significant at 5% even with the country dummy).

Madrid, Navarre and the Basque Country are the regions with higher share of qualified workers. Business R&D expenditure as a percentage of total investment is significantly lower than in the European countries as a whole. In Spain it is 2.0% while in European countries it has been significantly higher, reaching 6.3%. The Basque Country presents the highest ratio of all the Spanish regions (4.9%). As for the remaining two ICT indicators, broadband is lower in Spain (10.3%) and in all its regions. Only Madrid (13.1%) gets close to the European average. The use of Internet is also lower in an international context since only 48.4% of individuals use the Internet at least once a week, while in Europe this percentage reaches 59.9%. No one single Spanish region gets to this percentage; only Madrid (58.5%) gets close enough[4].

After reviewing the position of Spain and its regions in relation to the *benchmark* of European countries, we estimate how TFP growth would be affected by the variation of each determinant from its actual value to placing it at the *benchmark* level (the selection of European countries). The effect on TFP growth of variable *X* from the value of each region (X_{Region}) to the average of European countries ($X_{Benchmark}$) can be calculated as:

$$\text{Effect on TFP growth} = \beta_X \left(X_{Benchmark} - X_{Region} \right) \quad [2]$$

where β_X is the estimated regression coefficient obtained in table 2. The results of this exercise are shown in table 4.

As in the case above, all the effects on TFP growth of variations in the explanatory variables[5] are stable regardless of the estimated equation, except those related to the percentage of temporary workers. Given that temporary work in Spain is higher, the convergence to average European levels has a great impact —in fact, the greatest impact— as it would result in an increase of 0.8 percentage points in TFP growth[6]. The increase in Andalusia would be much higher (1.3 pp). In Canary Islands, Murcia, and Valencian Community, the increase in TFP is higher than 1 pp. On the contrary in Madrid, Rioja, Navarre and Catalonia the effect is lower (0.5 pp).

The deceleration of unit labour costs growth rate in Spain (1.1%) to the European average (0.4) would have a positive effect of 0.47 pp on Spanish TFP growth. In this case, the regions

[4] We do not include information for the regulatory variables since it is available only for Spain, with no regional disaggregation.
[5] Again, only the results of statistically significant variables are available.
[6] On average for all values of the estimates in table 2.

that would benefit the most from the convergence would be Murcia (1.39 pp), Balearic Islands (1.36) and Castille-La Mancha (1.12). While, the convergence of unit labour costs would have a small effect on TFP in the Basque Country or Madrid.

Given that there are not many differences in the size proxy variable between Spain and the European countries, this variable has a small impact on productivity growth, only 0.02 percentage points. It is possible that if better proxies of firm size were available[7], this variable would have an even greater impact on TFP growth.

If Spain increased the weight of investment in ICT assets to reach the average European value, its TFP growth would increase by 0.16 percentage points, being Castille-La Mancha and Murcia the regions with a higher impact of this variable converging to Europe. In general, the convergence to the benchmark in this variable would be highly beneficial for all the regions, except for Madrid, Extremadura and Canary Islands due to the small difference with respect to the benchmark.

If the weight of ICT activities is increased within the productive structure of Spain, higher growth in aggregate productivity would be achieved via TFP growth, given that these industries usually have higher productivity as reflected by the dummy variable shown before.
In relation to the other variables, those with no sectorial variability, the results show that the influence of investment in R&D is high. Increased investment in R&D would generate TFP gains of 0.51 pp. The effect of this variable across regions varies from a lower 0.2 pp (Basque Country) and a higher 0.7 (Balearic Islands). The extent of Internet use by citizens plays a key role in improving the productivity. The assumption of convergence in the percentage of the population using the Internet in Spain to the European average would increase TFP by 0.22 pp, and as much as 0.42 pp in Extremadura. Finally, if Spain was to converge to Europe in broadband penetration TFP growth would increase by 0.12 pp, and more than double in Extremadura (0.28 pp). Considering that Spain has higher prices than the majority of European countries, a measure to be considered is lowering the rates of broadband access in Spain in order to stimulate its use and improve TFP (Mas and Quesada, 2005). In general, in all these variables there are considerable differences in the effect of convergence to the benchmark across regions.

[9] For example, if the percentage of jobs or the weight in GVA were available, micro or large firms would obtain more conclusive results. However, this information is not available for all countries with the level of sectorial disaggregation required.

7. Conclusions

European economies, especially the peripheral ones, are experiencing one of the biggest downturns in recent history. Spain has accumulated significant imbalances such as high unemployment rates, problems deriving from sustainability of public accounts, the working of the banking sector, etc. Finding a solution to these problems is urgent. However, we must not forget that these problems stem mainly from the difficulties that the Spanish economy has in presenting a stable and sustainable pace of growth. To make this possible it is necessary for growth to be based on TFP growth and not the intensive use of capital and labour.

Indeed, in the years before the outbreak of the Great Recession, Spain's GDP grew at a high rate, although the slow growth of productivity was a sign that something was not working properly. As recent experience has shown, the global crisis has more serious consequences in countries that experienced lower productivity gains during these years. Within this group we find Spain and also Italy. For this reason, these are also the countries which are having most difficulty recovering from the crisis.

The results of this study indicate, as does other literature, that ICT producing industries have average rates of TFP growth superior to other branches of activity. However, public authorities should not force a greater presence of ICT producing industries for which Spain and its regions probably do not have competitive advantages. Other reforms are more urgent. Some of them deal directly with the working of institutions, while others are primarily linked to the productive specialization of the two countries.

In the case of Spain, the priority is the reform and improvement in the working of the labour market. It is urgent to reduce the existing duality by reducing the weight of temporary workers. It is also important to increase the size of firms, reducing the weight of micro-firms while progressively increasing the size of larger ones. In both respects, the public sector has much to say. A new framework in the labour market which reduces temporality and adjusts wage developments to productivity, as the one recently approved, would have positive effects on competitiveness. Changes in the regulation of companies which favour the emergence of new entrepreneurial businesses, would accelerate the disappearance of those with no future, and support the growth of the most efficient. A factor that would also contribute to improve productivity growth in most European countries is the reduction of the barriers to entry in service sectors.

Our results also indicate that the intensification of investment in ICT and R&D activities is key, but this should not be undertaken indiscriminately. That is to say, the production process must be transformed so as to be more intensive in the use of ICT, therefore exploiting the possibilities offered by these capital goods to improve productivity. In terms of R&D, given that Spain and all its regions are well below the European average, investment should be increased, especially privately funded investment. Public policy should also aim to encourage not only a higher endowment of Internet infrastructure, but to promote the use of these technologies by the majority of the population. The reduction in the price of communications and an increase in competition to bring it in line with other neighbouring countries is a step in the right direction. The increase in services provided by the government through the web would also be welcomed as it would not only improve the efficiency of firms by reducing costs, but also serve as an example for the entire population. Finally, the education system plays a crucial role in extending the use of ICT and the efficiency with which these tools can be used productively.

In general, all these policy conclusions are relevant for each Spanish region. But as the results presented show, the impact of each determinant on TFP is different depending on the region. That is, the capacity to increase productivity by means of the convergence to the benchmark values depends on the relative position of the region. Hence, the priority in policy action of each region may be different.

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Tabla 1. Growth Accounting. Productivity per hour worked. Market economy. 2000-2007
(percentage)

	Productivity per hour worked	Contributions of the Sources of Growth					Realloca-tion effect
		Changes in qualifi-cations	Total capital per hour worked	ICT capital per hour worked	Non-ICT capital per hour worked	TFP	
Andalusia	0,61	0,33	0,88	0,22	0,66	-0,64	0,04
Aragon	1,25	0,43	1,14	0,23	0,91	-0,14	-0,18
Asturias	1,01	0,34	0,59	0,14	0,44	0,42	-0,34
Balearic Islands	-0,47	0,38	1,35	0,37	0,97	-2,02	-0,18
Canary Islands	-0,11	0,54	0,70	0,27	0,43	-1,31	-0,04
Cantabria	0,81	0,54	0,26	0,09	0,17	-0,04	0,05
Castille and Leon	1,43	0,53	0,76	0,14	0,62	0,35	-0,21
Castile-La Mancha	0,74	0,44	0,77	0,14	0,64	-0,64	0,17
Catalonia	1,03	0,34	0,77	0,17	0,60	0,02	-0,10
Valencian Community	0,65	0,62	0,88	0,21	0,67	-0,86	0,01
Extremadura	1,75	0,54	0,41	0,18	0,23	0,47	0,33
Galicia	0,99	0,72	0,42	0,11	0,30	-0,13	-0,02
Madrid	1,01	0,76	1,23	0,31	0,92	-0,84	-0,14
Murcia	-0,17	0,46	0,86	0,21	0,65	-1,56	0,06
Navarre	0,99	0,31	0,88	0,19	0,69	-0,17	-0,03
Basque Country	1,51	0,41	0,69	0,23	0,46	0,41	-0,01
La Rioja	1,01	0,45	0,86	0,25	0,61	-0,38	0,08
Spain	0,87	0,50	0,85	0,21	0,64	-0,42	-0,06
EU-15ex	1,45	0,20	0,77	0,36	0,41	0,61	-0,13
Germany	1,56	0,13	0,63	0,36	0,27	0,70	0,10
United States	2,40	0,29	0,97	0,60	0,37	1,30	-0,16

[1] EU-15ex is made up of Germany, Austria, Belgium, Denmark, Spain, Finland, France, Italy, Netherlands and United Kingdom.

Source: EU KLEMS (2011), BBVA Foundation-Ivie (2012), INE (2012) and own elaboration.

Table 2. Determinants of TFP growth. 1998-2007[1]

(dependent variable: TFP growth)

	[1] With country effect	[2] Without country effect	[3] With country effect	[4] Without country effect	[5] With country effect	[6] Without country effect	[7] With country effect	[8] With country effect	[9] With country effect	[10] Without country effect	[11] With country effect	[12] Without country effect	[13] With country effect	[14] Without country effect
Unit labour cost growth	-74,032 *** (1.526)	-73,951 *** (1.526)	-74,739 *** (1.522)	-74,524 *** (1.519)	-74,430 *** (1.514)	-74,652 *** (1.519)	-74,549 *** (1.538)	-74,404 *** (1.535)	-75,249 *** (1.522)	-75,026 *** (1.527)	-74,382 *** (1.533)	-74,398 *** (1.521)	-74,521 *** (1.523)	-74,602 *** (1.520)
Percentage of temporary workers	-0,045 (0.031)	-0,055 *** (0.018)	-0,052 * (0.031)	-0,052 *** (0.018)	-0,063 ** (0.031)	-0,053 *** (0.019)	-0,061 ** (0.031)	-0,033 * (0.019)	-0,049 (0.031)	-0,055 *** (0.020)	-0,055 * (0.031)	-0,043 ** (0.019)	-0,056 * (0.031)	-0,051 *** (0.018)
Percentage of firms with 10 or more employees	0,029 *** (0.010)	0,019 * (0.010)	0,030 *** (0.010)	0,018 * (0.010)	0,031 *** (0.010)	0,011 (0.010)	0,032 *** (0.010)	0,018 * (0.009)	0,029 *** (0.010)	0,019 ** (0.010)	0,031 *** (0.010)	0,014 (0.009)	0,031 *** (0.010)	0,015 (0.009)
ICT investment / total investment	0,006 (0.010)	0,019 ** (0.009)	0,028 *** (0.008)	0,033 *** (0.008)	0,027 *** (0.008)	0,029 *** (0.008)	0,033 *** (0.008)	0,033 *** (0.008)	0,028 *** (0.008)	0,029 *** (0.008)	0,028 *** (0.008)	0,029 *** (0.008)	0,028 *** (0.008)	0,031 *** (0.008)
ICT user industry (dummy variable)	0,122 (0.223)	0,015 (0.239)												
ICT producing industry (dummy variable)	1,696 *** (0.420)	1,336 *** (0.438)												
Capital stock per capita	-0,041 *** (0.015)	0,002 ** (0.001)	-0,040 *** (0.015)	0,002 ** (0.001)										
Percentage of population with higher education					0,379 *** (0.090)	0,022 (0.017)								
R&D expenditure / total investment							0,337 *** (0.125)	0,119 *** (0.029)						
Barrier to entry in services									-1,725 *** (0.404)	-0,167 (0.142)				
Specific administrative burdens on road transport and retail trade sectors									-0,146 (0.360)	-0,022 (0.165)				
Barrier to entry in network sectors									-1,774 *** (0.402)	-0,452 ** (0.178)				
Percentage of individuals that use Internet											0,013 (0.016)	0,019 ** (0.008)		
Broadband Internet subscribers per 100 inhabitants													0,004 (0.032)	0,041 * (0.023)
Constant	3,279 ** (1.392)	1,189 *** (0.455)	3,277 ** (1.391)	1,052 ** (0.446)	-10,065 *** (2.652)	0,845 (0.561)	-0,143 (0.910)	0,136 (0.501)	8,880 *** (1.893)	2,602 *** (0.637)	-0,292 (1.231)	-0,031 (0.682)	0,326 (1.107)	0,284 (0.712)
Observations	1.634	1.634	1.634	1.634	1.634	1.634	1.597	1.597	1.634	1.634	1.634	1.634	1.634	1.634
R2	0,648	0,630	0,642	0,626	0,644	0,624	0,643	0,630	0,646	0,627	0,640	0,626	0,640	0,625
Chi2	2844,539	2712,456	2796,193	2687,847	2824,113	2680,459	2737,695	2660,384	2853,547	2708,647	2779,551	2692,665	2777,791	2684,414

* p<0.10, ** p<0.05, *** p<0.01. All estimations include individual random effects (sector and country) and temporal effects. In brackets standard errors.

Source : Own elaboration.

Table 3. Average values of the determinants of the rate of TFP. Total sectors. 1998-2007 average

	Andalusia	Aragon	Asturias	Balearic Islands	Canary Islands	Cantabria	Castile and Leon	Castile-La Mancha	Catalonia	Valencian Community	Extremadura
Unit labour cost growth (%)[2]	0,9	0,7	1,5	2,3	1,6	1,3	0,8	1,9	1,2	1,5	0,7
Temporary workers (%)[3]	35,8	22,0	23,1	25,5	33,6	23,3	22,9	28,2	21,0	30,4	27,4
Firms with 10 or more employees (%)[2]	5,4	5,9	4,9	5,9	6,5	5,5	4,5	5,4	6,8	6,8	4,4
Weight of ICT investment (%)	14,9	13,9	14,3	17,2	14,7	13,9	15,5	12,7	16,3	14,1	19,5
Capital stock per capita (thousands of euros)	45,2	69,4	58,5	71,9	59,7	65,5	64,6	55,0	77,6	63,4	51,3
Population with higher education (%)[2]	21,1	28,3	25,4	19,3	22,2	27,5	26,4	18,8	26,7	22,9	18,8
R&D expenditure / Total investment (%)	0,9	1,5	1,2	0,2	0,4	0,9	1,4	0,7	3,1	1,0	0,3
Population that uses Internet (%)[2]	42,2	49,6	48,0	52,7	48,3	47,5	44,0	42,9	54,7	47,0	37,7
Broadband penetration (%)[2]	8,7	10,0	10,1	12,0	10,9	10,8	8,4	7,7	12,5	9,4	6,4

	Galicia	Madrid	Murcia	Navarre	Basque Country	La Rioja	Spain	European countries	United States
Unit labour cost growth (%)[2]	1,5	0,6	2,3	1,1	0,4	1,4	1,1	0,4	-0,1
Temporary workers (%)[3]	28,0	20,3	32,5	20,5	22,1	20,4	26,1	10,7	0,0
Firms with 10 or more employees (%)[2]	5,1	6,6	7,0	7,0	6,2	6,6	6,1	7,0	25,1
Weight of ICT investment (%)	18,7	19,8	13,1	15,5	16,2	14,7	16,3	21,7	35,0
Capital stock per capita (thousands of euros)	51,5	82,1	52,2	73,9	72,0	69,2	63,7	85,2	89,8
Population with higher education (%)[2]	23,6	34,7	22,3	34,0	36,7	26,7	25,8	23,2	38,5
R&D expenditure / Total investment (%)	1,1	3,7	1,0	2,9	4,9	1,5	2,0	6,3	9,6
Population that uses Internet (%)[2]	40,6	58,5	43,1	51,3	51,0	46,6	48,4	59,9	71,0
Broadband penetration (%)[2]	7,3	13,1	8,0	9,5	10,7	9,3	10,3	13,2	14,9

[1] European countries: Austria, Denmark, Finland, France, Germany, Italy, Netherlands, Spain, Sweden and United Kingdom.

[2] The analyzed temporary period varies for the following variables: percentage of temporary workers, population with higher education and public expenditure (2000-2007), firms with 10 or more employees (1999-2007), population that uses Internet (2003-2009) and broadband penetration (2000-2009).

[3] Assuming that the percentage of temporary workers for United States is null.

Source: World Bank, EUKLEMS, Eurostat, BBVA Foundation-Ivie, INE, OECD and own elaboration.

Table 4. Estimated effects of the convergence of the Spanish regional economies to the average values of the European countries[1] for each determinant of productivity
(percentage points)

	Andalusia	Aragon	Asturias	Balearic Islands	Canary Islands	Cantabria	Castile and Leon	Castile-La Mancha	Catalonia
Unit labour cost growth (%)	0,36	0,22	0,80	1,36	0,87	0,64	0,27	1,12	0,57
Temporary workers (%)	1,30	0,59	0,64	0,76	1,19	0,65	0,63	0,91	0,53
Firms with 10 or more employees (%)	0,04	0,03	0,05	0,02	0,01	0,03	0,06	0,04	0,01
Weight of ICT investment (%)	0,20	0,23	0,22	0,13	0,21	0,23	0,18	0,27	0,16
Capital stock per capita (thousands of euros)	0,08	0,03	0,05	0,03	0,05	0,04	0,04	0,06	0,02
Population with higher education (%)	0,05	-0,11	-0,05	0,09	0,02	-0,09	-0,07	0,10	-0,08
R&D expenditure / Total investment (%)	0,64	0,57	0,61	0,73	0,71	0,65	0,58	0,67	0,38
Population that uses Internet (%)	0,34	0,20	0,23	0,14	0,22	0,24	0,30	0,32	0,10
Broadband penetration (%)	0,18	0,13	0,13	0,05	0,09	0,10	0,19	0,23	0,03

	Valencian Community	Extremadura	Galicia	Madrid	Murcia	Navarre	Basque Country	La Rioja	Spain
Unit labour cost growth (%)[2]	0,83	0,23	0,78	0,12	1,39	0,49	-0,05	0,72	0,47
Temporary workers (%)[3]	1,02	0,87	0,90	0,50	1,13	0,51	0,59	0,50	0,80
Firms with 10 or more employees (%)[2]	0,00	0,06	0,04	0,01	0,00	0,00	0,02	0,01	0,02
Weight of ICT investment (%)	0,23	0,06	0,09	0,05	0,25	0,18	0,16	0,21	0,16
Capital stock per capita (thousands of euros)	0,04	0,07	0,07	0,01	0,07	0,02	0,03	0,03	0,04
Population with higher education (%)[2]	0,01	0,10	-0,01	-0,25	0,02	-0,24	-0,30	-0,08	-0,06
R&D expenditure / Total investment (%)	0,63	0,71	0,62	0,31	0,64	0,40	0,17	0,58	0,51
Population that uses Internet (%)	0,25	0,42	0,37	0,03	0,32	0,16	0,17	0,25	0,22
Broadband penetration (%)	0,16	0,28	0,24	0,00	0,21	0,15	0,10	0,16	0,12