Testing for Political Effects on Total Factor Productivity*

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Abstract

We test the effects of different combinations of parties simultaneously holding office in the central and regional governments on regional economic growth. We hypothesize that if such effects indeed exist, they should accrue through total factor productivity (TFP). Using panel data for the Spanish regions over the 1988-2004 period, we find no effects of any combinations of parties on TFP growth rate. Our results are robust to different methods of estimation and different measures of TFP and could have a twofold interpretation. On the one hand, they could shed light on the consolidation of the governmental institutions of the Spanish federal state model. On the other hand, they could suggest, as shown by previous literature, that political effects on real economy could mainly accrue through aggregate demand policies.

Key words: Growth Accounting, Panel Data, Pork Barrel Politics, Partisan Theory.

JEL Classification: O18, H77, C33

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1 Introduction

In a country with multiple governance levels, the governments involved are responsible for the effective linkage between and good performance of their institutions, which can be defined as rules and bodies that drive the production atmosphere and are supposed to influence factor productivities. However, it is well known that differences in time might arise in the relationships between the levels of government involved due to party objectives, commitments, arrangements or disagreements. Specifically with mixed governance (i.e. different parties holding office at each level of government), disagreements about certain projects are more likely to arise as a result of the different points of view, political objectives and priorities of each political party. In fact, individual regional aspirations, major infrastructure projects or even environmental laws and the justice administration could depend on the combinations of parties ruling the central and regional governments. However, mixed governance has the advantage that it may function as a useful mechanism to prevent arbitrariness.

In this article we consider a developed country assumed to have qualified institutions as defined by Hall and Jones (1999)[1], Rodrick *et al.* (2004) and Dixit (2009)[2] and focus on political institutions. Defined in broad terms, political institutions include political parties, electoral rules and governance levels. Specifically, we are interested in analyzing the effects that combinations of parties holding office at the different levels of government could have on regional economic growth.

We consider a federalist country at two levels of governance, each of which is characterized by a parliamentary system (central and regional parliaments) and whose representatives are elected democratically through electoral processes. Which party governs depends on the composition of the parliament. Thus, when there are at least two parties, mixed governance is practically ensured in at least one region.

Literature relating the effect of political parties on the economy perfor-

[1] They define social infrastructure as institutions and government policies that determine the economic environment within which individuals accumulate skills and firms accumulate capital and produce output.

[2] He used the term economic governance defined as "the structure and functioning of the legal and social institutions that support economic activity and economic transactions by protecting property rights, enforcing contracts, and taking collective action to provide physical and organizational infrastructure."

mance falls in the Partisan Theory and Pork Barrel Politics.

Partisan Theory states that political parties have different preferences over macroeconomic goals. The seminal work of Hibbs (1977) showed that in Western European and North-American nations, left-wing governments are more concerned with low unemployment, while right-wing governments are more concerned with low inflation.[3] The "Rational Partisan Theory" (RPT) of Alesina (1987) presents a theoretical model supporting Hibbs' findings. Moreover, Alesina and Sachs (1988) empirically confirm Hibbs' results for the US case. Using data on OECD countries, Alesina and Roubini (1992) found that in the short term (about two years) left-wing governments expand the economy when elected. However, no support for permanent effects on real economy was found. Using the same database, Schmidt (1996) showed that party influence on economic outcomes is contingent upon the type of democracy, finding stronger partisan effects in majoritarian democracies. However, Schmidt pointed out that it is more difficult to identify partisan influence on public policy in consensus democracies in which the political-institutional circumstances allow for co-governance of the opposition parties. MidtbØ (1999) found that left-wing governments in the United States, Britain and Canada have reinforced the growth of both public spending and GNP. Recently, Pettersson-Lidbom (2008) found for Sweden that left-wing governments lower the unemployment rate by increasing public employment and spending and taxing more than right-wing governments.

Pork Barrel Politics can be broadly defined as the practice of targeting expenditure towards particular districts or regions based on political considerations. From the theoretical point of view, we have two findings. On the one hand, in the process to allocate funds, central governments may favor regions governed by their allies and discriminate against regions governed by opposition parties in order to win re-election (Cox and McCubbins, 1986). On the other hand, central governments may channel more resources to swing regions and diminish the uncertainty of the electoral outcome (Dixit and Lodregan, 1995,1996).

According to the Partisan Theory and Pork Barrel Politics the effect of political parties on the economy accrues through the aggregate demand. Therefore, an increase in the GDP corresponds to a shift upward of the aggregate demand over an unchanged aggregate supply with positive slope.

[3] A very good survey on the first fifteen years of research on the Partisan Theory can be found in Hibbs (1992).

Therefore, only a higher demand would allow to increase the inputs (labor and capital) of the production function, i.e., the production of the economy. However, nothing is said about shifts in the aggregate supply or effects on factor productivities.

Therefore, the aim of this article is to test for political effects on total factor productivity (TFP). We assume that the effect of mixed governance on economic growth accrues through TFP. Therefore, we estimate the TFP growth rate through a growth accounting exercise at the regional level. Hence, this is an endogenous variable in our analysis. A particular functional form has been specified for this variable to perform econometric estimations that allow us to control for explanatory variables that have been shown in the literature to affect the TFP growth rate. Moreover, dummy variables are introduced to capture combinations of parties ruling the different levels of government.

We consider the Spanish case at two levels of government: the central level and the regional level and focus on part of the democratic period (1988-2004) and all the autonomous communities.[4] We basically find three kinds of parties which we have classified as right, left and regional.

Our goal is interesting not only at the Spanish level, but also at the European level due to the resurgence of regional policies to reduce disparities between European regions.[5] Our results could be interpreted as a measure of consensus between different levels of government, i.e. among parties and their effects on the economy and could shed light of the consolidation of the governmental institutions of a federal state.

Our results show that none of the combinations of parties at either level of government have an effect on the TFP growth rate at any conventional significance level.

The article is organized as follows. An overview of the Spanish political system is presented in section 2. The econometric model and estimation issues are described in sections 3 and 4, respectively, while conclusions are drawn in section 5.

[4] The term "autonomous communities" refers to a set of territories that do not all share the same characteristics. Some have a more developed level of political decision-making than others.

[5] The regional policy of the European Union seeks to promote the reduction of structural differences between regions of the EU, the balanced development of the community and to ensure equal opportunities for all people.

2 An Overview of the Spanish Political System

Governance levels: Administrative Divisions

(i) *Central Government*

Spain, or the Kingdom of Spain, has a constitutional monarchy with a hereditary monarch and a bicameral parliament known as the *Cortes Generales*. The executive branch consists of a Council of Ministers presided over by the President of the Government (comparable to a prime minister), who is elected by National Assembly legislative elections and proposed by the monarch. The Constitution of 1978 sets the framework by which the country evolves and explicitly states the indivisible unity of the Spanish nation.

The Spanish nation is structured into what is known as the *Estado de las Autonomías* (State of Autonomies), thus creating a unique system of regional autonomy. Spain is one of the most decentralized countries in Europe, alongside Switzerland, Germany and Belgium.

(ii) *Autonomous communities*

An autonomous community is the first-level political division of the Kingdom of Spain as established under the Spanish Constitution of 1978, which culminated the Spanish transition to democracy. As a result, Spain presently comprises 17 autonomous communities and two autonomous cities with varying degrees of autonomy.

The autonomous communities enjoy broad legislative and executive autonomy through their own parliaments and regional governments. The distribution of powers may vary in each community as laid out in the basic institutional law on autonomous communities, the *Estatuto de las Autonomías* (Statutes of Autonomy). All autonomous communities have their own elected parliaments, governments, public administrations, budgets and resources. As a result, their health and education systems, among others, are managed regionally. Furthermore, some communities also retain their economic and fiscal autonomy allowing them to manage their own public finances and have their own full-range police forces which replace some of the functions of the state police corps. This assignation of functions at the regional level is known as the *Concierto Económico*.

The autonomous communities of Spain (NUTS2)[6] are Andalusia, Aragon, the Principality of Asturias, the Balearic Islands, the Basque Country, the Canary Islands, Cantabria, Castile-La Mancha, Castile and Leon, Catalonia, Extremadura, Galicia, La Rioja, Madrid, Murcia, Navarre and Valencia.

(iii) *Provinces and Municipalities*

The Spanish Constitution recognizes, grants and protects two subdivisions within the autonomous communities of Spain. As such, the *provincias* (provinces) serve as the local territorial building blocks for the former and are designed to carry out the activities of the state (the framework under which the autonomous communities were created). They are self-governing territories, which are led by provincial councils in communities having more than one province. Provincial councils have no legislative authority, but exercise certain executive functions. In turn, the provinces are divided into *municipios* (municipalities) which are granted autonomy to manage their internal affairs. Municipalities are the basic level of local government in Spain and are led by city councils, whose highest authority is the mayor. The functions carried out by these local bodies are considered to be in closest proximity to citizens.

Today, Spain is divided into 52 provinces and 8112 municipalities.

Political System

Spain's political system resembles a two-party system insofar as there are two dominant political parties, making it relatively difficult for political representatives to achieve electoral success under the banner of any other party. The Spanish Socialist Workers' Party (Partido Socialista Obrero Español, PSOE) and the People's Party (Partido Popular, PP) are the strongest parties. However, regional or nationalist parties can have a stronghold in autonomous communities such as Catalonia (Convergència i Unió, CiU) and the Basque Country (Partido Nacionalista Vasco, PNV) and are essential for central government coalitions or parliamentary majorities, thus transforming Spain's two-party system into a multi-party system.

Electoral Processes

[6]From 1979 to 1983, all the regions of Spain were established as autonomous communities. The process concluded in 1996 when Ceuta and Melilla gained autonomous status, but these last two cities are not considered in our study.

General and regional elections are typically held at four-year intervals with some exceptions. In our sample period general elections were held in 1989, 1993, 1996, 2000 and 2004. Regional elections took place in Aragon, Asturias, the Balearic Islands, the Canary Islands, Cantabria, Castile-La Mancha, Castile-Leon, Valencia, Extremadura, La Rioja, Madrid, Murcia and Navarre on the same day in 1991, 1995, 1999 and 2003. Andalusia held elections in 1990, 1994, 1996, 2000 and 2004; the Basque Country in 1990, 1994, 1998 and 2001; Galicia in 1989, 1993, 1997 and 2001; and Catalonia in 1988, 1992, 1995, 1999 and 2003.

3 Econometric Model

Let us consider that the TFP evolves according to a function as follows

$$\frac{B_{it}}{B_{it-1}} = f\left(\delta_i, \tau_t, D_{it}, SI_{it}, AE_{it}, CE_{it}, hc_{it}, k_{it}^{pu}, \varepsilon_{it}\right), \tag{1}$$

where B_{it} is a measure of the TFP of region i in year t when labor is adjusted for human capital, δ_i is a specific regional effect and τ_t is a time effect. D_{it} is a vector that collects our political variables including dummy variables for the different combinations of parties ruling both levels of governments.

In our context, right and left parties can hold office in both central and regional governments. However, regional parties can only be in charge of regional governments. Let us define the People's Party (PP) as a right party, and the Spanish Socialist Workers' Party (PSOE) as a left party. Let R (L) be a dummy variable that takes the value of one when the right (left) party holds office in the central government, and zero otherwise. And let r, l, n be dummy variables that take the value of one when the right, left and regional parties[7] respectively govern the i autonomous community, and zero otherwise. We also consider dummy variables that take the value of one if the central government holds a majority (M) or a minority (m), thus allowing us to control for the possibility of negotiation between central and

[7] In our sample period, regional or nationalist parties which held office can be considered center-right parties. These include the PNV in the Basque Country, CIU in Catalonia, Coalicion Canaria in the Canary Islands, Partido Aragonés in Aragon, and Unión para el Progreso de Cantabria and Partido Regionalista de Cantabria in Cantabria.

regional governments headed by different parties. In line with common political practice, when central governments lack a majority, they are willing to make concessions to regional parties governing autonomous communities in order to gain support for a law, the national budget, a foreign mission, etc. In fact, the Spanish experience shows that regional parties can play a key role in forming the central government when a majority is not reached. On the contrary, when the central government holds a majority, partners are not needed and there is no reason to negotiate to bring a proposal forward.

By constructing the interaction of dummies described above, we can specify the vector that collects the combinations of parties as

$$D_{it} = \begin{pmatrix} MRr_{it}, MRl_{it}, MRn_{it}, mRr_{it}, mRl_{it}, mRn_{it}, \\ MLl_{it}, MLr_{it}, MLn_{it}, mLl_{it}, mLr_{it}, mLn_{it} \end{pmatrix}' \tag{2}$$

When the central government holds a majority we have that MRr_{it} (MLl_{it}) is a dummy variable that takes the value of one when the right (left) party simultaneously holds office at both levels of government, and zero otherwise; MRl_{it} (MLr_{it}) is a dummy variable that takes the value of one when the right (left) party holds office in the central government and the left (right) party rules the regional government, and zero otherwise; and MRn_{it} (MLn_{it}) is a dummy variable that takes the value of one when the right (left) party holds office in the central government and a regional party rules the regional government, and zero otherwise. When the central government holds a minority, mRr_{it}, mRl_{it}, mRn_{it}, mLl_{it}, mLr_{it}, and mLn_{it} stand for the same combinations as above.[8]

We also introduce a set of controllers that the empirical literature has shown to influence the TFP growth rate, as described below.

SI_{it} is a specialization index as specified by Álvarez (2007) that accounts for the different economic structure of the regions with respect to the whole country. The index is defined as follows

$$SI_{it} = \sum_{j=1}^{5} \left(\frac{Y_{it,j}}{Y_{it}} - \frac{\mathbf{Y}_{t,j}}{\mathbf{Y}_t} \right)^2,$$

where subscript j denotes the sector (agriculture, industry, energy, construction and services), $Y_{it,j}$ is the gross added value of sector j in region i in year

[8]Notice that the first year of governance does not cover the whole year. Therefore, if in the first year of governance the party took office before June, this variable takes the value of one, and zero after June.

t, Y_{it} is the total gross added value of region i in year t and $\mathbf{Y}_{t,j}$ and $\mathbf{Y}_t$ stand for values referred to Spain. SI_{it} is zero when the regional productive structure is equal to that of the whole country and increases with the level of specialization.

AE_{it} and CE_{it} are variables that collect the effects of agglomeration and congestion in the regional economies. Ciccone and Hall (1996) and Ciccone (2002) show theoretical and empirical positive effects of agglomeration on labor productivity for the US and Europe. For Dutch regions, Broersma and van Dijk (2008) recently found that positive agglomeration effects overrule negative congestion effects on total factor productivity. Therefore, we use similar indicators: the number of efficient works relative to the surface (N_{it}/S_i) for agglomeration effects and the total number of cars per kilometers of roads (c_{it}/km_{it}) for congestion effects.[9]

hc_{it} is an indicator of the regional healthcare system. Cole and Neumayer (2006) found that poor health has a negative impact on TFP. A good healthcare system is related to healthy people, i.e. more productive workers. In particular, we consider the number of beds in hospitals per efficient worker, b_{it}/N_{it}.[10]

k_{it}^{pu} is a variable accounting for annual stock of regional public infrastructure per efficient worker. Aschauer (1989) found a positive relationship between public capital stock and TFP for the US. It is argued that poor infrastructure is one of the factors that may explain lowest per capita income and disparities in levels of productivity across European regions. In this regard, the provision of infrastructure under the EU's regional policy has played a central role in reducing disparities in levels of productivity and per capita income in regions of the European Union.[11] Therefore, we consider "core infrastructure" per efficient worker in k_{it}^{pu}, which includes streets and highways, water systems, railways, airports, ports and other urban infrastructures

[9] Regional data on surface, cars and roads are taken from the National Statistics Institute of Spain (INE).

[10] Data on hospital beds in the regions are taken from the INE.

[11] Founded on the concepts of solidarity and economic cohesion, this policy will materialize through various financial measures, in particular those of the Structural Funds and the Cohesion Fund. In 1986, the Single European Act introduced the objective of economic and social cohesion. Finally, the Treaty of Maastricht (1992) incorporated this policy into the EC Treaty (Articles 158 to 162). For the 2007-2013 period, regional policy is the second largest budget item of the European Union, with a strength of 348 billion euros.

provided by local governments.[12]

Finally ε_{it} is an *iid* disturbance.

Let us define an explicit function form for (1) such as

$$\frac{B_{it}}{B_{it-1}} = e^{\left(\delta_i+\tau_t+D'_{it}\beta_t+\varepsilon_{it}\right)}\left(\frac{SI_{it}}{SI_{it-1}}\right)^{\theta_1}\left(\frac{N_{it}}{S_i}\right)^{\theta_2}\left(\frac{\frac{c_{it}}{km_{it}}}{\frac{c_{it-1}}{km_{it-1}}}\right)^{\theta_3}\left(\frac{\frac{b_{it}}{N_{it}}}{\frac{b_{it-1}}{N_{it-1}}}\right)^{\theta_4}\left(\frac{k_{it}^{pu}}{k_{it-1}^{pu}}\right)^{\theta_5}, \tag{3}$$

Taking natural logarithm in (3) and considering the specification of the vector D_{it} in (2), we obtain the equation to be estimated,

$$\begin{aligned}\triangle Log\left(B_{it}\right) &= \delta_i+\tau_t+\beta_{1R}MRr_{it}+\beta_{2R}MRl_{it}+\beta_{3R}MRn_{it}\\ &+\beta_{4R}mRr_{it}+\beta_{5R}mRl_{it}+\beta_{6R}mRn_{it}\\ &+\beta_{1L}MLl_{it}+\beta_{2L}MLr_{it}+\beta_{3L}MLn_{it}\\ &+\beta_{4L}mLl_{it}+\beta_{5L}mLr_{it}+\beta_{6L}mLn_{it}\\ &+\theta_1\triangle Log\left(SI_{it}\right)+\theta_2 Log\left(\frac{N_{it}}{S_i}\right)+\theta_3\triangle Log\left(\frac{c_{it}}{km_{it}}\right)\\ &+\theta_4\triangle Log\left(\frac{b_{it}}{N_{it}}\right)+\theta_5\triangle Log\left(k_{it}^{pu}\right)+\varepsilon_{it}\end{aligned} \tag{4}$$

Our endogenous variable, $\triangle Log\left(B_{it}\right)$, is a non-observable variable that we calculate by performing a growth accounting exercise which is shown in the Appendix. An alternative to our approach is the econometric estimation of the production function, that is, to regress the growth rate of output ($\Delta Log\left(Y_{it}\right)$) on the growth rate of inputs ($\Delta Log\left(K_{it}\right), \Delta Log\left(N_{it}\right)$) and all variables on the right side of (4). However, Barro (1999) stresses the disadvantages of this approach such as endogeneity problems between $\Delta Log\left(K_{it}\right), \Delta Log\left(N_{it}\right)$ and $\triangle Log\left(B_{it}\right)$, inconsistent estimation if $\Delta Log\left(K_{it}\right)$ and $\Delta Log\left(N_{it}\right)$ are measured with errors and the static factor shares. Following a similar approach, Broersma and van Dijk (2008) highlight that the growth-accounting approach and the econometric approach are not competitors, but can instead complement one another. Therefore, econometric methods can be applied to further explain the productivity residual from growth accounting, which is what we are going to do in our analysis.

[12] These correspond to the classification by asset 2.1, 2.2, 2.3, 2.4, 2.5 and 2.6 according to the new methodology of the BBVA Foundation-IVIE .

4 Estimation Issues

Tables 1 and 2 show pooled and panel data regressions respectively of the equation (4) for both measures of TFP (A_t and B_t)[13]. Panel data regression considers individual and time fixed effects which are not shown for reasons of space.[14] We discard one time fixed effect in order to avoid perfect multicollinearity.

As it can be noticed, both pooled and panel data regression show similar results. We concentrate in describing the results for the latter. Notice also that results for both measures of TFP are similar.

Like Álvarez (2007), we have found that the more specialized the region, the higher the growth of TFP. The estimator is significant at the 1% level.

The agglomeration and congestion effects show unexpected signs. Moreover, they are not statistically significant at any conventional significance level. Martínez-Galarraga *et al.* (2008) show evidence of agglomeration effects in Spain over time. They pointed out that those effects seem to have been falling sharply from the mid-nineteenth century until late in the twentieth century. Moreover, according to their results there appears to be no positive evidence of agglomeration effects in industry in the period 1985–1999.

According to the general literature and to the literature specifically related to Spain, the estimation of the parameters that capture the effects of the healthcare system and public infrastructure are positive and statistically significant at the 1% level and are higher when TFP is adjusted for human capital. Using data from the autonomous communities of Spain, Rivera and Currais (2004) found the striking result that current government health spending has consistently significant positive effects, while governmental investment in healthcare has no effect on productivity. Aviles *et al.* (2001) suggest that public capital accumulation can be considered a tool for improving the competitiveness of Spanish firms since it reduces production costs. Along the same lines, Mas *et al.* (1996), Salinas-Jimenez (2003) and Álvarez and Delgado (2004) confirm that there is a significant positive contribution of infrastructure on both private production and the efficiency of Spanish regions.

As regards our main variables of interest (D_t), none of the coefficients

[13] Regressions for A_{it} use L_{it} instead of N_{it}.

[14] We also carried out panel data regression with individual and time random effects and obtain very similar results. Estimations are available upon request.

of the combination of parties are significant at any conventional significance level. Our results could be in line with those of Alesina and Roubini (1992) who found no support for permanent partisan effects on real economy.

In general, our results could have a twofold interpretation. On the one hand, if major structural economic reforms or changes in economic policy did not occur during the period in question, there is no reason to expect a significant effect of party combinations on the growth rate of TFP. In fact, the Spanish experience shows that major changes in economic policy took place in the early eighties to modernize the economy and meet the requirements for European Union adhesion. Moreover, it can be thought that Spanish governmental institutions have reached a high relative level of consolidation, such as the evolution of TFP is not affected by partisan effects which sheds light on the success of the Spanish federal state model from the economic point of view. On the other hand, our results could suggest that political effects do not affect the aggregate supply. Therefore, and in line with the previous literature, political effects on real economy could mainly accrue through aggregate demand policies which is the assumption in which is based the Partisan Theory and Pork Barrel Politics.

We report the *F-test* of null hypothesis of homogeneous individual and time fixed effects (F_i and F_t). We are unable to reject F_i at the any conventional significance level and we reject F_t at 5% level for both measures of TFP. Therefore, we can state that Spanish regions does not exhibit specific regional differences in TFP. However, time differences in the growth of TFP do account for.

Notice that the model is able to explain about 37% of the variability of the non-adjusted TFP growth rate and 68% of adjusted TFP growth rate. Moreover, the value of the Durbin-Watson (DW) statistic is very close to 2, thus suggesting no autocorrelation in the residuals from the regression and no omission of relevant economic variables in our specification. Finally, our results are robust to different methods of estimation and different measures of TFP.

5 Conclusions

In this article we test the effects of different combinations of parties ruling the central and regional governments on the economic growth of Spanish regions over the 1988-2004 period. We assume that these effects, if indeed they

exist, should accrue through total factor productivity (TFP). Therefore, we estimate the TFP growth rate series for Spanish regions through a growth accounting exercise. We specify functional forms for the growth rates of TFP to estimate an equation accounting for explanatory variables which are well-established in the literature.

We found that combinations of parties have no effect on the growth rate of TFP. Our results could be interpreted somehow as a consolidation of the governmental institutions of the Spanish federal state model and that political effects on real economy could mainly accrue through aggregate demand policies.

Appendix: TFP growth calculations

In this appendix we perform a growth accounting exercise for the 1988-2004 period to estimate the evolution of TFP in regions of Spain. We consider the standard assumptions about technology represented by an aggregate Cobb-Douglas production function and about input markets, capital and labor, which are given by perfect competition. The representative region i shows the following production function at each year t

$$Y_{it} = A_{it} K_{it}^{\alpha_{it}} L_{it}^{1-\alpha_{it}}$$

The final aggregate output (Y_{it}) is the annual gross added value of autonomous community i in year t provided by the National Statistics Institute of Spain (INE). The number of employees per year or annual labor input (L_{it}) is based on statistics of the Bancaja Foundation and the Economic Research Institute of Valencia (IVIE). The annual stock of non-residential productive physical capital (K_{it}) is provided by the BBVA Foundation and IVIE.[15] A_{it} is a measure of the total factor productivity (TFP)[16] in region i at each year t[17].

Moreover, we assume a specific aggregate production function with labor adjusted for human capital as:

$$Y_{it} = B_{it} K_{it}^{\alpha_{it}} N_{it}^{1-\alpha_{it}},$$

where B_{it} is the TFP when labor is adjusted for human capital and N_{it} denotes the amount of human capital-augmented labor used in production whose specification is an extension of Hall and Jones (1999),

$$N_{it} = \sum_{j=0}^{4} L_{it,j} e^{\eta_j x_j},$$

where $j = 0, 1, 2, 3, 4$ is levels of education, x_j is years of each educational level[18] and η_j is the rate of return to schooling (known as the Mincer index, 1974) from Lassibille and Navarro (1998).

[15] The Y_{it} and K_{it} series are referred to in constant euros with base year 2000.

[16] A_{it} is a good approximation to neutral technical progress using growth accounting in a non-parametric context.

[17] Annual data is considered for the seventeen autononomous communities. The sources for the statistics used for each variable are shown in section 4.

[18] We assume the middle point of each range of years of schooling, which are assumed to be equal for all regions and constant over time.

Regarding the choice of labor share series, $1-\alpha_{it}$, for the autonomous communities of Spain, we do not only consider the published series of wages because they might be underestimated if they are not adjusted to include self-employed and family workers. We use the measure proposed by María-Dolores and Puigcerver (2005) in order to correct for this bias.[19]

Given our choice of series for output Y_{it}, labor L_{it}, productive physical capital K_{it}, capital share α_{it}, years of schooling x_j and rate of return to schooling η_j, we calculate the growth rate of TFP through the Divisia-Tornqvist index as follows,

$$\Delta Log\left(B_{it}\right) = \Delta Log\left(Y_{it}\right) - \Delta Log\left(KN_{it}\right)$$

where

$$\Delta Log\left(KN_{it}\right) = \frac{\alpha_{it}+\alpha_{it-1}}{2}\Delta Log\left(K_{it}\right) + \frac{\left(1-\alpha_{it}\right)+\left(1-\alpha_{it-1}\right)}{2}\Delta Log\left(N_{it}\right)$$

Δ is the incremental operator and the log differentials are growth rates.

[19] This measure takes into account the value of labor income referred to as "mixed income".

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Table 1: Pooled Regression for the growth rate of TFP

	Non Adjusted TFP (A_{it})		Adjusted TFP (B_{it})	
	Coefficient	Std Error	Coefficient	Std Error
$Constant$	-0.01267	0.00780	-0.01934**	0.00766
MRr	0.00640	0.00564	0.01017	0.00621
MRl	0.00378	0.00618	0.00728	0.00678
MRn	0.00477	0.00723	0.00682	0.00798
mRr	0.00312	0.00534	0.00366	0.00589
mRl	-0.00088	0.00754	0.00253	0.00827
mRn	0.00367	0.00723	0.01029	0.00791
MLl	0.00869	0.00544	0.00619	0.00597
MLr	0.00555	0.00671	-0.00061	0.00734
MLn	0.00587	0.00688	0.00386	0.00756
mLl	0.00582	0.00547	0.00246	0.00601
mLr	0.00424	0.00595	0.00425	0.00656
mLn	0.00792	0.00682	0.00588	0.00752
$\triangle Log\left(SI_{it}\right)$	0.01315	0.00473***	0.01075**	0.00519
$Log\left(\frac{N_{it}}{S_i}\right)$	-0.00263	0.00128**	-0.00262*	0.00134
$\triangle Log\left(\frac{c_{it}}{km_{it}}\right)$	0.05874	0.06569	0.13140*	0.07143
$\triangle Log\left(\frac{b_{it}}{N_{it}}\right)$	0.14552	0.03506***	0.23463***	0.03627
$\triangle Log\left(k_{it}^{pu}\right)$	0.08365	0.03318**	0.13913***	0.03537
R^2	0.24336		0.51184	
DW	1.97451		1.96246	

* **, * *, * = Significant at 1%, 5% and 10% levels, respectively.

Table 2: Panel regression for the growth rate of TFP with time and individual fixed effects

	Non Adjusted TFP (A_{it})		Adjusted TFP (B_{it})	
	Coefficient	Std Error	Coefficient	Std Error
MRr	-0.01048	0.01161	-0.01276	0.01240
MRl	-0.01303	0.01179	-0.01355	0.01259
MRn	-0.00975	0.01425	-0.00782	0.01505
mRr	-0.00433	0.01150	-0.00899	0.01223
mRl	-0.00590	0.01270	-0.00546	0.01357
mRn	-0.00086	0.01410	0.00377	0.01497
MLl	0.01337	0.00941	0.01217	0.01010
MLr	0.00926	0.01066	0.00501	0.01134
MLn	0.01048	0.01038	0.01567	0.01086
mLl	-0.01147	0.01276	-0.00738	0.01378
mLr	-0.01368	0.01319	-0.00872	0.01414
mLn	-0.00708	0.01390	0.00177	0.01474
$\triangle Log\left(SI_{it}\right)$	0.01662***	0.00512	0.01594***	0.00545
$Log\left(\frac{N_{it}}{S_i}\right)$	-0.01354	0.02355	-0.00718	0.02440
$\triangle Log\left(\frac{c_{it}}{km_{it}}\right)$	0.02986	0.08639	0.04918	0.09249
$\triangle Log\left(\frac{b_{it}}{N_{it}}\right)$	0.16811***	0.03854	0.24361***	0.03853
$\triangle Log\left(k_{it}^{pu}\right)$	0.16192***	0.04733	0.28132***	0.04638
R^2	0.36820		0.61580	
DW	2.05346		2.02843	
F_i	1.02430	(0.43189)	1.37986	(0.15303)
F_t	2.00497	(0.01846)	3.07762	(0.00022)

* **, * *, * = Significant at 1%, 5% and 10% levels, respectively.