Partisan Alignment Effect on Total Factor Productivity*

Henry Aray†
University of Granada

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Abstract

This article tests the effect of partisan alignment (same party holding office in the central and regional governments simultaneously) on regional economic growth. Different to the literature on political effects on real economy (Partisan Theory and Distributive Politics) that suggests and has shown that partisan effects accrues through aggregate demand policies, it is hypothesized that such effects could also accrue through total factor productivity (TFP), i.e., through aggregate supply. Using panel data for the Spanish regions over the 1986-2010 period, the main results are: *i*) partisan alignment effect only arises when central government enjoys majority, *ii*) there exist contemporaneous and lagged effects, *iii*) in absolute value, the time varying partisan effects vanish over time. Moreover, contemporaneous effect is positive but lagged effects are negative and those effects jointly considered cancel out across time. However, lagged effects do not cancel out. Results are robust to different specifications and measures of TFP and methods of estimation.

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†Corresponding author: Universidad de Granada. Facultad de Ciencias Económicas y Empresariales. Dpto. de Teoría e Historia Económica. Campus de la Cartuja S/N, Granada Spain. e-mail: haray@ugr.es. Phone: +34958241000 ext. 20140. Fax: +34958249995.

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1 Introduction

Literature dealing with the effect of political parties on the economy falls within the sphere of the Partisan Theory (PT) and Distributive Politics (DP).

PT 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.[1] The "Rational Partisan Theory" (RPT) of Alesina (1987) presents a theoretical model supporting Hibbs' findings and Alesina and Sachs (1988) empirically confirm Hibbs' results for the US case. MidtbØ (1999) found that left-wing governments in the United States, Britain and Canada have reinforced the growth of public spending and, hence, in the GNP. 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. According to Alesina and Roubini (1992) PT is a short term phenomenon since they found that left-wing governments expand the economy when elected in the next two years. However, no support for permanent partisan effects on real economy was found. On the other hand, Schmidt (1996) showed that party influence on economic outcomes is contingent upon the type of democracy, finding stronger partisan effects in majoritarian democracies and pointed out that it is more difficult to identify partisan influence on public policy in consensus democracies, like Germany, in which the political-institutional circumstances allow for co-governance of the opposition parties.

DP can be broadly defined as the practice of targeting expenditure towards particular districts, states or regions based upon political considerations which suggest that elected officials strategically allocate public funds to curry secure votes and gain reelection. Theoretical literature has two major findings.[2] 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 and Grossman, 1994). On the other hand, central governments may channel more resources to swing regions to diminish the un-

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

[2] Rich (1989) sumarizes the earlier prominent theories in the literatura of Distributive Politics.

certainty of the electoral outcome (Lindbeck and Weibull, 1987, Dixit and Londregan, 1995,1996, 1998). At the empirical level, Wilson (1986), Levitt and Snyder (1995, 1997) and Levitt and Poterba (1999) found empirical evidence supporting the fact that parties play a significant role in determining the geographic distribution of federal expenditure in the US. Lee (2003) showed that political factors influence the distribution of earmarks in the US with majority government enjoying advantages and giving the minority some pork to inoculate itself against charges of wasteful spending. Ansolabehere and Snyder (2006) study the effect of party control of the state government on the distribution of public expenditures and found that the governing parties distribute the public funds in favor of areas that provided them with the strongest electoral support. Evidence on other countries are found by Worthington and Dollery (1998) and Leigh (2008) for Australia, Arulampalam et al. (2009) for India and Solé-Ollé and Sorribas-Navarro (2008) for Spain. Most of them confirmed that political aligned states receive more funds. Moreover, Crain and Oakley (1995), Cadot *et al.* (2006), Kemmerling and Stephan (2002), Castells and Solé-Ollé (2005) and Golden and Picci (2008) found that political factors influence the allocation of infrastructure investment across states or regions in the US, France, Germany, Spain and Italy, respectively.

PT and DP assume that the effect of political parties on the economy accrues through the aggregate demand. According to PT and DP, an increase in the GDP corresponds to a shift upward of the aggregate demand over an unshifted aggregate supply with positive slope. Hence, as stated by PT, a higher demand, by increasing the public spending during left-wing governments, would allow to increase the labor input of the production function, implying the growth of the production of the economy and the decrease of the unemployment rate. On the other hand, although the focus of DP is not the increase of the public spending at national level, it concentrates on the regional distribution of it and the return that provide to political party from the electoral point of view. Hence, some regions could benefit from the distribution due to partisan alignment, and get more resources, i.e. an increase, at least in relative terms, in the regional spending. Therefore, the key variable for PT and DP is the public expenditure in general, therefore, if there is any effect on the economy, it would be via the aggregate demand. However, nothing is said about shifts in the aggregate supply.

In this article we aim at shedding light on the existence of partisan effects on the economic growth but on the aggregate supply side. A shift in the aggregate supply may be caused by changes in the labor supply, changes in the capital stock or due to technological progress, which is called in the economic growth literature, total factor productivity (TFP). Changes in the labor supply are due to changes in individual preference between income and leisure or union pressures. Therefore, political effects, at least, intuitively, seem not to affect labor supply. Capital stock are affected by changes in the expectation of capital return or in the tax police which could depend on which party holds office. Moreover, political debate suggests, on the one hand, that right parties are more promptly to foster private capital accumulation through tax cuttings and at the expense on the public capital, and, on the other hand, left parties are more concern with increase of public capital and at the expense of private capital. Hence, in aggregate, net effect is not so clear. Therefore, we will focus on a kind of political effect on TFP. Our scope could lies in the literature on the effect of institutions on economic growth (North, 1990). Hall and Jones (1999) 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. Dixit (2009) 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." And Rodrick *et al.* (2004) used a measure of institutions capturing the protection afforded to property rights and the strength of the rule of law and found that institutions are the major source of economic growth across countries.

The design and performance of institutions depends mostly on the allocation of political power among elite groups, i.e. political institutions which appropriately chosen and managed can reduce the risks of opportunistic behavior of political and economic players. Thus, political institutions should provide incentives for politicians to abide by them repeatedly over time. According to that, political institutions determine both the constraints and incentives faced by political players in the society.

Defined in broad terms, political institutions include political regimes, electoral rules, political parties and governance layers. Literature on the effects of political institution on economic growth has been mostly focused, on the one hand, in the effect of political regime (Democracy vs. Dictatorship) on economic performance. Przeworski and Limongi (1993) stated that political institutions do matter for growth, but thinking in terms of regimes does not seem to capture the relevant differences. And, On the other hand, in the relationship between political instability and economic growth. Alesina et al (1996) show that countries and time periods with a high propensity of government collapse, growth is significantly lower than otherwise.

In this article, we choose a different way and concentrate on the political parties holding office at the different layers of government in a given country. In a country with multiple governance levels, the governments involved are responsible for the effective linkage between and performance of their institutions in order to create the environment and atmosphere that drive the economic activity and are supposed to influence factor productivities. Thus, the interrelationship among layers of governments could play a key role in creating such environment. However, such interrelationship between the layers of governments could be conditioned by the parties holding office at each layer. We call partisan alignment when the same party holds office at the different layers of government. It is well known that coincidences or differences arise in the relationships between the levels of government involved depending on the party colors. Partisan alignment makes easier any negotiation and agreement between layers of governments, while when different parties holding office at each level of government, i.e. non partisan alignment, disagreements about certain regional economic proposal or 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, the negotiation of the rules and body for the development of the federal status are typically more difficult in this case. Even though, environmental laws, the justice administration and other matters related with governmental institutions could depend on the alignment between the central and regional governments. However, non partisan alignment has the advantage that it might function as a useful mechanism to prevent arbitrariness.

We consider a federalist country at two levels of government, 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. Following the literature on institutions and economic growth, we assume that if partisan alignment effects exist on the aggregate supply of the regional economies it accrues through TFP. We focus on Spain which is a developed country assumed to have qualified institutions as defined by Hall and Jones (1999), Rodrick *et al.* (2004) and Dixit (2009).

In the empirical implementation we are especially concern with the robustness of the results. Thereby, our econometric strategy is based on two alternative specifications and measures of the TFP growth rates, different measures of input labor and different methods of estimations. Regarding the alternative specifications. On the one hand, a functional form is specified that can be understood as a production function whose inputs are variables that are supposed or have been shown in the literature to affect the TFP growth rate. On the other hand, we specify that TFP growth rate evolves over time according to the gap between the lag value of the TFP of the region and a reference level of TFP, which can be interpreted as a "frontier" or "optimal" level. In both alternative specifications, dummy variables are introduced to capture the effects of partisan alignment with a lag structure to account for dynamic effects. The growth rate of TFP is estimated through a growth accounting exercise at the regional level. Moreover, we obtain alternative econometric measures of TFP growth rates to that of the growth accounting approach by estimating Cobb-Douglas production functions. The measures of inputs labor used are number of workers and labor adjusted for human capital, i.e., efficient workers. We run panel data regression with fixed and random effect and two step least square (2SLS). Data for all the Spanish regions and 1986-2010 period are used.

Our results show that partisan alignment only arise when central government enjoys majority. Positive effect in the current period, but negative lagged effects are found. Moreover, in absolute value, the effect is decreasing over time. We tested the hypothesis of the sum of time partisan alignment effects equals zero, that is current and lagged years of partisan alignment, and we were unable to reject it, suggesting that those effects tend to cancel out across time. Therefore partisan alignment via aggregate supply seems to have no effect. However, whenever partisan alignment does not occur in the current period, a negative effect arise whenever partisan alignment happened in lagged consecutive periods. In any case, partisan alignment effects could only hold after two period which is in line with Alesina and Roubini (1992) who found no long-term political effects on the economy from the aggregate demand side, while our results are from aggregate supply side. Results are robust to different functional forms, measures of both labor input and TFP growth rates and methods of estimation.

The article is organized as follows. An overview of the Spanish political system is presented in section 2. Section 3 shows an overview of the data and growth in Spain in the considered period. The baseline econometric model is presented in section 4 and section 5 show the estimation issues. Section 6 presents an alternative model specification and its empirical issues. Section 7 show robustness checks and section 8 summarizes the main conclusions.

2 An Overview of the Upper Two Spanish Government Layers and Political System

(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 central government has exclusive power in defense, foreign affairs, economic stabilization and social security. Moreover, it has the right to establish basic legislation in the areas of education, health and public order.

(ii) *Regional Governments*: *Autonomous communities*

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. The term "autonomous communities" refers to a set of territories that do not all share the same characteristics and some have a more developed level of political decision-making than others. The autonomous community are 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 comprises 17 autonomous communities and two autonomous cities with varying degrees of autonomy, being one of the most decentralized countries in Europe, alongside Switzerland, Germany and Belgium.[3]

The autonomous communities of Spain (NUTS2)[4] are Andalusia, Aragon, the Principality of Asturias, the Balearic Islands, the Basque Country, the

[3] A good analysis of the decentralization process in Spain can be found in Moreno (2002).

[4] 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.

Canary Islands, Cantabria, Castile-La Mancha, Castile and Leon, Catalonia, Extremadura, Galicia, La Rioja, Madrid, Murcia, Navarre and Valencia.

The autonomous communities enjoy broad legislative and executive autonomy through their own elected parliaments and regional governments. Moreover, they have their own public administrations, budgets and resources. As a result, the health and education systems, among others matters are managed regionally. However, as we pointed out above, some have a more developed level of political decision-making than others. The acquired 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) which state different financing systems administrations and levels of assumed responsibilities.[5] The funding system leads to a fundamental distinction between the autonomous communities. Basque Country and Navarre enjoys what is called a "foral system" implying that those communities also retain their financial and fiscal autonomy, allowing them to manage their own public finances by controlling most of the taxes and also state the contribution to the general expenses of State for the not assumed responsibilities, by the payment of a quota or fixed contribution. This assignation of functions at the regional level is known as the *Concierto Económico* in the Basque Country and the *Convenio Económico* in Navarre. Such agreements give greater autonomy to their regional institutions. The rest of autonomous communities share a common fiscal system by which they obtain, apart from the self collected assigned taxes, transfers from the State in terms of assumed responsibility levels. However, it should stressed that there exist some distinction among them depending on the route taken to autonomy. Moreover, Canary Island has a special tax regime that gives a greater degree of fiscal autonomy from the rest, and Catalonia shares responsibilities for public order with the central government with their own police forces which replace some of the functions of the state police corps.

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

[5] A good revision of the responsibilities of the Autonomous Comunities can be found in Moreno (2002) and Carrión-i-Silvestre et al. (2008).

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.

3 An Overview of the Growth of the Spanish Regions

Let start with the main data used.[6] In the empirical implementation we use as the final aggregate output (Y_{it}), the annual gross value added of autonomous community i in year t calculated with data provided by the National Statistics Institute of Spain (INE). The annual stock of non-residential productive physical capital (K_{it}) is provided by the BBVA Foundation and Ivie.[7] Y_{it} and K_{it} series are referred to in constant euros with base year 2000. The variable indicating the numbers of efficient workers, i.e. workers adjusted by human capital, N_{it} is from the statistics of the Bancaja Foundation and the Economic Research Institute of Valencia (Ivie). This measured allow to account for not only education levels but also for skills which recognize the fact that human capital accumulates both through education system and experience. N_{it} is expressed in terms of the number of equivalent occupied workers without human capital (L_{it}).[8]

Table (1) shows the average annual growth rates for the 1986-2010 period of the value added (Y), productive capital (K), labor (L) and efficient worker (N). We also calculate those variable measure per worker. Thus, Y/L is the value added per worker, K/L is productive capital per worker, Y/N and K/N are the value added and the productive capital per efficient worker, respectively. Last two column shows the growth rate of TFP not adjusted (A_t) and adjusted for human capital (B_t) that we obtained performing an standard growth accounting which is shown in the Appendix. Variables in absolute value show an important average annual growth rate. Spanish economy grew

[6] Access to the data can be found in the following links: www.ine.es, www.fbbva.es and www.ivie.es.

[7] The methodology to construct productive capital series is from Mas *et al.* (2011).

[8] The methodology to construct the human capital series is from Serrano and Soler (2010).

on average 2.75% each year in the period 1986-2010 and most of the regions grew at average annual rates between 2% and 3%. This growth was largely supported by the increase in inputs as can be seen in Table (1). Productive capital experienced a large increase in the country and in all regions. It is also noticeable, that comparing the average annual growth rates of labor and human capital, the latter increased more. Therefore, we can say, that in general, the Spanish economy experienced important growth rates in inputs which made the economy to growth.

Nevertheless, when the variables are measures in terms of workers, we have a very different picture. The value added per worker (per efficient worker) shows that the country grew at an average annual rates of 0.63% (0.12%) far lower than 1%. Similar pictures shows most of the regions. However, notice that the productive capital per worker (efficient worker) grew at moderate rates. At the country level, the growth was 1.50% (0.98%) and some regions grew at rates about 2%. The gap between the growth of the value added per worker and the growth rate in productive capital per worker (efficient worker) is largely explained by the lower growth rate in the factor productivities, as it can be seen in the last two columns of the Table (1). In the considered period, the growth of the TFP is Spain was very low, even negative in some regions. In the whole country, it grew at an average annual rate of 0.29% without adjustment by human capital and decrease 0.11% when adjusted. At regional level, when TFP is not adjusted by human capital, with the exceptions of Extremadura and Galicia, all regions grew at rates lower than 1% and some regions as Andalusia, Balearic Islands, Canary Islands and Murcia had negative growth of TFP. When TFP is adjusted by human capital, no regions grew above 1% and most of them showed negative growth.

Figure 1 shows the annual growth rates of value added per efficient worker (Y/N) and the TFP.[9] Production per efficient worker and TFP growth rates are highly correlated for all regions and the whole country. Again, the low growth of the production per worker over time in Spain is mostly explained by the low growth of TFP. Years of partisan alignment in each regions are shaded. The high correlation hold in partisan and non partisan alignment periods.

[9] Although correlation coefficients are lower when labor is not adjusted by human capital similar picture is obtained.

4 Baseline Econometric Model

Let the final output of the region i in year t be given by a Cobb-Douglas production function with constant return to scale such 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 α_{it} and $1-\alpha_{it}$ are the capital and labor shares, respectively.

The production per efficient worker is

$$y_{it} = B_{it} k_{it}^{\alpha_{it}}, \tag{1}$$

with k_{it} being the annual stock of non-residential productive physical capital per efficient worker.

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

$$\begin{aligned} \frac{B_{it}}{B_{it-1}} &= \frac{Z_{it}}{Z_{it-1}} \left(\frac{SI_{it}}{SI_{it-1}}\right)^{\theta_1} \left(\frac{k_{it}^{pu}}{k_{it-1}^{pu}}\right)^{\theta_2} \left(\frac{k_{it}^{hc}}{k_{it-1}^{hc}}\right)^{\theta_3} \left(\frac{FA_{it}}{FA_{it-1}}\right)^{\theta_4} \times \\ & \left(\frac{NR_{it}}{NR_{it-1}}\right)^{\theta_5} \left(\frac{N_{it}}{S_i}\right)^{\theta_6} \left(\frac{\frac{c_{it}}{km_{it}}}{\frac{c_{it-1}}{km_{it-1}}}\right)^{\theta_7}, \end{aligned} \tag{2}$$

Where

$$\frac{Z_{it}}{Z_{it-1}} = e^{\left(\delta_i + \tau_t + \sum_{p=0}^{P} DM'_{it-p}\beta_{Mp} + \sum_{p=0}^{P} Dm'_{it-p}\beta_{mp} + \varepsilon_{it}\right)}$$

The growth rate of TFP is given by

$$\begin{aligned} \triangle Log\left(B_{it}\right) &= \delta_i + \tau_t + \textstyle\sum_{p=0}^{P} DM'_{it-p}\beta_{Mp} + \sum_{p=0}^{P} Dm'_{it-p}\beta_{mp} \\ & +\theta_1 \triangle Log\left(SI_{it}\right) + \theta_2 \triangle Log\left(k_{it}^{pu}\right) + \theta_3 \triangle Log\left(k_{it}^{hc}\right) \\ & +\theta_4 \triangle Log\left(FA_{it}\right) + \theta_5 \triangle Log\left(NR_{it}\right) + \theta_6 Log\left(\frac{N_{it}}{S_i}\right) \\ & +\theta_7 \triangle Log\left(\frac{c_{it}}{km_{it}}\right) + \varepsilon_{it} \end{aligned} \tag{3}$$

Being δ_i a specific regional effect that collects unobservable specific characteristics of the region i. τ_t is a time effect that collect unobservable characteristics that equally affect all regions over time. DM_{it-p} and Dm_{it-p} are the variables that capture the partisan alignment effect. DM_{it-p} is a dummy variable that takes the value of one when the same party holds office in the central and regional governments simultaneously and with majority in the central government and zero otherwise, Dm_{it-p} is a dummy variable that takes the value of one when the same party holds office in both levels of governments and with minority in the central government and zero otherwise. Construction of these variables is based upon RULERS, World Statement.org[10] and Spanish Ministry of Interior (*Ministerio del Interior).*[11]

By including lags of the dummy variable DM_{it} and Dm_{it} we are considering that economic agents could require time to adjust to changes when there is partisan alignment. The sum of the coefficients of the dummy variables, $\sum_{p=0}^{P} \beta_{Mp}$, $\sum_{p=0}^{P} \beta_{mp}$, yields an estimation of the long-rung response to changes and reforms foster during the period of partisan alignment.

We also introduce a set of controllers that are supposed 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

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

$Y_{it,j}$ is the gross value added of sector j in region i in year t, Y_{it} is the total gross value added of region i in year t and $\mathbf{Y}_{t,j}$ and $\mathbf{Y}_t$ stand for values referred to Spain.[12] SI_{it} is zero when the regional productive structure is equal to that of the whole country and increases with the level of specialization.

[10] RULERS and World Statement.org are non-profit organization whose aim is to freely provide detailed statistics on political cycles and other political matters on several countries.

[11] Sources can be found in www.rulers.com, http://www.worldstatesmen.org/ and http://www.interior.gob.es/. Since that the first year of governance does not cover the whole year, if the period of the governance in any level of government starts after June, this variable takes the value zero in that year, and one if was before June.

[12] Subscript j denotes the following sectors: agriculture, industry, energy, construction and services. These variables are calculated with data provided by the National Statistics Institute of Spain (INE).

k_{it}^{pu} is a variable accounting for annual stock of regional public infrastructure per efficient worker, with the stock of public infrastructure (K_{it}^{pu}) provided by the BBVA Foundation and Ivie. 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.[13] Therefore, we consider "core infrastructure", which includes streets and highways, water systems, railways, airports, ports and other urban infrastructures provided by local governments.[14]

k_{it}^{hc} is a variable accounting for annual stock of public health care capital per efficient worker, with health care public capital (K_{it}^{hc}) provided by the BBVA Foundation and Ivie. Cole and Neumayer (2006) found that poor health has a negative impact on TFP. A good health care system is related to healthy people, i.e. more productive workers.

FA_{it} is a variable that control for the fiscal and financial autonomy of the regions, and it is calculated as the ratio between the tax collected by the regional government in the region i and the tax collected by the central government in the same region in time t with data provided by Database of the Spanish Public Sector (*Base de Datos del Sector Público Español,* BADESPE).[15]

NR_{it} is a variable that control for the political decision-making power of the regions. We use the numbers of responsibilities ceded to the region i in time t from the Ministry of the Finance and Public Administrations (*Ministerio de Hacienda y Administraciones Públicas).*[16]

The variables FA_{it} and NR_{it} are intended to capture the differences of

[13] 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.

[14] 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 .

[15] Access to the data can be found in http://www.estadief.meh.es/.

[16] Access to the data can be found in http://www.seap.minhap.gob.es/index.html

the political and economic autonomy observed across Spanish regions, i.e. the effect of decentralization. Not weighting for such heterogeneity in the distribution of local powers across regions and over time could be likely to affect the empirical results.

N_{it}/S_i is the number of efficient workers relative to the surface (S_i) and collects the effect of agglomeration in the regional economies and c_{it}/km_{it} is the number of vehicles (c_{it}) per kilometer of roads (km_{it}) and collects the effect of congestion. Regional data on surface, vehicles and roads are taken from the National Statistics Institute of Spain (INE). Ciccone and Hall (1996) and Ciccone (2002) show theoretical and empirical positive effects of agglomeration on labor productivity for the US and Europe, respectively. Moreover, Broersma and van Dijk (2008) found, for Dutch regions, that positive agglomeration effects overrule negative congestion effects on total factor productivity. They used the number of workers relative to the surface (L_{it}/S_i) to control for agglomeration and the total number of cars per kilometers of roads for congestion effects. They assume an effect of the growth rate of L_{it}/S_i on the growth rate of TFP. However, to our knowledge, S_i, is a constant variable in the Spanish case.[17] Moreover, considering the growth rate of L_{it}/S_i or N_{it}/S_i implies introducing the growth rates of L_{it} or N_{it} which do not capture the agglomeration effects. For that reason, we introduce $Log\left(N_{it}/S_i\right)$ instead of $\Delta Log\left(N_{it}/S_i\right)$ as explanatory variable for the growth rate of TFP.

Finally ε_{it} is an iid disturbance.

The variable $\triangle Log\left(B_{it}\right)$, is a non-observable variable that we calculate by performing a growth accounting exercise.[18] Broersma and van Dijk (2008) highlight that the growth accounting and the econometric approaches are not competitors, but can instead complement one another. Therefore, econometric methods can be applied to further explain the productivity residual from growth accounting. Thereby, we will be able to estimate equation (3) in the next section.

[17] We dismiss if in the Dutch case S_i varies over time. In any case, we presume that S_i suffers very little time variation.

[18] See Appendix.

5 Estimation Issues

Tables (2) and (3) show panel data regression of the equation (3) with fixed and random effects respectively and including the control variables in a step-wise manner. We consider lag effects after three periods ($P = 3$). Therefore, partisan effects are supposed to have the length of the electoral cycles in Spain, which is a plausible assumption. Individual and time fixed effects for the last step are shown in ??.

As it can be noticed, regardless estimation method (fixed or random effects), similar results were obtained. The statistic of Hausmann test (H_{FE} test) in Table (3) shows the superiority of fixed effects methods in most of the step of the estimation, except in the last two. Therefore, with all the control variables included, random effects is superior.

Let describe the results focusing on the case of all variable included and random effects, last column of Table (3).

As it can be noticed, 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.

According to the general literature and that specifically related to Spain, the estimation of the parameters that capture the effects of the public infrastructure and health care system are positive and statistically significant at the 1% level. Aviles *et al.* (2001) suggest that public capital accumulation can be considered as 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 Delgado and Álvarez (2004) confirm that there is a significant positive contribution of infrastructure on both private production and the efficiency of Spanish regions. And 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 on productivity, while governmental investment in health care has not.

The variables capturing the effect of fiscal autonomy and decentralization, as well as, the variables accounting for agglomeration and congestion effects are not statistically significant at any conventional level. Carrion-i-Silvestre et al. (2008) using also a measures of revenues do not found statistical evidence in the case of Spain. 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. Specifically, they highlight that, according to their results, there appears to be no positive evidence of agglomeration effects in industry in the period 1985–1999.

As regards our main variables of interest. First, it can be clearly noticed that the partisan alignment effect only arise when the central government enjoys majority which suggest that the power that gives majority to the central government reaches the regional allies to the extend that can influence on the regional economies through the TFP.

Second, results suggest the existence of contemporaneous and lagged effects of partisan alignment. β_{M0} is significant at 1% level and β_{M1} and β_{M2} are significant at 5% level while β_{M3} is not significance at any conventional level. Therefore, decisions and reforms undertaken during partisan alignment are not only supposed to affect the current period but the effect lasts, at least, after two periods.

Third, the contemporaneous effect is positive, while the lagged effects are negative, which suggests the short-time horizon view of politicians as shown by Buchanan and Lee (1982) who state that politicians have little motivations to consider consequences that extend beyond the expected period of tenure. This is especially noticeable, in electoral years, when politicians concerned with reelection are seen as making decision on the basis of shorter time horizon that produce them near term electoral benefits that increase the probability of reelection even if the future effects of the decisions and reforms undertaken in the current period are negative. Moreover, according to Nordhaus (1975), political parties behave purely 'opportunistically', which means that they are solely interested in obtaining a majority of votes. Assuming that voters are heavily influenced by the actual state of the economy, politicians try to create desirable economic conditions by whatever means before elections, although these means may cause costly adjustments after the elections. According to our results such a political behavior is not exclusive in the electoral years, but, it can arise each year as a "natural" behavior in the case of partisan alignment.

Fourth, notice that, $|\beta_{M0}| > |\beta_{M1}| > |\beta_{M2}| > |\beta_{M3}|$. Therefore, the partisan alignment effect vanishes over time.

Finally, we test the hypothesis H_{P0}: $\sum_{p=0}^{P} \beta_{Mp} = 0$ for long-rung effect of partisan alignment on TFP and we are unable to reject in all steps of the estimation. Therefore, when the dummy variables, DM_{it-p}, with $p = 0, 1, 2, 3$, take simultaneously the value one, that is, partisan alignment during four consecutive years, those time effects cancel out.[19]. This results is stronger than that of Alesina and Roubini (1992), since we have obtained that even though there is a significant positive effect of partisan alignment in the current period, it is offset by the negative effects of the previous periods. Therefore, no partisan alignment effect on the aggregate supply through the TFP growth rate. Notice that such result occurs whenever the partisan alignment hold in the current year.

Suppose now, the case of non partisan alignment in the current year, but partisan alignment in the previous years and test the hypothesis H_{P1}: $\sum_{p=1}^{P} \beta_{Mp} = 0$, we reject it at any conventional level.[20] The aftermaths of partisan alignment hold after two periods which is in the same line of Buchanan and Lee (1982) and Nordhaus (1975).

Summarizing, with consecutive years of partisan alignment, whenever it occurs in the current year, no effect on TFP growth rate arises. However, with no partisan alignment in the current years, but consecutive lag years of partisan alignment, a negative effect on TFP growth rate arises. In any case, the results of the hypotheses H_{P0} and H_{P1} are in the same line of Alesina and Roubini (1992) who found no support for permanent partisan effects on real economy from the aggregate demand side, while our results are from the aggregate supply side.[21] Finally, notice that the model is able to explain about 53 percent of the variability of the growth rate of TFP.

6 Alternative specification: Introducing a frontier

An alternative to the specification in equation (2) can be a function that allows to capture a gap or the distance between a "reference level" or "frontier" of TFP and the TFP of the region i as follows[22]

[19] For two and three consecutive years, with the current years involved, show similar results.

[20] For two consecutive lagged years, similar results were found.

[21] Of course, some combinations of non consecutive years of partisan alignment could have significant aggregated effects. However, these cases are less frecuent, thereby, we neglected them.

[22] This specification is based on Jones (1998).

$$\frac{B_{it}}{B_{it-1}}=\left(\frac{\hat{B}_{it}}{B_{it-1}}\right)^{\gamma}e^{\left(\sum_{p=0}^{P}DM'_{it-p}\beta^{*}_{Mp}+\sum_{p=0}^{P}Dm'_{it-p}\beta^{*}_{mp}+\varepsilon_{it}\right)} \tag{4}$$

The component $\left(\frac{\hat{B}_{it}}{B_{it-1}}\right)^{\gamma}$ captures the distance to the TFP frontier, $\hat{B}_{it}$, which can be also interpreted as the optimal or desire level of TFP in period t. The parameter $\gamma \in [0,1]$ measures the strength of the catch-up effect.

Notice in equation (4) that whenever $\beta^{*}_{Mp}=\beta^{*}_{mp}=\mathbf{0}_{(P+1)\times 1}$, there no exist partisan alignment effects. Therefore, in the extreme case of $\gamma=1$, the TFP can only deviate from its optimal level due to a random disturbance and the expected level of TFP equals its optimum, $E\left(B_{it}\right)=E\left(\hat{B}_{it}\right)$. Analogously, if $\gamma=0$, $E\left(B_{it}\right)=E\left(B_{it-1}\right)$, we expect no growth in TFP. On the contrary, if $\beta^{*}_{Mp}\neq\mathbf{0}_{(P+1)\times 1}$ and/or $\beta^{*}_{mp}\neq\mathbf{0}_{(P+1)\times 1}$, with $\gamma=1$, the TFP can deviate from the optimal level due to the random disturbance and the partisan alignment and we would have that $E\left(B_{it}\right)\lesseqgtr E\left(\hat{B}_{it}\right)$. If $\gamma=0$, the expected TFP level could grow or decrease due to only the partisan alignment, $E\left(B_{it}\right)\lesseqgtr E\left(B_{it-1}\right)$.

$\hat{B}_{it}$ is an unobservable variable whose expectation level in period t has to be stated. Therefore, let $E\left(\hat{B}_{it}\right)$ be determined by unobservable specific characteristics of the region i, unobservable time effects and the lag value of the variables that are supposed to condition TFP such as

$$\begin{aligned}E\left(\hat{B}_{it}\right) &= e^{(\zeta_i+\eta_t)}\left(SI_{it-1}\right)^{\varphi_1}\left(k^{pu}_{it-1}\right)^{\varphi_2}\left(k^{hc}_{it-1}\right)^{\varphi_3}\left(FA_{it-1}\right)^{\varphi_4}\left(NR_{it-1}\right)^{\varphi_5}\times\\ &\left(\frac{N_{it-1}}{S_i}\right)^{\varphi_6}\left(\frac{c_{it-1}}{km_{it-1}}\right)^{\varphi_7}\end{aligned} \tag{5}$$

Taking expectation in equation (4), substituting (5) and taking logarithm we obtain

$$\begin{aligned}E\left[\triangle Log\left(B_{it}\right)\right] &= \delta^{*}_{i}+\tau^{*}_{t}+\textstyle\sum_{p=0}^{P}DM'_{it-p}\beta^{*}_{Mp}+\sum_{p=0}^{P}Dm'_{it-p}\beta^{*}_{mp}\\ &+\theta^{*}_{1}Log\left(SI_{it-1}\right)+\theta^{*}_{2}Log\left(k^{pu}_{it-1}\right)+\theta^{*}_{3}Log\left(k^{hc}_{it-1}\right)\\ &+\theta^{*}_{4}Log\left(FA_{it-1}\right)+\theta^{*}_{5}Log\left(NR_{it-1}\right)+\theta^{*}_{6}Log\left(\frac{N_{it}}{S_i}\right)\\ &+\theta^{*}_{7}Log\left(\frac{c_{it-1}}{km_{it-1}}\right)+\gamma^{*}Log\left(B_{it-1}\right)\end{aligned} \tag{6}$$

where $\delta_i^* = \gamma\zeta_i$, $\tau_t^* = \gamma\eta_t$ are the region specific and time effects, $\theta_j^* = \gamma\varphi_j$ for $j = 1, 2, 3, 4, 5, 6, 7$ and $-1 < \gamma^* = -\gamma < 0$.

This specification could be more sensible since it allows for a time lag between the realization of the control variables and their effects on TFP which, might be not to be immediate or contemporaneous. Moreover, $Log\left(B_{it-1}\right)$ capture the possible TFP catch up dynamics. However, it has the drawback that the absolute lagged value of TFP $\left(B_{it-1}\right)$ is not obtained from the growth accounting exercise since it gives growth rates. In order to overcome such disadvantages we have to construct TFP index for the regions based upon their growth rates. Thereby, we take year 2000 as the base in which the index take the value of 100.

Tables (4) and (5) shows the results of panel data regressions with fixed and random effects, respectively, again in stepwise manner. As it can be seen, in all the steps of the estimation random effect method is superior. Focusing on the last step with all the control variables included, we obtain that public infrastructure is significant at 5% level and with positive sign and one of the variables capturing the effect of decentralization ($Log\left(NR_{it-1}\right)$ is also significant at the same level but with negative sign. As expected, $-1 < \gamma^* < 0$ and significant at 1% level showing the presence of catch-up dynamic in B_{it}. Regarding the partisan alignment, we obtain similar results to the former specification, with $\beta_{M0}^* > 0$ and β_{M1}^*, $\beta_{M2}^* < 0$. The difference is that β_{M1}^* is not significant at any conventional level. However, β_{M0}^* and β_{M2}^* are significant at 1% and 5% levels respectively. Again, we get that contemporaneous effect is larger, $\beta_{M0}^* > \beta_{M1}^*, \beta_{M2}^*, \beta_{M3}^*$ and we are unable to reject H_{P0} and reject H_{P1}. Finally, the model is able to explain about 40 percent of the variability of the growth rate of TFP.

7 Robustness Check

7.1 Accounting for Endogeneity

According to specification in (2), control variables are likely to be simultaneously determined with the TFP growth rates. Therefore, results in Tables (2) and (3) could be affected by potential endogeneity problems. In order to overcome that, we run a two stage least square estimation (2SLS). Second column of Table (6) shows the results. Haussman exogeneity test (H_E test) rejects the hypothesis of exogeneity of the control variables. As it can be notice, once endogeneity is controlled, results remains almost the same regarding our variables of interest. However, estimations of parameters of the control variables change, none of their coefficients are significance at any conventional level. Nevertheless, Sargan test does not reject the hypothesis of exogeneity of the instruments, i.e., they are valid instruments. Although is less likely the presence of endogeneity problems using the specification of section 6, we also carry out Haussman exogeneity test and we are unable to reject it as can be seen in third column of Table (6).

7.2 Estimating Production Functions

An alternative to the growth accounting methodology is to obtain a measure of $\triangle Log\left(B_{it}\right)$ through an econometric approach by estimating an equation for the growth rate of output. However, Barro (1999) stresses the disadvantages of this approach such as endogeneity problems, the static factor share, α, and inconsistent estimation if the inputs, K_{it} and N_{it} are measured with errors. We think that the main drawback respect to the growth accounting approach is the static factor shares, since that the problem of endogeneity and error measures can be overcome using the instrumental variable estimator. Therefore, in this section, we first estimate the parameters of the model departing from equation (1) and next we estimate the parameters using and extended Cobb-Douglas production function accounting for public infrastructure and without imposing constant return to scale.

7.2.1 Estimation using production (1)

Departing from (1), an alternative econometric approach to the proposed methodologies in sections 5 and 6 is to regress the growth rate of output per efficient worker, $\Delta Log\left(y_{it}\right)$, on the growth rate of the input $\Delta Log\left(k_{it}\right)$ and all variables on the right side of (3) or (6), as shown in the following equations

$$
\begin{aligned}
\triangle Log\left(y_{it}\right) \quad = \quad & \delta_i + \tau_t + \textstyle\sum_{p=0}^{P} DM'_{it-p}\beta_{Mp} + \sum_{p=0}^{P} Dm'_{it-p}\beta_{mp} \\
& +\theta_1 \triangle Log\left(SI_{it}\right) + \theta_2 \triangle Log\left(k_{it}^{pu}\right) + \theta_3 \triangle Log\left(k_{it}^{hc}\right) \\
& +\theta_4 \triangle Log\left(FA_{it}\right) + \theta_5 \triangle Log\left(NR_{it}\right) + \theta_6 Log\left(\frac{N_{it}}{S_i}\right) \\
& +\theta_7 \triangle Log\left(\frac{c_{it}}{km_{it}}\right) + \alpha \triangle Log\left(k_{it}\right) + \varepsilon_{it} \qquad (7)
\end{aligned}
$$

or

$$
\begin{aligned}
\triangle Log\left(y_{it}\right) \quad = \quad & \delta_i^* + \tau_t^* + \textstyle\sum_{p=0}^{P} DM'_{it-p}\beta_{Mp}^* + \sum_{p=0}^{P} Dm'_{it-p}\beta_{mp}^* \qquad (8) \\
& +\theta_1^* Log\left(SI_{it-1}\right) + \theta_2^* Log\left(k_{it-1}^{pu}\right) + \theta_3^* Log\left(k_{it-1}^{hc}\right) \\
& +\theta_4^* Log\left(FA_{it-1}\right) + \theta_5^* Log\left(NR_{it-1}\right) + \theta_6^* Log\left(\frac{N_{it-1}}{S_i}\right) \\
& +\theta_7^* Log\left(\frac{c_{it-1}}{km_{it-1}}\right) + \gamma^* Log\left(B_{it-1}\right) + \alpha^* \triangle Log\left(k_{it}\right) + \varepsilon_{it}
\end{aligned}
$$

Table (7) shows, in the left panel, the results of the estimation of equation (7) and in the right panel, the estimation of equation (8). As it can be noticed, similar results are found to that of using $\Delta Log\left(B_{it}\right)$ from the growth accounting approach which was foreseeable due to the high correlation between $\Delta Log\left(B_{it}\right)$ and $\triangle Log\left(y_{it}\right)$ show in figure 1. Again, random effect estimation is superior to the fixed effect in both specification of TFP and Haussman exogeneity test shows evidence against exogeneity of the control variables in the baseline model at the 10% level of significance. In the frontier model of TFP the introduction of the $\triangle Log\left(k_{it}\right)$ cause endogeneity since we can reject the hypothesis of exogeneity at the 5% level of significance. Moreover, the estimate of the parameter or $\triangle Log\left(k_{it}\right)$ is statistically significant at 1% regardless the method of estimation and specification of TFP. In the case of the baseline model, once endogeneity is controlled, it is the only control variable with significant coefficient. While in the case of the frontier specification, significance hold for the coefficients of $\triangle Log\left(k_{it}\right)$, $Log\left(B_{it-1}\right)$, $Log\left(k_{it-1}^{hc}\right)$ and $Log\left(NR_{it-1}\right)$. Nevertheless, the last two, have the unexpected signs. Regarding our variables of interest we obtain very similar results to the previous one.

7.2.2 Estimating a production function including public infrastructure as an input

Barro (1990), in a theoretical model of endogenous economic growth, introduced public services in a Cobb-Douglas production function with constant return to scale and Aschauer(1989), in his empirical article, introduced public capital in a similar production function along with labor and nonresidential capital. Following them, let assume a production function as follows

$$Y_{it} = B_{it} \left(K_{it}^{r}\right)^{\alpha} \left(N_{it}\right)^{\phi} \left(K_{it}^{pu}\right)^{\delta}$$

Where K_{it}^{r} is the stock of nonresidential productive capital other than public infrastructure (K_{it}^{pu}). We do not impose constant return to scale and estimate the following equation

$$\triangle Log\left(Y_{it}\right) = \alpha \triangle Log\left(K_{it}^{r}\right) + \phi \triangle Log\left(N_{it}\right) + \delta \triangle Log\left(K_{it}^{pu}\right) + \mu_{it}, \qquad (9)$$

Where $\mu_{it} = \triangle Log\left(B_{it}\right)$. Due to the endogeneity problems in (9), we first estimate this equation through 2SLS and next we can use the estimation $\hat{\mu}_{it}$ as dependent variable to estimate equations (3) and (6) with fixed and random effects and 2SLS. Cole and Neumayer (2006) and Bronzini and Piselli (2009) used such two-step econometric strategy.

Table (8) shows the results of estimating equation (9). As it can be seen, coefficients of non-residencial productive capital and efficient workers are statistically significant at 1% level. However, coefficient of public infrastructure is not significant at any conventional level. The hypothesis of constant return to scale of private inputs is tested and we are unable to reject it at 5% level. Haussman test of exogeneity show evidence against exogeneity, as expected, and Sargan test do not reject the hypothesis of exogeneity of the instruments at the 5% level.

Table (9) presents the estimation results for the second step. Left panel shows the results of the estimation of equation (3) and right panel estimation of the equation (6). Very similar results were found to that of the Tables (2), (3), (4) (5) and (6).

7.3 Labor Measured as Number of Workers

Now let specify labor simply as the number of workers in the regional economies, L_{it}. We perform the growth accounting exercise with a production function non-adjusted by human capital as follows

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

where A_{it} is the TFP non-adjusted by human capital and we specify A_{it}/A_{it-1} similarly to (2) and (4) but with variables in terms of number of workers (L) instead of efficient workers (N).

Tables (10) and (11) shows the results and very little variations are obtained.

8 Conclusions

In this article we test the effect of partisan alignment (same party holding office in the central and regional governments simultaneously) on regional economic growth. Different to the literature on political effects on real economy (Partisan Theory and Distributive Politics) that suggests and has shown that partisan effects accrues through aggregate demand policies, we aim at shedding light on the existence of such effects on the economic growth but on the aggregate supply side. Hence, we hypothesize that partisan alignment could also accrue through total factor productivity (TFP). An econometric strategy based on two alternative specifications of the TFP growth rate is proposed. Dummy variables are introduced to capture the effects of partisan alignment with a lag structure to account for dynamic effects. The growth rate of TFP is estimated through a growth accounting exercise at the regional level and alternative econometric measures of TFP growth rates are also obtained by estimating Cobb-Douglas production functions. Using panel data for the Spanish regions over the 1986-2010 period, we find that, *i*) partisan alignment effect only arises when central government enjoys majority. *ii*) contemporaneous and lagged effects are found. *iii*) in absolute value, the time varying partisan effects vanish over time. Moreover, contemporaneous effect is positive but lagged effects are negative and those effects cancel out across time. Which suggest a null effect of partisan alignment on aggregate supply, very different to the usual strong partisan effect on the aggregate demand found by Partisan Theory and Distributive Politics. However, lagged effects do not cancel out. In general, partisan alignment effects could only hold after two period which is in line with Alesina and Roubini (1992) who found no long-term political effects on the economy from the aggregate demand side, while our results are from aggregate supply side. We carry out several robustness checks showing that the results are robust regardless the specification and measures of TFP, different measures of labor input and methods of estimation.

Appendix: TFP growth calculations

In this appendix we perform a growth accounting exercise for the 1986-2010 period to estimate the growth rate of TFP for the Spanish regions. We consider the standard assumptions about technology represented by an aggregate Cobb-Douglas production function and about input markets, capital and labor, which are assumed to be perfectly competitive markets. The representative region i shows the following production function at each year t

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

Where Y_{it} is the final aggregate output of autonomous community i in year t, K_{it} is the annual stock of non-residential productive physical capital, L_{it} is the number of employees per year or annual labor input and A_{it} is a measure of the total factor productivity (TFP)[23] in region i at each year t.[24]

Moreover, we assume a 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 or amount of efficient workers.

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.[25]

Given our choice of series for output, Y_{it}, efficient workers, N_{it}, productive physical capital, K_{it} and capital share α_{it}, we calculate the growth rate of TFP through the Divisia-Tornqvist index as follows,

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

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

[24] The data and sources are shown in section 3.

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

where

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

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Table 1: Average Annual Growth Rates of Output, Inputs and TFP in the Spanish Regions

Regions	Y	K	L	N	Y/L	K/L	Y/N	K/N	A_t	B_t
Andalusia	0.0288	0.0416	0.0260	0.0311	0.0027	0.0152	-0.0022	0.0102	-0.0010	-0.0047
Aragon	0.0259	0.0339	0.0154	0.0202	0.0103	0.0182	0.0055	0.0134	0.0063	0.0026
Asturias	0.0183	0.0290	0.0066	0.0123	0.0117	0.0223	0.0060	0.0165	0.0072	0.0023
Balearic Islands	0.0287	0.0490	0.0339	0.0370	-0.0050	0.0147	-0.0079	0.0116	-0.0092	-0.0114
Canary Islands	0.0284	0.0471	0.0279	0.0321	0.0005	0.0187	-0.0036	0.0145	-0.0044	-0.0075
Cantabria	0.0270	0.0323	0.0183	0.0235	0.0085	0.0138	0.0035	0.0087	0.0048	0.0011
Castile and Leon	0.0222	0.0338	0.0105	0.0152	0.0116	0.0231	0.0069	0.0183	0.0061	0.0025
Castile-La Mancha	0.0284	0.0446	0.0192	0.0246	0.0090	0.0249	0.0038	0.0196	0.0017	-0.0021
Catalonia	0.0288	0.0317	0.0222	0.0266	0.0065	0.0093	0.0021	0.0049	0.0045	0.0011
Valencia	0.0276	0.0336	0.0227	0.0286	0.0048	0.0106	-0.0009	0.0049	0.0018	-0.0024
Extremadura	0.0298	0.0310	0.0155	0.0200	0.0142	0.0153	0.0097	0.0108	0.0107	0.0072
Galicia	0.0224	0.0367	0.0020	0.0097	0.0204	0.0346	0.0126	0.0267	0.0112	0.0056
Madrid	0.0301	0.0369	0.0283	0.0333	0.0017	0.0083	-0.0031	0.0035	0.0002	-0.0038
Murcia	0.0303	0.0446	0.0315	0.0357	-0.0011	0.0127	-0.0052	0.0086	-0.0047	-0.0078
Navarre	0.0296	0.0427	0.0225	0.0275	0.0069	0.0198	0.0021	0.0149	0.0027	-0.0011
Basque Country	0.0228	0.0295	0.0171	0.0228	0.0056	0.0122	0.0000	0.0066	0.0028	-0.0016
La Rioja	0.0314	0.0366	0.0229	0.0281	0.0083	0.0134	0.00337	0.0083	0.0030	-0.0002
Spain	0.0275	0.0363	0.0210	0.0263	0.0063	0.0150	0.0012	0.0098	0.0029	-0.0011

Table 2: Panel Data Regression for the Growth Rate of TFP of the Baseline Model: Fixed Effects

Variable	Coefficients							
DM_{it}	0.0193***	0.0185***	0.0135***	0.0137***	0.0138***	0.0142***	0.0141***	0.0139***
	0.0048	0.0047	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041
DM_{it-1}	-0.0117**	-0.0117**	-0.0100**	-0.0099**	-0.0099**	-0.0101**	-0.0100**	-0.0098**
	0.0053	0.0052	0.0045	0.0045	0.0045	0.0045	0.0045	0.0045
DM_{it-2}	-0.0110**	-0.0104**	-0.0085**	-0.0086**	-0.0088**	-0.0089**	-0.0089**	-0.0092**
	0.0050	0.0050	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043
DM_{it-3}	0.0066	0.0064	0.0012	0.0008	0.0011	0.0012	0.0010	0.0012
	0.0041	0.0041	0.0036	0.0035	0.0035	0.0035	0.0035	0.0035
Dm_{it}	-0.0001	0.0002	-0.0021	-0.0021	-0.0023	-0.0016	-0.0022	-0.0022
	0.0038	0.0038	0.0033	0.0033	0.0033	0.0034	0.0034	0.0034
Dm_{it-1}	0.0000	-0.0005	-0.0000	0.0001	0.0007	0.0003	0.0003	0.0003
	0.0049	0.0049	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042
Dm_{it-2}	-0.0021	-0.0023	-0.0005	-0.0008	-0.0014	-0.0012	-0.0014	-0.0015
	0.0050	0.0050	0.0043	0.0043	0.0043	0.0043	0.0043	0.0043
Dm_{it-3}	-0.0017	-0.0010	-0.0024	-0.0022	-0.0020	-0.0023	-0.0029	-0.0028
	0.0042	0.0042	0.0036	0.0036	0.0036	0.0036	0.0036	0.0036
$\triangle Log\left(SI_{it}\right)$		0.0118**	0.0123***	0.0128***	0.0127***	0.0134***	0.0126***	0.0126***
		0.0046	0.0040	0.0039	0.0040	0.0040	0.0040	0.0040
$\triangle Log\left(k_{it}^{pu}\right)$			0.3673***	0.3308***	0.3285***	0.3286***	0.3218***	0.3288***
			0.0355	0.0372	0.0380	0.0380	0.0379	0.0390
$\triangle Log\left(k_{it}^{hc}\right)$				0.0593***	0.0608***	0.0621***	0.0638***	0.0627***
				0.0198	0.0200	0.0201	0.0200	0.0200
$\triangle Log\left(FA_{it}\right)$					-0.0083	-0.0084	-0.0092	-0.0093
					0.0075	0.0075	0.0074	0.0074
$\triangle Log\left(NR_{it}\right)$						-0.0234	-0.0236	-0.0238
						0.0228	0.0227	0.0227
$Log\left(\frac{N_{it}}{S_i}\right)$							-0.0288**	-0.0287**
							0.0131	0.0131
$\triangle Log\left(\frac{c_{it}}{km_{it}}\right)$								0.0371
								0.0484
R^2	0.3463	0.35922	0.5174	0.5304	0.5315	0.5330	0.5328	0.5337

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

Table 3: Panel Data Regression for the Growth Rate of TFP of the Baseline Model: Random Effects

Variable	Coefficients							
DM_{it}	0.0124***	0.0119***	0.0128***	0.0129***	0.0131***	0.0132***	0.0143***	0.0141***
	0.0040	0.0040	0.0036	0.0036	0.0036	0.0036	0.0040	0.0040
DM_{it-1}	-0.0074	-0.0075	-0.0105**	-0.0104**	-0.0103**	-0.0105**	-0.0102**	-0.0099**
	0.0046	0.0046	0.0042	0.0041	0.0041	0.0041	0.0044	0.0044
DM_{it-2}	-0.0116***	-0.0114***	-0.0096**	-0.0098**	-0.0098**	-0.0100**	-0.0090**	-0.0092**
	0.0044	0.0044	0.0040	0.0039	0.0039	0.0039	0.0042	0.0042
DM_{it-3}	0.0128***	0.0132***	0.0062*	0.0064**	0.0065**	0.0068**	0.0015	0.0017
	0.0036	0.0035	0.0032	0.0032	0.0032	0.0032	0.0034	0.0034
Dm_{it}	0.0031	0.0030	-0.0011	-0.0009	-0.0008	-0.0004	-0.0017	-0.0017
	0.0035	0.0034	0.0031	0.0030	0.0030	0.0031	0.0033	0.0033
Dm_{it-1}	-0.0010	-0.0013	0.0006	0.0008	0.0008	0.0007	0.0004	0.0004
	0.0044	0.0044	0.0039	0.0039	0.0039	0.0039	0.0041	0.0041
Dm_{it-2}	-0.0033	-0.0034	-0.0010	-0.0012	-0.0013	-0.0011	-0.0013	-0.0014
	0.0045	0.0044	0.0040	0.0039	0.0040	0.0040	0.0042	0.0042
Dm_{it-3}	-0.0059	-0.0059	0.0036	-0.0035	-0.0035	-0.0038	-0.0023	-0.0023
	0.0037	0.0037	0.0033	0.0033	0.0033	0.0033	0.0035	0.0035
$\triangle Log\left(SI_{it}\right)$		0.0106**	0.0123***	0.01300***	0.0130***	0.0133***	0.0133***	0.0133***
		0.0044	0.0038	0.0038	0.0038	0.0038	0.0039	0.0039
$\triangle Log\left(k_{it}^{pu}\right)$			0.2654***	0.2128***	0.2086***	0.2074***	0.3168***	0.3241***
			0.0270	0.0293	0.0298	0.0297	0.0362	0.0372
$\triangle Log\left(k_{it}^{hc}\right)$				0.0628***	0.0643***	0.0637***	0.0625***	0.0614***
				0.0180	0.0182	0.0182	0.0193	0.0194
$\triangle Log\left(FA_{it}\right)$					-0.0004	-0.0004	-0.0081	-0.0082
					0.0065	0.0065	0.0072	0.0072
$\triangle Log\left(NR_{it}\right)$						-0.0125	-0.0225	-0.0227
						0.0201	0.0221	0.0221
$Log\left(\frac{N_{it}}{S_i}\right)$							-0.0034	-0.0034
							0.0033	0.0033
$\triangle Log\left(\frac{c_{it}}{km_{it}}\right)$								0.0382
								0.0468
R^2	0.22714	0.23590	0.4623	0.4656	0.4629	0.4627	0.5270	0.5278
H_{FA} Test	28.4832	31.1000	37.6499	49.0558	50.0211	51.5837	5.3420	5.2799
p-values	0.0027	0.0011	0.0001	0.0000	0.0000	0.0000	0.9988	0.9895

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

Table 4: Panel Data Regression for the Growth Rate of TFP of the Frontier Model: Fixed Effects

Variable	Coefficients (Fixed Effects)								
DM_{it}	0.0193***	0.0192***	0.0192***	0.0193***	0.0197***	0.0197***	0.0196***	0.0193***	0.0174***
	0.0048	0.0048	0.0048	0.0047	0.0047	0.0047	0.0047	0.0047	0.0045
DM_{it-1}	-0.0117**	-0.0115**	-0.0113**	-0.0110**	-0.0107**	-0.0100*	-0.0096*	-0.0095*	-0.0067
	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0053	0.0050
DM_{it-2}	-0.0110**	-0.0110**	-0.0110**	-0.0109**	-0.0110**	-0.0106**	-0.0106**	-0.0106**	-0.0099**
	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0047
DM_{it-3}	0.0066	0.0065	0.0063	0.0066	0.0065	0.0070*	0.0068*	0.0066*	0.0051
	0.0041	0.0041	0.0041	0.0066	0.0041	0.0041	0.0041	0.0041	0.0039
Dm_{it}	-0.0001	-0.0000	-0.0001	-0.0004	-0.0004	-0.0014	-0.0011	-0.0012	-0.0003
	0.0038	-0.0000	0.0039	0.0038	0.0038	0.0039	0.0039	0.0039	0.0037
Dm_{it-1}	0.0000	-0.0000	-0.0000	0.0000	-0.0001	0.0008	0.0010	0.0011	0.0003
	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0049	0.0047
Dm_{it-2}	-0.0021	-0.0020	-0.0021	-0.0021	-0.0018	-0.0016	-0.0013	-0.0013	-0.0016
	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0047
Dm_{it-3}	-0.0017	-0.0015	-0.0017	-0.0018	-0.0021	-0.0013	-0.0009	-0.0006	-0.0006
	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0040
$Log\left(SI_{it-1}\right)$		-0.0018	-0.0021	-0.0027	-0.0026	-0.0027	0.0016	-0.0015	-0.0017
		0.0027	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0027
$Log\left(k^{pu}_{it-1}\right)$			0.0064	0.0083	0.0094	0.0076	0.0224*	0.0217*	0.0067
			0.0098	0.0098	0.0099	0.0100	0.0128	0.0128	0.0124
$Log\left(k^{hc}_{it-1}\right)$				-0.0142**	-0.0142**	-0.0103	-0.0062	-0.0045	-0.0132*
				0.0069	0.0069	0.0072	0.0075	0.0081	0.0078
$Log\left(FA_{it-1}\right)$					-0.0062	-0.0014	-0.0057	-0.0056	-0.0057
					0.0070	0.0074	0.0077	0.0078	0.0074
$Log\left(NR_{it-1}\right)$						-0.0330*	0.0371**	-0.0397**	-0.0233
						0.0173	0.0173	0.0244	0.0172
$Log\left(\frac{N_{it-1}}{S_i}\right)$							0.0389*	0.0460*	-0.1114***
							0.0212	0.0244	0.0352
$Log\left(\frac{c_{it-1}}{km_{it-1}}\right)$								-0.0164	-0.0054
								0.0276	0.0263
$Log\left(B_{it-1}\right)$									-0.2579***
									0.0434
R^2	0.3463	0.3367	0.3375	0.3460	0.3512	0.3585	0.3652	0.3659	0.4291

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

Table 5: Panel Data Regression for the Growth Rate of TFP of the Frontier Model: Random Effects

Variable	Coefficients (Random Effects)								
DM_{it}	0.0124***	0.0125***	0.0118***	0.0142***	0.0162***	0.0153***	0.0191***	0.0189***	0.0185***
	0.0040	0.0040	0.0040	0.0042	0.0043	0.0043	0.0046	0.0046	0.0044
DM_{it-1}	-0.0074	-0.0073	-0.0067	-0.0082*	-0.0091*	-0.0085*	-0.0103**	-0.0103**	-0.0080
	0.0046	0.0046	0.0046	0.0048	0.0049	0.0048	0.0051	0.0051	0.0049
DM_{it-2}	-0.0116***	-0.0115***	-0.0116***	-0.0112**	-0.0110**	-0.0110**	-0.0109**	-0.0109**	-0.0102**
	0.0044	0.0044	0.0044	0.0046	0.0047	0.0046	0.0048	0.0048	0.0046
DM_{it-3}	0.0128***	0.0129***	0.0136***	0.0111***	0.0097**	0.0097**	0.0066*	0.0066*	0.0058
	0.0036	0.0036	0.0035	0.0037	0.0038	0.0038	0.0039	0.0039	0.0038
Dm_{it}	0.0031	0.0030	0.0032	0.0022	0.0015	0.0015	-0.0007	-0.0006	-0.0002
	0.0035	0.0035	0.0034	0.0035	0.0036	0.0036	0.0037	0.0037	0.0036
Dm_{it-1}	-0.0010	-0.0010	-0.0011	-0.0008	-0.0005	-0.0003	0.0004	0.0004	0.0007
	0.0044	0.0044	0.0044	0.0045	0.0046	0.0046	0.0048	0.0047	0.0045
Dm_{it-2}	-0.0033	-0.0033	-0.0036	-0.0029	-0.0027	-0.0026	-0.0018	-0.0018	-0.0014
	0.0045	0.0045	0.0044	0.0046	0.0047	0.0046	0.0048	0.0048	0.0046
Dm_{it-3}	-0.0059	-0.0060	-0.0064*	-0.0053	-0.0043	-0.0038	-0.0018	-0.0017	-0.0007
	0.0037	0.0037	0.0037	0.0038	0.0039	0.0039	0.0041	0.0041	0.0039
$Log\left(SI_{it-1}\right)$		-0.0016	-0.0017	-0.0018	-0.0017	-0.0028	-0.0024	-0.0022	-0.0005
		0.0018	0.0018	0.0018	0.0019	0.0021	0.0020	0.0020	0.0024
$Log\left(k_{it-1}^{pu}\right)$			0.0015	0.0072	0.0075	0.0066	0.0101	0.0092	0.0254**
			0.0065	0.0072	0.0075	0.0077	0.0091	0.0092	0.0102
$Log\left(k_{it-1}^{hc}\right)$				-0.0078	-0.0094*	-0.0091	-0.0113**	-0.0116**	-0.0092
				0.0052	0.0054	0.0055	0.0057	0.0058	0.0065
$Log\left(FA_{it-1}\right)$					0.0009	0.0029	-0.0013	-0.0021	-0.0069
					0.0032	0.0035	0.0031	0.0033	0.0054
$Log\left(NR_{it-1}\right)$						-0.0092	-0.0171*	-0.0161*	-0.0260**
						0.0069	0.0090	0.0090	0.0131
$Log\left(\frac{N_{it-1}}{S_i}\right)$							0.0003	0.0076	-0.0074
							0.0034	0.0074	0.0144
$Log\left(\frac{c_{it-1}}{km_{it-1}}\right)$								-0.0098	0.0070
								0.0089	0.0163
$Log\left(B_{it-1}\right)$									-0.1342***
									0.0267
R^2		0.2144	0.1710	0.2878	0.3243	0.3212	0.3555	0.3568	0.4068
$H-Test$	28.4832	28.7908	32.7601	22.2714	15.5919	20.456	5.8040	5.5957	14.3457
p-values	0.0027	0.0112	0.0031	0.0732	0.3389	0.1164	0.9712	0.9757	0.4243

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

Table 6: 2SLS Estimation for the Growth Rate of TFP

Variable	Coefficient using (2)	Variable	Coefficients using (6)
DM_{it}	0.0204***	DM_{it}	0.0178***
	0.0060		0.0045
DM_{it-1}	-0.0115*	DM_{it-1}	-0.0066
	0.0061		0.0050
DM_{it-2}	-0.0118**	DM_{it-2}	-0.0097**
	0.0059		0.0047
DM_{it-3}	0.0078	DM_{it-3}	0.0051
	0.0051		0.0039
Dm_{it}	-0.0021	Dm_{it}	-0.0001
	0.0050		0.0037
Dm_{it-1}	0.0022	Dm_{it-1}	0.0001
	0.0059		0.0047
Dm_{it-2}	-0.0035	Dm_{it-2}	-0.0014
	0.0059		0.0047
Dm_{it-3}	-0.0004	Dm_{it-3}	-0.0009
	0.0049		0.0041
$\triangle Log\,(SI_{it})$	-0.0134	$Log\,(SI_{it-1})$	-0.0038
	0.0148		0.0033
$\triangle Log\,(k_{it}^{pu})$	-0.0845	$Log\left(k_{it-1}^{pu}\right)$	0.0078
	0.1287		0.0135
$\triangle Log\left(k_{it}^{hc}\right)$	-0.0067	$Log\left(k_{it-1}^{hc}\right)$	-0.0153*
	0.0420		0.0087
$\triangle Log\,(FA_{it})$	-0.0070	$Log\,(FA_{it-1})$	-0.0099
	0.0196		0.0129
$\triangle Log\,(NR_{it})$	0.0838	$Log\,(NR_{it-1})$	-0.0197
	0.0700		0.0256
$Log\left(\frac{N_{it}}{S_i}\right)$	0.0161	$Log\left(\frac{N_{it-1}}{S_i}\right)$	-0.1204***
	0.0194		0.0426
$\triangle Log\left(\frac{c_{it}}{km_{it}}\right)$	-0.0036	$Log\left(\frac{c_{it-1}}{km_{it-1}}\right)$	0.0063
	0.1975		0.0307
		$Log\,(B_{it-1})$	-0.2642***
			0.0555
R^2	0.1821	R^2	0.4325
H_E Test25.1140 (0.0007). Sargant Test 9.7912 (0.13372)		H_E Test9.2581 (0.3210).Sargan Test11.1680 (0.1924)	

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

Table 7: Regression for the growth rate of the production per efficient worker

B_{it} defined as in (2)				B_{it} defined as in (4)			
Variables	FE	RE	2SLS	Variables	FE	RE	2SLS
DM_{it}	0.01400^{***}	0.0141^{***}	0.0195^{***}	DM_{it}	0.01363^{***}	0.0145^{***}	0.0161^{***}
	0.0037	0.0036	0.0054		0.0036	0.0035	0.0040
DM_{it-1}	-0.0071^{*}	-0.0074^{*}	-0.0100^{*}	DM_{it-1}	-0.0038	-0.0049	-0.0050
	0.0041	0.0040	0.0056		0.0040	0.0039	0.0044
DM_{it-2}	-0.0084^{**}	-0.0085^{**}	-0.0109^{**}	DM_{it-2}	-0.0079^{**}	-0.0081^{**}	-0.0089^{**}
	0.0039	0.0038	0.0054		0.0038	0.0037	0.0041
DM_{it-3}	0.0023	0.0030	0.0068	DM_{it-3}	0.0017	0.0023	0.0035
	0.0032	0.0031	0.0046		0.0031	0.0030	0.0035
Dm_{it}	-0.0026	-0.0023	-0.0029	Dm_{it}	-0.0029	-0.0030	-0.0011
	0.0030	0.0029	0.0044		0.0029	0.0028	0.0032
Dm_{it-1}	0.0007	0.0010	0.0027	Dm_{it-1}	0.0007	0.0012	0.0002
	0.0038	0.0037	0.0052		0.0037	0.0036	0.0040
Dm_{it-2}	-0.0021	-0.0020	-0.0035	Dm_{it-2}	-0.0013	-0.0011	-0.0015
	0.0039	0.0038	0.0053		0.0038	0.0037	0.0041
Dm_{it-3}	−0.0027	-0.0023	-0.0013	Dm_{it-3}	-0.0030	-0.0028	-0.0022
	0.0033	0.0032	0.0044		0.0032	0.0031	0.0036
$\triangle Log\left(SI_{it}\right)$	0.0127^{***}	0.0132^{***}	-0.0142	$Log\left(SI_{it-1}\right)$	-0.0005	0.0005	-0.0022
	0.0036	0.0035	0.0133		0.0022	0.0019	0.0029
$\triangle Log\left(k_{it}^{pu}\right)$	0.0365	0.0308	-0.1194	$Log\left(k_{it-1}^{pu}\right)$	0.0096	0.0263^{***}	0.0099
	0.0505	0.0479	0.0993		0.0100	0.0080	0.0116
$\triangle Log\left(k_{it}^{hc}\right)$	0.0397^{**}	0.0359^{**}	-0.0000	$Log\left(k_{it-1}^{hc}\right)$	-0.0121^{*}	-0.0069	-0.0155^{**}
	0.0183	0.0177	0.0379		0.0062	0.0050	0.0075
$\triangle Log\left(FA_{it}\right)$	-0.0103	-0.0090	-0.0090	$Log\left(FA_{it-1}\right)$	-0.0053	-0.0052	-0.0113
	0.0068	0.0065	0.0172		0.0059	0.0039	0.0110
$\triangle Log\left(NR_{it}\right)$	-0.0279	-0.0240	0.0737	$Log\left(NR_{it-1}\right)$	-0.0046	-0.0119	-0.0080
	0.0206	0.0199	0.0615		0.0138	0.0097	0.0227
$Log\left(N_{it}/S_i\right)$	-0.0196	-0.0019	0.0055	$Log\left(N_{it-1}/S_i\right)$	-0.1077^{***}	-0.0077	-0.1267^{***}
	0.0120	0.0031	0.0179		0.0282	0.0099	0.0366
$\Delta Log\left(\frac{c_{it}}{km_{it}}\right)$	0.0384	0.0426	-0.0284	$Log\left(\frac{c_{it-1}}{km_{it-1}}\right)$	0.0105	0.0116	0.0114
	0.0439	0.0423	0.1727		0.0211	0.0114	0.0265
$\triangle Log\left(k_{it}\right)$	0.7260^{***}	0.7230^{***}	0.4504^{***}	$Log\left(B_{it-1}\right)$	-0.1965^{***}	-0.0818^{***}	-0.2562^{***}
	0.0581	0.0553	0.1375		0.0350	0.0210	0.0471
				$\triangle Log\left(k_{it}\right)$	0.7553^{***}	0.7603^{***}	0.4849^{***}
					0.0376	0.0364	0.0831
R^2	0.7511	0.7489	0.5768	R^2	0.7635	0.7517	0.7267
H_{FA} Test	5.7785 (0.9903)			H_{FA} Test	17.6393 (?????)		
H_E Test13.6050 (0.0927). Sargan Test10.4509 (0.1644)				H_E Test19.9706 (0.0181). Sargan Test7.1456 (0.6220)			

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

Table 8: Regression for the Production Function of equation (9)

Variables	2SLS
$\Delta Log\left(K_{it}^{r}\right)$	0.2438***
	(0.0588)
$\Delta Log\left(N_{it}\right)$	0.6497***
	(0.0565)
$\Delta Log\left(K_{it}^{pu}\right)$	0.0076
	(0.0419)
R^2	0.2742
H_E Test39.8280 (0.0000).	Sargan Test: 6.6275 (0.0848)
H_0: $\hat{\alpha}+\hat{\phi}=1$	3.4675 (0.0633)

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

Table 9: Regression for the growth rate of TFP

B_{it} defined as in (2)				B_{it} defined as in (4)			
Variables	FE	RE	2SLS	Variables	FE	RE	2SLS
DM_{it}	0.0137***	0.0139***	0.0197***	DM_{it}	0.0168***	0.0179***	0.0172***
	0.00388	0.0038	0.0056		0.0042	0.0041	0.0042
DM_{it-1}	-0.0092**	-0.0093**	-0.0107*	DM_{it-1}	-0.0062	-0.0075*	-0.0061
	0.0043	0.0041	0.0057		0.0047	0.0045	0.0047
DM_{it-2}	-0.0089**	-0.0090**	-0.0112**	DM_{it-2}	-0.0096**	-0.0098**	-0.0094**
	0.0041	0.0039	0.0055		0.0044	0.0043	0.0044
DM_{it-3}	0.0017	0.0023	0.0075	DM_{it-3}	0.0050	0.0057	0.0049
	0.0033	0.0032	0.0048		0.0036	0.0035	0.0036
Dm_{it}	-0.0024	-0.0019	-0.0027	Dm_{it}	-0.0009	-0.0008	-0.0007
	0.0032	0.0031	0.0047		0.0034	0.0033	0.0035
Dm_{it-1}	0.0006	0.0007	0.0028	Dm_{it-1}	0.0007	0.0010	0.0004
	0.0040	0.0039	0.0054		0.0043	0.0042	0.0044
Dm_{it-2}	-0.0018	-0.0017	-0.0036	Dm_{it-2}	-0.0019	-0.0017	-0.0017
	0.0041	0.0040	0.0055		0.0044	0.0043	0.0044
Dm_{it-3}	-0.0028	-0.0023	-0.0009	Dm_{it-3}	-0.0010	-0.0011	-0.0013
	0.0034	0.0033	0.0046		0.0038	0.0036	0.0038
$\triangle Log\left(SI_{it}\right)$	0.0130***	0.0136***	-0.0145	$Log\left(SI_{it-1}\right)$	-0.0011	0.0000	-0.0029
	0.0038	0.0037	0.0138		0.0025	0.0023	0.0031
$\triangle Log\left(k_{it}^{pu}\right)$	0.2877***	0.2841***	-0.0785	$Log\left(k_{it-1}^{pu}\right)$	0.0075	0.0260***	0.00756
	0.0369	0.0353	0.1199		0.0116	0.0095	0.0125
$\triangle Log\left(k_{it}^{hc}\right)$	0.0519***	0.0503***	-0.0091	$Log\left(k_{it-1}^{hc}\right)$	-0.0125*	-0.0087	-0.0146*
	0.0189	0.0183	0.0391		0.0073	0.0060	0.0080
$\triangle Log\left(FA_{it}\right)$	-0.0091	-0.0079	-0.0092	$Log\left(FA_{it-1}\right)$	-0.0038	-0.0058	-0.0085
	0.0070	0.0068	0.0183		0.0069	0.0050	0.0120
$\triangle Log\left(NR_{it}\right)$	-0.0253	-0.0241	0.0776	$Log\left(NR_{it-1}\right)$	-0.0213	-0.0231*	-0.0172
	0.0215	0.0209	0.0652		0.0160	0.0121	0.0238
$Log\left(\frac{N_{it}}{S_i}\right)$	-0.0291**	-0.0034	0.0070	$Log\left(\frac{N_{it-1}}{S_i}\right)$	-0.1085***	-0.0075	-0.1219***
	0.0124	0.0033	0.0181		0.0328	0.0131	0.0396
$\Delta Log\left(\frac{c_{it}}{km_{it}}\right)$	0.0454	0.0471	-0.0224	$Log\left(\frac{c_{it-1}}{km_{it-1}}\right)$	-0.0044	0.0082	0.0056
	0.0457	0.0443	0.1840		0.0245	0.0149	0.0286
				$Log\left(B_{it-1}\right)$	-0.2389***	-0.1189***	-0.2536***
					0.0404	0.0247	0.0516
R^2	0.5168	0.5100	0.1784	R^2	0.4276	0.4031	0.4314
H_{FA} Test	5.9172 (0.9202)			H_{FA} Test	15.4233 (0.4939)		
H_E Test22.4377 (0.0021). Sargan Test9.2177 (0.1617)				H_E Test10.1127 (0.2572). Sargan Test9.5693 (0.2966)			

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

Table 10: Regression for the growth rate of TFP not adusted for human capital: Baseline Model

	$\Delta Log\,(A_{it})$ from growth accounting			$\Delta Log\,(A_{it})$ from $\Delta Log\,(y_{it})$			$\Delta Log\,(A_{it})$ from $\Delta Log\,(Y_{it})$		
Variables	FE	RE	2SLS	FE	RE	2SLS	FE	RE	2SLS
DM_{it}	0.0122***	0.0124***	0.0144***	0.0131***	0.0132***	0.0154***	0.0124***	0.0126***	0.0149***
	0.0040	0.0038	0.0053	0.0037	0.0035	0.0047	0.0039	0.0038	0.0053
DM_{it-1}	-0.0093**	-0.0096**	-0.0101*	-0.0070*	-0.0074*	-0.0089*	-0.0091**	-0.0094**	-0.0100*
	0.0044	0.0042	0.0056	0.0040	0.0039	0.0051	0.0043	0.0042	0.0056
DM_{it-2}	-0.0080**	-0.0079**	-0.0084	-0.0077**	-0.0077**	-0.0080	-0.0080*	-0.0080**	-0.0084
	0.0042	0.0041	0.0055	0.0038	0.0037	0.0049	0.0041	0.0040	0.0055
DM_{it-3}	0.0016	0.0022	0.0066	0.0025	0.0030	0.0057	0.0017	0.0023	0.0065
	0.0034	0.0033	0.0047	0.0032	0.0030	0.0043	0.0034	0.0033	0.0047
Dm_{it}	-0.0023	-0.0018	-0.0026	-0.0026	-0.0022	-0.0027	-0.0024	-0.0018	-0.0028
	0.0033	0.0032	0.0046	0.0030	0.0029	0.0041	0.0032	0.0031	0.0046
Dm_{it-1}	-0.0000	0.0000	0.0002	0.0005	0.0007	0.0010	0.0001	0.0001	0.0008
	0.0041	0.0040	0.0054	0.0038	0.0037	0.0048	0.0041	0.0040	0.0054
Dm_{it-2}	-0.0006	-0.0005	-0.0002	-0.0016	-0.0015	-0.0009	-0.0010	-0.0008	-0.0006
	0.0042	0.0041	0.0054	0.0038	0.0037	0.0049	0.0041	0.0040	0.0054
Dm_{it-3}	-0.0029	-0.0021	-0.0008	-0.0028	-0.0022	-0.0020	-0.0031	-0.0023	-0.0014
	0.0035	0.0034	0.0046	0.0032	0.0031	0.0041	0.0035	0.0034	0.0045
$\triangle Log\,(SI_{it})$	0.0122***	0.0129***	-0.0079	0.0126***	0.0131***	-0.0107	0.0129***	0.0136***	-0.0115
	0.0039	0.0038	0.0136	0.0036	0.0035	0.0122	0.0039	0.0037	0.0136
$\triangle Log\,(k_{it}^{pu})$	0.2930***	0.2823***	-0.0283	0.0280	0.0251	-0.1163	0.2202***	0.2105***	-0.0987
	0.0384	0.0358	0.1122	0.0498	0.0468	0.0920	0.0380	0.0357	0.1119
$\triangle Log\left(k_{it}^{hc}\right)$	0.0590***	0.0569***	-0.0247	0.0363**	0.0317*	-0.0161	0.0517***	0.0501***	-0.0307
	0.0195	0.0188	0.0401	0.0181	0.0174	0.0372	0.0193	0.0186	0.0400
$\triangle Log\,(FA_{it})$	-0.0094	-0.0085	0.0066	-0.0104	-0.0092	-0.0002	-0.0095	-0.0086	0.0044
	0.0072	0.0070	0.0178	0.0066	0.0064	0.0158	0.0072	0.0069	0.0177
$\triangle Log\,(NR_{it})$	-0.0152	-0.0137	0.1007	-0.0223	-0.0178	0.0677	-0.0156	-0.0144	0.1004
	0.0221	0.0214	0.0642	0.0203	0.0196	0.0566	0.0219	0.0212	0.0640
$Log\left(\frac{L_{it}}{S_i}\right)$	-0.0253**	-0.0025	0.0171	-0.0191*	-0.0018	0.0034	-0.0292*	-0.0029	0.0099
	0.0124	0.0021	0.0182	0.0115	0.0026	0.0170	0.0123	0.0023	0.0181
$\Delta Log\left(\frac{c_{it}}{km_{it}}\right)$	0.0311	0.0289	0.0214	0.0308	0.0342	-0.0467	0.0358	0.0348	-0.0024
	0.0470	0.0453	0.1924	0.0432	0.0415	0.1728	0.0465	0.0449	0.1919
$\triangle Log\,(k_{it})$				0.6963***	0.6867***	0.5036***			
				0.0573	0.0545	0.1231			
R^2	0.4939	0.4873	0.2034	0.7415	0.7390	0.6122	0.4132	0.4036	0.0612
H_{FA} Test	4.9668 (0.9924)			5.9136 (0.9890)			6.1784 (0.9766)		
H_E/ Sargan Tests:	24.7513 (0.0008) / 10.4811 (0.1058)			13.3675 (0.0998) / 12.1597 (0.0954)			23.9051 (0.0012) / 11.2671 (0.0805)		

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

Table 11: Regression for the growth rate of TFP not adusted for human capital: Frontier Model

	From growth accounting			$\Delta Log(A_{it})$ from $\Delta Log(y_{it})$			$\Delta Log(A_{it})$ from $\Delta Log(Y_{it})$		
Variables	FE	RE	2SLS	FE	RE	2SLS	FE	RE	2SLS
DM_{it}	0.0134***	0.0145***	0.0139***	0.0126***	0.0134***	0.0135***	0.0132***	0.0142***	0.0136***
	0.0043	0.0041	0.0043	0.0036	0.0034	0.0038	0.0040	0.0039	0.0041
DM_{it-1}	-0.0066	-0.0078*	-0.0064	-0.0042	-0.0052	-0.0049	-0.0060	-0.0073*	-0.0057
	0.0047	0.0046	0.0048	0.0040	0.0038	0.0042	0.0045	0.0044	0.0045
DM_{it-2}	-0.0078*	-0.0080*	-0.0076*	-0.0073*	-0.0074**	-0.0074*	-0.0077*	-0.0079*	-0.0075*
	0.0045	0.0044	0.0045	0.0037	0.0036	0.0039	0.0042	0.0041	0.0042
DM_{it-3}	0.0044	0.0052	0.0044	0.0016	0.0023	0.0027	0.0035	0.0043	0.0035
	0.0037	0.0036	0.0037	0.0031	0.0030	0.0033	0.0035	0.0034	0.0035
Dm_{it}	-0.0003	-0.0002	-0.0002	-0.0026	-0.0027	-0.0012	-0.0010	-0.0009	-0.0009
	0.00347	0.0034	0.0035	0.0029	0.0028	0.0031	0.0033	0.0032	0.0033
Dm_{it-1}	-0.0007	-0.0004	-0.0009	0.0003	0.0007	-0.0004	-0.0002	0.0001	-0.0004
	0.0044	0.0043	0.0044	0.0037	0.0036	0.0039	0.0042	0.0040	0.0042
Dm_{it-2}	0.0007	0.0007	0.0010	-0.0005	-0.0004	0.0001	0.0003	0.0004	0.0007
	0.0045	0.0044	0.0045	0.0037	0.0036	0.0039	0.0042	0.0041	0.0042
Dm_{it-3}	-0.0005	-0.0008	-0.0007	-0.0029	-0.0028	-0.0022	-0.0012	-0.0015	-0.0013
	0.0038	0.0037	0.0039	0.0032	0.0031	0.0034	0.0036	0.0035	0.0037
$Log\,(SI_{it-1})$	-0.0022	-0.0011	-0.0030	-0.0006	0.0002	-0.0016	-0.0018	-0.0007	-0.0028
	0.0025	0.0023	0.0031	0.0021	0.0018	0.0027	0.0024	0.0021	0.0029
$Log\left(k^{pu}_{it-1}\right)$	0.0121	0.0261***	0.0123	0.0134	0.0270***	0.0144	0.0201*	0.0320***	0.0211*
	0.0117	0.0095	0.0127	0.0097	0.0077	0.0110	0.0110	0.0089	0.0120
$Log\left(k^{hc}_{it-1}\right)$	-0.0087	-0.0064	-0.0094	-0.0108*	-0.0063	-0.0117	-0.0094	-0.0077	-0.0095
	0.00739	0.0060	0.0082	0.0062	0.0048	0.0072	0.0070	0.0056	0.0078
$Log\,(FA_{it-1})$	-0.0092	-0.0083*	-0.0155	-0.0066	-0.0054	-0.0146	-0.0091	-0.0075*	-0.0155
	0.0070	0.00494	0.0122	0.0058	0.0037	0.0105	0.0066	0.0045	0.0115
$\triangle Log\,(NR_{it-1})$	-0.0255	-0.0249**	-0.0257	-0.0069	-0.0115	-0.0122	-0.0277*	-0.0258**	-0.0296
	0.0163	0.0121	0.0243	0.0137	0.0093	0.0219	0.0154	0.0112	0.0229
$Log\left(\frac{L_{it-1}}{S_i}\right)$	-0.0917***	-0.0016	-0.1020**	-0.0990***	-0.0065	-0.1149***	-0.0858***	-0.0022	-0.0939**
	0.0333	0.0134	0.0403	0.0277	0.0097	0.0353	0.0315	0.0122	0.0381
$Log\left(\frac{c_{it-1}}{km_{it-1}}\right)$	-0.0163	0.0012	-0.0087	0.0061	0.0101	0.0023	-0.0114	0.0039	-0.0074
	0.0250	0.0151	0.0295	0.0209	0.0111	0.0259	0.0237	0.0138	0.0279
$Log\,(B_{it-1})$	-0.2419***	-0.1248***	-0.2598***	-0.1886***	-0.0763***	-0.2480***	-0.2248***	-0.1141***	-0.2443***
	0.0415	0.0250	0.0526	0.0347	0.0204	0.0457	0.0393	0.0234	0.0498
$\Delta Log\,(k_{it})$				0.7171***	0.7208***	0.4998***			
				0.0380	0.0367	0.0709			
R^2	0.4131	0.3908	0.4179	0.7541	0.7424	0.7307	0.3770	0.3534	0.38208
H_{FA} Test	14.7022 (0.5466)			17.1297 (0.4456)			15.1941 (0.5105)		
H_E/ Sargan Tests	7.4367 (0.4903) / 11.2761 (0.1865)			21.6542 (0.0100) / 7.6902 (0.5656)			9.3848 (0.3109) / 11.4372 (0.2469)		

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