Distributive Politics and Public Infrastructure Accumulation: The Case of Spain*

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Abstract

We test the effects of different combinations of parties simultaneously holding office in the central and regional governments on the growth rate of regional public infrastructure. Using panel data for the regions of Spain over the 1988-2004 period, we find evidence to support Distributive Politics on the growth rate of public infrastructure under both right-wing and left-wing central governments holding a majority and a minority. Our results show that right-wing central governments reward regions governed by the right party, but do not punish regions governed by opposition parties. On the contrary, left-wing central governments do not reward regions governed by the left party, but punish regions governed by opposition parties and especially those governed by regional parties.

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1 Introduction

In this article, we are interested in the effects that combinations of parties holding office at the different layers of government could have on the accumulation of public infrastructure at the regional level. Therefore, we focus on the allocation of expenditures in infrastructure among the regions which can be explained in part by political factors. 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 (i.e. different parties governing at each level of government) is practically ensured in at least one region.

Literature dealing with the effect of political parties on the economy falls within the sphere of the Partisan Theory and Distributive Politics. The Partisan Theory holds that the preferences on economic outcomes are different depending on political parties, while the Distributive Politics analyze the influence of political preferences on the regional distribution of total expenditure. Therefore, our work can be framed in the literature on Distributive Politics. We hypothesize that the distribution of public infrastructure across

\footnote{See the seminal works of Hibbs (1977) and Alesina (1987) and the relevant contributions of Alesina and Sachs (1988) and Alesina and Roubini (1992). Moreover, a very good survey on the first fifteen years of research on the Partisan Theory can be found in Hibbs (1992).}
regions could be affected by the different combinations of parties in the two levels of government. It is well known that differences in time might arise in the relationships between the two levels of government involved due to party objectives, commitments, arrangements, disagreements and individual regional aspirations. Specifically with mixed governance, disagreements about certain projects are more likely to arise. In fact, major infrastructure projects could depend on the combinations of parties in the central and regional governments and it might take years of discussion before being implemented due to the different interests and points of view of the politicians holding office in each level of government. The central government could even favor regional governments led by the same party, punishes regions governed by other parties, or the two levels of government may simply agree or disagree about undertaking public infrastructure projects. We therefore test whether ideological combinations in the different levels of government could have an effect on regional public infrastructure accumulation.

In line with Castells and Solé-Ollé (2005), we specify an equation for the growth rate of regional public infrastructure per worker allowing for efficiency criteria, special infrastructure needs and political factors.

In this paper, we consider the Spanish case at two levels of government: the central level and the regional level. We focus on part of the democratic period (1988-2004) and all the autonomous communities of Spain\(^2\). We ba-

\(^2\)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
sically 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 the regional policy to reduce disparities between European regions. 3

Our evidence supports Distributive Politics under both right-wing and left-wing central governments holding a minority and a majority in Spain. Our results show that in the allocation of public infrastructure: i) right-wing central governments reward only regions governed by the right party. However, a null effect is found for regions governed by opposition parties. ii) Left-wing central governments do not favor regions governed by the left party, that is a null impact is found for these regions. However, left-wing central governments punish regions governed by opposition parties.

The article is organized as follows. A review of the literature on Distributive Politics is provided in section 2. The econometric model and estimation issues are then described in sections 3 and 4, respectively, while conclusions are drawn in section 5.

2 Literature Review on Distributive Politics

Distributive Politics can be broadly defined as the practice of targeting expenditure towards particular districts, states or regions based on political

3The 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.
considerations which suggest that elected officials strategically allocate public funds to curry secure votes and gain reelection.\footnote{Rich (1989) summarizes the earlier prominent theories in the literature of Distributive Politics.} Levitt and Poterba (1999) state that "there are two broad categories of distributive models: nonpartisan models that emphasize incentives of individual legislators, and partisan models that focus on the incentives of congressional political parties". Our article can be framed in the literature on Partisan Distributive Politics. Theoretical literature has two major 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 and Lindbeck and Weibull, 1987). On the other hand, central governments may channel more resources to swing regions to diminish the uncertainty of the electoral outcome (Dixit and Lodregan, 1995,1996). At the empirical level, there is vast evidence for the US case. Wilson (1986), Levitt and Snyder (1995) and Levitt and Poterba (1999) sketched a number of theoretical conjectures and found empirical evidence supporting the fact that parties play a significant role in determining the geographic distribution of federal expenditure. Levitt and Snyder (1997) developed and subsequently estimated a theoretical model, finding similar results. 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. However, he found no evidence that political factors influence the distribution of funds to states. Ansolabehere and Snyder (2006) study the effect of party control of the state government on the distribution of public expenditures in the US and found that the governing parties distribute the public funds in favor of areas that provided them with the strongest electoral support. Directly related to our objective, Crain and Oakley (1995), Cadot et al. (2006), Kemmerling and Stephan (2002) and Golden and Picci (2008) found that political factors influence the allocation of infrastructure investment across states or regions in the US, France, Germany and Italy, respectively. For the specific case of Spain, Castells and Solé-Ollé (2005) estimated an equation of infrastructure investment allocation across Spanish provinces accounting for political factors. Their results suggest that political factors explain the regional allocation of infrastructure. Kemmerling and Bodenstein (2006) showed that even at the European level there is a link between partisanship and the distribution of structural funds. Costa-I-Font et al. (2003) found evidence for Mexico, Leigh (2008) for Australia and Arulampalam et al. (2009) for India.
3 Econometric Model

3.1 Specification of the Evolution of the Stock of Regional Public Infrastructure

Most of the empirical evidence on Partisan Theory and Distributive Politics is based on aggregated macroeconomic variables, considering their growth rates, ratios on GDP or shares. This may be due to the fact that these studies have taken a short-term approach to explain business electoral cycles. Since public infrastructure is an input of the production function of the economy, and we want to analyze economic performance by public physical capital accumulation, our study is novel in that we consider variables measured per worker to shed light on the long-term economic implications of combinations of political parties leading the different layers of governments. Therefore, we propose a simple specification for the evolution of public infrastructure per worker as follows,

\[
\frac{k_{it}^{pu}}{k_{it-1}^{pu}} = e^{(D_{it}^{v} + \varepsilon_{it})} \left( \frac{k_{it}^{pu}}{k_{it-1}^{pu}} \right)^{\gamma}, \quad 0 \leq \gamma \leq 1, \quad (1)
\]

where \(k_{it}^{pu} = K_{it}^{pu} / L_{it}\) is a variable accounting for annual stock of regional public infrastructure per worker in region \(i\) during period \(t\). We consider "core infrastructure" in constant euros with base year 2000, \(K_{it}^{pu}\), in region \(i\) during period \(t\), which includes streets and highways, water systems, railways, airports, ports and other urban infrastructures provided by local governments from the BBVA Foundation and the Economic Research Institute of Valencia.
The number of employees per year or annual labor input in region $i$, $L_{it}$, is based on statistics of the Bancaja Foundation and the IVIE. $\tilde{p}_{it}$ is the optimal (desired) annual level of regional public infrastructure per worker and $\gamma$ is the adjustment coefficient towards its optimal level. $D_{it}$ is a vector that collects our political variables including dummy variables for the different combinations of parties ruling both levels of governments and for years $t$ in which regional electoral processes are held.

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 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

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5 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.

6 In our sample period, regional or nationalist parties which held office can be considered center-right parties. These include the Partido Nacionalista Vasco (PNV) in the Basque Country, Convergència i Unió (CiU) in Catalonia, Coalicion Canaria (CC) in the Canary Islands, Partido Aragonés (PAR) in Aragon, and Unión para el Progreso de Cantabria (UPCA) and Partido Regionalista de Cantabria (PRC) in Cantabria.
regional governments headed by different parties. In line with common politi-
cal 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 spec-
ify the vector that collects the combinations of parties as

\[ D_{it} = \left( MR_{rt}^{it}, MR_{lt}^{it}, MR_{nt}^{it}, mR_{rt}^{it}, mR_{lt}^{it}, mR_{nt}^{it}, \right) \]

When the central government holds a majority we have that \( MR_{rt}^{it} \)
(\( ML_{lt}^{it} \)) 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; \( MR_{lt}^{it} \) (\( ML_{rt}^{it} \)) 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
\( MR_{nt}^{it} \) (\( ML_{nt}^{it} \)) 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 govern-
ment holds a minority, \( mR_{rt}^{it} \), \( mR_{lt}^{it} \), \( mR_{nt}^{it} \), \( ML_{lt}^{it} \), \( ML_{rt}^{it} \), and \( ML_{nt}^{it} \) stand
for the same combinations as above.\(^7\) \(V_{it}\) is a dummy variable that takes the value of one in the years that regional elections are held.

\(\varepsilon_{it}\) is an \(iid\) random disturbance.

Notice in equation (1) that whenever \(\beta = 0\), no effect of the combination of parties on public infrastructure accumulation is implied. Therefore, in the extreme case of \(\gamma = 1\), the public infrastructure of a regional economy can only deviate from its optimal level due to a random disturbance and the expected value of public infrastructure would equal its optimal expected level, \(E(k_{it}^{pu}) = E(\hat{k}_{it}^{pu})\). Analogously, if \(\gamma = 0\), \(E(k_{it}^{pu}) = k_{it-1}^{pu}\), we expect no growth in public infrastructure. On the contrary, if \(\beta \neq 0\) and \(\gamma = 1\), the economy can deviate from the optimal level of public infrastructure due to the random disturbance and political factors and we would have that \(E(k_{it}^{pu}) = e^{D_{it\alpha}}E(\hat{k}_{it}^{pu})\). If \(\gamma = 0\), the expected public infrastructure level could grow or decrease due to the political factors, \(E(k_{it}^{pu}) = e^{D_{it\alpha}}k_{it-1}^{pu}\).

In order to estimate a model based on equation (1), we follow the same assumptions made by Castells and Solé-Ollé (2005). On the one hand, the central government has to decide whether or not to allocate infrastructure investment in region \(i\) in time \(t\) based on an expectation of the optimal level of public infrastructure per worker, \(E\left(\hat{k}_{it}^{pu}\right)\). On the other hand, since it is difficult for the government to instantaneously adapt the allocation of

\(^7\)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.
investment to a region after a change in its economic characteristics and because investment decisions are most likely based on the most recent data available for each region, we specify $E \left( \hat{k}_{it}^{pu} \right)$ as follows

$$E \left( \hat{k}_{it}^{pu} \right) = e^{(\phi_i + \zeta_t)} (y_{it-1})^{\varphi_1} \left( \frac{L_{it-1}}{S_i} \right)^{\varphi_2} \left( \frac{c_{it-1}}{km_{it-1}} \right)^{\varphi_3}, \quad (3)$$

where $\phi_i$ is a constant specific regional effect, $\zeta_t$ is a time effect, $y_{it-1}$ is the output per worker in region $i$ in the $t-1$ period (gross added value per worker in constant euros with base year 2000), $L_{it-1}/S_i$ is the number of workers relative to the surface in region $i$ in the $t-1$ period (agglomeration effect) and $c_{it-1}/km_{it-1}$ is the total number of cars per kilometers of roads in region $i$ in the $t-1$ period (congestion effect).\(^8\)

By substituting (3) in (1), considering (2) and taking natural logarithm and expectations, we obtain the expected regional public infrastructure growth rate

$$E \left[ \Delta \text{Log} \left( k_{it}^{pu} \right) \right] = \delta_i + \tau_t + \beta_{1R}MR_{it} + \beta_{2R}MRl_{it} + \beta_{3R}MRn_{it} \quad (4)$$

$$+ \beta_{4R}mRr_{it} + \beta_{5R}mRl_{it} + \beta_{6R}mRn_{it}$$

$$+ \beta_{1L}MLl_{it} + \beta_{2L}MLr_{it} + \beta_{3L}MLn_{it}$$

$$+ \beta_{4L}mLl_{it} + \beta_{5L}mLr_{it} + \beta_{6L}mLn_{it} + \beta_{7V}it$$

$$+ \theta_1 \text{Log} \left( \frac{y_{it-1}}{k_{it-1}^{pu}} \right) + \theta_2 \text{Log} \left( \frac{L_{it-1}}{S_i} \right) + \theta_3 \text{Log} \left( \frac{c_{it-1}}{km_{it-1}} \right)$$

\(^8\)Regional data on gross added value, surface, cars and roads are taken from the National Statistics Institute of Spain (INE).
where \( \delta_i = \gamma \varphi_i \) is the specific regional effect, \( \tau_t = \gamma \zeta_t \) is the time effect and \( \theta_1 = \gamma \varphi_1, \theta_2 = \gamma \varphi_2, \theta_3 = \gamma \varphi_3. \)

Notice that our specification given by (4) allows us to capture efficiency criteria, special infrastructure needs and political factors as in Castells and Solé-Ollé (2005). Efficiency criteria are captured by \( \log (y_{it-1}/k^u_{it-1}) \), while special infrastructure needs are collected by the agglomeration and congestion effects.

Our specification has two shortcomings. First, equation (4) does not allow to test for the effect of swing voters in public infrastructure allocation. Nevertheless, Castells and Solé-Ollé (2005) do test that and they do not find any significant evidence of swing regions. Second, as in Arulampalam et al. (2009) we test only one half of the completely story since that voting behavior is left unaddressed. Public infrastructure could be distributed across regions in order to win votes or elections in the future.

3.2 Hypotheses

According to the Distributive Politics, we hypothesize that if the central government is opportunistic and uses its discretion to favor regions on the basis of political considerations and assuming that political parties are risk-averse, they will tend to over-invest in their closest supporters in order to

\[^9\text{Notice that the parameter } \gamma \text{ is left unidentified. However, we are not especially interested in estimating it.}\]

\[^{10}\text{However, our specification differs from Castells and Solé-Ollé mainly because our endogenous variable is measured per worker as is some of the exogenous variables.}\]
maximize their expected vote. Thus, a party holding office in the central government would favor regions governed by its own party. Therefore, we should expect that $\beta_{1j} > \beta_{2j}, \beta_{3j}$ and $\beta_{4j} > \beta_{5j}, \beta_{6j}$ for $j = L, R$, even though all the coefficients turn out to be negative, since in that case we would have that $|\beta_{1j}| < |\beta_{2j}|, |\beta_{3j}|$ and $|\beta_{4j}| < |\beta_{5j}|, |\beta_{6j}|$.

We also perform a more powerful sequential test as described below.

For $j = L, R$

\[
\begin{align*}
H_{1j}^M: \beta_{1j} &= \beta_{2j} = \beta_{3j} = 0 & H_{1j}^m: \beta_{4j} &= \beta_{5j} = \beta_{6j} = 0 \\
\text{If Rejected} & & \text{If Rejected} \\
H_{2j}^M: \beta_{1j} &= \beta_{2j} = \beta_{3j} & H_{2j}^m: \beta_{4j} &= \beta_{5j} = \beta_{6j} \\
\text{If Rejected} & & \text{If Rejected} \\
\text{Distributive Politics} & & \text{Distributive Politics}
\end{align*}
\]

We first test the hypotheses $H_{1j}^M$ and $H_{1j}^m$. If we do not reject the hypotheses, we conclude that there is no evidence for the effect of combinations of parties on our endogenous variables, i.e. no evidence of Distributive Politics. Whenever we reject any of them, we find evidence supporting the influence of political factors on our endogenous variables but we cannot conclude that Distributive Politics are taking place. In order to show evidence on that, we test the second set of hypotheses, $H_{2j}^M$ and $H_{2j}^m$. The rejection of any of the hypotheses implies that a party holding office in the central government discriminates across regions, i.e. evidence of Distributive Politics.
4 Estimation Issues

As an important methodological aspect, Ansolabehere and Snyder (2006) poses that "studies of a single state, or even a single national government, may lack sufficient variation to allow the estimation of the effect of party control". Therefore, our panel data do contains enough variation to reach that aim.

Table 1 shows the panel data regression for $\Delta \log (k_{it}^{pu})$ using the least squares dummy variable approach (LSDV) to estimate the individual and time fixed effects which are not shown for reasons of space. All the regions of Spain (autonomous communities, NUTS2) are included:11 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.

The estimations are robust to heteroskedasticity using a covariance matrix à la White (1980). Although our controllers exhibit the expected signs, only the congestion effect has a significant positive effect at the 10% level of significance. According to these results, efficiency criteria and special needs do not play a relevant role in the allocation of public infrastructure in Spain.

11From 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 due to the lack of data for the entire period.
Although Castells and Solé-Ollé (2005) found that some efficiency criteria and special needs variables have a statistically significant effect, they conclude that these variables play a limited role.

Regarding the political variables, our expectations on the opportunistic behavior of the central government have been fulfilled, i.e. evidence to support Distributive Politics. We have obtained that $\beta_{1j} > \beta_{2j}, \beta_{3j}$ and $\beta_{4j} > \beta_{5j}, \beta_{6j}$ for $j = L, R$. Moreover, $\beta_{2j} > \beta_{3j}$ and $\beta_{5j} > \beta_{6j}$. Although, we must be cautious in interpreting the results, this finding might be consistent with the loyal voter models. It is striking that regions governed by regional parties are negatively affected regardless which party holds office in the central government and if it holds minority or majority. The effects are negative in all cases. This result could somehow suggest that in regions governed by a regional or nationalist party, voters could be classified as an opposition group according to Cox and McCubbins (1986), that is, a group which is consistently opposed to the central government or that finds more reasons for opposing than agreeing with the central government. Notice that during minority left-wing central governments, $|\beta_{4L}| < |\beta_{5L}| < |\beta_{6L}|$ coinciding with the implementation of policies to correct the severe public deficit in the mid-nineties. However, regions governed by opposition parties seem to have suffered higher cuts in public infrastructure spending per worker.

A glance at the individual statistical significance of combinations of parties reveals that under right-wing central governments with both majority
and minority, the only significant coefficient with a positive value is the coefficient for those regions also governed by right parties ($\beta_{1R}, \beta_{4R} > 0$ and $\beta_{2R} = \beta_{3R} = \beta_{5R} = \beta_{6R} = 0$). As we already pointed out, under minority left-wing central governments, we obtain that, all regions exhibit negative effects of the combination of parties on $\Delta \log (k_{it}^{pu})$. However, stronger statistical evidence is only found for regions governed by opposition parties since we reject the null hypothesis of significance at 5% ($\beta_{5L}, \beta_{6L} < 0$), while we cannot reject the null hypothesis for regions governed by left parties ($\beta_{4L} = 0$) at the same level of significance. It is rejected at 10% level of significance. Moreover, under majority left-wing central governments, we obtain that the only significant coefficient at the 5% level is the coefficient for regions governed by regional parties and with a negative sign ($\beta_{3L} < 0$).\(^{12}\)

The results suggest that although the left and right parties behave differently at allocating public infrastructure when hold office in the central government, they individually behave homogeneously regardless majority or minority. Right-wing central governments especially favor the accumulation of public infrastructure in the regions also governed by the right party, while a null impact is found in regions governed by opposition parties. And, during left-wing central government, regions governed by the left parties are not especially favored in the process of allocation of public infrastructure.

\(^{12}\)The same results were found in a pooled regression and considering the variables measured per efficient workers à la Hall and Jones (1999) instead of number of workers. Therefore, our results are robust to different methods of estimation and labor measures. Results are available upon request.
projects. However, regions governed by opposition parties, and especially those governed by regional parties, are generally negatively affected.

The right party’s political criteria in the allocation of public infrastructure when holds office in the central government seems to be in line with the partisan supporters hypothesis of the Distributive Politics, which conjectures that politicians will reward areas that contain a large percentage of their core supporters. They might do this in order to send clear signals to voters, induce higher turnout, or avoid excessive deadweight costs. Ansolabehere and Snyder (2006) show evidence on a positive effect of public spending on turnout and they argue that the best strategy for a party holding office is to devote disproportionately more resources where there are high concentrations of party’s supporters.

Regarding the result when the left party holds office in the central government, the finding that regions governed by regional parties are mainly punished in the allocation of public infrastructure, is more difficult to justify with the theoretical literature. It might be the case that those regions could be favored in other matters, for instance, advances in regional self-government. It is well known that in Spain, left-wing central governments are more prone to cede competences to autonomous communities than right-wing central governments.

It can be also notice in Table 1 that no evidence of regional electoral processes was found. Moreover, the model is able to explain about 81% of the
variability of the $\Delta \log (k_{it}^{pu})$ and the $DW$ statistic is close to 2, suggesting no autocorrelated residuals and that relevant economic variables have not been omitted in our specification.

We also test the null hypotheses of equal individual and time fixed effects ($W_i$ and $W_t$). Both are rejected. Therefore, different regional and time fixed effects affect $\Delta \log (k_{it}^{pu})$.

Let us now show the results of our sequential test in Table 2. Considering up to a 10% significance level, we have found that all the hypotheses are rejected. Therefore, stronger evidence of Distributive Politics is found under both right-wing and left-wing central governments holding a minority and a majority. At the 5% level of significance we have found evidence of Distributive Politics under right-wing central governments holding both a majority and minority and under majority left-wing central governments. At the 1% level of significance, evidence is only found under majority left-wing central governments.

5 Conclusions

In this article we test the effects of different combinations of parties ruling the central and regional governments on public infrastructure accumulation of the Spanish regions. Our econometric specification allow to cast evidence on Distributive Politics.

We specify an equation for the growth rate of regional public infrastruc-
ture per worker that allows us to account for efficiency criteria, special infrastructure needs and political factors.

Using panel data regression for the regions of Spain during the 1988-2004 period, we find evidence to support Distributive Politics under both right-wing and left-wing central governments regardless of whether or not they hold a majority or a minority in the central parliament. Our results show that in the allocation of public infrastructure: i) right-wing central government only reward regions governed by the right party. However, a null effect is found for regions governed by opposition parties. ii) Left-wing central government does not favor regions governed by the left party, that is a null impact is found for those regions. However, the evidence indicates that left-wing central government punishes regions governed by opposition parties, and especially those governed by regional parties.
References


Table 1: Panel Data Regression for the growth rate of Public Infrastructure

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M R r$</td>
<td>0.0210</td>
<td>0.0076</td>
</tr>
<tr>
<td>$M R l$</td>
<td>0.0125</td>
<td>0.0077</td>
</tr>
<tr>
<td>$M R n$</td>
<td>-0.0084</td>
<td>0.0122</td>
</tr>
<tr>
<td>$m R r$</td>
<td>0.0266</td>
<td>0.0085</td>
</tr>
<tr>
<td>$m R l$</td>
<td>0.0079</td>
<td>0.0094</td>
</tr>
<tr>
<td>$m R n$</td>
<td>-0.0092</td>
<td>0.0153</td>
</tr>
<tr>
<td>$M L l$</td>
<td>0.0059</td>
<td>0.0182</td>
</tr>
<tr>
<td>$M L r$</td>
<td>0.0010</td>
<td>0.0207</td>
</tr>
<tr>
<td>$M L n$</td>
<td>-0.0387***</td>
<td>0.0187</td>
</tr>
<tr>
<td>$m L l$</td>
<td>-0.0305*</td>
<td>0.0182</td>
</tr>
<tr>
<td>$m L r$</td>
<td>-0.0372**</td>
<td>0.0187</td>
</tr>
<tr>
<td>$m L n$</td>
<td>-0.0548***</td>
<td>0.0191</td>
</tr>
<tr>
<td>$V_{it}$</td>
<td>0.0015</td>
<td>0.0040</td>
</tr>
<tr>
<td>$\log \left( \frac{L_{it-1}}{S_t} \right)$</td>
<td>0.0160</td>
<td>0.0331</td>
</tr>
<tr>
<td>$\log \left( \frac{c_{it-1}}{k_{it-1}} \right)$</td>
<td>0.1214*</td>
<td>0.0728</td>
</tr>
<tr>
<td>$\Delta \log \left( \frac{y_{it-1}}{k_{it-1}^{pu}} \right)$</td>
<td>0.0337</td>
<td>0.0269</td>
</tr>
</tbody>
</table>

$R^2$     0.8076
$DW$     2.2138
$W_i$     80.6234 0.0000
$W_t$     291.0058 0.0000

* ***, **, * – Significant at 1%, 5% and 10% levels, respectively.
Table 2: Sequential Hypothesis Testing

<table>
<thead>
<tr>
<th></th>
<th>For $j = R, L$</th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_1^M: \beta_{1j} = \beta_{2j} = \beta_{3j} = 0$</td>
<td>$\downarrow$</td>
<td>$H_1^{im}: \beta_{4j} = \beta_{5j} = \beta_{6j} = 0$</td>
<td>$\downarrow$</td>
</tr>
<tr>
<td>Right</td>
<td>11.6557 (0.0087)</td>
<td>Left</td>
<td>17.0807 (0.0005)</td>
</tr>
<tr>
<td></td>
<td>11.6035 (0.0089)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rejection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$H_2^M: \beta_{1j} = \beta_{2j} = \beta_{3j}$</td>
<td>$\downarrow$</td>
<td>$H_2^{im}: \beta_{4j} = \beta_{5j} = \beta_{6j}$</td>
<td>$\downarrow$</td>
</tr>
<tr>
<td>Right</td>
<td>6.8106 (0.0332)</td>
<td>Left</td>
<td>7.1283 (0.0283)</td>
</tr>
<tr>
<td></td>
<td>7.1283 (0.0283)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>17.2744 (0.0002)</td>
<td></td>
<td>5.4309 (0.0662)</td>
</tr>
</tbody>
</table>