Allocation of European structural funds and strategic interactions: is there a yardstick competition between regions in the public aid for development?

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Abstract

This paper analyzes the relationships between the degree of decentralization of public policy and the emergence of horizontal strategic interactions. We analyze the structural funds allocation process in determining how the structure of governance of cohesion policy affects the development of strategic interactions between regional governments. We develop a political agency model in which we capture the effect of the governance structure of public policy on the decision of voters to acquire information on the activities of local governments. We show that the appearance of spatial interactions resulting from a mechanism of "yardstick competition" is increasing with the degree of policy decentralization. From an empirical analysis of the 2000-06 period, we confirm the proposed model by showing that spatial interactions are more intense when the policy governance is decentralized. This work highlights a new source of spatial interaction in the allocation of grants from institutional determinants in addition to socioeconomic factors studied so far.

Keywords: Intergovernmental grant allocation, European Union, Political agency, Yardstick competition, Information acquisition, Spatial econometrics.

1. Introduction

. Two major trends in the evolution of the governance systems of European States can be highlighted. First, the Member States seek to improve the efficiency of their public sector by placing the decision-making as

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close as possible to citizens and better take into account the diversity of local situations. This trend of decentralization is at the same time accompanied by the creation of supranational organisations aiming at the economic and political integration of a set of States (the European Community is the most advanced example of such an organisation). The creation of these sets involves the centralisation of certain functions. The organisation of the European regional policy has not been spared by this trend, so that we can distinguish at least three levels of legitimate decisions (EU, Member States and regional policy makers).

. Ever since the decentralisation implies a decision partitioned between several governments, it can lead to the emergence of strategic interactions between governments. The recent contributions of political economy in this topic try to show that these interactions are caused by the implementation of "yardstick competition" for local governments by voters (Besley and Case, 1995). By comparing the activity of their local decision makers to the activity of other governements, voters can more accurately assess the activity of their local decision makers and local governments and penalize inefficient ones ("yardstick competition" Salmon (1987)). Therefore, the mechanism of "yardstick competition" encourages the local decision-makers elected to consider the choices of other decision makers.

. The aim of this paper is to determine the reasons why strategic interactions occur and interfere with the allocation of EU structural funds. We consider a model of political agency in which local decision-makers engage in a lobbying effort to capture regional development subsidies. The control of this activity is done by the voters. The vote here is a way to guide the activities of the local politicians (Barro, 1986). We endogeneise the information structure by introducing a step in which the voter can choose to acquire the information needed to use the mechanism of "yardstick competition". This step allows us to analyze how the governance of this policy may affect the development of strategic interactions. When the degree of decentralization is high, the contribution of local government to the utility of the voter is also high. The voter is more easily interested in acquiring the information to more precisely control the effort of his local government.

. Conversely, the incentive to acquire information is limited when the level of decentralization is low, because the potential gain from this acquisition is lower. The decision to acquire information (and use the mechanism of yardstick competition) is positively affected by an increase of the decentralization level. Therefore, if the spatial interactions in the allocation of funds are caused by an yardstick competition mechanism, the intensity of these interactions should be higher when local governments are directly responsible for the management of these funds (high decentralization level).

. In a second step, we test the last proposition on the allocation of Structural Funds for the programming period 2000-06. We exploit the heterogeneity between Member States in their choice in the management structure of european funds. Using a spatially autoregressive model with two regimes (Allers and Elhorst, 2005), we show that spatial interactions are more intense when local officials have managed the implementation of the policy. The level of aid received by other regions affects positively the level of funds received by an area where implementation is decentralized, while those interactions are not significant in the case of centralized management (or devolved). These results remain valid for different weights of interactions, but also when we control for similar characteristics between neighbouring regions.

. Section 2 presents the institutional process of funding allocation and review recent papers on politico-economic determinants of the allocation of european funds. Section 3 describes theoretically how yardstick competition can occur in the context of regional fund alllocation. Finally, section 4 provides an empirical test of this mechanism and section 5 concludes.

2. Institutional background of european structural fund allocation

. The main objective of the European regional policy is to ensure the economic and social cohesion within the Community. The European regulations emphasize the redistributive policy (Art. 158 TEC, Art. TCUE 174). Since 2004, we can however notice a certain evolution of motivations more efficiently to be able to fund the investments necessary to the success of the Lisbon and Gothenburg strategies.

. This policy has been radically reformed by the Single European Act (1986) to increase the effectiveness of the three Structural Funds and to provide them with greater financial resources. The allocation of funds is determined on the basis of a multi-year program (4-7 years) to ensure continuity of community intervention. There is a regulatory framework specific enough about the definition of projects eligible for subsidies (targeted subsidies, Boadway and Shah (2009)) and even the geographical areas concerned. However, the amount of funds paid to each Member State and region remains partly discretionary. Indeed, it is not possible to predict correctly the amounts received by a region based on the criteria put forward by the European Commission. Moreover, the evolution of these allocations does not seem to follow a redistributive logics (Dotti, 2010). This is all the more telling when comparing the allocation mechanism of funds with that of intergovernmental established subsidies designed by the 'historically' federal States (Germany, Switzerland, Sweden ...). For example, the Swedish tax system has a specific redistribution rule which determines the transfers received by a municipality. This rule involves the difference from the fiscal potential of a region with the average Swedish level (Edmark and Ågren, 2008). The amount of subsidy paid by the central government is determined solely by this difference.

. The remainder of this section offers some insights on the lack of socio-economic and politico-economic factors to adequately explain the allocation of structural funds. Specifically, the result of the allocation process reveals a spatial interdependence which is not consistent with any explanations provided by previous analysis.

2.1. The socio-economic determinants of the allocation of structural funds

. The regulatory framework for cohesion policy defines strict economic criteria for eligibility under Objective 1. Indeed, the regions are eligible for Objective 1 funds if their level of wealth per capita is less than 75% of the EU average.

. However, when we depict the allocation of structural funds (and not mere eligibility for Objective 1 funds) depending on two main socio-economic determinants (GDP per capita and unemployment rate), we can observe that regions with similar socio-like economic benefit do not necessarily have the same amount of Community subsidies. We observe indeed a negative relationship between the GDP level and the regional amount of funds received (FIG. 1). However, when we split our sample program between Objective 1 and other regions, this relationship does not seem to be obvious to the subsample of Objective 1 regions (the two left quadrants, Fig. 1) . The level of regional wealth does not appear as a precise criterion for the allocation of structural funds within Objective 1 program. Indeed, there are wide disparities in the allocation of funds for similar levels of wealth (*e.g.* ITF5 and ITF3 or ES43 and PT18). This leads us to underline that once the eligibility criterion is adopted, the allocation of funds among the regions of Objective 1 is determined from other considerations than the level of wealth per capita. Unlike the Swedish system, the level of wealth is only a threshold, and does not guarantee equal "treatment" for regions of the same levels of wealth. The allocation of funds among regions that are not eligible under Objective 1, however, seem more sensitive to the level of wealth. We can note the "under" allocation of some british (UKJ and UKH) and Belgium (BE23 and BE25) regions.

. We can observe a positive relationship between the subsidies received and the unemployment rates of regions, regardless of the program in which they participate (FIG. 2). However, regions are widely dispersed around the trend, so that unemployment rates for similar amounts of money received varies greatly (*e.g.*

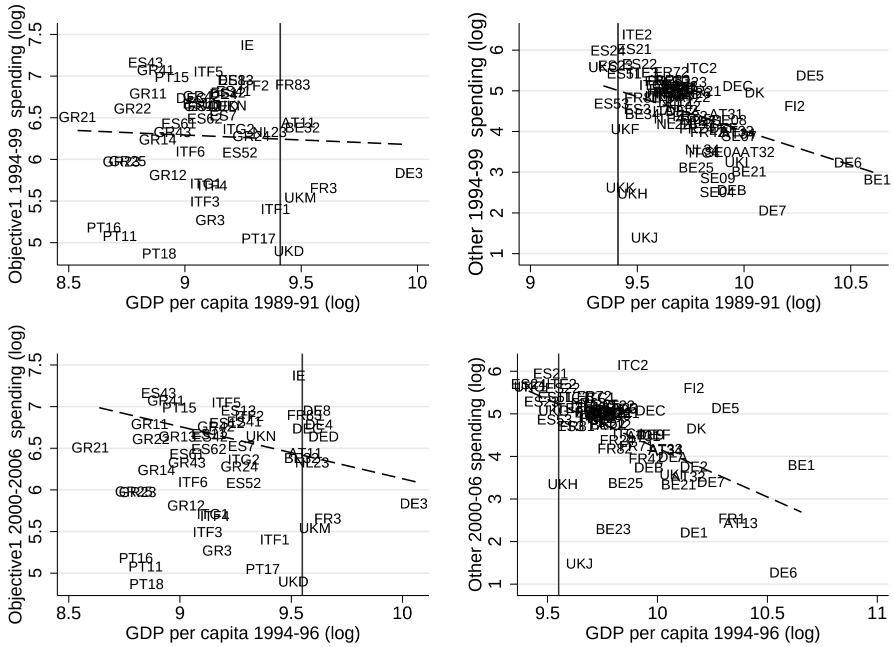

Figure 1: Correlation between structural funds and regional income

UKK and PT15; ITC2 and AT13). These intuitions are confirmed by the results of a regression on all of these factors (see table 1, p. 24). Note that the explanatory power of these factors is limited to 50% of the variation in the amount of funds.

2.2. *What is the influence of the negotiation process? Politico-economic determinants of the allocation of funds*

. The section 2.1 depicts the following findings: the traditional criteria are insufficient to adequately describe the process of allocating European funds. According to the "Public Choice" theory, the procedures for the preparation and implementation of such a public policy could explain the distortion of the allocation relative to what would have been produced by criteria "socio-economic".

. Kemmerling and Bodenstein (2006) were the first ones to show that although poorer areas receive more regional funds, "being poor" is not a "sufficient predictor" to explain the amount of funds received by a region. While reviewing the allocation of structural funds in several Member States, they show that the left-wing regional are more effective to put pressure on their central governments and the Commission and that

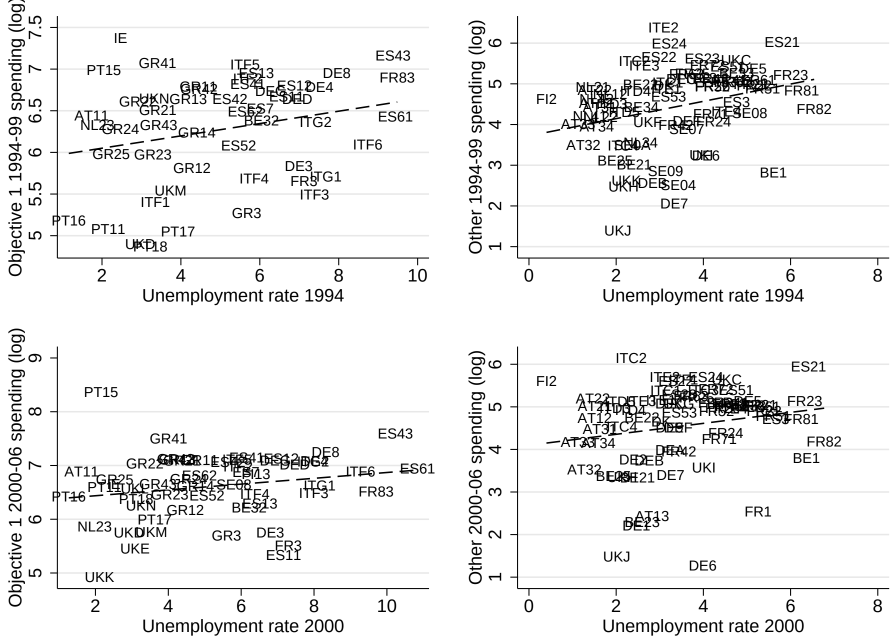

Figure 2: Correlation between structural funds and unemployment rate

they obtain more subsidies than those of regional right-wing parties. This finding is supported by Bodenstein and Kemmerling (2008) and Bouvet and Dall'erba (2010), who also find that areas where margins are low electoral advantage to receive EU funds. The work of Carrubba (1997) to establish a population relatively "Euro-skeptic" in a region increases the amount of structural funds that the region receives. The reason given by the author is that EU funds are used to increase support of public opinion in favor of the EU, and prevent the feeling of euro-skepticism hinders the pursuit of European integration. All these studies highlight the influence of politico-economic determinants on the allocation of funds.

. Bodenstein and Kemmerling (2008) tried to analyze the impact of patronage on the regional distribution of structural funds. Their empirical analysis shows that the 2000-06 allocation is affected by the intensity of electoral competition in national elections for the regions benefiting from Objective 2, while the intensity seems to be a significant factor in the allocation of Objective 1 funds.

. Bouvet and Dall'erba (2010) tested a set of politico-economic factors with a model on censored data (Tobit). The authors differentiate the allocation of funds received for Objective 1 of the Objective 2 and 3.

While other articles use national political data (Carrubba, 1997) or only regional ones (Kemmerling and Bodenstein, 2006), Bouvet and Dall'erba (2010) also characterized the influence of politico-economic factors at the national level, from specific at the regional level. Overall, their results suggest that the allocation of funds is influenced by political considerations, but that the influence of national and regional characteristics varies depending on whether the region belongs to the Objective 1 set or not.

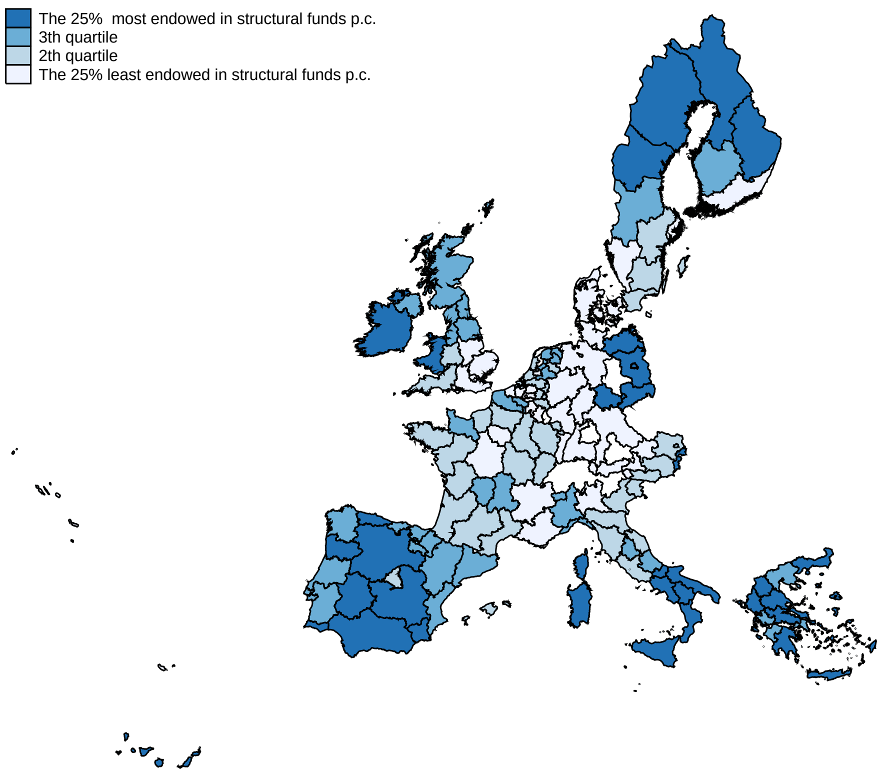

Figure 3: Regional allocation of structural funds (per capita, 2000-06)

2.3. Spatial interdependence in structural fund allocation: bridging a gap?

. Although these studies have greatly advanced our understanding of the process for allocating Structural Funds, none considers the presence of spatial interdependence in this allocation. Indeed, by mapping the regional allocation of funds, we can observe a clear interdependence between the amounts received by a region and those obtained from its neighbourhood (FIG. 3). This observation implies two things. On the one hand, the allocation process may be not the cause of the observed spatial interdependence, despite the presence of spatial interdependencies that are not taken into account by previous studies, which questions the validity of results. On the other hand, the process of allocating funds may be affected by the phenomenon of strategic interaction between regions, and this highlights a new scheme explaining the allocation process that explicitly integrates the spatial distribution. Of course, such an allocation is not necessary the consequence of the allocation process. It may be a simple reflection of the core-periphery pattern of regional wealth levels.

. None of these works consider the presence of spatial interaction in its analysis of the process of allocating European funds. However, residual variation of the estimate of the regional allocation of structural funds by the socio-economic and politico-economic set up untill now reveals a spatial autocorrelation in the allocation of funds (Table 1) which does not depend on economic factors (unemployment rate, GDP per capita), or explanations related to the strategic behavior of central governments (European Union Member States). These initial observations lead us to assume that a mechanism of interaction in the spatial distribution of structural funds affects their allocation process. In the remainder of this paper, we seek to test whether this is actually institutional. We will show how this interaction comes from a mechanism of yardstick competition in their areas of application development assistance. We'll use the fact that the intensity of this phenomenon is higher when the policy is decentralized.

3. Is there a mechanism of yardstick competition between European regions in their request for development grants?

3.1. Model description

. We present here how the intensity of the "yardstick competition" within a scheme of agency policy may vary depending on the degree of decentralization policy. For this, we rely on a principal-agent model in which the voters (principal) want to regulate the effort of requesting assistance from their elected representatives (agent).

. The utility level of the voter is positively related to the level local government effort. Instead, the effort is a disutility to be elected. The utility of the voter is affected by a random shock, so that the voter observes the result of the effort of local government is random (the voter can not discern the effect of government action on the result of the shock).

. This result is an imperfect signal of the lobbying activity performed by the local government. We highlight that the acquisition of a more specific example of the shock that occurred in neighbouring regions, allows the voter to determine a more restrictive rule for re-election, urging the Government to greater effort and thus increase the voter's expected utility. We show that the decision to acquire this signal increases with the degree of policy decentralization, at least for an environment sufficiently stable for incentives linked to the vote to be effective, but in which the variance of the shock is large enough for the marginal benefit of acquiring information to be positive.

Objective function of the voter

. The utility for the voter that the government gets subsidies is written as follows:

$$y(l_i, \varepsilon_i) = \lambda l_i + \varepsilon_i \tag{1}$$

. This utility is directly related to the level of effort for applying for subsidies from local government (l_i). The effect of the effort of local government on the utility of the voter is weighted by the degree of policy decentralization (λ). In our case, the benefit derived by the voter is confused with the amount of funds allocated to their region of residence.

. Finally ε_i is a random shock (economic, determinants not controlled by local government). We will consider that the design of the shock is perfectly correlated between the regions (Besley and Case, 1995). The parameter λ is the degree of decentralization of the cohesion policy. As its value depends on a third institution (Member State), we consider its behavior as exogenous, and not indexed. This setting means that the impact of the effort of local government is increasing with the degree of decentralization. Somehow, we consider the impact of the actions of local governments on the welfare of the voters even more important that skills are decentralized. The voter knows what degree of decentralization and takes into account when determining the direct rule re-election.

Objective function of the local government

. The local decision-maker makes a profit (R) reelection (prestige, ego *etc*...). His (expected) welfare function depends on his re-election as follows:

$$V_i = Rp(l_i) - l_i \tag{2}$$

where $p(l_i)$ is the probability of re-election in the level of effort of the local government in its business application support (l_i). Similarly to most principal-agent models, we consider l_i as a disutility for local decision-maker (opportunity cost, for example).

Reelection rule

. The voter of region i sets a minimum threshold of well-being at the end of period over which the local government is re-elected ($\underline{y_i}$). The control variable on which the re-election rule applies an incentive remains the government's effort: it is quite equivalent to reason with a minimum level of effort ($\underline{l_i}$). The level of government effort is not known to the voter. However, it can be inferred ($\hat{l}_i$) according to the information available to the voter. Generally, a local government shall be re-elected if and only if:

$$\lambda \hat{l}_i + \varepsilon_i \geq \lambda \underline{l_i}$$

The voter considers the degree of decentralization of political by weighting with λ the limits set, so does not ask for the balance of benefit to the local government effort when the degree of decentralization is low, all things being equal. Otherwise, it would be forced to make an effort greater than his marginal contribution (definition of λ) in the utility of voters is low.

Timing of the game

. The different steps of the game are as follows:

0. Choice to acquire information on the impact of the neighbouring region (I)
1. Commitment on the reelection rule (threshold, $\underline{l_i}$)
2. Choice of effort by local government (l_i)
3. Realizations of random shocks (ε_i ε_{-i})
4. Obervations ex post of outcomes (y_i y_{-i})
5. Reelection or not of the government of the region i.

Information structure

. We are in a situation where the information structure depends directly on the voter's choice whether to acquire a signal on the realisation of the shock in the neighbouring region. This information provides to the voter, when the election period occurs (stage 5 of the game), a more accurate estimate of the effort supplied by his own government. From the relationship of agency policy previously presented, we can define the condition under which a voter of region i decides to acquire information on the realisation of the shock in the neighbouring region.

. We represent the result related to the decision of the voter by a dichotomous variable I that takes the value 1 when the voter acquires the signal and 0 otherwise. To decide if it acquires information (y_i^1), the voter will compare the expected utility he will get information with the cost of acquiring information (C_I) and the value obtained without information on the random shock in the neighborhood (y_i^0). We summarize this decision with the following condition ($I^\star \geq 0$):

$$I = 1\left[I^\star \geq 0\right]$$

3.2. Equilibrium without yardstick competition (y_i^0)

. We will first consider the game in the absence of information acquisition, *i.e.* in cases where the voter rule implements a re-election without taking into account the "Informational externalities" that could bring the acquisition of a signal about the shock that exists in the neighbouring region. This choice implies the absence of interaction resulting from "yardstick competition" between regions. We analyse sequentially the behaviour of the local government, conditional on the rule of election fixed by the voter. Then, we analyse how the voter determines the re-election threshold that maximises the effort of the local government (better response to the behaviour of the local government). We focus our analysis on the impact parameter λ and σ when characterising the equilibrium.

. In the absence of yardstick, the best estimate available of the voter is the "amount of funds received" (y_i):

$$\hat{l}_i = E\left(l_i | y_i\right) = y_i$$

In this case, the government will be reelected if $E\left(l_i | y_i\right) \geq \lambda \underline{l_i}$ where $\underline{l_i}$ is the level minimum effort from which the government is reelected.

Behavior of the local government

. The local government maximizes its objective function (V_i) by determining its level of effort, before observing the realization of the shock, and taking the voter behavior as given. This section therefore analyzes its behavior for a given threshold $\underline{l_i}$.

. The local government is re-elected if:

$$\begin{aligned} y_i \geq \lambda \underline{l_i} \quad \Longleftrightarrow \quad & \lambda l_i + \varepsilon_i \geq \lambda \underline{l_i} \\ & \varepsilon_i \geq \lambda\left(\underline{l_i} - l_i\right) \end{aligned}$$

Noting Φ be the distribution function of standard normal distribution and variance σ^2, the probability of re-election of local government according to the applied load is given by[1]:

$$p(l_i) = 1 - \Phi\left(\frac{\lambda\left(\underline{l_i} - l_i\right)}{\sigma}\right)$$

The local government program is written as follows:

$$\max_{l_i}\left[R\left(1 - \Phi\left(\frac{\lambda\left(\underline{l_i} - l_i\right)}{\sigma}\right)\right) - l_i\right]$$

Lemma 1. *Let* $A = 2\sigma^2 ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})$, $\overline{\sigma} = \frac{\lambda R}{\sqrt{2\pi}}$ *and we define the incentive condition* $IC(A,\sigma)$ *by:*

$$-\Phi\left(\frac{-\sqrt{A}}{\sigma}\right)R - \frac{\sqrt{A}}{\lambda} \geq \underline{l_i} - \Phi\left(\frac{\lambda \underline{l_i}}{\sigma}\right)R$$

The level of effort produced by the local government is:

- $\forall\sigma \geq \overline{\sigma}\ l_i^\star = 0$,
- $\forall\sigma \leq \overline{\sigma}\ l_i^\star = \underline{l_i} + \frac{1}{\lambda}\sqrt{A}$ *when the* $IC(A,\sigma)$ *is binded , otherwise* $l_i^\star = 0$.

Proof. *cf.* appendix A (p. 32) □

. When the variance is very large (over $\overline{\sigma}$), the local government knows that its effort was very unlikely to have a significant impact on the welfare of voters. Ultimately, this welfare is determined by the realization of the shock. Therefore, the local government considers preferable to let the chance to act rather than an effort that will not be "much-valued" because of its low impact on the utility of voters.

. For a lower level of variance, the local government chooses between a positive effort and leaves it to chance. His choice is subject to the constraint of re-election ($\underline{l_i}$), whose level is determined by the elector. It is now important to note that the local government does not provide an equivalent effort on the threshold of re-election, but provides a slightly higher effort in order to cover the realization of a shock especially important ($\frac{1}{\lambda}\sqrt{A}$). We define from now on this term as the effect of local government self-protection.

[1] the probability of re-election can be written as $Pr(y \geq \underline{y}) = 1 - Pr(\varepsilon_i \geq \lambda\left(\underline{l_i} - l_i\right))$, ε_i follows a standard normal law with a variance σ^2.

Behavior of the voters

. Now that we know the behavior of a local government conditionaly on the re-election rule, we can determine the re-election rule that maximizes the aid received by the area (the voter). Since this function (y_i) is increasing with effort (l_i), the rule of re-election is therefore determined so that the local government is required to produce a maximal effort ($\underline{l_i}^\star = \arg\max\ y(l_i^\star)$). This level of effort is one that leaves the local government indifferent between producing a positive effort and let the chance (to which effort is zero). The optimal re-election rule is such that:

Proposition 1. *The optimal re-election rule is such that:*
$\forall\sigma \geq \overline{\sigma}$ *re-election rule does not affect the behavior of local government. It will produce no effort.*
$\forall\sigma \leq \overline{\sigma}$ *there is only one positive value* ($\underline{l_i}^\star$) *that binds the incentive constraint.*

Proof. cf. appendix B (p. 33) □

When the variance is greater than $\overline{\sigma}$, the re-election rule has no incentive effect on the effort produced by the local government, whatever the threshold set for re-election. In the case where the environment is more stable, then there exists a threshold value that saturates the incentive constraint and provides a second best for the voter. It may be noted that this equilibrium value ($\underline{l_i}^\star$) is greater than the insurance effect of local government ($\frac{1}{\lambda}\sqrt{A}$).

Comparative statics

. We will now evaluate the sensitivity of the results to changes in the environment (the dispersion of the shock and the degree of decentralisation).

Proposition 2. *The variation of the dispersion of the random shock (σ) has a negative effect on the level of the rule of re-election, and the level of force produced by the local government.*

Proof. cf. appendix C (p. 33) □

. When the variance of the shock is high (but less than $\overline{\sigma}$), the voter has difficulties to infers the effort of local government from the utility observed at the end. If the rule of re-election is too strong (high threshold), the local government receives no incentive to make any effort, since it is unlikely that the voter can correctly distinguish the effect of this effort from the hazard effect. To avoid this, the voter's interest is to set a re-election rule relatively low, to encourage the local government to provide a positive effort. The re-election rule is thus decreasing with the variance of the shock (proposition 2).

. The effect of the variation of σ on the effort of local government is more complex. Indeed, this effort is determined by the sum of the effects of the threshold for re-election and the effect of insurance, which also depends on σ. If the threshold for re-election increases with the variance of the shock, the insurance effect is first increasing and then decreasing with σ. If the dispersion of the shock is low, then the insurance effect increases with σ: the local government will find better to hedge against adverse shocks. From a certain level of variance, the cost of insurance becomes too large relative to the earnings so that the insurance effect then decreases with σ. For $\sigma \leq \overline{\sigma}$ this second effect is always dominated by the effect of σ on the threshold of re-election. Therefore, the effort of local government decreases with the variance.

Proposition 3. *The variation in the degree of decentralization (λ) has a positive effect on the rule of re-election and on the force produced by the local government for $R > 1$.*

Proof. cf. appendix D (p. 35) □

Corollary 1. *The variation in the degree of decentralization (λ) has a positive effect on the utility of the voter (y_i). The variation of the dispersion of the random shock has a negative effect on the utility of the voter.*

Proof. cf. appendix D (p. 35) □

. For a re-election rent greater than unity, the threshold for re-election increases with the degree of decentralisation. As soon as the gain of the local government related to his re-election is sufficiently large ($R > 1$), then the voter is better to establish a re-election rule even more restrictive when the degree of decentralisation is increasing. The more important the weight of the action of local government is in the utility of the voter, the more the later is interested to set a high threshold.

. The effect on the effort of local government is more ambiguous. In this case, we can prove (for all values of $\sigma \leq \overline{\sigma}$) that the effect of the degree of decentralization through the threshold of re-election continues to dominate the resulting effect of Insurance ($\frac{1}{\lambda}\sqrt{A}$). When the dispersion of the impact is relatively low, the effort of the local government is growing with the degree of decentralization (the effect through the threshold of re-election dominates). For a fairly stable environment, the local government is interested in increasing his effort because the gain of a re-election is higher than the cost of insurance.

3.3. *Equilibrium under yardstick competition ($E_{\chi_i}\left[y_i^C\right] = y_i^1$)*

. In this section, we analyze the equilibirum of the game between the local government and the voter when the voter decides to acquire some information (a signal) on the shock realization in the neighbouring region.

The signal allows the voter to know with greater precision the realisation of the shock occurred in his own region, and thus the effort of his own government. The signal received by the voter is:

$$\chi_i = \varepsilon_{-i} + \mu_i$$

where ε_{-i} a standard normal distribution with a variance σ^2, μ_i is a white Gaussian noise ($\mu_i \sim \mathcal{N}(0,1)$) The joint distribution $(\varepsilon_{-i}, \chi_i)$ is determined by the distribution parameters of the two random variables and their correlation (ρ): $(\varepsilon_{-i}, \chi_i) \sim \mathcal{N}(0, 0, \sigma^2, \sigma^2, \rho)$ And distribution of ε_{-i} knowing χ_i is written: $\varepsilon_{-i}|\chi_i \sim \mathcal{N}(\rho\frac{\sigma}{\sigma}\chi_\text{i}, \sigma^2(1-\rho)^2)$ Moreover, similarly to Besley and Case (1995), we consider the case where the realisation of the shocks between regions is perfectly correlated: $E\left[\varepsilon_i|\chi_i\right] = E\left[\varepsilon_{-i}|\chi_i\right] = \rho\chi_i$ The voter considers the level of effort as follows:

$$\hat{l}_i = y_i - E\left[\varepsilon_i|\chi_i\right]$$

$$\hat{l}_i = l_i + \varepsilon_i - \rho\chi_i$$

The re-election rule is now defined by:

$$\lambda l_i + \varepsilon_i - \rho\chi_i \geq \lambda \underline{l_i}$$

The local government knows that if re-elected:

$$\varepsilon_i - \rho\chi_i \geq \lambda\left(\underline{l_i} - l_i\right)$$

Define $H_i = \varepsilon_i - \rho\chi_i$, the distribution of a sum of normal random variables is itself normal:

$$H_i \sim \mathcal{N}(0, \underbrace{\sigma^2(1-\rho^2))}_{\nu^2}$$

The maximization program of the local government writes similarly to the previous one, where ν replaces σ.

Lemma 2. *Define* $Z = 2\nu^2 ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})$, $\overline{\sigma} = \frac{\lambda R}{\sqrt{2\pi}}$ *the incentive constraint* $IC(A,\sigma)$ *below:*

$$-\Phi\left(\frac{-\sqrt{Z}}{\nu}\right)R - \frac{\sqrt{Z}}{\lambda} \geq \underline{l_i} - \Phi\left(\frac{\lambda \underline{l_i}}{\nu}\right)R$$

The level of effort by the local government is:

- $\forall \nu \geq \overline{\sigma}\ l_i^\star = 0$,
- $\forall \nu \leq \overline{\sigma}\ l_i^\star = \underline{l_i} + \frac{1}{\lambda}\sqrt{Z}$ *when the incentive constraints are satisfied, otherwise* $l_i^\star = 0$.

Proof. *cf.* proof of Lemma 1 (p. 32). □

The voter will determine the threshold value of re-election that induces the maximum effort produced by the local government.

Proposition 4. *The optimal re-election rule is such that:* $\forall v \geq \overline{\sigma}$ *the re-election rule does not affect the behaviour of the local government. He will produce no effort.* $\forall v \leq \overline{\sigma}$ *there is only one positive value* $(\underline{l_i}^{\star})$ *that binding the incentive constraint.*

Proof. *cf.* proof of proposition 1 (p. 33) □

. The acquisition of the signal by the voter implies that the latter has more accurate information on the level of effort of the local government. Therefore, the variance v^2 is lower in the case where the local government is in competition than in the benchmark case (σ^2). The effect of the acquisition of the signal acts as if the voter would have achieved a reduction of the variance of the random shock. Through this mechanism, we can consider that the variance is an inverse measure of "verifiability" of the action of the local government.

Proposition 5. *The situation of yardstick competition from the local government, resulting from the acquisition by the voter of a signal increases the minimum effort required by the voter, the effort produced by the local government and therefore the utility of the voter. For an intermediate level of* σ ($\frac{R}{\sqrt{2\pi}}e^{-\frac{(R-1)}{2}} \leq \sigma \leq \overline{\sigma}e^{-\frac{3}{2}}$)*, the effect of a change in the degree of decentralisation on the threshold of re-election effort and the local government is higher in the case of yardstick competition.*

Proof. *cf.* appendix E (p. 36) □

. The situation of yardstick competition brings greater utility to voters. The latter have, with acquisition of a signal, a better estimate of the effort exerted by the local government. From this mechanism, they can determine a stricter re-election rule. Similarly, the local government knows that by providing a high effort, he is more likely to be re-elected in yardstick competition case, because the effect induced by his effort is easily differentiated from the shock's one.

. The marginal effect of the degree of decentralization on the threshold of re-election and on the government's effort is also higher in yardstick competition environment, at least for values close to the threshold $\overline{\sigma}$. Reducing uncertainty about the action of local government can better discern the effect of effort on the effect of hazard. By definition, this effort is particularly important for the utility of the voter when the degree of decentralization is high. Consequently, the marginal benefit for the voter to encourage the local government to produce an effort is even higher when the yardstick competition mechanism provides a better understanding of the action of local government (reduced variance). We show that this is true at least close to the threshold.

3.4. Decision to acquire information with an exogenous fixed cost ($I^\star$)

. The voter's choice to acquire the information necessary to more precisely control the activity of his local government depends on the following condition:

$$I = 1\left[E_{\chi_i}\left[y_i^C\right] - C_I - y_i^0 \geq 0\right]$$

This means that the gain in expected utility ($E_{\chi_i}\left[y_i^C\right] - y_i^0$) must be greater than the cost of acquiring this information (C_I).

Proposition 6. *Assuming that this cost is fixed and exogenous, the voter decides to acquire information at a cost below the following:*

$$\overline{C_I} = E_{\chi_i}\left[y_i^C\right] - y_i^0$$

Proof. *cf.* appendix F (p. 38) □

. From this result, it is clear that the voter's decision to acquire the signal is related to the degree of decentralisation of the policy (by the effect of λ on y_i). If the degree of decentralization does not directly affect the cost of acquiring information, the threshold value that switches the voter's decision is affected by the value of λ. The close link between the decision to acquire information and the degree of decentralization comes from the expected gain in utility term that generates the acquisition of information. When the degree of decentralization is low, the weight of local government activity is usually low, the gain that would provide better control of this activity is therefore also low. Gradually, as the degree of decentralization is increasing, the gain expected from the acquisition of the signal increases and the cost threshold below which the voter decides to acquire the signal also increases.

. Finally, we need only to determine, based on previous results, the effect of a change in the degree of decentralization on the voter's decision to acquire information on the shock occurred in the neighbouring region. This decision depends solely on the effect of the variation of λ on the condition of acquiring the information ($I^\star$)):

$$\frac{\partial I^\star}{\partial \lambda} = \frac{\partial y_i^1}{\partial \lambda} - \frac{\partial y_i^0}{\partial \lambda}$$

Proposition 7. *For an intermediate level of σ ($\frac{R}{\sqrt{2\pi}} e^{-\frac{(R-1)}{2}} \leq \sigma \leq \overline{\sigma} e^{-\frac{3}{2}}$), an increasing degree of decentralisation always affects positively the decision to aquire information ($\frac{\partial I^\star}{\partial \lambda} > 0$.)*

Proof. *cf.* appendix G (p. 38) □

. This proposal shows that the voter's decision to acquire information on the realization of shocks in neighbouring regions (and implement a "contract" under yardstick competition) is always increasing with the degree of decentralization of the policy, at least when the variance of the shock is close to the variance threshold beyond which the government exerts no effort. That is exactly around this threshold that the marginal benefit of acquiring information is the highest. Close to the threshold, the marginal benefit is always increasing with the degree of decentralization, since it allows voters to encourage their local government to pass a null effort toward a positive effort.

4. Empirical analysis

. The main difficulty in our empirical analysis is to ensure that the spatial interactions of the allocation of structural funds do originate from a mechanism of yardstick competition. Similarly to research the origin of fiscal externalities, it is logical to consider that these spatial interdependencies can be the result of spillover effects of economic or even unobserved shock that propagates through a spatial process.

. Our theoretical model shows that the voter decision to acquire information increases with the degree of decentralization. When the degree of decentralization is low, the weight of the decision of the local government in the utility of voters is low. The gain that would provide better control of its activity is therefore low. Gradually, as the degree of decentralization increases, the expected gain associated with the acquisition of information (and to use yardstick competition) increases. For a decentralized system, the voter of each region has a stronger incentive to acquire information, which allows it to better discipline their own government. The effort of this local government will be higher, leading this region to obtain larger amounts. This reasoning breeding within each region, we obtain a positive effect on the amount of funds received by a region of the amounts received by its neighbors for each region whose system of governance is decentralized. This prediction thus implies that the intensity of spatial interactions (caused by yardstick competition) is stronger when the policy is decentralized.

. The proposition 7 (section 3) highlights how incentives may change depending on the structure of implementation of the policy. These results allow us to infer that if the interactions are caused by the mechanism of yardstick competition, then their intensity should be higher for regions whose management is delegated to local authorities (decentralized system). The fact that the choice of the governance structure of the policy is determined by each Member State, will allow us to identify whether the origin of the interaction is effectively an institutional ("yardstick competition") by providing us with a change in the type of structure used in place (section 4.1). Specifically, we will use the heterogeneity between member states in their decision to delegate the implementation of funds to local authorities (decentralized system) or not (centralized-decentralized system.

4.1. Incentives of local government and cohesion policy governance

. The decision to delegate the management of structural funds to local elected officials is determined by each Member State. We can distinguish three types of choice within the EU 15 for the programming period 2000-06 (Bachtler, 2008).

. Some of the member states chose to keep the responsibility for cohesion policy at the central level. In practice, it relies heavily on decentralized services to ensure a more close to citizens. Under this regime, we assume that the local governments have no incentive to engage in lobbying activity because voters can clearly monitor the activities of local government regarding this policy. This choice is often linked to traditionally "centralised" states. Thus, this scheme has been introduced by France, UK, Ireland, Portugal and Greece.

. The second regime corresponds to a decentralised management of funds. In this case, the policy management is delegated to local governments. Comparing the results of the process of allocating funds based on lobbying is easier. Section 3 tells us that voters are more inclined to use the mechanism of yardstick competition when the degree of decentralization policy is high. This is because the marginal contribution to the effort of local government is by definition more powerful when the degree of decentralization is high. We expect that the incentive for local governments is higher under decentralized situations. This choice corresponds mainly to the "federal" Member States like Germany, Austria, Belgium, Denmark, Finland, the Netherlands and Sweden. Even beyond the informational aspects illustrated by the theoretical model, voters clearly associate the implementation of cohesion policy as an activity specific to local government, which reinforces the effect of "disciplining" of the procedure for re-election.

. Finally, Spain and Italy have chosen an mixed regime. Both Member States have decided to give the responsibility Objective 1 program to the central government and to delegate the management of other programmes to the regional governments. For these two countries, we consider programs Objective 1 by the centralized system while other programs will be considered under the decentralized system.

. We are aware that this categorization of governance structures is greatly simplified. The key determinant of our study is to distinguish whether the local decision-maker (responsible for local implementation of the policy) is an elected representative (decentralized system) or not (centralized system).

4.2. Estimation methods

. The models of strategic interactions between governments are generally estimated using the tools developed by spatial econometrics. There are generally two types of specifications (Anselin, 1988): the spatially autocorrelated error model (SEM) and spatially autoregressive model (SAR). According to work Brueckner (2003), spatially autoregressive specification is the most appropriate for estimating a reaction function after a model of strategic interaction, whatever the origin of these interactions. Matrix form, this gives:

$$\left(\frac{SF}{pop}\right) = \alpha + (\mathbf{ECO})\beta + (\mathbf{POL})\gamma + \rho W\left(\frac{SF}{pop}\right) + \epsilon \tag{3}$$

The amount of funds received $\left(\frac{SF}{pop}\right)$ by a region is positively correlated ($\rho > 0$) with the level received by the neighbouring regions ($W\left(\frac{SF}{pop}\right)$). Each local government (noting that voters can assess his lobbying indirectly) will be encouraged to engage in an activity of looking for grants to get as much as its neighbours. W is the neighbourhood matrix, (**ECO**) and (**POL**) are the vectors of socio-economic and politico-economic.

. The existence of spatial interactions may still come from different sources than the yardstick competition. If one considers that different regions are competing for a scarce resource (the central government grants), then the amount of funds received by a region may be affected by the amounts received by others. One can logically assume that there is an interdependence of policy choices other than the mechanism of yardstick competition. It may come with similar characteristics were not taken into account in the specification or even a common shock that the diffusion support is space. Two estimation methods are available to enable us to identify whether the yardstick competition is at the origin of spatial interactions.

. The first approach uses an spatial autoregressive specification in which we introduce an interaction variable between the variable of choice of fund management system and the autoregressive variable:

$$\left(\frac{SF}{pop}\right) = \alpha + (\mathbf{ECO})\beta + (\mathbf{POL})\gamma + \rho W\left(\frac{SF}{pop}\right) + \varrho reg.W\left(\frac{SF}{pop}\right) + \epsilon \tag{4}$$

with reg is a dummy variable equal to 1 when the funds are managed by locally elected policymakers (decentralized system). The coefficient on this interactive variable is significantly positive when the yardstick competition mechanism is at work. This approach is similar to Case et al. (1993) or Solé Ollé (2003). Equation (4) is estimated using an instrumental variables strategy. This technique can be useful when you suspect some variables (in addition to the spatial autoregressive term) endogenous. However, this estimator suffers from significant shortcomings in the estimation of a SAR. The estimated interaction effect may fall outside the space in which it is defined. Moreover, its use is limited to cases where the level of funds received by a region is not affected by the characteristics of its neighborhood.

. The second method is to estimate a model introducing two regimes in the spatial autoregressive variable:

$$\left(\frac{SF}{pop}\right) = \alpha + (\mathbf{ECO})\beta + (\mathbf{POL})\gamma + \rho_{reg=1} MW\left(\frac{SF}{pop}\right) \tag{5}$$
$$+\rho_{reg=0}(I_N - M)W\left(\frac{SF}{pop}\right) + W\mathbf{X}\delta + \epsilon$$

in which we estimate two effects of spatial interactions based on the fund management system. The above equation is estimated using a maximum likelihood method (Allers and Elhorst, 2005). An important advantage of this technique lies in the ability to control the results by the WX.

. We have to ensure that other sources of spatial autocorrelation are not influencing our results. The best strategy would be to estimate a spatial Durbin model, including a simultaneous spatial autoregressive term, additional variables spatially lagged and a spatially correlated error term. Unfortunately, it is not possible to simultaneously identify all of these parameters (Elhorst and Fréret, 2009). In this case, Le Sage and Pace (2009) explain that the least "bad" solution is to exclude the error term spatially autocorrelated for the simple reason that this solution is the only one able to produce unbiased estimates, even if the true generating process SAR data is a SEM or a combination of both.

4.3. Data and variables

Our dataset consists in 152 NUTS1/NUTS2 regions, grouped into 14 Member States for UE-15 over the period 2000-2006: Austria (15 regions), Denmark (1 region), Spain (17 regions), Finland (5 regions), France (22 regions), Greece (13 regions), Ireland (1 region), Italy (19 regions), Netherlands (12 regions), Portugal (6 regions), Sweden (8 regions) and United Kingdoms (12 regions).

. Socio-economic data come from the "Cambridge econometrics" database. Data on structural funds regional display are extracted from the 11th report on structural funds (1999). We used data from the "European Election database" to build the politico-economic variables that enable us to test the assumptions depicted in the previous section.

. The typology of management structure comes from the work of Bachter (2008). The socio-economic variables are:

- the per capita gross domestic product (lngdp). According to the redistributive logics of the cohesion policy, we expect a negative effect of this variable on the allocated funds.

- the unemployment rate, expressed as a percentage of the regional active population (lnunemprate). A region having a high unemployment rate should receive more funds and we expect a positive effect of this variable.

- the share of active population in the whole population, expressed as a percentage of the whole population (lnpartactivpop). This variable permits us to control for the demographic structure of the regional population.

- the share of agricultural employment in the total amount of jobs (lnagricemp). This variable is a proxy for the amounts of funds received by a region for CAP subsidies. We wish to control the assumption that high agricultural regions receive less structural funds, because they receive subsidies from the CAP.

. Moreover, we introduce politico-economic variables to control for the possible rigging of funds allocation by member states:

- we use the intensity of electoral competition at the regional level during parliament elections (in percent) to control for "swing voter" assumption. We expect appositive effect of this variable because the higher the intensity of electoral competition in a region, the higher amounts of funds she should receive. This variable is constructed from the absolute difference of votes received by the two major parties (Cdiff).

- to control for regional overrepresentation on national parliaments, we introduce a variable measuring the total number of regional seats per capita within the parliamentary majority of each member state (majreppc). We expect a positive impact of this variable on the receipt of EU funds.

. Unfortunately, we were not able to control for the partisan hypothesis because we did not have the needed data on the results of local elections. We consider several definitions for building the spatial weight matrix (W). The first is defined from the notion of contiguity:

$$\begin{cases} w_{ij} = 1 & if\ i\ and\ j\ share\ a\ common\ border\ \forall\ i \neq j \\ w = 0 & \begin{cases} otherwise \\ if\ i = j \end{cases} \end{cases}$$

. The above spatial weight definition may appear too general in the way that the information on the amounts of funds received is available to the citizens. Indeed, the simple notion of contiguity does not account for cultural factors, and may limit the dissemination of needed information. The language barrier, or more generally the borders of Member States may be an example of these factors limiting the dissemination of information. Thus, we define the spatial interaction from membership in the same Member State:

$$\begin{cases} w_{ij} = 1 & if\ i\ and\ j\ is\ included\ in\ the\ same\ Member\ State\ \forall\, i \neq j \\ w = 0 & otherwise \end{cases}$$

. This definition remains highly questionable because it can also capture effects related to a process of direct competition between regions within the same Member State in their funding requests. Nevertheless, we will use this matrix to control the average effects level per member state of the different variables to control for. Finally, we construct a matrix combining the two matrices presented above.

4.4. Results

. In table 1, we present estimates of equation (3), without taking into account strategic interactions. As expected, the level of wealth per capita (unemployment) affect negatively (positively) the amount of funds received by a region. We can also note that the over-representation of a region within the majority parliamentary of its Member State is positively associated with the amount of funds. These results are consistent with the logic presented by Kemmerling and Bodenstein (2006), or Bouvet and Dall'erba (2010), since the process of allocating funds is affected by the socio-economic factors as well as politico-economic factors (over-representation of some regions within national majorities). These last factors are due to institutional and political features in each Member State that lead a distortion in the fund allocation compared to a pure redistributive allocation. However, we detect the presence of spatial autocorrelation using a Moran I test on estimate residuals (table 1). This result supports our hypothesis on the presence of spatial interactions between regions in the allocation of structural funds.

. To learn further about the shape of this spatial autocorrelation, we use the strategy proposed by Anselin et Florax (1995). The strategy is to detect the the most appropriate form of spatial autocorrelation for our model. SARMA test confirms the results of the Moran test and wrongly omitted an unknown form of spatial autocorrelation (table 2, p. 24).

	OLS		
lngdp	-0.28*	-2.46***	-2.46***
	(-1.61)	(-5.41)	(-5.41)
lnunemprate	1.45***	0.83**	0.83**
	(6.01)	(2.90)	(2.90)
lnpartactivpop	8.76***	11.03**	11.03**
	(2.76)	(3.14)	(3.14)
lnagricemp	8.77	1.91	1.91
	(5.97)	(1.13)	(1.13)
lncdiff		0.17	0.17
		(1.33)	(1.33)
lnmajreppc		0.67***	0.67***
		(3.83)	(3.83)
constant	1.08	21.69***	21.69***
	(1.24)	(5.02)	(5.02)
R^2	0.41	0.59	0.59
I_{moran}	5.7126	2.3716	2.3716
$p.v._{I_{moran}}$	(<0.01)	(0.01)	(0.01)
N	152	152	152

*, **, *** indicate respectively the significance at 10%, 5% and 1% level.

Student t are displayed in parentheses beneath the coefficient estimates.

Table 1: Estimations without spatial interactions

W_{cont}	LM_e	RLM_e	LM_{lag}	RLM_{lag}	$SARMA$
Test statistic	1.50	3.95	2.44	4.58	4.594
$p.v.$	0.22	0.05	0.11	0.03	0.03
H_0	$\lambda = 0$	$\lambda = 0$	$\rho = 0$	$\rho = 0$	$\rho = \lambda = 0$

Table 2: LM tests for spatial autocorrelation

. We choose a spatial spatial autoregressive (SAR) model for two reasons. Relying on the decision rule proposed by Anselin and Florax (1995), we reject the form for which p.v. associated with LM and RLM are most significant. The comparison of these results on a process where errors are spatially autoregressive (LM-e and RLM-e) with those obtained with a spatially autoregressive variable (LM-lag and lag-MLR) show that this latter form is the most appropriate in our case. The choice of the spatial autocorrelation specification obtained from these tests is still very fragile. In our case, we suspect the possibility of multiple sources of spatial autocorrelation. These sources can take different forms. For example, we can not overlook the impact of neighbourhood characteristics on the amount of funds received by a given region (WX).

	SOCIO-ECO			POLITICO-ECO		
	IV	ML		IV	ML	
	No control	No control	$W_{cont}X$ control	No control	No control	$W_{cont}X$ control
lngdp	-2.20***	-0.30*	0.07	-3.15***	-1.88***	-1.94***
	(-6.67)	(3.08)	(0.20)	(-5.17)	(14.59)	(14.18)
lnunemprate	0.66***	1.44***	1.82***	0.54**	0.99***	1.33***
	(2.68)	(33.13)	(38.44)	(1.97)	(12.91)	(16.60)
lnpartactivpop	8.14***	8.70***	1.26	9.51**	10.92***	6.01
	(3.05)	(7.69)	(0.20)	(2.95)	(11.04)	(2.89)
lnagricemp	4.86***	8.43***	6.92***	3.38**	3.39**	3.09**
	(3.28)	(30.33)	(25.53)	(2.05)	(4.45)	4.03)
lncdiff				0.40***	0.15	-0.04
				(3.28	(1.52)	0.09)
lnmajreppc				0.16	0.96***	0.39**
				(1.49)	(25.18)	4.14)
Wlnsfpc	-0.09*	0.07	0.49***	-0.27	-0.10**	0.2**
	(-1.81)	(1.97)	(29.71)	(-1.26)	(3.86)	(3.85)
constant	22.53***	1.01	0.44	31.63	15.30	18.98
Wlngdp			-0.52***			-0.11
			(5.73)			(0.18)
Wlnunemprate			-1.45***			-1.10
			(12.66)			(5.44)
R^2	0.44			0.44		
log-likehood		-247.51	-215.38		-148.97	-141.81
Sargan	14.76 (0.002)			19.96 (0.001)		
N	135	152	152	135	104	104

*, **, *** indicate respectively the significance at 10%, 5% and 1% level. Student t are displayed in parentheses beneath the coefficient estimates.

Table 3: Estimation of equation (3)

. The results from estimating equation (3) (with the spatial lag) are more surprising. Firstly for a given region, the amount of funds received by a region seem negatively related (-0.1) with those received by its neighbours (columns 1,2,4 and 5). The sign of this relation seems at first sight to be inconsistent with the yardstick competition thesis.

. The introduction of spatially lagged explicative variables alters both the sign of this relationship (which becomes significantly positive) and the intensity of interdependence, since the coefficients are now contained between 0.2 and 0.5. We interpret the volatility of the sign of this interaction as as possible that the estimate of the latter results from the combination of several sources:

- a negative effect of a mechanism of direct competition between regions for a scarce resource (the development grants in our case)

- a negative effect of a mechanism of direct competition between regions for a scarce resource (the development grants in our case)

To determine whether the second effect is indeed at work, we introduce the strategy described in section 4.1.

. First of all, we can note that the interpretation of results is similar, whatever the estimation method used (cross-product estimator or model with two spatial regimes). However, the results of the Sargan test on the method of cross product involves the rejection of a correct identification by the instruments used (p.v. equal to 0.01). Therefore, we will focus on the results provided by the second method.

. The estimation of two regimes for the spatial lag (one for regions where management is delegated to local government, the other not) provides results for the emergence of a mechanism of yardstick competition between regions in the demand for development grants. Indeed, this interaction is not significant in the case where management is delegated to local governments while the latter is significantly positive in the case of decentralized management (0.26). The difference between the coefficients of the two regimes is still significant (table 4, "Diff").

. The introduction of WX (table 4, colonnes 3 et 4) affects neither the sign nor the significance of the coefficient associated with the decentralised regime. The intensity of this interaction is more modest; however, the coefficient varies between 0.22 (when the WX are designed from the contiguity matrix) and 0.13 (when the WX are built based on the Member State membership).

. We use a "Member state membership" matrix to determine how the variables measured in national average may affect the results (table 4, column 4). We observe that the level of GDP pc national average negatively affects the amount of funds received by its regions (-0.57). The average unemployment rate of Member state seems to affect negatively the amount of funds received by the regions (-0.83). The WX constructed from the contiguity matrix do not significantly affect the process of allocation of structural funds (table 4, column 2).

	Cross-product	Two-regime Spatial lag					
	IV	ML					
	No control	No control		$W_{cont}X$ control		CX control	
lngdp	-2.26***	-0.19		-0.12		0.19	
	(-3.84)	(-1.33)		(-0.86)		(0.75)	
lnunemprate	0.78***	1.51***		1.26***		1.54***	
	(2.94)	(6.15)		(5.05)		(5.23)	
lnpartactivpop	7.60***	10.23***		9.06***		0.26	
	(2.67)	(3.37)		(3.06)		(0.06)	
lnagricemp	3.63**	8.32***		6.48***		4.91***	
	(2.42)	(5.81)		(4.20)		(2.87)	
lncdiff	0.16			0.10		0.14	
	(1.62)			(1.10)		(1.11)	
lnmajreppc	0.14			0.29***		0.39	
	(1.12)			(2.70)		(1.52)	
spatial lag GDP						-0.57*	
						(-1.81)	
spatial lag UNEMP						-0.83*	
						(-1.87)	
Wlnsfpc*reg	0.78**	regional autonomy					
	(2.35)	no	yes	no	yes	no	yes
Wlnsfpc	-0.16	-0.04	0.26***	-0.05	0.22***	-0.06	0.13*
	(-0.47)	(-0.69)	(3.16)	(-0.81)	(2.71)	(-1.08)	(1.71)
Diff		-0.30 (-2.89)		-0.27 (-2.63)		-0.20 (-2.02)	
constant	-3.78**	-1.67***		-1.84***		-1.42***	
R^2	0.57	0.45		0.49		0.54	
log-likehood		-243.33		-238.30		-228.52	
Sargan	49.69 (0.01)						
N	135	72	80	72	80	72	80

*, **, *** indicate respectively the significance at 10%, 5% and 1% level. Student t are displayed in parentheses beneath the coefficient estimates.

Table 4: Estimation of equations (4) and (5)

. To test the sensitivity of the interaction with the definition of the spatial weight matrix, we perform the estimates with a spatial lag constructed using matrices "belonging to a single Member State (C)" and a combination of this last matrix with the contiguity matrix (W_{mixed}). The interaction within the same member state remains more intense for member state that have delegated the management of funds to local governments (0.6).

5. Conclusion

. This paper offers an institutional explanation of spatial interaction of the allocation of EU structural funds. We implement an estimation strategy to identify the proportion of interactions caused by a yardstick compe-

	Country weights (C)				Mixed weights (W_{mixed})			
	No control		CX control		No control		$W_{mixed}X$ control	
lngdp	0.06		0.18		-0.08		0.23	
	(0.40)		(0.82)		(-0.54)		(0.92)	
lnunemprate	1.13***		1.68***		1.17***		1.48***	
	(4.85)		(6.43)		(4.66)		(4.96)	
lnpartactivpop	4.05		-1.44		7.87***		-0.99	
	(1.48)		(-0.40)		(2.65)		(-0.24)	
lnagricemp	5.89***		5.20***		6.58**		4.93**	
	(4.07)		(3.44)		(4.23)		(2.85)	
lncdiff	0.05		0.19*		0.12		0.19	
	(0.68)		(1.68)		(1.30)		(1.41)	
lnmajreppc	0.28***		0.40**		0.28***		0.36	
	(2.75)		(1.79)		(2.58)		(1.37)	
spatial lag GDP			-0.18				-0.60*	
			(-0.61)				(-1.88)	
spatial lag UNEMP			-1.29***				-0.83*	
			(-3.19)				(-1.84)	
	regional autonomy							
	no	yes	no	yes	no	yes	no	yes
spatial lag of lnsfpc	0.05	0.57***	0.02	0.60***	-0.02	0.15**	-0.02	0.07
	(0.40)	(6.49)	(0.07)	(6.15)	(-0.29)	(2.02)	(-0.35)	(1.08)
Diff	-0.53 (-3.77)		-0.58 (-2.42)		-0.16 (-1.73)		-0.10 (-1.05)	
constant	-3.18***		-3.37***		-1.27***		-0.89**	
R^2	0.56		0.64		0.47		0.54	
log-likehood	-229.72		-271.11		-239.90		-229.86	
N	72	80	72	80	72	80	72	80

*, **, *** indicate respectively the significance at 10%, 5% and 1% level. Student t are displayed in parentheses beneath the coefficient estimates.

Table 5: Robustness to the spatial weight definition (equation (5))

tition mechanism of between regions in its demand for public aid for development. We back our empirical identification from results of a political agency model (Sand-Zantman, 2003), where we endogeneise the voter's decision to use the mechanism of yardstick competition by acquiring information on the realization of economic shocks in the neighbourhood. We show that this decision is positively affected by the degree of decentralization policy. In the context of cohesion policy, the proposal identifies whether the interaction is due to a mechanism of yardstick competition by using the choice of Member States to decentralize (or not) the implementation of this policy. Using a spatially autoregressive specification with two regimes, we show that the difference between the two regimes (one for areas where management is delegated to local government, the other not) is always significant and in support of the emergence (existence) of yardstick competition between regions in the demand for development grants.

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Appendix: proofs

A. Lemma 1

Proof. The first order condition (FOC) provides:

$\frac{\partial V_i}{\partial l_i} \overset{!}{=} 0 \Leftrightarrow -R\left(-\frac{\lambda}{\sigma}\right)\Phi'\left(\frac{\lambda\left(\underline{l_i}-l_i\right)}{\sigma}\right) - 1 = \frac{\lambda R}{\sigma\sqrt{2\pi}} e^{-(\lambda(\underline{l_i}-l_i))^2/2\sigma^2} - 1 = 0$

The second order condition (SOC) is:

$\frac{\lambda R}{\sigma^3\sqrt{2\pi}}\lambda(\underline{l_i}-l_i)e^{-(\lambda(\underline{l_i}-l_i))^2/2\sigma^2}$

The sign of the second derivative depends on the sign of the second term ($(\underline{l_i}-l_i)$).

Si $\underline{l_i} \geq l_i$ ***the SOC is positive, which implies that the function is convex***

The local government then chooses an effort level between zero and a level $\underline{l_i}$

If the function is increasing then $\underline{l_i}^0 = \underline{l_i}$.

If the function is decreasing then $\underline{l_i}^0 = 0$.

For a nul effot, the government's objective function is written:

$\frac{\partial V_{l_i=0}}{\partial l_i} = \frac{\lambda R}{\sigma\sqrt{2\pi}} e^{-(\lambda(\underline{l_i}))^2/2\sigma^2} - 1$

$\frac{\partial V_{l_i=0}}{\partial l_i} \leq 0 => \frac{\lambda R}{\sigma\sqrt{2\pi}} e^{-(\lambda(\underline{l_i}))^2/2\sigma^2} \leq 1$

$\frac{-(\lambda(\underline{l_i}))^2}{2\sigma^2} \leq ln\left(\frac{\sigma\sqrt{2\pi}}{\lambda R}\right)$

If $\frac{\sigma\sqrt{2\pi}}{\lambda R} > 1$ *i.e.* $\sigma \geq \frac{\lambda R}{\sigma\sqrt{2\pi}}$ then we always have $\frac{\partial V_{l_i=0}}{\partial l_i} < 0$ and $\underline{l_i}^0 = 0$.

If $\sigma \leq \frac{\lambda R}{\sigma\sqrt{2\pi}}$ we have $\frac{-(\lambda(\underline{l_i}))^2}{2\sigma^2} \geq ln\left(\frac{\sigma\sqrt{2\pi}}{\lambda R}\right)$

Let $L = \frac{\sigma}{\lambda}\sqrt{2ln\left(\frac{\sigma\sqrt{2\pi}}{\lambda R}\right)}$

If $\underline{l_i}$ eis high (greater than L) then $\frac{\partial V_{l_i=0}}{\partial l_i} < 0$ and $\underline{l_i}^0 = 0$.

If $\underline{l_i} \leq l_i$ ***the SOC is negative, and the function is concave.***

The FOC is written:

$\frac{\lambda R}{\sigma\sqrt{2\pi}} e^{-\lambda^2(\underline{l_i}-l_i)^2/2\sigma^2} - 1 = 0$

$ln(\frac{\lambda R}{\sigma\sqrt{2\pi}} e^{-\lambda^2(\underline{l_i}-l_i)^2/2\sigma^2}) = 0$

$ln\left(\frac{\lambda R}{\sigma\sqrt{2\pi}}\right) + ln\left(e^{-\lambda^2(\underline{l_i}-l_i)^2/2\sigma^2}\right) = 0$

$\lambda^2(\underline{l_i}-l_i)^2 = 2\sigma^2 ln\left(\frac{\lambda R}{\sigma\sqrt{2\pi}}\right)$

Let $X = \lambda^2(\underline{l_i}-l_i)^2$

We get 2 solutions $\lambda(\underline{l_i}-l_i) = +/- \sqrt{2\sigma^2 ln\left(\frac{\lambda R}{\sigma\sqrt{2\pi}}\right)}$

It has $\lambda > 0$ but no information on the sign of $(\underline{l_i}-l_i)$.

If we put a risk aversion of local government, this implies $\lambda(\underline{l_i}-l_i) < 0$.

$\lambda(\underline{l_i}-l_i) = -\sqrt{2\sigma^2 ln\left(\frac{\lambda R}{\sigma\sqrt{2\pi}}\right)}$

As $\lambda(\underline{l_i}-l_i) < 0$ we have a single solution:

$\Leftrightarrow l_i^0 = \underline{l_i} + \frac{1}{\lambda}\sqrt{A}$ when whe let $A = 2\sigma^2 ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})$

We have $\frac{\lambda R}{\sigma\sqrt{2\pi}} \leq 1$ for $\sigma \geq \frac{\lambda R}{\sqrt{2\pi}}$ and therefore we can summarize the behavior of local government function the threshold for re-election and conclude in all cases:

$l_i^0 = 0$ for $\sigma \geq \frac{\lambda R}{\sqrt{2\pi}}$

$l_i^0 = \underline{l_i} + \frac{1}{\lambda}\sqrt{A}$ for $\sigma \leq \frac{\lambda R}{\sqrt{2\pi}}$ □

B. Proposition 1

Proof. The level of effort that determines the decision rule is defined by:

$V_{l_i=l_i^\star} \geq V_{l_i=0}$ (IC(A,σ))

which equivalent to:

$R\left(1-\Phi\left(\frac{-\sqrt{A}}{\sigma}\right)\right) - \underline{l_i} - \frac{\sqrt{A}}{\lambda} \geq R\left(1-\Phi\left(\frac{\lambda \underline{l_i}}{\sigma}\right)\right)$

rearranging we get:

$-\Phi\left(\frac{-\sqrt{A}}{\sigma}\right)R - \frac{\sqrt{A}}{\lambda} \geq \underline{l_i} - \Phi\left(\frac{\lambda \underline{l_i}}{\sigma}\right)R$

we seek $\underline{l_i}$ which incites local government to produce a positive effort.

Let:

$F(\underline{l_i}) = -\underline{l_i} + \Phi\left(\frac{\lambda \underline{l_i}}{\sigma}\right)R - \Phi\left(\frac{-\sqrt{A}}{\sigma}\right)R - \frac{\sqrt{A}}{\lambda}$

Our goal is to analyze the function $F(\underline{l_i})$ to determine a value of $\underline{l_i} > 0$ which binds IC(A, σ).

We note that:

$F(\underline{l_i}) = 0$ for $\underline{l_i} = \frac{-\sqrt{A}}{\lambda}$

$\frac{\partial F}{\partial \underline{l_i}} = -1 + \frac{\lambda R}{\sigma\sqrt{2\pi}} e^{-\lambda^2 \underline{l_i}^2/2\sigma^2} = 0$

$\lambda^2 \underline{l_i}^2 = 2\sigma^2 ln\left(\frac{\lambda R}{\sigma\sqrt{2\pi}}\right)$

$\Leftrightarrow \underline{l_i}^\star = \frac{-\sqrt{A}}{\lambda}$ or $\frac{\sqrt{A}}{\lambda}$

The SOC:

$\frac{d^2F}{d^2\underline{l_i}} = -\frac{\lambda R}{\sigma^3\sqrt{2\pi}}\lambda \underline{l_i} e^{-\lambda \underline{l_i}^2/2\sigma^2}$

$$\frac{d^2F}{d^2\underline{l_i}} = \underbrace{-\frac{\lambda R}{\sigma^3\sqrt{2\pi}}\lambda \underline{l_i}} \quad \underbrace{e^{-\underline{l_i}^2/2\sigma^2}}$$

$\forall \underline{l_i} \leq 0$	≥ 0	≥ 0
$\forall \underline{l_i} \geq 0$	≤ 0	≥ 0

$\forall \underline{l_i} \leq 0$ **the function F is convex**, and reaches a minimum in $\frac{-\sqrt{A}}{\lambda}$. Furthermore, we know that the value of this minimum is zero ($F(\underline{l_i}) = 0$). Therefore $F \geq 0$ for $\underline{l_i} \leq 0$ and $F(0) > 0$. $\forall \underline{l_i} \geq 0$ F **is strictly concave**, so there is only one solution to the equation $F(\underline{l_i}) = 0$ pour $\underline{l_i} \geq 0$. We know that this value is greater than $\frac{\sqrt{A}}{\lambda}$ (since F reaches a maximum for this value).

There is a value $\underline{l_i} > 0$ solution of the equation $F(\underline{l_i}) = 0$ i.e. that binds the incentive constraint. We know that this value is greater than $\frac{\sqrt{A}}{\lambda}$. □

C. Proposition 2

Proof. The effect of a variation of σ on the variation of the rule re-election effort and level of central government is given by (implicit function theorem):

$\frac{\partial \underline{l_i}}{\partial \sigma} = -\frac{\partial F/\partial \sigma}{\partial F/\partial \underline{l_i}}$

Moreover, we know that $\partial F/\partial \underline{l_i} < 0$ around of equilibrium.

$$\frac{\partial F}{\partial \sigma} = -\frac{R}{\sigma^2\sqrt{2\pi}}\lambda \underline{l_i} e^{-\lambda^2 \underline{l_i}^2/2\sigma^2} - R\left[\frac{-\sqrt{A(\sigma,.)}}{\sigma}\right]' . \frac{1}{\sqrt{2\pi}} e^{-A/2\sigma^2} - \frac{A'(\sigma,.)}{2\lambda\sqrt{A(\sigma,.)}}$$

$$\left[\frac{-\sqrt{A(\sigma,.)}}{\sigma}\right]' = \frac{\frac{-2\sigma^2}{\sqrt{A}} ln\left(\frac{\lambda R}{\sigma\sqrt{2\pi}}\right) + \frac{\sigma^2}{\sqrt{A}} + \sqrt{A}}{\sigma^2}$$

$$= \frac{\frac{-A}{\sqrt{A}} + \frac{\sigma^2}{\sqrt{A}} + \sqrt{A}}{\sigma^2}$$

$$= \frac{1}{\sqrt{A}}$$

$$\frac{\partial F}{\partial \sigma} = -\frac{R}{\sigma^2\sqrt{2\pi}}\lambda \underline{l_i} e^{-\lambda^2 \underline{l_i}^2/2\sigma^2} - R\frac{1}{\sqrt{2\sigma^2 ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} . \frac{1}{\sqrt{2\pi}} \underbrace{e^{-A/2\sigma^2}}_{\frac{\sigma\sqrt{2\pi}}{\lambda R}} - \frac{2\sigma(2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})-1)}{\lambda 2\sqrt{2\sigma^2 ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}$$

$$\frac{\partial F}{\partial \sigma} = -\frac{R}{\sigma^2\sqrt{2\pi}}\lambda \underline{l_i} e^{-\lambda^2 \underline{l_i}^2/2\sigma^2} - \frac{R\sigma\sqrt{2\pi}}{\lambda R\sigma\sqrt{2\pi}\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} - \frac{\sigma(2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})-1)}{\lambda\sqrt{2\sigma^2 ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}$$

$$\frac{\partial F}{\partial \sigma} = -\frac{R}{\sigma^2\sqrt{2\pi}}\lambda \underline{l_i} e^{-\lambda^2 \underline{l_i}^2/2\sigma^2} - \frac{1}{\lambda\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} - \frac{(2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})-1)}{\lambda\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}$$

$$\frac{\partial F}{\partial \sigma} = -\frac{R}{\sigma^2\sqrt{2\pi}}\lambda \underline{l_i} e^{-\lambda^2 \underline{l_i}^2/2\sigma^2} - \frac{1-2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})+1}{\lambda\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}$$

$$\frac{\partial F}{\partial \sigma} = -\frac{R}{\sigma^2\sqrt{2\pi}}\lambda \underline{l_i} e^{-\lambda^2 \underline{l_i}^2/2\sigma^2} - \frac{\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}{\lambda}$$

$$\frac{\partial F}{\partial \sigma} < 0 \ \frac{\partial \underline{l_i}}{\partial \sigma} = -\frac{\partial F/\partial \sigma}{\partial F/\partial \underline{l_i}} < 0$$

The variation of σ has a negative effect on $\underline{l_i}$.

In addition, the effect of the variation of the variance of the shock on the level of effort is written:

$$\frac{\partial l_i}{\partial \sigma} = \frac{\partial \underline{l_i}}{\partial \sigma} + \frac{1}{\lambda}\left[\frac{A'(\sigma,.)}{2\sqrt{A(\sigma,.)}}\right]$$

If $A'(\sigma,.) < 0$ then $\frac{\partial l_i}{\partial \sigma} < 0$

if $A'(\sigma,.) > 0$ which effect dominates the other?

Multiplying by $\frac{\partial F/\partial \underline{l_i}}{\partial F/\partial \underline{l_i}}$:

$$\frac{\partial l_i}{\partial \sigma} = -\frac{1}{\partial F/\partial \underline{l_i}}\left(\frac{\partial F}{\partial \sigma} - \frac{\partial F}{\partial \underline{l_i}}\frac{1}{\lambda}\left[\frac{A'(\sigma,.)}{2\sqrt{A(\sigma,.)}}\right]\right)$$

$$\frac{\partial F}{\partial \underline{l_i}} = \frac{\lambda R}{\sigma\sqrt{2\pi}} e^{-\lambda \underline{l_i}^2/2\sigma^2} - 1$$

$$\frac{\partial l_i}{\partial \sigma} = -\frac{1}{\partial F/\partial \underline{l_i}}\left(-\frac{R}{\sigma^2\sqrt{2\pi}}\lambda \underline{l_i} e^{-\frac{\lambda \underline{l_i}^2}{2\sigma^2}} - \frac{1}{\lambda\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} - \frac{A'(\sigma,.)}{2\lambda\sqrt{A(\sigma,.)}} - \left(\left(\frac{\lambda R}{\sigma\sqrt{2\pi}} e^{-\lambda \underline{l_i}^2/2\sigma^2} - 1\right)\frac{1}{\lambda}\left[\frac{A'(\sigma,.)}{2\sqrt{A(\sigma,.)}}\right]\right)\right)$$

$$\frac{\partial l_i}{\partial \sigma} = -\frac{1}{\partial F/\partial \underline{l_i}}\left(-\frac{R}{\sigma^2\sqrt{2\pi}}\lambda \underline{l_i} e^{-\frac{\lambda \underline{l_i}^2}{2\sigma^2}} - \frac{1}{\lambda\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} - \frac{A'(\sigma,.)}{2\lambda\sqrt{A(\sigma,.)}} - \left(\frac{A'(\sigma,.)}{2\lambda\sqrt{A(\sigma,.)}}\left(\frac{\lambda R}{\sigma\sqrt{2\pi}} e^{-\lambda \underline{l_i}^2/2\sigma^2} - 1\right)\right)\right)$$

$$\frac{\partial l_i}{\partial \sigma} = -\frac{1}{\partial F/\partial \underline{l_i}}\left(-\frac{R}{\sigma^2\sqrt{2\pi}}\lambda \underline{l_i} e^{-\frac{\lambda \underline{l_i}^2}{2\sigma^2}} - \frac{1}{\lambda\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} - \frac{A'(\sigma,.)}{2\lambda\sqrt{A(\sigma,.)}} - \frac{A'(\sigma,.)}{2\lambda\sqrt{A(\sigma,.)}}\frac{\lambda R}{\sigma\sqrt{2\pi}} e^{-\lambda \underline{l_i}^2/2\sigma^2} + \frac{A'(\sigma,.)}{2\lambda\sqrt{A(\sigma,.)}}\right)$$

$$\frac{\partial l_i}{\partial \sigma} = \underbrace{-\underbrace{\frac{1}{\partial F/\partial \underline{l_i}}}_{<0}}_{>0}\left(\underbrace{-\frac{R}{\sigma^2\sqrt{2\pi}}\lambda \underline{l_i} e^{-\frac{\lambda \underline{l_i}^2}{2\sigma^2}} - \frac{1}{\lambda\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} - \frac{A'(\sigma,.)}{2\lambda\sqrt{A(\sigma,.)}}\frac{\lambda R}{\sigma\sqrt{2\pi}} e^{-\lambda \underline{l_i}^2/2\sigma^2}}_{<0}\right)$$

$$\frac{\partial l_i}{\partial \sigma} < 0$$

□

D. Proposition 3

Proof. The effect of a variation of λ on the variation of the rule re-election effort and level of central government is given by (implicit function theorem):

$\frac{\partial \underline{l}_i}{\partial \lambda} = -\frac{\partial F/\partial \lambda}{\partial F/\partial \underline{l}_i}$

Moreover we know that $\partial F/\partial \underline{l}_i < 0$ around of the equilibirum.

$$\frac{\partial F}{\partial \lambda} = \frac{R}{\sigma\sqrt{2\pi}}\underline{l}_i e^{-\frac{\lambda^2 \underline{l}_i^2}{2\sigma^2}} + \frac{A'(\lambda,.)}{2\sigma\sqrt{A(\lambda,.)}\sqrt{2\pi}} e^{-\frac{A(\lambda,.)}{2\sigma^2}} - \left[\frac{\left(\frac{A'(\lambda,.)}{2\sqrt{A(\lambda,.)}}\right)\lambda - \sqrt{A(\lambda,.)}}{\lambda^2}\right]$$

$$= \frac{R}{\sigma\sqrt{2\pi}}\underline{l}_i e^{-\frac{\lambda^2 \underline{l}_i^2}{2\sigma^2}} + \frac{\frac{2\sigma^2}{\lambda}}{2\sigma\sqrt{2\sigma^2 ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}\sqrt{2\pi}} e^{-\frac{2\sigma^2 ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}{2\sigma^2}} - \left[\frac{\left(\frac{2\sigma^2}{2\lambda\sqrt{2\sigma^2 ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}\right)\lambda - \sqrt{2\sigma^2 ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}{\lambda^2}\right]$$

$$= \frac{R}{\sigma\sqrt{2\pi}}\underline{l}_i e^{-\frac{\lambda^2 \underline{l}_i^2}{2\sigma^2}} + \frac{2\sigma^2}{2\sigma^2\lambda\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}\sqrt{2\pi}} e^{-ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})} - \left[\frac{\frac{2\sigma^2\lambda}{2\sigma\lambda\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} - \sigma\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}{\lambda^2}\right]$$

$$= \frac{R}{\sigma\sqrt{2\pi}}\underline{l}_i e^{-\frac{\lambda^2 \underline{l}_i^2}{2\sigma^2}} + \frac{1}{\lambda\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}\sqrt{2\pi}} e^{ln(\frac{\sigma\sqrt{2\pi}}{\lambda R})} - \left[\frac{\frac{\sigma}{\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} - \sigma\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}{\lambda^2}\right]$$

$$= \frac{R}{\sigma\sqrt{2\pi}}\underline{l}_i e^{-\frac{\lambda^2 \underline{l}_i^2}{2\sigma^2}} + \frac{\sigma\sqrt{2\pi}}{\lambda^2 R\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}\sqrt{2\pi}} - \left[\frac{\sigma}{\lambda^2\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} - \frac{\sigma\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}{\lambda^2}\right]$$

$$= \frac{R}{\sigma\sqrt{2\pi}}\underline{l}_i e^{-\frac{\lambda^2 \underline{l}_i^2}{2\sigma^2}} + \frac{\sigma}{\lambda^2 R\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} - \left[\frac{\sigma - \sigma 2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}{\lambda^2\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}\right]$$

$$= \frac{R}{\sigma\sqrt{2\pi}}\underline{l}_i e^{-\frac{\lambda^2 \underline{l}_i^2}{2\sigma^2}} + \frac{\sigma}{\lambda^2 R\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} - \left[\frac{\sigma(1 - 2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}}))}{\lambda^2\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}\right]$$

The sign depends directly on $-(1 - 2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}}))$.

We investigate for which parameter values (σ puis R) the effect is always positive..

The effect is always positive when:

$1 - 2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}}) \leq 0$

$2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}}) \geq 1$

$ln(\frac{\lambda R}{\sigma\sqrt{2\pi}}) \geq \frac{1}{2}$

$\frac{\lambda R}{\sigma\sqrt{2\pi}} \geq e^{\frac{1}{2}}$

$\lambda R \geq \sigma\sqrt{2\pi}e^{\frac{1}{2}}$

$\sigma \leq \frac{\lambda R}{e^{\frac{1}{2}}\sqrt{2\pi}}$

$\frac{\partial F}{\partial \lambda} > 0 \ \forall \ \sigma \leq \frac{\lambda R}{e^{\frac{1}{2}}\sqrt{2\pi}}$

This value of σ covers a large part of the definition domain the equilibrium defined by the conduct of local government ($\overline{\sigma} \leq \frac{\lambda R}{\sqrt{2\pi}}$).

We can also show that this effect is positive:

$$\frac{\partial F}{\partial \lambda} = \frac{R}{\sigma\sqrt{2\pi}}\underline{l}_i e^{-\frac{\lambda \underline{l}_i^2}{2\sigma^2}} + \frac{\sigma}{\lambda^2 R\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} - \left[\frac{\sigma - \sigma 2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}{\lambda^2\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}\right]$$

$$= \frac{R}{\sigma\sqrt{2\pi}}\underline{l}_i e^{-\frac{\lambda \underline{l}_i^2}{2\sigma^2}} + \frac{\sigma - \sigma R}{\lambda^2 R\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} + \frac{2\sigma ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}{\lambda^2\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}$$

$$= \frac{R}{\sigma\sqrt{2\pi}}\underline{l_i}e^{-\frac{\lambda \underline{l_i}^2}{2\sigma^2}} + \frac{\sigma(1-R)}{\lambda^2 R\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} + \frac{2\sigma ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}{\lambda^2\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}$$

$1 - R \geq 0$

$\frac{\partial F}{\partial \lambda} > 0 \; \forall \; R \geq 1$

Therefore, $\frac{\partial \underline{l_i}}{\partial \lambda} > 0$

We obtain the effect on the level of effort from:

$$\frac{\partial l_i}{\partial \lambda} = \frac{\partial \underline{l_i}}{\partial \lambda} + \left[\frac{1}{\lambda}\sqrt{A(\lambda,.)}\right]'$$

$$\frac{\partial l_i}{\partial \lambda} = \frac{\partial \underline{l_i}}{\partial \lambda} + \left[\frac{\left(\frac{A'(\lambda,.)}{2\sqrt{A(\lambda,.)}}\right)\lambda - \sqrt{A(\lambda,.)}}{\lambda^2}\right]$$

We know that: $\frac{\partial \underline{l_i}}{\partial \lambda} = -\frac{\partial F/\partial \lambda}{\partial F/\partial \underline{l_i}}$

Giving:

$$\frac{\partial l_i}{\partial \lambda} = \frac{\partial F/\partial \lambda}{\partial F/\partial \underline{l_i}} + \left[\frac{\left(\frac{A'(\lambda,.)}{2\sqrt{A(\lambda,.)}}\right)\lambda - \sqrt{A(\lambda,.)}}{\lambda^2}\right]$$

$$= -\frac{1}{\partial F/\partial \underline{l_i}}\left(\partial F/\partial \lambda - \partial F/\partial \underline{l_i}\left[\frac{\left(\frac{A'(\lambda,.)}{2\sqrt{A(\lambda,.)}}\right)\lambda - \sqrt{A(\lambda,.)}}{\lambda^2}\right]\right)$$

$$= -\frac{1}{\partial F/\partial \underline{l_i}}\left(\frac{R}{\sigma\sqrt{2\pi}}\underline{l_i}e^{-\frac{\lambda \underline{l_i}^2}{2\sigma^2}} + \frac{\sigma}{\lambda^2 R\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} - \left[\frac{\left(\frac{A'(\lambda,.)}{2\sqrt{A(\lambda,.)}}\right)\lambda - \sqrt{A(\lambda,.)}}{\lambda^2}\right] - \partial F/\partial \underline{l_i}\left[\frac{\left(\frac{A'(\lambda,.)}{2\sqrt{A(\lambda,.)}}\right)\lambda - \sqrt{A(\lambda,.)}}{\lambda^2}\right]\right)$$

We also know that: $\frac{\partial F}{\partial \underline{l_i}} = \frac{\lambda R}{\sigma\sqrt{2\pi}}e^{-\lambda \underline{l_i}^2/2\sigma^2} - 1$

Substituting, we get:

$$= -\frac{1}{\partial F/\partial \underline{l_i}}\left(\frac{R}{\sigma\sqrt{2\pi}}\underline{l_i}e^{-\frac{\lambda \underline{l_i}^2}{2\sigma^2}} + \frac{\sigma}{\lambda^2 R\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} - \left[\frac{\left(\frac{A'(\lambda,.)}{2\sqrt{A(\lambda,.)}}\right)\lambda - \sqrt{A(\lambda,.)}}{\lambda^2}\right] - \left[\frac{\lambda R}{\sigma\sqrt{2\pi}}e^{-\lambda \underline{l_i}^2/2\sigma^2} - 1\right]\left[\frac{\left(\frac{A'(\lambda,.)}{2\sqrt{A(\lambda,.)}}\right)\lambda - \sqrt{A(\lambda,.)}}{\lambda^2}\right]\right)$$

$$= -\frac{1}{\partial F/\partial \underline{l_i}}\left(\frac{R}{\sigma\sqrt{2\pi}}\underline{l_i}e^{-\frac{\lambda \underline{l_i}^2}{2\sigma^2}} + \frac{\sigma}{\lambda^2 R\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} - \left[\frac{\left(\frac{A'(\lambda,.)}{2\sqrt{A(\lambda,.)}}\right)\lambda - \sqrt{A(\lambda,.)}}{\lambda^2}\right]\right.$$

$$\left. + \left[\frac{\left(\frac{A'(\lambda,.)}{2\sqrt{A(\lambda,.)}}\right)\lambda - \sqrt{A(\lambda,.)}}{\lambda^2}\right] - \left[\frac{\left(\frac{A'(\lambda,.)}{2\sqrt{A(\lambda,.)}}\right)\lambda - \sqrt{A(\lambda,.)}}{\lambda^2}\right]\left[\frac{\lambda R}{\sigma\sqrt{2\pi}}e^{-\lambda \underline{l_i}^2/2\sigma^2}\right]\right.$$

Which finally gives:

$$= -\frac{1}{\partial F/\partial \underline{l_i}}\left(\frac{R}{\sigma\sqrt{2\pi}}\underline{l_i}e^{-\frac{\lambda \underline{l_i}^2}{2\sigma^2}} + \frac{\sigma}{\lambda^2 R\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} - \left[\frac{\left(\frac{A'(\lambda,.)}{2\sqrt{A(\lambda,.)}}\right)\lambda - \sqrt{A(\lambda,.)}}{\lambda^2}\right]\left[\frac{\lambda R}{\sigma\sqrt{2\pi}}e^{-\lambda \underline{l_i}^2/2\sigma^2}\right]\right)$$

$\frac{\partial l_i}{\partial \lambda} > 0 \quad \forall \sigma \leq \frac{\lambda R}{e^{\frac{1}{2}}\sqrt{2\pi}}$

Corrolaire: The utility function of the voter is strictly increasing with the effort produced by the local government.

$\frac{\partial y_i}{\partial \lambda} = l_i(\lambda,.) + \lambda\frac{\partial l_i}{\partial \lambda}$ □

E. Proposition 5

Proof. To prove the first part of this proposal, we need only determine whether $\sigma \geq \nu$, as **this inequality implies a higher level of effort produced by the government and determined by the elector in the rule of re-election**($\frac{\partial l_i}{\partial \sigma} < 0$).

$\sigma^2 - \nu^2 = 0$

$= \sigma^2 - \sigma^2(1 - \rho^2)$

$= \sigma^2 - \sigma^2 + \sigma^2\rho^2$

$= \underbrace{\sigma^2\rho^2}_{>0}$

The second part of this proposal requires **to show that the derivative of the incentive constraint with respect to the degree of decentralization is decreasing with the variation of σ:**

$$\frac{\partial^2 F}{\partial\lambda\partial\sigma} = \left(\frac{\lambda \underline{l}_i^3 R}{2\sigma^4\sqrt{2\pi}} - \frac{\underline{l}_i R}{\sigma\sqrt{2\pi}}\right) e^{\frac{-\lambda^2 \underline{l}_i^2}{2\sigma^2}} + \frac{1}{\lambda^2 R\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} + \frac{1}{\lambda^2 R(2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}}))^{\frac{3}{2}}} - \frac{3}{\lambda^2\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} + \frac{\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}{\lambda^2} - \frac{R}{\lambda^2(2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}}))^{\frac{3}{2}}} + \frac{2}{\lambda^3\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}$$

$$= \left(\frac{\lambda \underline{l}_i^3 R}{2\sigma^4\sqrt{2\pi}} - \frac{\underline{l}_i R}{\sigma\sqrt{2\pi}}\right) e^{\frac{-\lambda^2 \underline{l}_i^2}{2\sigma^2}} + \frac{1}{\lambda^2 R\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} + \frac{1-R}{\lambda^2 R(2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}}))^{\frac{3}{2}}} + \frac{2-3\lambda}{\lambda^3\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}} + \frac{\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}{\lambda^2}$$

$$= \left(\frac{\underline{l}_i R\left(\lambda^2 \underline{l}_i^2 - 2\sigma^3\right)}{2\sigma^4\sqrt{2\pi}}\right) e^{\frac{-\lambda^2 \underline{l}_i^2}{2\sigma^2}} + \frac{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})+1-R}{\lambda^2 R(2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}}))^{\frac{3}{2}}} + \frac{2-3\lambda+\lambda 2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}{\lambda^3\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}$$

The first term is negative for $\lambda^2 \underline{l}_i^2 - 2\sigma^3 \leq 0$ *i.e.* $\lambda \leq \frac{2\sigma^3}{\underline{l}_i^2}$.

The second term is negative for $\lambda \geq \frac{2}{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})+3}$.

Finally the last term is also negative for $\lambda \leq \frac{\sigma\sqrt{2\pi}}{R} e^{\frac{R-1}{2}}$.

By definition, $0 < \lambda < 1$**: We can thus find a range of σ (depending on other parameters) for which $\frac{\partial^2 F}{\partial\lambda\partial\sigma}$ is always negative.** Therefore,

$$\frac{\partial^2 F}{\partial\lambda\partial\sigma} < 0 \quad \forall \underbrace{\frac{2}{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}}) + 3}}_{\leq 0\ \forall\ \sigma \leq \frac{\lambda R}{\sqrt{2\pi}} e^{-\frac{3}{2}}} \leq \lambda \leq \begin{cases} \frac{\sigma\sqrt{2\pi}}{R} e^{\frac{R-1}{2}} \\ \frac{2\sigma^3}{\underline{l}_i^2} \end{cases}$$

$$\lambda \leq 1\ \forall\ \sigma \geq \frac{R}{\sqrt{2\pi}} e^{-\frac{(R-1)}{2}}$$

We seek to show that this interval is not empty.

We know from Proposition 1 that $\underline{l}_i > \frac{\sqrt{A}}{\lambda}$ thus $\frac{1}{\underline{l}_i^2} < \frac{\lambda^2}{A}$.

$\lambda \leq \frac{2\sigma^3}{A}\lambda^2 <=> 1 \leq \frac{2\sigma^3}{A}\lambda$

$1 \leq \frac{\sigma}{ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}\lambda <=> \lambda\sigma - ln(\frac{\lambda R}{\sigma\sqrt{2\pi}}) \geq 0$

$<=> \lambda^2 ln(\frac{\overline{\sigma}}{\sigma}) \leq \sigma <=> \lambda^2 ln(\overline{\sigma}) \leq \sigma + \lambda^2 ln(\sigma)$

$\frac{2}{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})+3} \leq 0$

$\frac{1}{ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})} + \frac{2}{3} \leq 0 <=> 1 \leq \frac{2}{3}\left(ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})\right)$

$\frac{3}{2} \leq ln(\frac{\lambda R}{\sigma\sqrt{2\pi}}) <=> e^{ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})} \geq e^{\frac{3}{2}}$

Finally $\lambda \leq \frac{\sigma\sqrt{2\pi}}{R} e^{\frac{R-1}{2}} \geq 1$ for $\sigma \geq \frac{R}{\sqrt{2\pi}} e^{-\frac{(R-1)}{2}}$

$\lambda R \geq \sigma\sqrt{2\pi} e^{\frac{3}{2}} <=> \sigma \leq \frac{\lambda R}{\sqrt{2\pi}} e^{-\frac{3}{2}}$ where $\overline{\sigma} = \frac{\lambda R}{\sqrt{2\pi}}$

$e^{-\frac{(R-1)}{2}} \leq \frac{\sigma}{\overline{\sigma}} \leq e^{-\frac{3}{2}}$

This interval is not empty for $R \geq 4$. □

F. Proposition 6

Proof. The condition of signal acquisition (I) is binded at a cost of signal acquisition: $E_{\chi_i}\left[y_i^C\right] - C_I - y_i^0 = 0$ giving:

$\overline{C_I} = E_{\chi_i}\left[y_i^C\right] - y_i^0$ ◻

G. Proposition 7

Proof. We seek to know the effect of varying the degree of decentralization policy on the voter's decision to acquire information ($I^\star$): $\frac{\partial I^\star}{\partial \lambda} = \underbrace{\frac{\partial y_i^1}{\partial \lambda}}_{l_i^1+\lambda\left(\frac{\partial l_i^1}{\partial \lambda}\right)} - \underbrace{\frac{\partial y_i^0}{\partial \lambda}}_{l_i^0+\lambda\left(\frac{\partial l_i^0}{\partial \lambda}\right)}$

$$= l_i^1 + \lambda\left(\frac{\partial l_i^1}{\partial \lambda}\right) - l_i^0 - \lambda\left(\frac{\partial l_i^0}{\partial \lambda}\right)$$

$$= \underbrace{l_i^1 - l_i^0}_{>0} + \lambda\left(\frac{\partial l_i^1}{\partial \lambda} - \frac{\partial l_i^0}{\partial \lambda}\right)$$

$$= \underbrace{l_i^1 - l_i^0}_{>0} + \lambda\left(\frac{\partial l_i^1}{\partial \lambda} - \frac{\partial l_i^0}{\partial \lambda} + \frac{\nu\left(1-2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})\right) - \sigma\left(1-2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})\right)}{\lambda^2\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}\right)$$

$$= \underbrace{l_i^1 - l_i^0}_{>0} + \underbrace{\lambda}_{>0}\left(\underbrace{\frac{\partial l_i^1}{\partial \lambda} - \frac{\partial l_i^0}{\partial \lambda}}_{\substack{>0 \\ Si\ \frac{\partial^2 F}{\partial\lambda\partial\sigma}\leq 0}} + \underbrace{\frac{\sigma(1-\rho)\left(1-2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})\right)}{\lambda^2\sqrt{2ln(\frac{\lambda R}{\sigma\sqrt{2\pi}})}}}_{\substack{>0 \\ \forall\ \sigma\leq\frac{\lambda R}{\sqrt{2\pi}}e^{-\frac{1}{2}}}}\right)$$

We know from the previous proposition that $\frac{\partial^2 F}{\partial\lambda\partial\sigma} \leq 0$ for an intermediate level σ $\forall$ $\frac{R}{\sqrt{2\pi}}e^{-\frac{(R-1)}{2}} \leq \sigma \leq \frac{\lambda R}{\sqrt{2\pi}}e^{-\frac{3}{2}}$.

For this same interval, the decision to acquire information is monotonically increasing with the degree of decentralization. ◻