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Spatial distribution of innovative activities and economic performances: A geographical-friendly model

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Répartition spatiale des activités d'innovation et performances économiques : un modèle "geographical-friendly'

Résumé

Le papier identifie cinq faits stylisés pour caractériser la répartition géographique des activités d'innovation en France (notamment leur forte concentration en Ile-de-France). Il propose un modèle original de croissance régionale dans une économie basée sur la connaissance, prenant en compte la densité des activités scientifiques et technologiques ainsi que la connectivité avec les autres régions. Deux configurations types (une équirépartition et une hyperconcentration dans une région centrale) sont utilisés pour simuler la croissance des régions. Les résultats conduisent à la conclusion que l'équirépartition est Pareto-efficiente par rapport à la configuration de l'hyperconcentration : le taux de croissance de l'économie nationale est plus élevé et les inégalités spatiales de revenu sont plus faibles. En conclusion, les implications en terme de politique de centralisation/décentralisation des activités scientifiques sont discutées.

Mots-clés : Croissance régionale ; France ; Géographie de l'innovation ; Simulation ; Spill over de connaissances

Spatial distribution of innovative activities and economic performances: A geographical-friendly model

Abstract

The paper identifies 5 stylized facts to characterize the geographic distribution of innovative activities in France (mainly its high concentration in the region Ile-de-France). It proposes an original model of regional growth in a knowledge-based economy considering the density of RD activities and the connectivity to the other regions. The model is computed and run into 2 different configurations: equidistribution and overconcentration. The simulations' results lead to the conclusion that the equidistribution configuration is Pareto-efficient (higher growth rate of the national economy, lower income spatial inequalities) compared to the overconcentration. Policy implications are discussed in conclusion.

Keywords: France; Geography of innovation; Knowledge spillover; Regional growth; Simulation

JEL : O330; R110

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Introduction[1]

It is generally assumed in the economic literature, that agglomeration of scientific and technological activities is a factor of performance for the dynamic of innovation, due to firms' proximity to related partners (suppliers, customers, science) participating to the resolution of new problems associated to firms' search activities (Feldman, 1994; Audrestch, Feldman, 1996; Kirat, Lung, 1999; Frenken et alii, 2007; Carrincazeaux, Coris, 2010). Location in metropolitan areas characterised by spatial concentration of science-based and technological activities is then considered as an advantage for firms (Martin, Ottaviano, 1999), due to external effects of technological spillovers, which would be largely geographically based.

In such a view, innovation policy would locate most of public RD expenses in a limited number of metropolitan areas, concentrating large scientific and technological infrastructures to maximize their external effects. Such geographical configuration could be deduced from the cumulative nature of innovation dynamic. In a context of limited RD resources, other regions would be outside the new growth regime associated to the knowledge-based economy, the concentration of public RD expenses in selected places being necessary to consolidate the national knowledge basis and the economy's competitiveness.

Our paper will discuss such a view, taking into consideration not only the positive effects of proximity in the innovation process, but also its negative aspects due to overconcentration and to shadow effects that central regions could generate to their neighbour (pericentral) regions.

The structure of the paper is the following one: section 1 will shortly characterize the stylized facts of the geographic distribution of scientific and technological activities in France; in section 2 we propose a model of regional growth within a knowledge-based economy which could correspond to such stylised facts; section 3 presents the results of simulations comparing different spatial distribution of scientific and technological activities within an economy; and finally, conclusion will discuss its policy implications.

[1] This research has been supported by the Ministère de l'Enseignement Supérieur et de la Recherche and the Conseil Régional d'Aquitaine (project *Les trajectoires de l'innovation,* MSHA), and by the European Union (EURODITE Integrated Project, FP6). Previous versions of the model have been presented and discussed in different places. The authors would thank their colleagues for their remarks and comments, particularly professor Francesco Ricci (Université de Poitiers). Nevertheless, they remain responsible for any error in the present version

1. Stylized facts on the geographic distribution of innovative activities in France

Five main stylized facts characterize the spatial distribution of innovative activities in France.

Stylized fact 1: There is a high (over-)concentration of RD activities in Ile-de-France

The central region (the Great Paris) concentrates 42.3% of the total domestic spending on RD (DIRD) in France in 2005: about 44% of domestic corporate RD activities (measured by expenses or number of researchers) and 35-40% of academic research activities in France (Table 1).

Allocating more than 3% of its gross regional product to RD (3.1% compared to 2.1% at the national level in 2005), Ile-de-France outreaches the objective associated to the Lisbon Agenda and it is the European leading region. According to OST statistical data (OST, 2008), it ranks #1 at the European level whatever the indicator used: Ile-de-France concentrates 4.7% of scientific publications, 5.5% of patents and 5.1% of scientific and technological activities in the European Union.

Stylized fact 2: The share of Ile-de-France in domestic RD activities is regularly declining

As indicated in Table 1, central region' share in domestic RD activities has significantly declined during the last period, mainly for industrial research: it loses 10% of total firms' researchers (and 9% of RD spending) from 1992 to 2005.

Table 1 – Evolution of Ile-de-France share in French RD activities

Share in domestic RD activities

	1992	2005
Corporate research activities		
Corporate spending on RD (DIRDE)	53.2%	44.1%
Industrial researchers	54.6%	44.5%
Academic public research		
Public spending (DIRDA)	41.9%	39.1%
Public researchers	(1998) 37,2%	35,5%

Source: Ministère de la recherché et de l'enseignement supérieur
http://cisad.adc.education.fr/reperes/public/chiffres/france/reg.htm

Such a decrease of the central region' share suggests that, after other manufacturing and services activities (Combes, Lafourcade, Thisse and Toutain, 2009), the French RD geography is on the right size of the bell-shaped evolution of the spatial concentration of innovative activities.

Stylized fact 3: Such a spatial configuration of innovative activities is not efficient

While the central region concentrates about 39.1% of civil public research's spending, only 35.8% of scientific publications are originated from Ile-de-France (IDF). Regarding corporate RD activities, the performance can also be discussed: while 44.5% of corporate spending is located in the central region, only 37.6% of European patents come from IDF (Table 2).

Such data does not demonstrate an under-performance of spatial concentration of RD activities, as structural effects could explain these results. Nevertheless, it allows to discuss the advantage of such overconcentration and to take seriously the hypothesis of dominant disadvantages associated to such a spatial configuration (see Carré, 2006).

Table 2 – Relative performances of research activities in IDF

Industrial research index	Share of IDF in European patents / Share of IDF in total industrial R&D expenses (2005)	0,845
Public research index	Share of IDF in total scientific publications / Share of IDF in total public R&D expenses (2005)	0,916

Source: OST, 2008

Stylized fact 4: No specific regional systems of innovation can be observed in regions

Previous statistical analysis done to identified diversity within regional configuration of innovative innovation, following the social system of innovation and production (SSIP)'s methodology developed by Amable, Barré and Boyer (1997) led to the conclusion that no specificities can be observed at the regional level in France (Carrincazeaux, Lung, 2005). This result has been extended to the analysis of European regions where, except for metropolitan areas, national effect is dominant in the institutional configuration (Carrincazeaux, Gaschet, 2006).

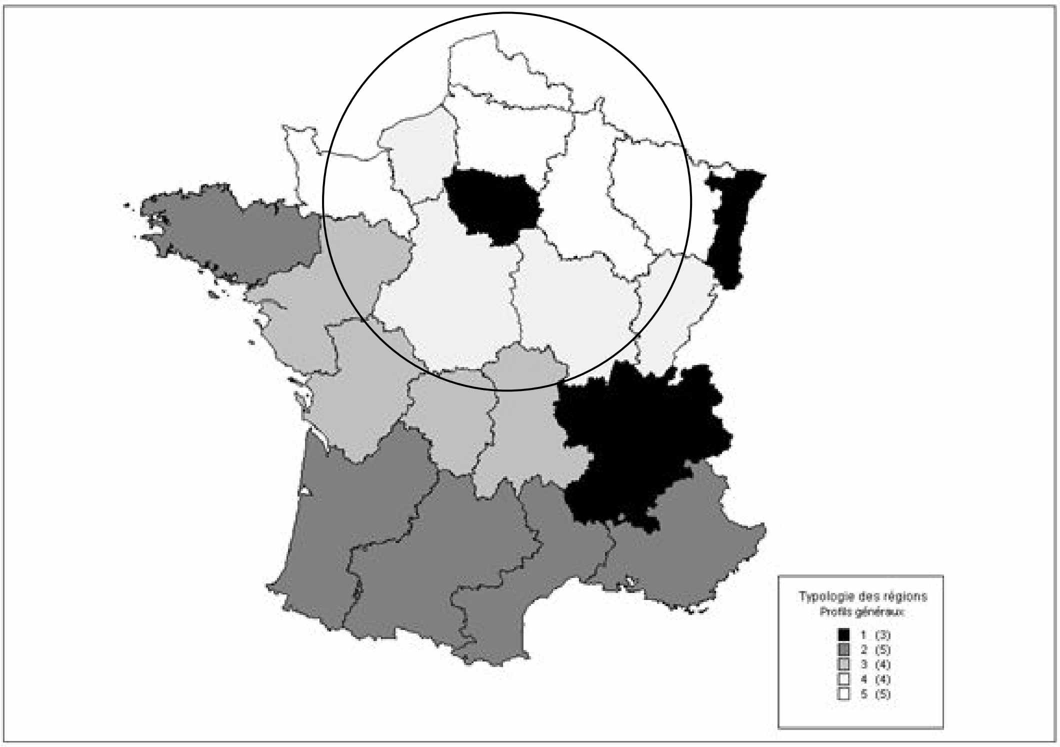
We can conclude that there is no true "regional innovation system"[2], the main institutional arrangements which influence the dynamics of innovation (finance, policies, education and training, wage-labour nexus) being socially constructed at the national level (Amable, 2003). If region can be characterized by a regional configuration of innovative activities, it is mainly a specification of the national system of innovation.

Stylized fact 5: There are evident shadow's effects of IDF on contiguous regions.

On the basis of previous analysis of regional configuration of innovative activities in France (Carrincazeaux, Lung, 2006), it appears clearly that regions closed to IDF have a low density of scientific and technological activities, and that their economic and social performances remain low (map 1).

[2] Due to their openness (higher interactions with elements outside region rather than inside, which is particularly evident for scientific and technological interactions), region cannot definitively be defined as system. The hypothesis of quasi-decomposability would have to be rejected.

Map 1 –Synthetical profiles of French regions (1996-1998)



Type 1 - Diversified and dynamic regions

Type 2 - Regions fitting into the new growth regime

Type 3 - Intermediary regions

Type 4 - Industrial regions in transition

Type 5 - Penalized industrial regions

Source: Carrincazeaux, Lung, 2006

2. A model of regional growth in a knowledge-based economy

We elaborate a theoretical model which reproduces these main stylized facts. This model based on three main hypotheses.

Hypothesis 1: The regional rate growth depends on the performance of regional scientific and technological activities (RD).

In a knowledge-based economy, regional economic growth depends on the regional innovative capabilities. These capabilities determine the performances of local scientific and technological activities, i.e. location of RD resources in the region, their collective efficiency through interacting processes and their accessibility to competencies located in other regions.

We consider a national economy composed of n regions R_i. This economy is characterized by a national system of innovation which predominates within each region. This hypothesis leads to ignore institutional dimension of innovation dynamics in our model, as institutions are supposed identical in each region.

The national product Q_t can be deduced from regional products Q_i:

$$Q_t = \sum_{i=1}^{n} Q_{i,t} \qquad [1]$$

The growth rate of regional product q_i is given by:

$$q_{i,t} = \alpha_1 e_{i,t} + \alpha_2 y_{i,t} \qquad [2]$$

with e_i, an indicator of performance of regional configuration of scientific and technological activities and y_i, other factors.
α_1 and α_2 are parameters reflecting the sensitivity of regional growth rate to these two variables ($\alpha_1 \geq 0$ and $\alpha_2 \geq 0$).

Hypothesis 2: Regional performance of scientific and technological activities is function of RD density and connectivity of the region (interregional spillover effects)

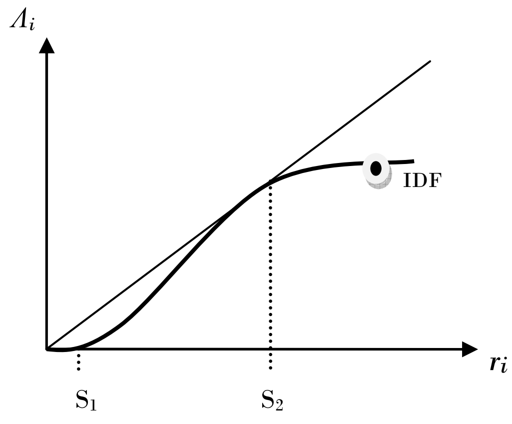
The performance of regional configuration of scientific and technological activities depends on the RD density r_i of the region. Two effects occur.

First, we assume a <u>positive effect of spatial agglomeration of scientific and technological activities</u> related to size effects of located competencies (increasing returns) and their diversity. This is reflected by the Λ_i function:

$$\Lambda_{i,t} = \frac{\pi_1}{\pi_2 + \pi_3 . e^{-\pi_4 . r_{i,t}}} \qquad [3]$$

with π_1, π_2, π_3 and π_4 parameters ($\pi_1, \pi_2, \pi_3, \pi_4 > 0$).

Figure 1 – Underdevelopment trap and excessive spatial concentration



Λ_i is a logistic function with two threshold effects (Figure 1):

- on one side, the underdevelopment trap for low level of RD activities (S_1). After a critical low value, increasing returns appear associated to agglomeration of knowledge activities;
- on the other side (S_2), excessive spatial concentration induces to external diseconomies and urban congestion effects leading to decreasing returns (Boschma, 2005).

This hypothesis is coherent with Antonelli et alii (2008) hypothesis which consider that there is an inverted U-shaped relationship between the agglomeration of innovative activities and productivity growth. Empirically, it is supported by the analysis on the paradoxical performances of Ile-de-France (Carré, 2006).

Second, we assume that regional connectivity of located RD to other regions has a positive effect on performance of configuration of scientific and technological activities. Regional connectivity relies on accessibility to resources located into other regions and absorption capacity of external knowledge which depends on internal RD density (Autant-Bernard, 2001; Massard and Meier, 2009). Regional connectivity is defined by the Ω_i function:

$$\Omega_{i,t} = a.\ln\left(\sum_{j\neq i}^{n-1} p_{ij}.r_{i,t}.r_{j,t}\right) \qquad [4]$$

with a, a scale factor associated to regional absorption capabilities of spillover effects ($a \geq 0$) and p_{ij}, an indicator of interregional proximity, here reduced to spatial contiguity between regions: $p_{ij} = 1$ if regions *i* and *j* share a common border, $p_{ij} = 0$ otherwise.

Finally, the performance of regional configuration of scientific and technological activities e_i is given by:

$$e_{i,t} = \Lambda_{i,t} + \Omega_{i,t} \qquad [5]$$

Hypothesis 3: RD activities density depends on regional attractiveness for scientific and technological activities.

Regional RD density r_i is given by following function:

$$r_{i,t} = r_{i,t-1} + \Delta r_{i,t} \qquad [6]$$

Change in RD density Δr_i depends on the regional attractiveness of new activities, which is explained by two mechanisms. First, we assume a cumulative dynamic of spatial concentration of RD reflected by the function θ_i:

$$\theta_{i,t} = \gamma_1.r_{i,t-1} \qquad [7]$$

with γ_1, a parameter ($\gamma_1 \geq 0$).

The second mechanism relies on shadow effects and knowledge spillovers, through function φ_i:

$$\varphi_{i,t} = \gamma_2 \sum_{j\neq i}^{n-1} p_{ij}.\rho(\varepsilon_{ij,t}) \quad [8]$$

with γ_2, a parameter ($\gamma_2 \geq 0$), and ρ, a function depending on the balanced results between shadow effects and knowledge spillovers. ρ is a quadratic function given by the following equation:

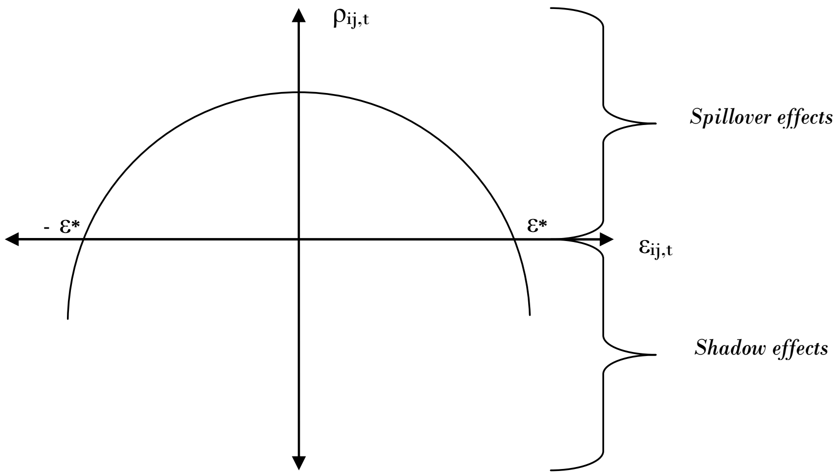
$$\rho(\varepsilon_{ij,t}) = -b\varepsilon_{ij,t}^2 + c \qquad [9]$$

with b and c, parameters ($b \geq 0$ and $c \geq 0$) and ε_{ij}, the relative distance between r_i, regional density of RD activities, and r_j, densities within nearby regions:

$$\varepsilon_{ij,t} = \frac{r_{j,t} - r_{i,t}}{r_{i,t}} \qquad [10]$$

In fact, to implement their innovations, companies need complementary external resources. These resources can be found in their region, but also in neighbour regions. Consequently, the decision to locate in region *i* will depend on the RD density of region *i*, but also on access to complementary resources in these neighbour regions.

Figure 2 – Balanced results between shadow effects and knowledge spillovers



In this way, the quadratic form for ρ can be justified as follow (see Figure 2):

- when regions *i* and *j* have a close density[3] ($-\varepsilon^* < \varepsilon_{ij} < \varepsilon^*$), the probability to find complementary resources in the neighbour region is high, which leads to spillover effects. In fact, when regions have a close density, companies located in one region can benefit from knowledge externalities from the other regions, in particular the neighbour and especially contiguous regions. The smaller the gap between the two regions, the higher knowledge spillover effects. When the gap grows, knowledge spillovers decrease because resources complementarities tend to lower and location in a contiguous region becomes preferable. The attractiveness of the considered region decreases.
- When the distance becomes significant ($\varepsilon_{ij} > |\varepsilon^*|$), the complementarities between regions disappear and contiguous regions produce/suffer from shadow effects. If region *i* is sharply less dense than its neighbour region *j* ($\varepsilon_{ij} > \varepsilon^*$), it will suffer from shadows effects because it is too small to benefit from knowledge externalities from region *j* and companies will tend to locate their activities in this central region characterized by a strong RD density. In this case, the central region *j* can be considered as a "black hole". Symmetrically, if region *i* is sharply denser than its

[3] If we consider an economy with one industry, this can be considered as technological proximity.

neighbour region *j* (ε_{ij} < - ε*), it will also suffer from shadow effects because companies located in region *i* cannot benefit from external complementary resources from region *j*. They will tend to locate in regions characterized by potential technological spillovers. This last configuration would correspond to the relationships between IDF and its contiguous regions ("quasi-desert") and to its slightest performances (it does not benefit from technological spillovers from neighbours regions).

We can notice that *ρ* depends on the relative distance between regions, which implies that for the same absolute distance between two regions, shadow effects or knowledge spillovers will be lower in the denser region.

Finally, change in R&D density Δr_i is given by:

$$\Delta \mathbf{r}_{i,t} = \theta_{i,t} + \varphi_{i,t} = \gamma_1 . \mathbf{r}_{i,t-1} + \gamma_2 \sum_{j \neq i}^{n-1} p_{ij} . \left(- b \left(\frac{\mathbf{r}_{j,t} - \mathbf{r}_{i,t}}{\mathbf{r}_{i,t}} \right)^2 + c \right) \qquad [11]$$

3. Simulation results

We use the LSD 5.8 simulation platform[4] to compute and run the model. In the simulation experiments, we formalized 26 Christallerian (hexagonal) regions (cf. Figure 3). We ran two simulations of 450 periods each to study two scenarios. In the first scenario C1 (equidistribution), all the regions have the same initial RD density r_i and regional product Q_i. In the second scenario C2 there is initially an "overconcentration" of RD activities within one central region corresponding to the stylized facts of Ile-de-France: we assume that the central region L12 initially concentrates 50% of the total RD expenditures and 25% of the national product Q_0. All the other regions have the same initial RD density and regional product. We use a specific configuration of the parameters in order to understand and examine the main mechanisms of the model dynamics. A sensitivity analysis of the parameters is proposed in appendix 2. To simplify, we assume that the regional growth rate q_i depends only on the performance of regional configuration of scientific and technological activities (e_i). There is no other variable ($y_i = 0$).

We will concentrate our analysis on the trend of RD density (r_i), regional configuration of scientific and technological activities of regions (e_i) and economic performances (q_i and Q_i).

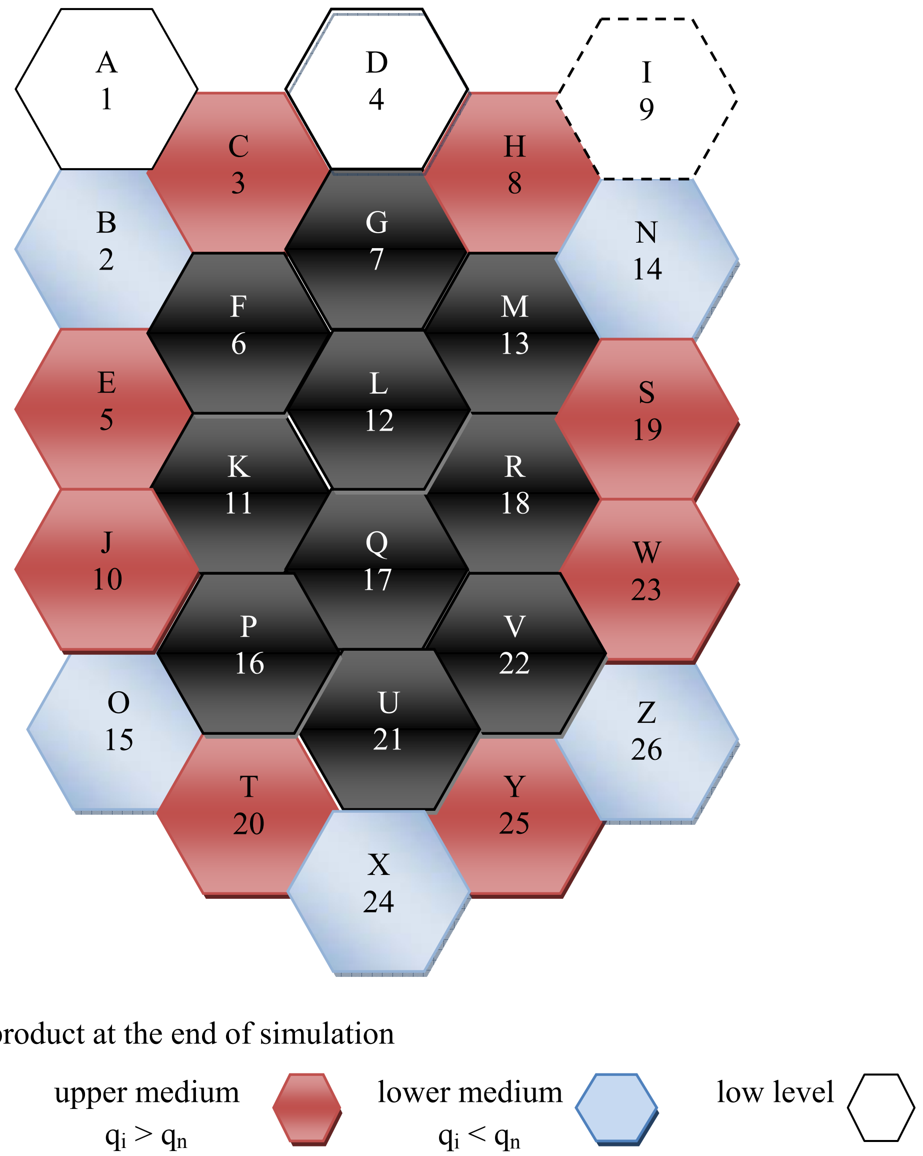
Configuration 1: Equidistribution (C1)

In the first scenario, we observe in the end of the simulation two groups of regions: central regions and peripheral regions. Central regions L12 and Q17 have the highest RD densities (r_i) and consequently the best performance of regional configuration of scientific and technological activities (e_i), and their neighbour regions benefit from / generate localized knowledge externalities, with decreasing effects as the distance to the centre grows.

[4] http://www.marcovalente.eu

This expected configuration "centre vs. periphery" is explained by knowledge spillovers and regional connectivity. In fact, in this very simple model, the more a region has neighbours, the more it is connected to other regions and the more it is likely to benefit from knowledge spillovers. In this way, the positive proximity effects will be higher for central regions than peripheral regions. There is an auto-reinforcement of central regions due to their great interconnection and knowledge spillovers. This phenomenon leads to an increasing trend for their technological and economic performances (growth rate). Since all the regions have initially the same RD density, there is no shadow effect and regions' trajectories depends mainly on knowledge externalities from neighbour regions, thus from the number of borders with other regions. Consequently, the technological distance between these regions remains small over all the simulation.

Figure 3 – Spatial configuration associated to equidistribution of innovative activities.



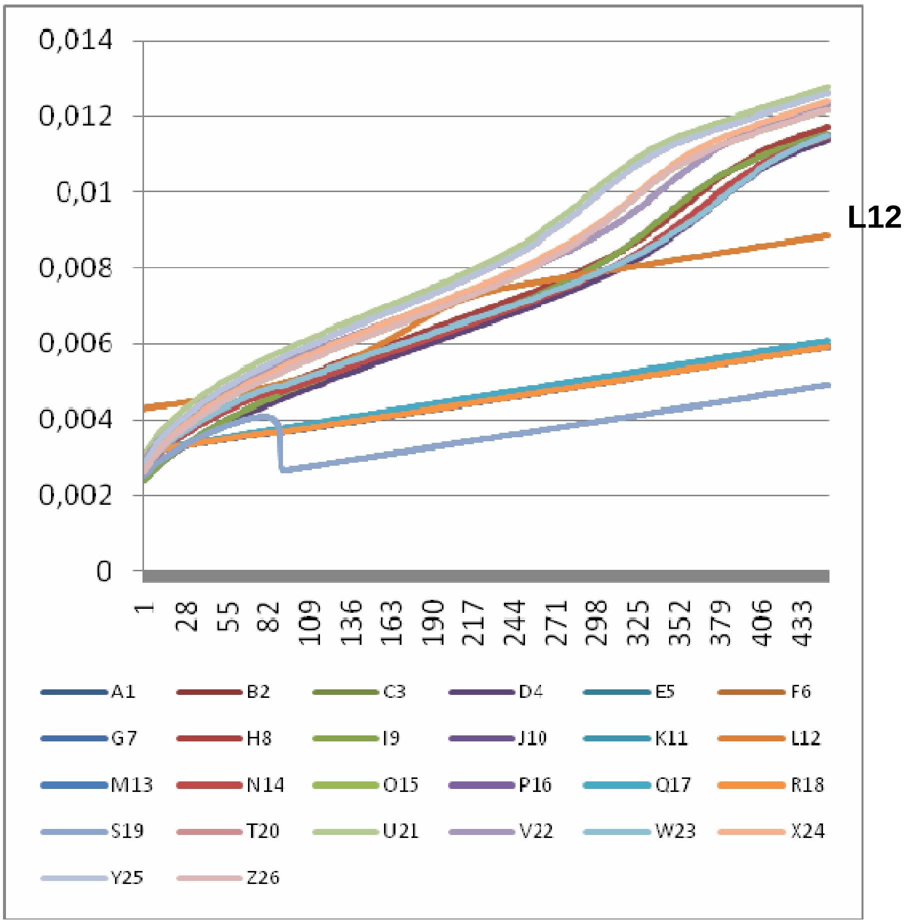
Most of the peripheral regions have increasing performance too, but because of their lower regional connectivity, this rate is lower than the rate of the central regions. Consequently, the gap between centre and periphery is increasing over time and central regions will tend to generate shadow effects to their neighbour peripheral regions (pericentral regions), which will lower their growth rate. In the final analysis, we can notice a double geographical burden for peripheral places since they suffer from a low regional connectivity and a shadow effect from the central regions.

Considering an equidistribution of domestic income between the 26 regions at time t_o, the evolution in spatial distribution of innovative activities led to differential regional growth rate and a spatial organisation of a centre-periphery type.

Configuration 2: Over-concentration (C2)

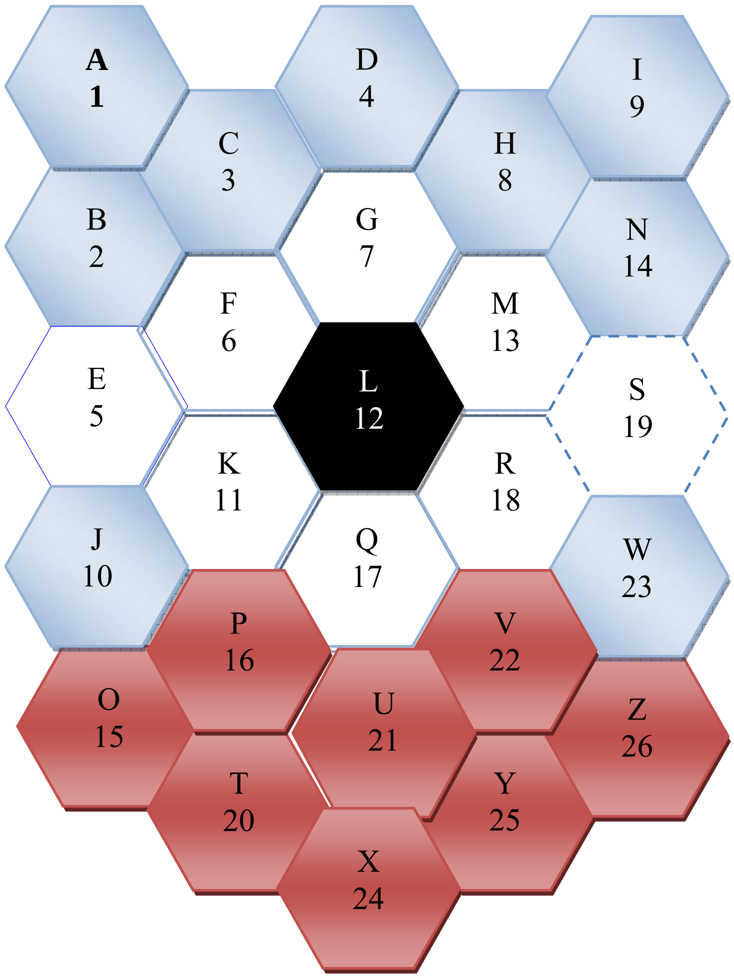
In this second scenario C2, the region L12 has initially the highest RD density with 50% of the total RD resources. The simulation results show that L12 decreases progressively its advantage over the time and, in the end of the simulation run, L12 agglomerates 22.5% of the national RD resources. At the same time, regarding the configuration of scientific and technological activities of regions, L12, which has initially the best performance, is quickly exceeded by the geographically distant Southern regions U21, T20, X24, Y25 and their neighbour regions.

Figure 4 – Evolution of the performance of regional configuration of scientific and technological activities (e) during the simulation (overconcentration)



This result is explained by negative effects of proximity due to the initial overconcentration of RD in the central region L12. This overconcentration generates shadow effects to its neighbour regions explaining the low RD density of the other pericentral regions (contiguous to L12). There are also shadow effects on L12 because its neighbour regions are too small to generate knowledge spillovers. L12 is then connected with weak regions which will limit its development. In the final analysis, the RD density of L12 is increasing because the cumulative effect of spatial concentration of RD overtakes these shadow effects but the share of L12 in the national RD resources is regularly declining due to the development of distant regions. In fact, the most distant regions are too far away to be affected by these shadow effects from L12. They will then benefit from positive effects of proximity and will develop knowledge spillovers leading to a very efficient configuration of scientific and technological activities. Symmetrically to the South, a Northern pole appears progressively, but it remains weaker due to the frontier which implies low connectivity.

Figure 5 – Spatial configuration associated to overconcentration of innovative activities in central region L12.



Variable: regional product at the end of simulation

high level ⬢ upper medium ⬢ lower medium ⬢ low level ⬡

Nevertheless, the greater initial product of L12 combined with its relatively high growth rate gives it a great initial advantage and even if the growth rate of L12 is rapidly becoming smaller than U21, T20, Y25 and X24, the central region maintains its dominant share in national product.

In this configuration, a clear Christallerian configuration (central places hierarchy) emerges from an initial situation of equidistribution outside the central region. The simulation is related with the French case: compared with the previous configuration, contiguous regions close to the central region (pericentral) suffer from shadow effects, a Southern pole emerges with the development of strong competencies in scientific and technological activities, and better performances of these activities compared to the central region.

Conclusion: Policy implications

The limited aim of this paper was to introduce a discussion on the performance of the spatial distribution of RD activities, questioning the over-concentration in the central region Ile-de-France in the France case. Surprisingly the Conseil d'Analyse Economique report recently published on this topic (Madiès, Pradier, 2008) did not discuss this specific situation, while centralisation and the role of Paris region is a tremendous characteristic of the French national system. If there are presently high debates on the organisation of the Great Paris region, to ameliorate its economic performances, we can observe a true "black out" on the crucial question: *is the concentration of RD in Ile-de-France a source of economic performance?*

Quite the contrary, it is said that the reinforcement of Ile-de-France attractiveness of RD activities would be a factor of competitiveness of the French national economy, without any strong argument to support such a proposal. If the trade-off between efficiency and equity associated to spatial agglomeration of innovative activities is globally discussed, this is done to justify this over-concentration and governmental policies which reinforces this tendency by locating new public scientific great equipments and developing financial supports for corporate RD (see the development Plateau de Saclay area –in the suburbs of Paris– presented as the main urgency for the French innovation policy).

Our results are definitively opposed to such a generally accepted view: configuration C1 (equidistribution) is Pareto-efficient compared to the second scenario C2 (hyperconcentration) considering the two criteria:

- The growth rate for the national economy is higher in configuration C1 (+19.3%). Then the national wealth (GNP) is lower in the hyperconcentration configuration C2 than in the equidistribution scenario.
- Inequalities in the distribution of regional income (GRP) is lower in scenario C1: using the Herfindahl Hirschman Index, the spatial inequality associated to the distribution of regional product is: $HHI_{C1} = 0{,}0388 < HHI_{C2} = 0{,}0871$

Despite its limits, our model suggests that it would be necessary to stop the cluster-mania and to open the research agenda of the impact of spatial distribution of innovative activities on economic performances.

Appendix 1
Parameters value and initial value for variables in simulation

Parameters:

$\alpha_1 = 0.2$ $\alpha_2 = 0$
$\pi_1 = 0.0001$ $\pi_2 = 0.05$ $\pi_3 = 2$ $\pi_4 = 0.01$
$\gamma_1 = 0.01$ $\gamma_2 = 0.1$
a = 0.00065
b = 1
c = 0.5

Initial value for variables:

$Q_0 = 1000$

$$\sum_{i=1}^{26} r_{i,0} = 200$$

Appendix 2
Sensitivity analysis of the parameters

We have tested the stability of the results obtained in the over-concentration scenario, analysing the impact of changes of the parameters' value on the results for the last period of each simulation. We ran 500 simulations for each parameter where the value of the parameter studied was initially randomly chosen. The main parameters were chosen between the following maximum and minimum values: $\gamma_1 \in [0 ; 0.02]$; $\gamma_2 \in [0 ; 0.2]$; $b \in [0 ; 2]$; $c \in [0 ; 1]$[5].

Concerning the parameter γ_1 (equation [7]), reflecting the weight of cumulative dynamic in the variation of RD density Δr_i, as expected we can notice a positive effect on RD density and regional growth rate. The higher the cumulative effect, the higher RD density and consequently the higher regional growth rate.

For parameter γ_2 (equation [8]) -weight of spillover/shadow effects in the variation of RD density Δr_i- we observe a positive effect on RD density and regional growth rate for the Northern and Southern regions and a negative effect for the other regions. This result is easy to explain. A higher value for γ_2 increases the impact of shadows effects for the regions close to the central region L12 and at the same time it increases the impact of spillover effects for the peripheral Northern and Southern regions.

[5] We have also test the sensitivity of our results to the parameters of the logistic function Λ_i (equation (3)) with $\pi_1 \in [0 ; 0.0002]$; $\pi_2 \in [0 ; 0.1]$; $\pi_3 \in [0 ; 4]$; $\pi_4 \in [0 ; 0.02]$. Interested readers may obtain a full copy of the results by writing to the authors.

As regards the parameters of the quadratic function (equation [9]), we observe a negative effect of b and a positive effect of c on RD density and regional growth rate. In fact, ε* is equal to $(c/b)^{1/2}$ and the maximum value for ρ is equal to c. Consequently, the higher the value for b, the scarcer spillover effects: RD densities of regions have to be very close to generate spillover effects. On the contrary, the higher the value for c, the easier to benefit from knowledge spillovers.

Concerning the hierarchy between regions in terms of economic performance, we can notice that the core of the configuration (the central region L12 and the pericentral regions) is very stable. Whatever the value of the different parameters, there are only shadow effects between the central region L12 and its neighbours. Consequently, the growth rates of these regions are less sensitive to the parameters than the other regions. As regards these last regions, depending on the value of the different parameters, a spillover effect could become a shadow effect and vice versa leading to jumps or falls in economic performance of regions. Higher values for γ_1 and c expand spillover effects leading to jumps in economic performance while higher values for γ_2 and b tend to expand shadow effects which favours falls in economic performance of regions. Consequently, the place of some regions within the hierarchy could change depending on the configuration of parameters, especially for intermediate regions localized between different centres (B2, N14, J10 and N23). But, we can notice that whatever the value of the parameters, the central region L12 maintains its dominant share in national product.

References

AMABLE Bruno (2003) *The Diversity of Modern Capitalism,* Oxford University Press, Oxford.

AMABLE Bruno, BARRE Rémi, BOYER Robert (1997) *Les système d'innovation à l'ère de la globalisation*. Paris : Economica

ANTONELLI Cristiano, PATRUCCO Pier Paulo, QUATRARO Francesco (2008) "The Governance of Localized Knowledge Externalities", *International Review of Applied Economics,* 22(4), 479-98.

AUDRETSCH David, FELDMAN Maryann (1996) "R&D Spillovers and the Geography of Innovation and Production", *American Economic Review*, 86 (3), 630-40

AUTANT-BERNARD Corinne (2001) "The Geography of Knowledge Spillovers and Technological Proximity", *Economics of Innovation and New Technology*, 10 (4), 237-54

BOSCHMA Ron (2005), "Proximity and Innovation: A critical assessment", *Regional Studies,* 39(1), 61-74.

CARRE Denis (2006) "Les performances paradoxales de l'économie de l'Ile-de-France : essai d'interprétation", *Revue d'économie régionale et urbaine,* n°4, 575-95.

CARRINCAZEAUX Christophe, CORIS Marie (2010) "Proximity and Innovation', in P. Cooke et alii (eds.), *Handbook of Regional Innovation and Growth*, Edward Elgar, Cheltenham, forthcoming

CARRINCAZEAUX Christophe, GASCHET Frédéric (2006) "Knowledge and the diversity of innovation systems: a comparative analysis of European regions"*, Cahiers du GRES*, 2006-29, http://ideas.repec.org/p/grs/wpegrs/2006-29.html.

CARRINCAZEAUX Christophe, LUNG Yannick (2005) "Configurations régionales des dynamiques d'innovation et performances des régions françaises", *Concentration économique et ségrégation spatiale,* D. Mignot (coord.), De Boeck, Bruxelles, 130-45.

CARRINCAZEAUX Christophe, LUNG Yannick (2006) "Conflit ou coopération dans la géographie de l'innovation des régions françaises : la proximité de l'Ile de France comme handicap pour les espaces contigus", in C. Bouneau, Y. Lung (coord.), *Les territoires de l'innovation, espaces de conflits*, Presses de la MSHA, Pessac, 221-46.

COMBES Pierre-Philippe, LAFOURCADE Miren, THISSE Jacques-François, TOUTAIN Jean-Claude (2009) "The rise and fall of spatial inequalities in France: A long-run perspective", *Document de travail CEPR* 7101.

FRENKEN Koen, van OORT Frank, VERBURG Thijs (2007) "Related Variety, Unrelated Variety and Regional Economic Growth", *Regional Studies,* 41(5), 685-97.

KIRAT Thierry, LUNG Yannick (1999) "Innovation and proximities: territories as a loci of collective learning", *European Urban and Regional Studies*, 1999, 6(1), 27-38

MADIES Thierry, PRAGER Jean-Claude (2008) *Innovation et compétitivité des régions,* Rapport du CAE, La Documentation Française, Paris.

MARTIN Philippe, OTTAVIANO Gianmarco (1999) "Growing Locations: Industrial location in a Model of Endogeneous Growth", *European Economic Review,* 43, 281-302.

MASSARD Nadine, MEHIER Caroline (2009) "Proximity and Innovation through an "Accessibility to Knowledge Lens", *Regional Studies,* 43 (1), 77-88.

OST (2009), *Indicateurs de science et technologies,* Economica, Paris.

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