

# Towards the new economic geography in the brain power society

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## Abstract

This article proposes the further development of the New Economic Geography towards a comprehensive theory of spatial economics in the age of brain power society, in which the dynamics of spatial economy arise from the dual linkages in the economic and knowledge fields.

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## 1. Welcome to the brain power society

In my recent trip to Jyväskylä in Finland, I happened to find an interesting advertisement in a free booklet provided at my hotel.<sup>1</sup> The advertisement placed by the Øresund Region in Sweden called for high-tech firms. It is a simple one-page advertisement with a photograph of a smiling biochemist, together with the following two sentences:

“The Bad News: The brain is the only natural resource in the  
Øresund Region.

The Good News: The brain is the only natural resource that  
expands with use.”

This is very much in contrast with the traditional regional advertisements (which tend to emphasize the usual economic features such as low wages, low taxes and transportation accessibility), as it focuses on the single most important resource for creative activity.

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<sup>1</sup> Structural Change in Europe 2 - new northern knowledge, Hagbath Publisher, May 2002, p.22.

The topic on stimulating creative sectors of society brings to mind another interesting article by Fairclough (2004) entitled “Gay Asia: Tolerance Pays,” which reports about the increasing acceptance of gay rights in Asian countries. In particular, it features about the annual *Gay Nation Party* in Singapore (held to coincide with *Singapore Nation Day* in August), where 8000 gay men from all over the world gather and dance to pulsing house music and laser lights, whipping off their shirts. A party organizer wears a T-shirt that proclaims.

“Choose Sin Gapore”

This is a scene unimaginable a few years ago in Singapore, known as a rigid and highly-regulated city state, where persons caught with mere possession of chewing gum risked arrest.

According to Gordon Fairclough, the driving force behind Singapore’s more relaxed attitude towards homosexuality reflects a broader government strategy to open up the ideas-driven economy and to tap potential creative resources. In fact, this new strategy of the Singapore government is supported by a recent study by Richard Florida and Gary Gates (2001) in the US, which reports that a city’s openness to gay communities is a good indicator of the city’s capacity for embracing diverse people, one of the essential ingredients of a creative community that spurs the transformation of a successful high-tech city. Indeed, the high-tech capital of the world, San Francisco (where Silicon Valley is), is also well known as the gay capital of the world, where nearly 700,000 gay men and women gather for the *Pride Parade* each year.

Welcome to the “brain power society” or “C-society.” According to Lester Thurow at MIT, advanced countries are shifting from the capitalism based on mass production of commodities to the *brain power society* in which creation of knowledge and information using brain power plays the central role (Thurow, 1996). The concept of a brain power society is essentially the same as that of the *C-society* advocated by Åke Andersson who maintains that advanced countries are leaving the industrial society (with its reliance on simplicity of production and products and the heavy use of natural resources and energy), and entering the C-society with and increasing reliance on creativity, communication capacity, and complexity of products (Anderson, 1985). In this essay, the term “brain power society” is taken to be synonymous with the “C-society” of Åke Anderson.

The ultimate concern of this essay is the further development of the *New Economic Geography* (NEG) towards a more comprehensive theory of geographical economics in the age of brain power society, in which the dynamics of the spatial economy arise from the dual linkages in the economic and knowledge fields. Before elaborating this ultimate objective, let me review briefly what is the so called the New Economic Geography.

## 2. The New Economic Geography and its future: incorporating dual linkages in economic and knowledge fields

As is well-known, since about 1990 there has been a renaissance of theoretical and empirical work on economic geography. Among others, the pioneering work of Paul Krugman (1991) on the core-periphery model has triggered a new flow of interesting contributions to economic geography. The work represented by this new school of economics is called the New Economic Geography (NEG).<sup>2</sup>

<sup>2</sup> See Fujita et al. (1999) for a comprehensive manifestation of this approach. See also Fujita and Thisse (2002) and Baldwin et al. (2003) for recent developments in NEG. For an overview of NEG, see also Fujita and Krugman (2004), Fujita (2005), and Fujita and Mori (2005).

The hallmark of the NEG is the presentation of a unified approach to modeling a spatial economy characterized by a large variety of economic agglomeration – one that emphasizes the three-way interaction among increasing returns, transport costs (broadly defined), and the movement of productive factors – in which a general equilibrium model is combined with nonlinear dynamics and an evolutionary approach for equilibrium selection. The observed spatial configuration of economic activities is considered to be the outcome of a process involving two opposing types of forces, that is, *agglomeration* (or *centripetal*) forces and *dispersion* (or *centrifugal*) forces. As a complicated balance of these two opposing forces, a variety of local agglomeration of economic activity emerges, and the spatial structure of the entire economy is self-organized. And, with the gradual changes in technological and socioeconomic environments, the spatial system of the economy experiences a sequence of structural changes, evolving toward an increasingly complex system.

In this framework, then, the first two questions of obvious importance are:

Question 1: How does one explain the agglomeration forces?

Question 2: How does one explain the dispersion forces?

The answer to Question 2 is rather easy, for the concentration of economic activities at a location will naturally increase factor prices (such as land price and wage rate), and induce congestion effects (such as traffic congestion and air pollution), and increase competition in product markets, which can be readily explained by the traditional economic theory. Thus, the principal concern of the NEG is Question 1, i.e., how to explain the agglomeration forces behind the formation of a large variety of spatial agglomeration such as cities and industrial districts.

In most models of the NEG so far, agglomeration forces arise solely from pecuniary externalities through linkage effects among consumers and industries, neglecting all other possible sources of agglomeration economies such as knowledge externalities and information spillovers. This has led to the opinion that the theories of the NEG have been too narrowly focused, ignoring as much of the reality as old trade theory.

It is true that the theoretical framework of the NEG has been very narrowly focused. But, it was a deliberate choice. That is, such a narrow focus of the NEG was designed in order to establish a firm micro-foundation of geographical economics based on modern tools of economic theory. It does not necessarily mean that the NEG is limited to such a narrow range of models and issues. On the contrary, its framework is widely open to further development. Indeed, recently many of such possibilities are being explored vigorously by many young scholars.<sup>3</sup>

That much said, however, I admit that there still remains a wide range of topics for further development of the NEG. In particular, research on one type of agglomeration forces of which micro-foundations have seen little development so far: that is, the linkages among people through the creation and transfer of knowledge, or in short, the K-linkages. (Hereafter, “knowledge” is defined broadly to include ideas and information.)

Traditionally, K-linkage effects have been called either “knowledge spillovers” or “knowledge externalities”. However, the term, “spillovers”, tends to have a connotation of passive effects. And, the term, “externalities”, tends to imply too many different things at once. So, in the remaining discussion, instead of knowledge spillovers or externalities, let me use the term, K-linkages, in order to emphasize that they represent the agglomeration forces, or more generally, the relationship among agents resulting from the activities related to both the “creation of knowledge” and the “transfer of knowledge” or “learning” (encompassing active and passive modes). In contrast to the K-linkages,

<sup>3</sup> See those articles reviewed in Fujita and Mori (in press).

Table 1  
Dual linkages in the brain power society

E-linkages	the linkages among firms and consumers through the production and transactions of (traditional) goods and services
K-linkages	the linkages among people through the creation and transfer of knowledge

the traditional linkages through the production and transactions of (traditional) goods and services may be called the *E-linkages* (where “E” representing the economic activities in the traditional economics). Table 1 contrasts the two types of linkages.

Using such a terminology, we may imagine that *the agglomeration forces in the real world arise from the dual effects of E-linkages and K-linkages*. In this context, we conjecture that the role of K-linkages has become increasingly more dominant recently. Yet, developing the micro-foundations of K-linkages seems to be the most challenging task, largely left for young scholars in the future.

I am in haste to add that there has been a great amount of conceptual studies on knowledge externalities/spillovers in a spatial context, starting with Marshall (1890), and including more recent pioneering work such as Jacobs (1969), Anderson (1985) and Lucas (1988) in an urban context, and Porter (1998) in the context of industrial clusters. Yet, it would be fair to say that there is a lot of room left for advancing the micro-foundations of K-linkages in space. Particularly, in developing the micro-foundations of K-linkages, “creation of knowledge” must be clearly distinguished from “transfer of knowledge” or “learning”. Furthermore, for the creation of new ideas, cooperation among heterogeneous people is essentially important. Yet, through communication and migration, the degree of the heterogeneity of people in a region changes over time. Thus, the nature of K-linkages is essentially dynamic, and hence their full-fledged treatment requires a dynamic framework.

### 3. Dynamics of innovation through endogenous knowledge heterogeneity

In standard microeconomic theory, the concept of production function plays the central role. The production function is supposed to represent the stable physical relationship between inputs and outputs, which is supposed to be invariable over time as long as the underlying technologies remain the same. In the same vein, E-linkages among firms and consumers can be considered to represent a time-invariant relationship as long as the underlying environments remain the same.

We cannot, however, expect the same time-invariant relationship to hold for K-linkages. On the contrary, by definition, K-linkages represent a dynamical relationship similar to the illustration in Fig. 1.

This figure represents abstractly the cooperative process of knowledge creation by two persons,  $i$  and  $j$ , when they meet and collaborate to create new ideas (or new knowledge) together.

The left circle,  $K_i$ , represents *the state of knowledge*, or just *knowledge*, of person  $i$  (at the time of meeting), whereas the right circle,  $K_j$ , the knowledge of person  $j$ . The overlapping area,  $C_{ij}$ , represents their knowledge in common, or just *common knowledge*,<sup>4</sup> whereas the left area,  $D_{ij}=K_i-C_{ij}$ , shows the *differential knowledge of person  $i$  from  $j$* , the right area  $D_{ji}=K_j-C_{ij}$  the *differential knowledge of person  $j$  from  $i$* . Through the mutual communications and discussions based on the common knowledge  $C_{ij}$ , the two persons endeavor to develop new ideas by combining their differential knowledge  $D_{ij}$  and  $D_{ji}$ . This joint process of knowledge creation can be expected to be most productive when the proportions of the three components, i.e., the

<sup>4</sup> Here, “common knowledge” represents simply the short expression of “knowledge in common” or “mutual knowledge.” It is not the term used in game theory.

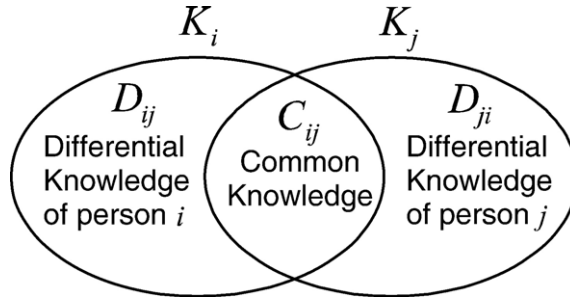


Fig. 1. Cooperative process of knowledge creation.

common knowledge ( $C_{ij}$ ), the differential knowledge of person  $i$  ( $D_{ij}$ ), and the differential knowledge of person  $j$  ( $D_{ji}$ ), are well-balanced. A sufficient amount of common knowledge is necessary for effective communications between two persons. Furthermore, if one person does not have a sufficient amount of differential knowledge, there is little motivation for the other person to meet and collaborate. In other words, too much common knowledge means little heterogeneity or originality in the collaboration, unable to yield enough synergy.

Therefore, in general, for a cooperative process of knowledge creation by a group of people to be productive, both a sufficient heterogeneity and a sufficient common base in their states of knowledge are essential. When such a delicate balance in their states of knowledge exists, an unexpected synergy potentially evolves from their close collaboration.

Actually, this observation is not entirely new. We have, for example, an old Chinese saying,

“San ge chou pi jiang, Di ge Zhuge Liang”

which roughly means

“With three ordinary persons getting together, splendid ideas will come out.”

However, any nice saying must be taken with caution, for it may imply an antinomy. Concerning the previous Chinese saying, we may continue:

But, after three ordinary persons meeting for three years, no more splendid idea will come out.”

Likewise, returning to Fig. 1, even when the two persons have initially a sufficient heterogeneity in their states of knowledge, if they continue a close cooperation in knowledge creation, their heterogeneity may keep shrinking. This is because the very cooperative process of knowledge creation results in *the expansion of their common knowledge* through both the sharing of newly created ideas and the transfer of differential knowledge to each other. Thus, unless some additional complementary mechanisms are not working, the cooperative process of knowledge creation among the same group of people tends to become less productive eventually.

#### 4. Knowledge creation as a square dance

Building upon what has been discussed above, [Berliant and Fujita \(2006a,b\)](#) present a micro-model of knowledge creation through the interactions among a group of people/researchers, in which research-partnership is compared to dance-partnership in a square dance. Although it is a simple model in the absence of location/space, it incorporates two key aspects of the cooperative process of knowledge creation discussed above, that is: (i) heterogeneity of people in their state of

knowledge is essential for successful cooperation in the joint creation of new ideas, while (ii) the very process of cooperative knowledge creation affects the heterogeneity of people through the accumulation of knowledge in common.

Specifically, consider a given time  $t$ , and focus on two persons,  $i$  and  $j$ . In terms of Fig. 1, let  $n_{ij}^d(t)$  be the size of  $D_{ij}$ ,  $n_{ij}^c(t)$  the size of  $C_{ij}$ ,  $n_{ji}^d(t)$  the size of  $D_{ji}$  at time  $t$ . And, let

$$\begin{aligned} n_i(t) &= n_{ij}^c(t) + n_{ij}^d(t) \\ n_j(t) &= n_{ij}^c(t) + n_{ji}^d(t) \end{aligned}$$

so that  $n_i(t)$  represents the size of  $K_i$  and  $n_j(t)$  the size of  $K_j$  at time  $t$ .

At each moment of time, there are two mutually exclusive ways to produce new knowledge or new ideas. The first way is to work alone, away from others. We denote the event that person  $i$  does research alone at time  $t$  by  $\delta_{ii}(t)=1$ , indicating that  $i$  works by herself. Otherwise,  $\delta_{ii}(t)=0$ . Alternatively, person  $i$  can choose to work with a partner, say person  $j$ . We denote the event that person  $i$  wishes to work with  $j$  at time  $t$  by  $\delta_{ij}(t)=1$ . Otherwise,  $\delta_{ij}(t)=0$ . In equilibrium, this partnership is realized at time  $t$  if  $\delta_{ij}(t)=\delta_{ji}(t)=1$ .

Consider first the case where person  $i$  works alone. In this case, idea production is simply a function of the stock of  $i$ 's ideas at that time. Let  $a_{ii}(t)$  be the rate of production of new ideas created by person  $i$  in isolation at time  $t$ . Then we assume that the creation of new knowledge during isolation is governed by the following equation:

$$a_{ii}(t) = \alpha \cdot n_i(t) \text{ when } \delta_{ii}(t) = 1. \quad (1)$$

where  $\alpha$  is a positive constant.

If a meeting occurs between  $i$  and  $j$  at time  $t$  ( $\delta_{ij}(t)=\delta_{ji}(t)=1$ ), then joint knowledge creation occurs, and it is governed by the following dynamics:

$$a_{ij}(t) = \beta \cdot (n_{ij}^c)^{\theta} \cdot (n_{ij}^d \cdot n_{ji}^d)^{\frac{1-\theta}{2}} \text{ when } \delta_{ij}(t) = \delta_{ji}(t) = 1 \text{ for } j \neq i \quad (2)$$

where  $0 < \theta < 1$ ,  $\beta > 0$ . So when two people meet, joint knowledge creation occurs at a rate proportional to the normalized product of their knowledge in common, the differential knowledge of  $i$  from  $j$ , and the differential knowledge of  $j$  from  $i$ . The rate of creation of new knowledge is high when the proportions of ideas in common, ideas exclusive to person  $i$ , and ideas exclusive to person  $j$  are in balance. The parameter  $\theta$  represents the weight on knowledge in common as opposed to differential knowledge in the production of new ideas. Commonly shared ideas are necessary for communication, while ideas exclusive to one person or the other imply more heterogeneity or originality in the collaboration. If one person in the collaboration does not have exclusive ideas, there is no reason for the other person to meet and collaborate. The multiplicative nature of the function in Eq. (2) drives the relationship between knowledge creation and the relative proportions of ideas in common and ideas exclusive to one or the other agent. Under these circumstances, no knowledge creation in isolation occurs.

During meetings at time  $t$ , knowledge transfer occurs in addition to the creation of new knowledge. Knowledge transfer is governed by the following dynamics:

$$\begin{aligned} b_{ij}(t) &= \gamma \cdot (n_{ij}^d)^{\mu} \cdot (n_{ij}^c)^{1-\mu} \\ b_{ji}(t) &= \gamma \cdot (n_{ji}^d)^{\mu} \cdot (n_{ij}^c)^{1-\mu} \end{aligned} \quad (3)$$

So when a meeting occurs, knowledge transfer  $b_{ij}(t)$  from  $i$  to  $j$  happens at a rate proportional to the normalized product of the number of ideas that person  $i$  has but that person  $j$  does not have, and the ideas commonly held by both persons. The explanation is that communication is necessary for knowledge transfer, so the two persons must have some ideas in common ( $n_{ij}^c(t)$ ). But in addition, person  $i$  must have some ideas that are not already possessed by person  $j$  ( $n_{ij}^d(t)$ ). The same intuition applies to knowledge transfer in the opposite direction from  $j$  to  $i$ , represented by the second equation in Eq. (3).

The change in the number of ideas that both persons have in common ( $\dot{n}_{ij}^c(t)$ ) is the sum of knowledge transfers in both directions and the new ideas jointly created. From person  $i$ 's perspective, the number of ideas that  $i$  has but  $j$  doesn't have ( $n_{ij}^d(t)$ ) decreases with knowledge transfers from  $i$  to  $j$ . Finally, the change in the number of ideas possessed by person  $i$  is the sum of the ideas that are jointly created and the number of ideas transferred from  $j$  to  $i$ . The analogous statements hold for the variables associated with  $j$ . Let us focus on agent  $i$  (the equations for agent  $j$  are analogous). With a meeting, we have the following dynamics incorporating both knowledge creation and transfer:

$$\dot{n}_i(t) = a_{ij}(t) + b_{ji}(t) \quad (4)$$

$$\dot{n}_{ij}^c(t) = a_{ij}(t) + b_{ij}(t) + b_{ji}(t)$$

$$\dot{n}_{ij}^d(t) = -b_{ij}(t) \quad (5)$$

Whether a meeting occurs or not, each person produces the numeraire good at each time, which yields the income. Define  $y_i(t)$  to be production output (or income) for person  $i$  at time  $t$ . Normalizing the coefficient of production to be 1, we take

$$y_i(t) = n_i(t)$$

so

$$\dot{y}_i(t) = \dot{n}_i(t)$$

To keep the model tractable, here we assume a myopic rule. Let  $N$  be the number of persons in the economy. At each time  $t$ , person  $i$  will choose the values of  $\delta_{ii}(t)$  and  $\delta_{ij}(t)$  for all  $j \neq i$ , subject to

$$\sum_{j=1}^N \delta_{ij}(t) = 1,$$

in order to maximize the increase in the rate of  $i$ 's output,  $\dot{y}_i(t)$ . Note that we use the *increase in the rate of output* rather than the rate of output since in a continuous time model, the rate of output at time  $t$  is unaffected by the decision about whether to meet made at time  $t$ . As indicated by Eqs. (4) and (5), if the same pair of persons,  $i$  and  $j$ , continue to do research together, their common knowledge expands while the differential knowledge of each person shrinks. This will make eventually the productivity of the partnership low, inducing for each person to find a new partner. In this way, knowledge interactions among  $N$  persons will proceed in a form of square dance, in which each person sequentially finds a new partner for joint research.



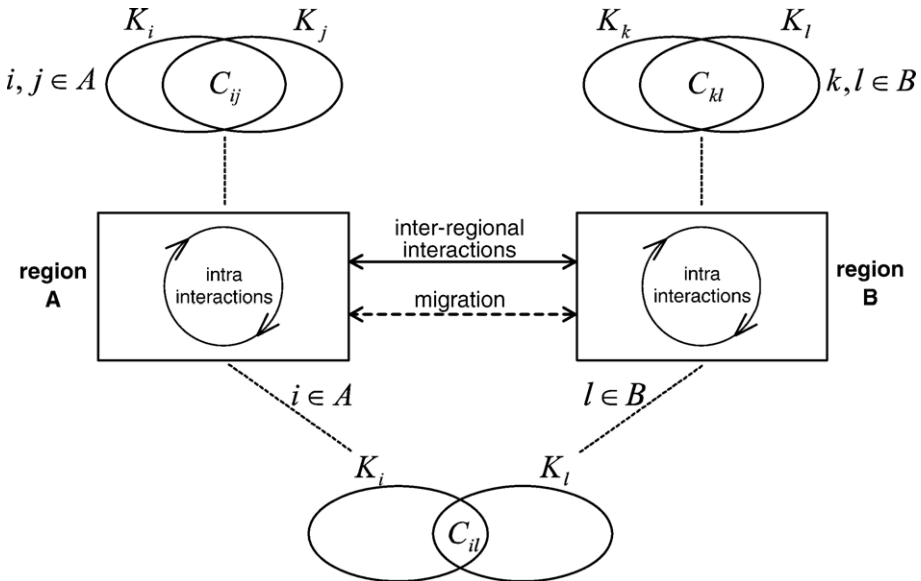


Fig. 2. Knowledge interactions in a two-region economy.

As described above, the model features myopic agents in a pure externality model of interaction. Surprisingly, in the general case for a large set of initial conditions, they find that the equilibrium process of knowledge creation may converge to the most productive state, where the population splits into smaller groups of optimal size; close interaction takes place within each group only. This optimal size is larger as the heterogeneity of knowledge is more important in the knowledge production process.

## 5. Future tasks

Needless to say, the main contribution of [Berliant and Fujita \(2006a,b\)](#) is, in effect, opening Pandora's box, exposing a large number of new problems to be investigated further. Indeed, to make the model more realistic and interesting, we must extend it by considering/introducing various new elements such as knowledge structures and hierarchies, multiple channels of knowledge transfer, side payments and the markets for ideas, foresight and strategic behavior, and uncertainty and stochastic elements.

In particular, we must return to our original motivation for this model, as stated in the introduction. That is, location seems to be an essential feature of knowledge creation and transfer, so regions and migration are important, along with urban economic concepts more generally. To do so, the first step may be to combine a dynamic version of NEG such as [Fujita and Thisse \(2003\)](#) with the K-linkage model by [Berliant and Fujita \(2006a,b\)](#), in which each person resides in a region and engages in the production activity in that region while participating in the intra-regional and inter-regional K-interactions in the economy. Given that each person will make contacts more frequently with the people in the same region than those in another region, each region will naturally develop the set of common knowledge, or the “culture,” that is different from other regions. That is, as depicted in [Fig. 2](#), a typical pair of persons in the same region, *A* or *B*, will accumulate a much larger common knowledge than a typical pair of persons, say *i* and *l*, in different regions. In this way, each region



will develop a unique culture, while the economy as the whole will yield synergy through the interactions of different cultures. In this context, we can investigate the relationship between agglomeration, innovation and culture.

With continued efforts, step by step, we may be able to move closer to our ultimate objective of developing a comprehensive theory of geographical economics in the brain power society, in which the dual linkages in the economic and knowledge fields work in unison. Let me close this article by quoting the following statement in Lösch, (1940, p.508), which seems to represent the essence of a spatial economy:

If everything occurred at the same time there would be no *development*. If everything existed in the same place there could be no *particularity*. Only space makes possible the particular, which then unfolds in time. Only because we are not equally near to everything; only because everything does not rush in upon us at once; only because our world is restricted, for every individual, for his people, and for mankind as a whole, can we, in our finiteness, endure at all. ... Space creates and protects us in this limitation. Particularity is the price of our existence.

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