Territorial dynamics: Economic impacts and returns

Abstract

Referring to territorial innovation models, we studied Grenoble-GIANT, a geographical network. The past 60 years of investment (€2.81 billion) have catalyzed the concentration of knowledge resources toward economic specialization, SME competitiveness, knowledge spillovers, and economies of scope. Support of research centers and universities positively affects patent and spin-off development, strengthening economic growth. Our microeconomic methodology measures the economic effects of GIANT with respect to budget, employment and spin-off generation. The eight GIANT partners directly employ 7,500 individuals. In 2008, the annual direct economic impact was evaluated at €655 million, and the annual total induced economic impact was evaluated at €1.2 billion. Factoring in the economic impact of jobs in the microelectronics, software, and related industries/services, the total impact is approximately €3.2 billion. The originality of our study lies in the comparison between the amount of investment (€2.81 billion) and the annual total economic impact (€3.2 billion).

Key words: Public investments; Social, economic impact; Territorial Innovation Models

1. INTRODUCTION

The notion of economic specialization was introduced to the economics literature by the classical school of economics. Under the influence of Plato and Xenophon, Adam Smith (1723-1790) was the first to recognize the positive influence of the division of labor on productivity. As a contrast to the division of labor, Hayek (1899-1992) formulated the notion of the division of knowledge in 1937. Porter discussed a “paradox” within an economy driven by knowledge, observing that “enduring competitive advantages in a global economy lie increasingly in local things – knowledge, relationships, motivation – that distant rivals cannot match” (Porter, 1998, p78). In this sense, knowledge has become key to the development of modern economies (Davenport & Prusak, 1998). Knowledge and innovation are strongly related (Jensen, Johnson, Lorenz, & Lundvall, 2007; Nonaka & Takeuchi, 1995) and positively affect economic growth (Schumpeter, 1942).

National investments have positive effects at the territorial level, as noted by the National System of Innovation (Freeman, 1987) and the National Innovation System (Nelson, 1993; Lundvall, 1992). In France, the importance of national competitiveness is a recurrent question. Considering the scares availability of public resources, the question of returns on public funds is of an increasing matter. This question is dual, both theoretical and empirical. From a theoretical perspective, multiple models have emerged and none of them has created a consensus in the community. From an empirical perspective, attempts to measure economic impacts are a challenging task which can present multiple limits. Current theoretical and empirical gaps clearly require further studies to be conducted.

Based on the agglomeration theory of Alfred Marshall (1920), territorial innovation models (TIMs) are used to assess the territorial aspects of innovation. The original aim of such models was to improve our understanding of the disparities between flourishing regions and regions that are losing ground. The cohesion policy of the European Commission is an effort to reduce differences between European regions while supporting overall economic growth (Midtkandal & Sörvik, 2012). Multiple TIMs exist: “innovative milieu” (Aydalot, 1986; Camagni & Maillat, 2006; Ratti, 1989), “industrial districts”, “science parks” (Bagnasco, 1977; Camagni, 1991; Becattini, 1992, 2003; Garofali, 1992; Dei Ottati 1994a, 1994b; Benko & Lipietz, 1992), “new industrial spaces” (Storper & Scott, 1988; Storper 1995, 1997; Saxenian, 1994), and “clusters of innovation” (Porter, 1990a, 1996, 1998, 2000; Krugman, 1991; Fujita, Krugman, & Venables, 2000). TIMs mobilize various local stakeholders.

Foray et al. (2012) argued that the knowledge triangle of education, research, and innovation is relevant in the context of smart specialization. In TIMs, an increasing number of stakeholders are involved in the innovation process. According to Björk & Magnusson (2009), there are multiple sources of innovation, including “universities and governments, firms’ research and development departments, and individual inventors”. The traditional linear model in which research centers are positioned between universities (upstream) and firms that apply innovations (downstream) is no longer valid because new forces have gained strength and new challenges have emerged.

Anders (1992) argued that globalization and increasing competition have dramatically increased political and financial pressures on universities and public research laboratories to contribute to local economic development. Adams (2006) viewed links between universities and firms as “new evidence on the practice of industrial Research and Development”. Since the mid-1990s, universities have played a major role in regional economic development (Thanki, 1999a), whereas research centers have adopted a more downstream position by focusing on applications, applied sciences, patenting, licensing, business partnerships, and entrepreneurship. Rosenberg (1992) argued that the impact of large scientific instruments on the economy requires further study.

We studied Grenoble-GIANT, a geographical network of universities, engineering and management schools, large scientific instruments, and public research centers. We selected this cluster because GIANT does not fully match one of the TIMs developed by scholars in the field of geographical economics. There is a need to better understand this hybrid structure which may offer a good alternatives to the models currently operating.

More specifically, we posed the following research question: As a new specialized cluster initiative differing from other TIMs, what are the economic effects of and returns on investment in GIANT?

We measure the economic effects of GIANT through a microeconomic analysis of competitiveness at the cluster level.

The article presents a review of the literature on multi-level governance at the European, national, and regional levels (TIMs). We consider the investments in GIANT, which was founded in 2006, by eight scientific and academic partners located in the Grenoble Polygon. We identify the potential economic effects and returns of such investments. We then develop a detailed methodology to measure these effects. Based on an analysis of our results, we discuss the match between investments and returns and the characteristics of Grenoble-GIANT considered as a specialized learning-based district.

2. LITERATURE REVIEW

Marshall (1920) studied the cutlery industry in the Sheffield area, where “the mysteries of the trade become no mysteries, but are as it were in the air”. Clusters “have acquired industrial ‘atmospheres’ of their own; which yield gratis to the manufacturers of cutlery great advantages, that are not easily to be had elsewhere: and an atmosphere cannot be moved” (Marshall, 1927). Marshall (1920) analyzed the economies of scale that firms achieve in industrial districts. In that sense, proximity networking with other firms, suppliers, and clients create knowledge spillovers that lower costs.

Based on agglomeration theory and the notion of “the trunk and branches structure” (Foray et al., 2012, p66), we focused on such factors as economic geography, endogenous growth, innovative milieu, innovation systems, clusters, and industrial districts as the bases of smart specialization.

Industrial districts were conceived by Bagnasco (1977), who argued that SMEs are strongly affected by the industries within their geographic areas. An industrial district is characterized by its ability to divide tasks, jobs, and the value chain among local SMEs. Dei Ottati (1994a; 1994b) focused on the mode of coordination, arguing that the quality of information and the ability to share this information facilitate arrangements among local agents. Becattini (2003) defined an industrial district as a “socio-economic vortex”. Local interaction intensity and stability lends an “institutional thickness” to some regions (Amin & Thrift, 1995). The aim is to guarantee trust and reciprocity and thereby decrease transaction costs while expanding the division of labor. According to Camagni (1991), local institutions play a central role in reducing uncertainty in knowledge dynamics and implementing collective learning processes.

The concept of “new industrial spaces”, introduced by Storper & Scott (1988), concerns the contribution to knowledge of each stakeholder. The notion capitalizes on that of the industrial district while adding flexible production systems, social regulation, and local community dynamics. Storper (1995; 1997) argued that existing economies of scale and interdependencies explain initial spatial clustering. Saxenian (1994) provided an explanation of regional economic competitiveness and localized “industrial systems” that combine local institutions, the local industrial structure, and related relationships between firms and the internal organizational structures of firms.

“Innovative milieu” highlights the notion that each innovative agent is not isolated but an actor within established relationships between firms and the environment. Ratti (1989) emphasized the importance of learning within a milieu where agents depend on local spillovers. Relationships and collaborations contribute to technical changes and economic growth within territories. Morgan (1997) emphasized the positive effects of learning on innovation and social capital of learning within a network. The knowledge acquisition process is critical, according Lundvall & Johnson (1994), as knowledge itself is the most important strategic resource. Cappellin (2006) argued that territorial knowledge capital is likely to be the most effective measure of innovation within a region.

The notion of knowledge creation within clusters has been strongly influenced by Porter (1990a). A cluster is “a geographically proximate group of inter-connected companies and associated institutions in particular fields, linked by commonalities and complementarities” (Porter, 2000). Physically, clusters “range from a single city or state to a country or even a group of neighboring countries”. Clusters are determined by the geographical concentration and connections among companies, suppliers, service providers, firms, and institutions (Porter, 1998). In clusters, external economies of scale are available (Krugman, 1991; Fujita, Krugman, & Venables, 2000), including those achieved with customers and suppliers (Porter, 1998). Engel & Del-Palacio (2011) defined a cluster of innovation “as an environment that favors the creation and development of high potential entrepreneurial ventures, and is characterized by heightened mobility of resources, including people, capital and information”.

Within Rhône-Alpes, one of the most vibrant locations is Grenoble-GIANT, a geographical network of universities, engineering and management schools, large scientific instruments, and public research centers created in 2009. GIANT can be viewed as an institution of technology infrastructure (ITI), as defined by Cohendet, Koschatzky, & Héraud (1996) and Bureth & Héraud (2000). More precisely, GIANT is an association of eight scientific and academic partners located in the Grenoble Polygon: the Atomic Energy Commission (CEA), the National Polytechnic Institute of Grenoble (INPG), the Joseph Fourier University (UJF), Grenoble Ecole de Management (GEM), the National Centre for Scientific Research (CNRS), the Laue Langevin Institute (ILL), the European Synchrotron Radiation Facility (ESRF), and the European Molecular Biology Laboratory (EMBL).

One advantage to study GIANT is the creation of a unique gathering of partners to meet the need of tomorrow. However, one drawback is the lack of a strong historical background of such gathering which only counts five years life time.

Since the creation of this scientific polygon in the mid-1950s, large investments have been made in the CENG-CEA, CNRS, ILL, ESRF, and EMBL MINATEC (a campus for innovation in micro- and nanotechnologies). More broadly, the Grenoble area has benefited from massive public investments (by state and local authorities) on the occasions of the establishment of the campus of Saint-Martin d'Hères (1963-1966), the holding of the Olympic Games (1964-1968), the establishment of ZIRST (founded in 1972 and becoming Inovallée in 2005) together with the CNET (National Centre for Telecommunications Research) and INRIA (National Institute for Research in Computer Science and Control), and the creation of Villeneuve de Grenoble-Echirolles (early 1970s).

The Grenoble area has also greatly benefited from national research policy and funding from central government institutions, including the Advisory Committee on Scientific and Technical Research (CCRST, created in 1958), the General Delegation for Scientific Research and Technology (DGRST, founded in 1959), and the Delegation for Spatial Planning and Regional Action (DATAR, founded in 1963). The concentration of knowledge resources for economic specialization increases the likelihood of success (Foray et al., 2012).

Nearly €3 billion in today's prices were injected into the Grenoble area during the 1968 Olympics by GIANT partner organizations. This sum does not include urban development investments (Villeneuve, ZIRST) or the investments of CENG-CEA, CNET, and EMBL (data not available).

Investments undertaken have a positive impact on universities and research centers, with academic research strongly influencing innovation (Mansfield, 1991, 1995). For instance, American universities, such as Stanford University, have significantly affected the sciences through knowledge spillovers (e.g., the creation of Sun Microsystems, Oracle, Yahoo, and Google). Regional changes are linked to synergies, including economies of scope and spillovers (Foray et al., 2012). External R&D spillovers have been studied by Griliches (1979, 1991). Spillovers from the university are often limited from a geographical and technological perspective (Adams & Jaffe, 1996). "Universities are often well placed to observe the emergence of new clusters in a region through the networks they form when working with companies on research programs (for example, in Framework program activities). The university can therefore act as a catalyst or facilitator in the development of network and cluster organizations" (Goddard & Kempton, 2011, p16). Research centers also positively impact patent development and spin-offs. Artz et al. (2010) further argued that there is a positive link between patenting and innovation. The protection and management of intellectual property rights appears to be key to the conversion of research into commercial success stories (Schröcker, 2013).

Economic studies take the form of either accounting assessments of the economic impact of spending or analyses of the regional economy using input-output tables and/or econometric models, Keynesian income-expenditure calculations, or social cost-benefit accounting methods (Thanki, 1999b). Carroll & Smith (2006) argued that economic effects can be attributed to four types of expenditures: (1) capital and operational expenditures of the university, (2) employee spending, (3) student spending, and (4) visitor spending. These various expenses are direct, indirect, or induced. Total direct expenses are increased by a multiplier to consider interdependencies with local economic activity and to assess both indirect and induced expenditures. Multipliers range from 1.03 to 8.44 (with a median of 1.8), according to Siegfried, Sanderson, & McHenry (2007).

According to Thanki (1999), economic studies are typically limited to analyses of growth, including employment, contribution to local GDP, number of enterprises created, whereas an analysis of development should be broader and encompass income distribution, inequality reduction, technology transfer, changes in the industrial structure, and increasing the standard of education and learning. Thanki (1999) recommended broader economic approaches, as universities [and research] influence training, tourism, the price and quality of housing, urban regeneration, and the business climate, including the attractiveness of the region to businesses. In addition, universities increase the average level of education and hence raise the average wage (Moretti, 2004) and the region's capacity for innovation and productivity growth (Krueger & Lindahl, 2001).

3. METHODS: MEASUREMENT OF ECONOMIC IMPACT

GIANT has a strong influence on the local industrial and employment base. Our intention was to capture the direct economic effects (jobs, wages, spending by students, employees and visitors, and institutions' budgets) and business creation by former students of higher education institutions and former employees of public research units. The challenge was to design the study in a way that avoided the methodological issues noted by Siegfried et al. (2007), including the basis for measurement of impact with and without a given institution, the definition of a limited geographical area, the quality and reliability of data, potential issues of double counting and assimilation of expenditures/jobs that should not be attributed to an organization, and the integration of multipliers.

We collected data from the eight GIANT partners in the following domains: employment (permanent or provisional work contract, full or part time, level of education, nationality), students (institution of registration, doctoral or post-doctoral), visitors (number, number of equivalent full-time days, geographic origin), dissemination (number of days dedicated to scientific dissemination), and global budget (wages, operating costs, investment, and share of Rhône-Alpes spending in Euros).

The eight GIANT partners have been mobilized collectively and all partners have answered positively to the invitation for collaboration. CEA was a key partner because they already attempted to conduct similar study on economic impact at the research center level. All partners were willing to collect the data in their own organization. We have been in touch with only one or two or maximum three representatives per institution. The follow up on data collection has been done organization by organization to increase the control on the data collection. Some partners have been very proactive while some others faced more issues about the feasibility of the data collection. For the one having difficulties, we either assisted them in the data collection or we did the data collection ourselves.

The direct economic impact was calculated based on the following assumptions: only contractors working more than 12 hours per year were recorded; the propensity to consume was set at 0.847, according to the national average published by INSEE in the National Accounts of 2008 (Aviat, Houriez, & Mahieu, 2009); students spending more than 50% of their time in the scientific polygon were provided with a monthly budget of €950, which corresponds to a monthly rent of €450, including charges, a daily food cost of €10, daily expenditure on transportation and travel of €2, and a balance of €140 for miscellaneous expenses (e.g., clothing, entertainment, stationery); students spending less than 50% of their time in the scientific polygon were provided with a monthly budget of €300 to be spent in Grenoble; to calculate the economic impact of graduates working in Isère and who are in the Rhône Alpes region, a rate of 22.2% (from INSEE regional data) was applied to determine the number of managers working in Isère as a proportion of all managers in the Rhône Alpes region with an average annual salary of €41,300; the impact of other jobs on the GIANT site was calculated based on gross disposable income per capita in the Rhône-Alps area, an amount equal to €18,997; the economic effect of visits was evaluated based on the following average costs: €30 for intra-regional visitors, €170 for visitors from other French regions, and €250 for foreign visitors.

A column was dedicated to comments on the sources of data within each institution and the methodology used to estimate local effects. The consolidated estimation of the total impact of GIANT is then calculated after the addition of the data provided by each partner. When the requested information was not documented by the partner, a literature search was conducted and, if available, information was integrated into the table.

4. ANALYSIS

As has been noted, when the information sought was not documented, a literature search was conducted and, where appropriate, information was integrated into the tables. For the University Joseph Fourier (UJF), aggregate data from the various uploaded documents was rated at 11.1% (calculated as the ratio of the 300 people working on the GIANT site to the total of 2,700 faculty, researchers, and staff). This rating is equivalent to the ratio of employees in the polygon to the total workforce, figures officially used by the GIANT administration. This figure implies that 88.9% of the staff and students are based at sites other than UJF. This allocation key is similar to the one officially recognized in October 2009 by the GIANT Steering Committee (Table 2). The allocation key is 8%, and the rounded key is 10%, for a staff of 300, which account for 5% of total employment at GIANT (6,600 persons).

	CEA	**Large instruments (ESRF, ILL, EMBL)**	**CNRS**	**GEM**	**INPG**	**UJF**
Staffing	3,200	1,200	700	500	700	300
% of GIANT	48%	18%	11%	8%	11%	5%
Agreed allocation keys	39%	18%	12%	10%	12%	8%
Rounded distribution keys	40%	20%	10%	10%	10%	10%

Table 2: Staffing and allocation keys at GIANT (GIANT steering committee, 2009)

The eight GIANT partners have nearly 7,500 employees and 24,600 students, of which nearly 5,000 spend more than 50% of their time working in the scientific polygon. The partners awarded 6,800 degrees in 2008, of which 344 were doctorates and HDRs. In 2008, GIANT partners received more than 56,000 days of working visits and organized nearly 2,100 days of scientific dissemination. The annual direct economic impact of the eight institutions is evaluated at just over €655 million in 2008. Using the median multiplier of 1.8, as shown in the literature review, this value yields a total annual economic impact of GIANT of nearly €1.2 billion (Table 3). Please refer to Appendices 1, 2, and 3 for further details.

		TOTAL GIANT		
Units		**Number**	**Euros**	**Local effect**
Direct employment	**TOTAL direct employment**	**7,519**	**443,939,162**	**376,016,470**
	Students ≥ 50% present on GIANT site	4,927		4,680,965
	Students < 50% present on GIANT site	19,705		5,911,400
Education	**TOTAL students**	**24,632**		**10,592,365**
	Granted degrees before doctorate	6,352		0
	Granted doctoral degrees	344		0
	TOTAL alumni	**217,000**		**80,924,777**
	Students registered in Grenoble	1,043		990,850
	Students registered elsewhere	82		77,900
	TOTAL students in R&D units	**148**		**1,068,750**
Other staff on GIANT site	**TOTAL staff in joint laboratories**	**90**		**1,448,141**
Visitors	**Number of visitors per year**	**10,655**		
	TOTAL number of visitor days per year	**56,416**		**12,360,145**
Dissemination	Number of days for scientific dissemination	**2,092**		
Budget	**Total Budget**		**1,065,278,419**	
	TOTAL without personnel expenses		**413,512,330**	**172,595,547**
Total local effect in Isère				**655,438,563**
Total with induced effects				**1,179,789,413**

Table 3: Total economic impact

5. DISCUSSION

In the present article, we have compared investments estimated at €2.81 billion and an annual total economic impact estimated at €3.2 billion. Such a comparison encourages further discussion on the cohesion policy for the 2014-2020 period. We argue that the concentration of resources and knowledge was crucial to the achievement of economies of scope while offering valuable spillovers to surrounding stakeholders.

We argue that GIANT successfully achieved synergies through the suitable deployment of large investments. We encourage the European Regional Development Fund to prioritize regions that are developing similar structures that merge academic institutions with research institutions. One of the key criteria is GIANT's focus on research and innovation but also education, reinforcing the views of Mills & Quinet (1992) regarding the importance of investing in the future to promote economic growth and employment. GIANT promotes multipurpose technologies, such as ICT, nano- and biotechnologies, advanced materials, and software.

Our research suggests the positive impact of universities and research centers on innovation (Mansfield, 1991, 1995), the creation of synergies, economies of scope, and spillovers (Foray et al., 2012; Adams & Jaffe, 1996; Goddard & Kempton, 2011).

Absent the decision by the CEA to create a center of excellence in microelectronics and the EFCIS spin-off in 1971, it is likely that the vast majority of companies in the high-tech industry would not have a local presence today. These companies include ST Microelectronics, NXP (Philips), Freescale (Motorola), E2V, Trixell, Thales, Tronics Microsystems, ULIS, Crocus, XENOCS, Alcatel Vacuum, SUSS Microtec, Applied Materials, LAM, SOITEC, and Tracit. Based on estimates of AEPI (2008), one should also recognize that such decisions helped attract many large corporations in the electronic equipment industry, such as Hewlett Packard, Xerox, Schneider Electric, Bull, and France Telecom-Orange.

Although Genthon (2009) attributed the implementation of CSF to St. Egrève, the real impetus behind the regional electronic component industry is the CEA, as demonstrated by Delemarle (2007). The CEA (then named the CENG) is the source of the development of the microelectronic industry in the area. It has properly fulfilled the role of anchor-tenant, as defined by Agrawal & Cockburn (2003), by stimulating both academic and industrial research, although, as emphasized by Balas & Palpacuer (2008), the microelectronics industry has now moved outside the territory, and the cluster has modified its initial local concentration in favor of international networks.

In our study, we referred to the use of TIMs to study the geographical network of Grenoble-GIANT. In this section, our intent is to characterize Grenoble-GIANT as a new form of specialized learning-based district. One of the key characteristics of Grenoble-GIANT is its strong specialization, manifesting the division of labor of Smith or the division of knowledge of Hayek. Forming a strong industrial agglomeration, as advocated by Marshall (1920), Grenoble has benefitted from its unique atmosphere.

We observed that GIANT achieved economies of scale as a result of learning synergies across its eight members. Referring to industrial districts, we argue that SMEs strongly benefit from proximity (Bagnasco, 1977). Each member occupies a different stage in the value chain and benefits from "institutional thickness" (Amin & Thrift, 1995) and the implementation of collective learning processes (Camagni, 1991). Related to the concept of new industrial spaces, we refer to Saxenian (1994) in describing how GIANT achieves its regional economic competitiveness by combining local institutions. There is true learning between connected innovative agents catalyzing technical changes and economic growth within a territory.

Referring to Porter (1990a) and his definition of clusters, we did not address the involvement of inter-connected companies, suppliers, clients and service providers (Porter, 1998). Thus, Grenoble-GIANT cannot be presented as a cluster, although there is a favorable environment (available resources and knowledge) for the creation of high-potential entrepreneurial ventures.

6. CONCLUSION

Employing 7,500 individuals, the eight GIANT partners have an annual direct economic impact of €655 million and an annual induced economic impact of €1.2 billion. Aggregated with the economic impact of specialized jobs (microelectronics, software, and related industries and services), GIANT has a total economic impact of €3.2 billion annually. It is possible to compare the volume of investment (€2.81 billion) and the annual total economic impact (€3.2 billion).

The research implications of this study relate to the characterization of a new form of specialized learning-based district that benefits from the division of labor and knowledge, a unique atmosphere, economies of scale, available resources and knowledge, learning synergies, complementarity in the value chain, institutional thickness, regional economic competitiveness, and economic growth within a territory.

First, from an economic perspective, we encourage scholars to explore optimal "specialization," as strong specialization encourages excessive spatial concentration, also known as a "technological regime" (Nelson & Winter, 1982), or the accumulation of knowledge within a limited area (Torre & Gilly, 2000).

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