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Innovations Systems and Learning Processes in the EU and US Regions

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Abstract

European regions suffer from weaker regional clusters and cluster portfolios than their peers in the United States (U.S.) or elsewhere in the world. The latter can be an important factor keeping them behind in global competition. The following research paper focuses both on regions as systems of innovation and as technology clusters. The selected case studies examine the development as well as structure and types of collaboration networks in the two leading Information and Communications Technologies (ICT) clusters in the U.S. and EU: Silicon Valley in California and Kista cluster of Stockholm Region in Sweden.

1. Introduction

European regions suffer from weaker regional clusters and cluster portfolios than their peers in the United States (U.S.) or elsewhere in the world. The latter can be an important factor keeping them behind in global competition. Therefore, it is very important to analise the patterns of growth as well as methodological principles, objectives and structures of the public policies supporing the regional innovation processes in both continents.

The following research paper focuses both on regions as systems of innovation and as technology clusters. The selected case studies examine the development as well as structure and types of collaboration networks in the two leading Information and Communications Technologies (ICT) clusters in the U.S. and EU: Silicon Valley in California and Kista region cluster in Sweden.

More specifically the paper's aim is to, firstly, explore the theoretical foundations of the two most popular approaches to regional innovation processes - "cluster approach" and Regional Innovation System (RIS) approach; secondly, discuss the existing EU and U.S. policies (at EU/federal, national/state and regional levels) as well as their role in stimulating regional innovation and "cluster development"; thirdly, present the spatial differences between the U.S. and the EU economies in terms of selected innovation indicators; last but not least identify the structures of knowledge and collaboration networks in the selected EU and U.S. case study clustes.

Both quantitative and qualitative methods were applied in achieving the paper's objectives: a qualitative research, such as study of governmental reports and publications and qualitative research, by interviewing various policy analysts and research experts. The latter method contributed with complementary information to the quantitative method and enabled to identify the existing policy successes and challenges.

The first part of the paper presents the selected theoretical concepts explaining the role of innovation in building competitive advantage and sustaining growth. The second part evaluates the differences between the two regional economies in terms of the major 'inputs' and 'outputs' of innovation as well as nature and dynamics of the R&D investments, following the presentation of the geographical concentration of innovation activities in the US and EU. The fourth part is introducing the innovation and cluster policies on regional and state levels in the US and EU. The last part of the paper discusses the selected case studies of ICT clusters in the EU and the U.S. The paper ends with some concluding remarks and implications for the further development of the innovation potential of the analised regions.

2. Regional Innovation System *versus* Cluster Approach to Regional Learning Processes

There are at least two approaches to the regional innovation and learning processes in knowledge-based economies that result from either the systemic or interrelated nature of innovation. The first originates from the innovation-system approach at the both national,

regional or local levels. This approach has originated and developed mostly in Europe, "(…) from the (mainly italian school) 'industrial districts' and the (mainly francophone and spanish school) 'innovative milieux', to the '*regional innovation system approach'* (largely inspired by the national (small-country) innovation systems literature from the 'scandinavian' school) and, more recently, the 'learning region' approach" (Landabaso 2000, p.19).

According to the second approach - *cluster approach* - thoroughly presented in Michael Porter's works on cluster development (Porter 1998, 2008) the increasingly knowledge-based competitive success of the economy depends on the ability to produce knowledge and utilize its effectively. Porter's cluster approach has been vastly popularized at the regional and local level in the United States.

The regional innovation systems and 'learning region' approaches are "broader in scope than the clusters approach and focus their attention in a wider set of inter-relationships among regional innovation actors in the economy" (Landabaso 2000, p. 20). They do not concentrate solely on firms and factor conditions within preselected or identified clusters, but also consider other firms outside clusters. They are concerned mainly with making the regional innovation process more efficient, that is to make universities, educational and R&D institutions, technology centers, the public sector at different administrative levels and firms interact with each other (through 'cluster' or sectoral network building). Regional innovation systems also deal with broader issues, like improving the general business innovation management, promoting entrepreneurial culture and allowing tacit or codified knowledge "to flow more vigorously, thus irrigating the regional economy as a means to economic modernization and diversification through new business opportunities" (e.g., via technology transfer agencies, technology parks, universities, public labs, etc.), Landabaso 2000, p. 20-21).

The literature on innovation systems has grown significantly in the last decade, introducing different definitions of a "regional innovation system". One of them is the definition given by Nauwelaers and Reid, according to which a regional innovation system is "the set of economic, political and institutional relationships occurring in a given geographical area which generates a collective learning process leading to the rapid diffusion of knowledge and best practice" (Wolfe 2000). Similar aspects of innovation were observed by Lundvall, who pointed out that innovation is the result of an interactive learning process between firms and their environment, ensuring territorial and social integration with cultural and institutional context (1992). The systemic approach to innovation provides instruments to analyze the interdependencies of innovation processes that could be easily grouped into demand and supply side forces of innovation. The supply side of the regional innovation system are the institutional sources of knowledge creation such the institutions responsible for training and the preparation of highly qualified labour power. On the demand side of the system are the productive systems, firms and organizations that develop and apply the scientific and technological output of the supply side in the creation and marketing of innovative products and processes.

Moreover, the regional innovation systems consider a larger role for the public sector and its institutional setting as well as public policy efficiency and building of social-capital in promoting competitiveness. Whereas the 'traditional' cluster approach assignes a rather limited role to be to the public sector.

The U.S. 'cluster's' approach refers to fairly traditional role of public sector in regional policy:

> "the role of the public sector has not been made very clear or explicit over and above providing incentives for long-term investments, provision of (physical) infrastructures, improving the business climate (taxes in particular) and, most interestingly, contributing to the organizational base of the economy by promoting business association and cooperation" (Landabaso 2000, p. 21).

Regardless of the approach considered successful regions need to develop a collective identity, enhanced by geographical and cultural proximity, where consumers and producers can learn from each other through the access to market information, build new competencies and acquire new skills by "learning-through-interacting" (Wolfe 2000). Thus, there is a growing pressure for firms, communities, regions and countries to invest more in education and training than they have in the past as well as enhance mutual dialogue.

Eventhough, with the easier and cheaper access to information there are certain forms of knowledge that cannot be codified and transmitted electronically. Thus, factors of space and proximity stimulate the tacit knowledge and capacity for learning that support innovation (Maskell and Malmberg 1999). This is because in the same local or regional economy all regional actors share the same values, backgrounds and understanding of technical and commercial problems. In addition, cultural interaction is further supported by the creation of regional institutions which help to produce and reinforce a set of rules and conventions governing local firms behavior and inter-firm interaction.

2.1. Clusters, Social Capital and Learning Processes

There is no single unified definition of cluster that can be adopted. Perhaps most known is the Michael Porter's definition of cluster, as "a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities" (Porter 1998, p.199). Some examples of them include: concentrations of interconnected companies, services providers, suppliers of specialized inputs to the production process, customers, manufacturers of related products, government and other institutions like universities, research institutes and training institutions. According to Van der Berg, Braun, and van Winden (2001), "Most definitions share the notion of clusters as localized networks of specialized organizations, whose production processes are closely linked through the exchange of goods, services and/or knowledge." Roelandt and den Hertog (1999) emphasizes the role of the cluster in a value-adding production chain processes, whereas Simmie and Sennett (2001) underline the importance of considering the supply chains when evaluating clusters performance.

Porter describes different types of clusters according to their size, structure and state of maturity:

> "Clusters vary in size, breadth, and state of development. Some clusters consist primarily of small- and medium-sized firms (…). Other clusters involve both large and small firms (…). Some cluster center on research universities, while others have no important university connection".

Porter recognizes the importance of social capital in building successful clusters. He refers here to the value of information and knowledge that firms are willing to share and the role of cluster as "a magnet drawing the skilled labour". The location of educational and training institutions within the cluster can supply it with new and highly skilled labour (e.g., Stanford and Berkeley in Silicon Valley and MIT and Harvard in Route 128). Furthermore, the internal competition and cooperation are both present in the cluster and enhance the learning processes.

3. Social Capital and Learning Processes in the EU and U.S. Regions

In most European contexts, the regional government and its development related agencies play a key role in animating the regional innovation system to stimulate the learning processes. Yet, in order to enhance the transition to a learning region regional governance structures must undergo a cultural and organizational shift away from traditional bureaucratic structures toward more flexible and promoting an effective partnership with private sector organizations and associations (Wolfe 2000).

Furthermore, it is important to identify two aspects of social capital within the European regions: first results from historical and cultural factors that buried in the region's past, the second is built up through the dense interactions of various economic actors in interrelated regional activities, that have developed a mutual trust. The second type of social capital is particularly important for the experimentation and interactive learning (Leadbeater 2000; Wolfe 2002).

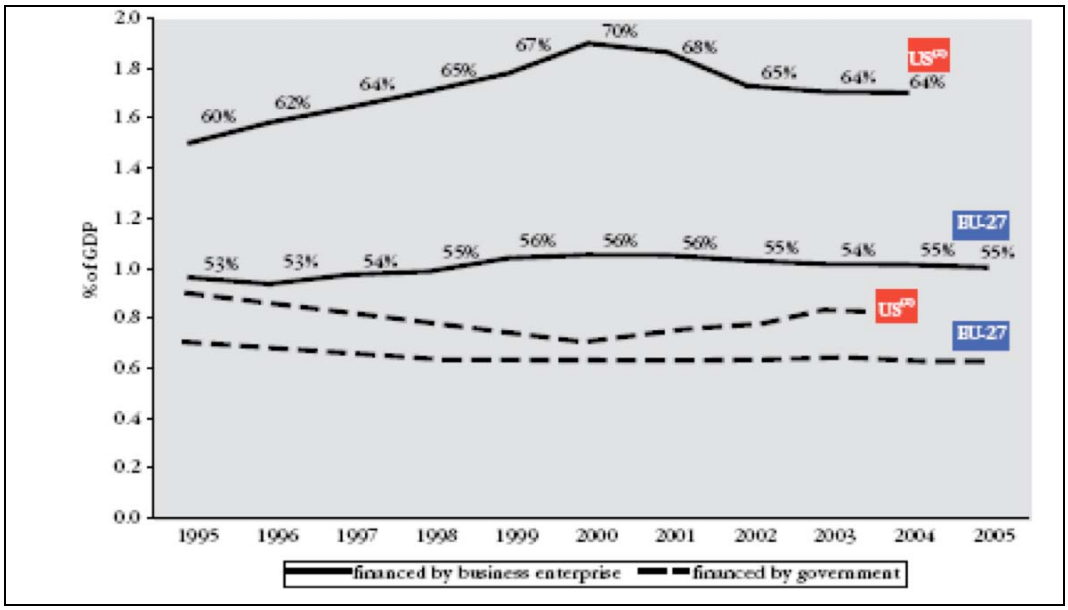
The social capital found in the competitive US regional economies is much closer to the second mentioned type. For example, social capital in Silicon Valley is grounded in the collaborative networks of interacting firms and various institutions that emerge out of pursuit of common objectives related to innovation and competitiveness. "The trust found in the Silicon Valley is based on assumptions about the reliability and reputation of the key actors" (Wolfe 2002). The principle elements comprising the networks of social capital in Silicon Valley include: the core research universities and outside firms involved in adopting and commercialization the output of research programmers; US government institutions, especially in the early period of Silicon Valley's history, that funded the critical research underlying the region's core innovations numerous venture capital firms that serve as an essential source of start-up capital; legal firms with specialized knowledge and experience to assist high-tech companies; business networks that reinforce the patterns of interaction among the firms; a high degree of labour market mobility that helps to circulate ideas among the networks of firms (Mowery 1997; Wolfe 2002; Cohen and Fields 1999).

To the extent similar conditions generating high level of trust and social capital can be found in come of the EU high technology regions (see case of Kista region in Sweden, pp.32-36).

4. Science and Technology Indicators for the U.S. and EU Regions

The analysis of the empirical literature has disclosed some significant differences in the nature and dynamics between the EU's and US R&D investments. First, there are differences in the contributions from the business sector to the financing of R&D. R&D financed by the business sector remained at about 1% of GDP in the EU, without any noticeable variation over the decade (Figure 1). In 2004, the private sector financed 64% of total R&D in the U.S., whereas in the EU the comparable figure was only 55%. It is estimated that at least three-quarters of business R&D is performed by manufacturing industries in both regions (*Key Figures 2007,* http://www.cordis.europa.eu). Second, growth of business R&D is much more dependent on business cycles in the U.S. than in the EU. The growth of business R&D in the U.S. was two to three times higher than overall GDP growth and dropped sharply than in 2000-2002 to again recover stronger in 2003.

Figure 1. Gross Domestic Expenditure on R&D Financed By Business Enterprise And By Government as% of GDP, 1995-2005



Notes: (1) The percentages on the graph refer to the share of GERD financed by business enterprise. (2) US: GERD does not include most or all capital expenditure. GERD can also be broken down by four sources of funding: (i) Business enterprise; (ii) Government; (iii) Other national sources; and (iv) Abroad.

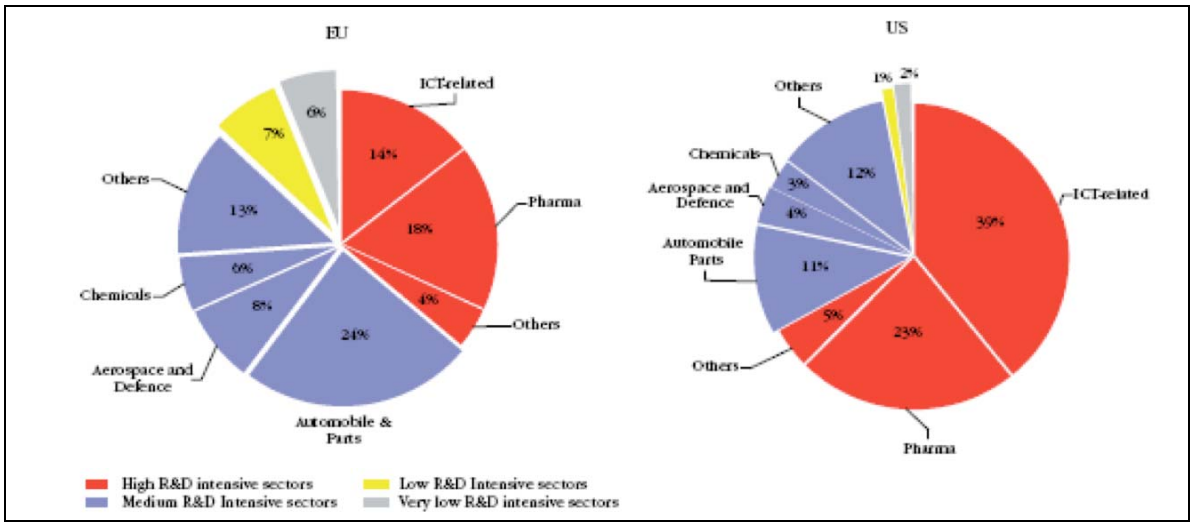
Sources: Eurostat 2006.

Moreover, differences in innovation performance between the U.S. and the EU largely emanate from differences in industrial structure of R&D. In the U.S., manufacturing R&D is more concentrated in high-tech industries than in the EU, whereas European industrial R&D is

more likely to be concentrated in medium-high-tech manufacturing (55% of total manufacturing R&D in the EU and 70% in the U.S. was carried out in high-tech industries (2003)). Therefore, in the U.S., high-tech industries account for a larger share of industrial value added and GDP than in the EU. In the U.S., high-tech manufacturing industries represent 28% of industrial value added (3.7% of GDP) compared with 19% (3.1% of GDP) in the EU (2003) (Figure 2).

When examining differences within high-tech industries between the EU and the U.S., it appears that ICT sector manufacturing industries explain almost the entire R&D funding gap between the EU and the U.S.. The ICT sector also tends to be more R&D-intensive in the U.S.. The higher concentration of R&D expenditure in medium-tech industries in the EU is found primarily in two sectors: 'Machinery and equipment' and 'Electrical machinery and apparatus.'

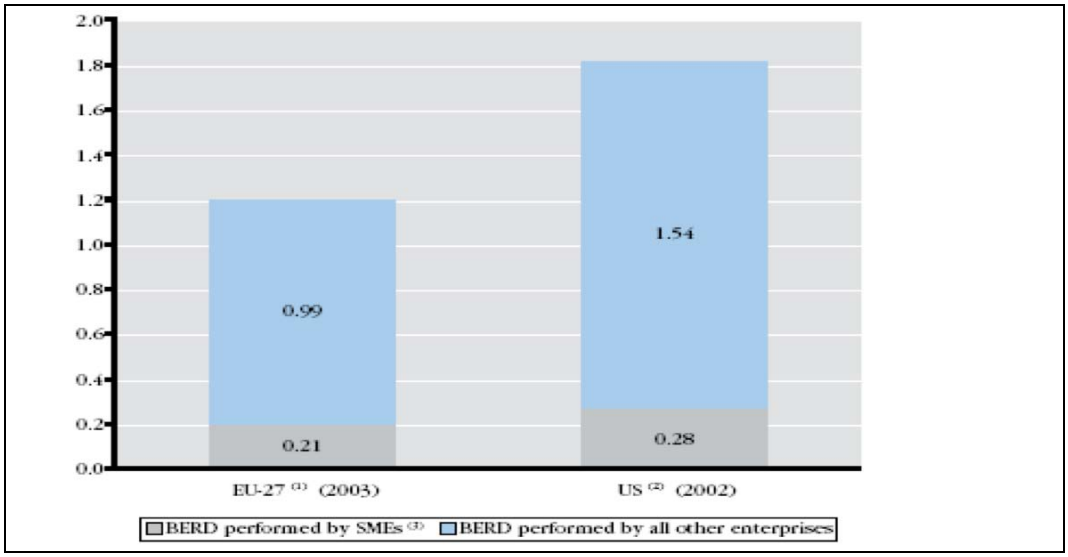
Figure 2. Sectoral Composition of R&D Investment By EU and US Companies, 2005



Source: Key Figures 2007, http://www.ec.europa.eu/

Similarly, the gap in R&D funding between the U.S. and EU results from the larger size of the U.S. industrial sectors, whereas in the EU SMEs constitute a higher share of total business R&D expenditure. Figure 3 shows the business R&D expenditure performed by SMEs and larger firms in the EU and in the U.S. as % of GDP. Business R&D carried out by SMEs is only slightly lower in the EU than in the U.S., however, SMEs represent a higher share of total output in the EU than in the U.S.

Figure 3. Business Enterprise Expenditure on R&D (BERD) by Type of Enterprise as % of GDP



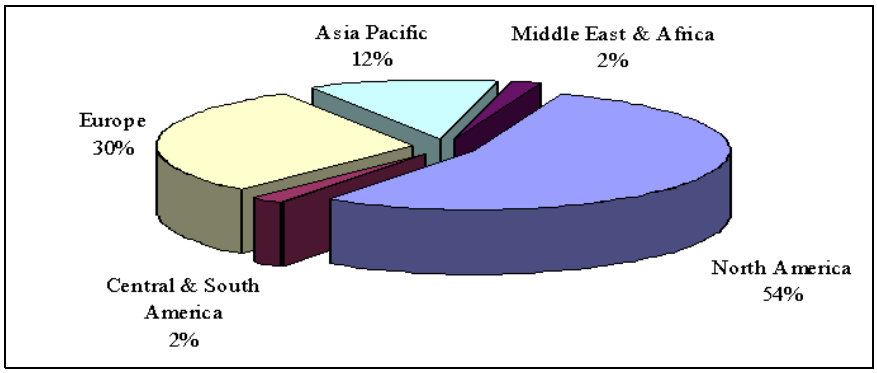
Source: Key Figures 2007, http://www.ec.europa.eu/

The weak attractiveness of the EU as a location for R&D investment, compared to the U.S., widens the innovation gap between the two regions. In fact, many European companies carry out their R&D activities in the U.S.. From 1997-2003, US spending on R&D in EU15 increased from 9.7 to 14.2 billion PPP USD. In the meantime, EU15 R&D spending in the U.S. rose from 9.9 to 18.7 billion PPPUSD. Furthermore, the U.S. companies seem to be active in diversifying of the outward R&D investment, by investing in all major regions of the world, especially in Asia (*Key Figures 2007*).

The EU regions also tend to have a weaker linkages between patented inventions and the science base, especially in fields such as lasers, semi conductors and biotechnology. Moreover, the U.S. inventors apply for more high-tech patents at the European Patent Office than do their European counterparts. The EU share of high-tech patents was only 29% compared to 37% for the U.S. as for 2003. Instead, the EU leads in a number of patents in traditional domains, such as chemistry, astronomy, physics and engineering sciences, accounting for 38% compared with 33% for the U.S (*Key Figures 2007*).

Finally, in terms of venture capital investment in relation to GDP, the EU is still lagging behind the U.S. The cumulative investment share in the global PE/VC market for the period 1998-2005 was 54% for the North American region in comparison to 30% for Europe. American venture companies were more active in exploiting breakthroughs in electronic, medical or data-processing technologies (Figure 4).

Figure 4. Cumulative Investment Share in the Global PE/VC Market Per Region 1998-2005



Source: Global Private Equity Report 2006, PricewaterhouseCoopers

In 2005, the U.S.'s total venture capital investment was 1.8 euro per thousand GDP, almost 40% higher than the amount invested in the EU. The U.S.-EU differences are even more marked when only early-stage investment is considered: early-stage venture capital investment equals 0.35 euro per thousand GDP in the U.S. compared to 0.21 in the EU, a difference of 64% (*Key Figures 2007*).

4.1. Spatial Analysis of Selected Innovation Indicators in the U.S. and the EU

The spatial organization of innovation sources determines the levels of localized economies of scale and knowledge externalities, and thus the level of innovative output (Crescenzi et al. 2007). One major finding of studies of economic geography in the U.S. and EU has been that the diffusion of technology is quite localized and that technological knowledge is more local than global (Keller 2002; Milner 2003). Audretsch and Feldman found that new product innovations were most highly concentrated in a few US regions and in those industries in which new knowledge played an important role (1996). Furthermore, the study results presented by Crescenzi et al. (2007) show that the dispersion of innovative activities seems to be less accentuated in the U.S. than in the EU. The convergence parameter appeared to be smaller and less significant in the U.S. than in the EU. Thus, according to Crescenzi et al. the production of knowledge and innovation are more localized in the U.S. than in the EU.

The empirical data on the U.S. and the EU regions confirm these studies. Innovative activity, measured by new patents and per capita expenditures on R&D, tends to be more localized around the largest agglomerations in both regions (Figures 5, 6 and 7). Agglomeration increases innovative output due to its access to human capital, labour market interactions, linkages between intermediate and final good suppliers, high-tech industry structure, R&D university infrastructure and knowledge spillovers.

According to the *World Knowledge Competitiveness Benchmarks 2003/2005* only a few of the U.S. MSAs are ranked relatively high in per capita expenditures on R&D performed by government and business, accompanied by a relatively high rank in a number of patents registered per one million inhabitants . Such regions included Boston-Cambridge-Quincy, San

Francisco-Oakland-Fremont, San Jose-Sunnyvale-Santa Clara, Seattle-Tacoma-Bellevue and the metropolitan Hartford area. Similar tendencies were observed in the EU. Moreover, EU regions are significantly lagging behind the U.S. regions in all three innovation patterns, with exception to certain EU regions.

Figure 5. Best-performing U.S. and EU Regions in Per Capita Expenditures on R&D Performed by Business

Region	Rank	Rank	Rank	Rank	Change
Hartford, US	1	3	10	9	8
Bridgeport-Stamford-Norwalk, US	2	-	-	-	-
Boston-Cambridge-Quincy, US	3	5	5	4	1
Grand Rapids, US	4	7	1	2	-2
Detroit-Warren-Livonia, US	5	6	2	1	-4
Seattle-Tacoma-Bellevue, US	6	1	3	3	-3
West, Sweden	7	4	13	14	7
Providence-Fall River-Warwick,	8	-	-	-	-
San Diego-Carlsbad-San Marcos,	9	12	9	7	-2
San Jose-Sunnyvale-Santa Clara,	10	8	-	-	-
Los Angeles-Long Beach-Santa	11	11	8	5	-6
San Francisco-Oakland-Fremont,	12	10	6	8	-4
Oxnard-Thousand Oaks-Ventura,	13	-	-	-	-
Riverside-San Bernardino-	14	9	-	-	-
Sacramento--Arden-Arcade--	15	13	6	6	-9
Stockholm, Sweden	17	2	4	10	-7
Eastern, UK	21	25	19	23	2
Minneapolis-St. Paul-	23	22	26	21	-2
Portland-Vancouver-Beaverton,	24	27	31	27	3
Île de France, France	25	14	16	13	-12
Baden-Württemberg, Germany	26	18	17	17	-9
Pohjois-Suomi, Finland	29	-	-	-	-

Source: World Knowledge Competitiveness Benchmarks 2003/2005, http://www.hugginsassociates.com/

The best performing regions in terms of innovation activities were localized in the Nordic and Western part of the EU, for example, Uusimaa (Finland), Stockholm (Sweden), Smaland Medoarna (Sweden), South Sweden, West Sweden, South Netherlands and Baden-Württemberg (Germany).

Figure 6. Best-performing US and EU Regions in Per Capita Expenditure on R&D Performed by Government

Region	Rank	Rank	Rank	Rank	Change
Washington-Arlington-Alexandria,	1	1	1	1	0
Baltimore-Towson, US	2	2	-	-	-
Richmond, US	4	3	12	7	3
Virginia Beach-Norfolk-Newport	5	4	13	8	3
Boston-Cambridge-Quincy, US	6	5	70	70	64
Providence-Fall River-Warwick,	7	-	-	-	-
Hartford, US	8	6	117	117	109
Bridgeport-Stamford-Norwalk, US	9	-	-	-	-
San Francisco-Oakland-Fremont,	10	9	62	63	53
San Diego-Carlsbad-San Marcos,	11	12	62	62	51
Oxnard-Thousand Oaks-Ventura,	12	-	-	-	-
Riverside-San Bernardino-Ontario,	13	10	-	-	-
San Jose-Sunnyvale-Santa Clara,	14	8	-	-	-
Los Angeles-Long Beach-Santa	15	11	62	60	45
Sacramento--Arden-Arcade--	16	13	61	61	45
Seattle-Tacoma-Bellevue, US	17	7	67	65	48
Denver-Aurora, US	18	16	56	56	38
Colorado Springs, US	19	-	-	-	-
Phoenix-Mesa-Scottsdale, US	20	15	88	88	68
Pittsburgh, US	21	20	105	106	85
Lazio, Italy	22	17	10	4	-18
Prague, Czech Republic	23	18	6	3	-20

Source: World Knowledge Competitiveness Benchmarks 2003/2005, http://www.hugginsassociates.com

In the EU, the regions that invest the most on R&D did not file the highest number of patents. In fact, their innovative activities were shaped more by interregional knowledge spillovers, enhanced by the greater proximity and lower distance between the EU regions. In sum, greater innovative outcome of the EU regions is correlated with innovative inputs in neighboring regions. In the U.S., the spatially-weighted average of neighboring MSAs' R&D expenditure failed to exert any statistically significant influence upon innovation outcome of MSAs. This is because the greater distance between the U.S. MSAs has led to the creation of self-contained innovative areas, relying more on their own innovative inputs than on spillovers from other MSAs R&D. Innovation inputs in the U.S. regions tend also to be more specialized and finely targeted than in the EU regions. The efforts by many EU states to establish leadership in a number of R&D areas has resulted in duplications and redundancies (Crescenzi et al. 2007).

Figure 7. Best-performing US and EU Regions in Number of Patents Registered Per One Million Inhabitants

Region	Rank	Rank	Rank	Rank	Change
San Jose-Sunnyvale-Santa Clara, US	3	4	-	-	-
San Diego-Carlsbad-San Marcos, US	4	8	14	15	11
Los Angeles-Long Beach-Santa Ana, US	5	7	48	49	44
San Francisco-Oakland-Fremont, US	6	6	4	2	-4
Riverside-San Bernardino-Ontario, US	7	5	-	-	-
Oxnard-Thousand Oaks-Ventura, US	8	-	-	-	-
Sacramento--Arden-Arcade--	9	9	57	55	46
Boston-Cambridge-Quincy, US	10	11	15	17	7
Minneapolis-St. Paul-Bloomington, US	11	10	12	14	3
Portland-Vancouver-Beaverton, US	12	14	23	23	11
Colorado Springs, US	13	-	-	-	-
Denver-Aurora, US	14	13	25	27	13
Bridgeport-Stamford-Norwalk, US	15	-	-	-	-
Hartford, US	16	23	30	28	12
South, Netherlands	17	49	16	20	3
Baden-Württemberg, Germany	19	44	19	19	0
Providence-Fall River-Warwick, US	22	-	-	-	-
Detroit-Warren-Livonia, US	23	15	22	22	-1
Grand Rapids, US	24	16	40	42	18
Seattle-Tacoma-Bellevue, US	26	19	28	29	3
Milwaukee-Waukesha-West Allis, US	27	18	31	34	7

Source: World Knowledge Competitiveness Benchmarks 2003/2005, http://www.hugginsassociates.com/

Moreover, a higher patent growth rate in the U.S. MSAs was associated with the higher level of R&D expenditure in the knowledge-intensive industries (Table 3). For example, San Jose-Sunnyvale-Santa Clara metropolitan area specializes in semiconductors, computers, software, communication equipment and data storage; the Boston-Cambridge-Quincy in computers, medical devices, and software (biotechnology); Seattle-Tacoma-Bellevue in software (biotechnology, aerospace); and Washington-Arlington-Alexandria in databases, and Internet service (telecommunications, biotechnology).

Summing up, the Silicon Valley region in Northern California (Jose-Sunnyvale-Santa Clara metropolitan area) has still one of the strongest innovation assets in the world. However, other global regions are also working hard on developing their innovative capacities. One of the most innovative regions in terms of R&D spending and the number of patents in the EU is the region is Stockholm. The experience of the Stockholm region, with its Kista cluster, seems to be comparable to the case of Silicon Valley in the U.S. In both cases, advanced technologies, especially ICT as well as close network to the university and industry leaders were the main drivers of their dynamic development.

5. Selected Case Studies – ICT Clusters in the EU and the U.S.

5.1. The Kista Cluster of Stockholm Region

Kista is a district of Stockholm Municipality in Sweden, located northwest of central Stockholm and belonging to Rinkeby-Kista.

At the beginning of the century, Kista region was a military training ground for Swedish government. During the 1970s, Swedish government started a housing construction programme on that piece of land. Kista was supposed to become an town with a residential area separated from the commercial properties, with the extensive public services and a range of commercial businesses[1].

The construction of the industrial section of Kista began not later then 1970s, when some companies such as SRA (Svenska Radio Aktiebolaget, now a part of Ericsson), RIFA (later Ericsson Microelectronics and now Infineon Technologies) and IBM Svenska AB (the Swedish branch of IBM) located their offices there (Figure 8). Yet, the real growth in the number of IT companies in Kista had mainly occurred since 1992.

Figure 8. Some Milestones in Kista's History



1905 Military training ground

1972 Construction of houses gets underway

1975 First to move in: Ericsson – SRA och Rifa

1976 The last farmer leaves

1980 IBM moves in

1985 The City of Stockholm takes an initiative to build an electronics centre

2000 The work to create a joint vision starts. The building of Kista Science City starts

2003 Ericsson moves their headquarters to Kista 2001.

Source: Presentation by Béland M. and Soulier L., ARISE Kick-off meeting, 19th-20th September 2005, Kista Science City, http://www.arise-project.com/

[1] Sandberg Å., Augustsson F. and Lintala A. *IT and Telecom Companies in Kista Science City, Northern Stockholm – Activities, Networks, Skills and Local Qualities*, National Institute for Working Life and Arbetslivsinstitutet, 2007, http://www.mpra.ub.uni-muenchen.de.

Today, the Kista[2] urban area is Sweden's largest corporate center and one of the most important ICT clusters in the world, with multinational companies such as Ericsson, IBM, Sun, Tele2, Tieto Enator, and Nokia. Ericsson has its head office in Kista and, with a staff of more than 9,000, is the largest single employer. It estimated that some 28,000 employees are currently working in some 750 Kista companies, with two-thirds of them working in the ICT sector[3].

It is a home of two leading education institutions in Sweden - KTH School of Information and Communication Technology and Stockholm University. Research is conducted in the broad range of high-tech areas, mainly related to ICT sector, such as: Materials and Semiconductor Physics; Electronic devices; Optics, Photonics and Quantum Electronics; Electronic and Computer Systems; Communication Systems; Information and software systems / System analysis; Software Development; Communication and Cognition; IT and Society; IT Security. The Kista Campus is close to shops, restaurants, and transportation junctions, e.g., it is located between Arlanda Airport and Stockholm City.

5.1.1. Brief Companies Profile

The reliable empirical data on Kista region is difficult to find, due to limited official statistics and dynamism of the industry. The latest data of 2007 on the region was based on the study conducted by Sandberg Å., Augustsson F. and Lintala A. [4] entitled "IT and Telecom Companies in Kista Science City, Northern Stockholm – Activities, Networks, Skills and Local Qualities". The study surveyed establishments that were located in areas of Kista, Akalla and Husby that worked in IT related business and that had 0–199 employees. The results were based on questionnaires that were sent to companies in 2003/2004. Questionnaires were sent to at total of 397 establishments and we received 173 replies. It is also important to mention that Kista's companies are of relatively young Age, with more than half established after the dotcom crash. Before establishing in Kista, a total of 67 per cent of the companies had operations at a different location, 48 per cent had operations in other parts of greater Stockholm, 20 per cent in the rest of Sweden, 24 per cent abroad, whereas 10 per cent of the currently active companies were spin offs from other companies in Kista (Sandberg et al. 2007).

Some 65 per cent of establishments perform IT related activities, whereof half is active in the production of software, R&D, trade and the publication of software/ data processing/other activities. Big establishments (although with fewer than 200 employees) also conduct some R&D

[2] The reliable empirical data on Kista region is difficult to find, due to limited official statistics and dynamism of the industry, with its constant start-ups, relocations, mergers and shutdowns.

[3] Campus Kista, http://http://www.it-univ.se/

[4] Sandberg Å., Augustsson F. and Lintala A., *IT and Telecom Companies in Kista Science City, Northern Stockholm – Activities, Networks, Skills and Local Qualities,* Work Life in Transition, 2007:1, http://http://www.mpra.ub.uni-muenchen.de/ (The study was performed as part of the MITIOR programme (media, IT and innovation in organisation and work) at the Swedish National Institute for Working Life and NADA (Royal Institute of Technology department working with numerical analysis, computer science, computer interaction and media technology). The results are based on questionnaires that were sent (in 2003/2004) to all establishments (irrespective of size) in Kista, Akalla and Husby that work in IT related operations, according to the definition and SNI (Swedish Standard Industrial Classification) 92 and 02 for the sector.

within this field, whereas small companies are more focused on activities such as consulting, service and trade in IT-related areas (Sandberg et al. 2007).

5.1.2. Structure and Types of Collaboration Networks

Cooperative ventures, such as exchange of experience and strategic cooperation with other companies in Kista was conducted in 54 per cent and 44 per cent of the surveyed companies. More than a quarter (27 per cent) of companies outsourced parts or all of their IT-related activities to other companies (an average of 37 per cent of their turnover). The most common outsourced activities were hardware production, consulting and computer service operations, the maintenance of infrastructure, and R&D. However, the share of establishments that outsource their IT-related activities to other establishments located in Kista was relatively low, e.g., in consulting and maintenance of infrastructure - 5 per cent, in R&D and hardware production - 18 and 15 per cent respectively. The smallest proportion of outsourced activities within Kista concerned marketing, administration, computer support and recruitment (Sandberg et al. 2007).

Some forty-one per cent of the establishments performed IT related subcontract work. However, only eleven per cent of those had done it for companies located in Kista. Subcontracting was extremely common in consulting and computer servicing operations. Yet, nearly half the establishments neither did subcontract work nor outsourced work (Sandberg et al. 2007).

The results also show that only a small proportion of the companies' cooperation was within Kista region. Most of the partners were located elsewhere in Sweden. Compared to outsourcing activities subcontract work was more local and regional, with the Stockholm region accounting for 70 per cent compared to 50 per cent for outsourcing companies (Sandberg et al. 2007).

In sum, clustering in Kista is featured more by geographical proximity rather than direct cooperation with other local companies. As authors of the survey concluded "The number of local cooperative ventures not directly related to the running of the businesses is lower than many would perhaps have expected based on theories about the necessity of local clusters with face-to-face contacts and triple helix structures" (Sandberg et al. 2007).

The actions promoting the Stockholm as a world IT cluster region are supported by the network of various private and public institutions, such as: Ericsson, TeliaSonera, IBM, Logica (former WM-data), Microsoft, Intel, Stockholm Business Region, ITandTelekomföretagen, Kista Science City, Stokab, the Stockholm County Council as well as different organizations such as: Electrum Foundation, Stockholm Science City Foundation, Organization of Stockholm Innovation and Growth, Innovation Relay Centres, Stockholm IT Region, Stockholms Teknikhöjd, etc.

- **The Electrum Foundation in Kista**, was established in the 80s. Its aim was to create a platform of interaction between the city, industry and academia to promote the development of computer and electronics industry. The Foundation main mission is to enhance the cooperation between industry and academic R&D as well we assure a healthy collaboration between research, academia, the City and the business

community. Its growth model is based on the Triple Helix principle. It assists companies in finding competence and useful contacts within the universities. The strategies of Foundation ensure a continued growth in Kista Science City, which primarily take place through research-based and innovative growth companies based on the application of ICT. The Foundation's board comprises leading representatives from Ericsson, Acreo, IBM, Atrium Ljungberg, PacketFront, KTH and the City of Stockholm. The Foundation's work is supported by six strategy groups: Strategy Council A Living City, Strategy Council for Higher Education, Skills-Provision, and Entrepreneurship, Strategy Council for Innovation, New Growth Businesses and Global Expansion, Strategy Council for Infrastructure for Growth Strategy Council for Marketing and Strategic Business Recruitment, Strategy Council for Research and the Business Community containing a cross-section of activities at Kista Science City. Their work is to match strategies, objectives and activities within the framework for each area contributing to the realisation of the Kista Science City vision. Two operative subsidiaries have been formed - Kista Science City AB and STING AB - to guarantee that objectives are achieved (http://www.kista.com).

- The mission of **Stockholm Science City Foundation** is to attract academia and business to the areas Norra station and Albano in Stockholm. The Stockholm Science City Foundation is commissioned by the three leading universities Karolinska Institutet, The Royal Institute of Technology (KTH) and Stockholm University as well as the city and county and the business sector. http://www.ssci.se/en/ We are commissioned by the three leading universities Karolinska Institutet, The Royal Institute of Technology (KTH) and Stockholm University as well as the Stockholm County Council and the City of Stockholm.

- **Organization of Stockholm Innovation and Growth**: Incubation activities have been run for many years to support new innovative growth companies through Stockholm Innovation and Growth AB, which has extensive experience of successful clusters and support to entrepreneurs. This takes place through incubation activities for KTH at Campus Kista and at Campus Valhallavägen as well as for Karolinska Institutet in Flemingsberg. Organisation STING is owned by the Electrum Foundation and is a sister company to Kista Science City AB. STING is a non-profit company and its activities are financed in part using public funding from the Electrum Foundation and from its main collaborative partner Innovationsbron, and in part from private partners and its own financing http://www.kista.com/.

- **Innovation Relay Centres**: the development of new enterprises is also a matter of the Innovation Relay Centres, IRC, whose core task is international technology transfer. The network consists of 150 offices in 15 European countries of which two are located in Stockholm. The IRC network is a service for companies, especially for SMEs.

- **Stockholms Teknikhöjd** supports the commercialisation of research results and business ideas originating from students from KTH and the University of Stockholm

by offering office space and information infrastructure, and giving advice in patenting, licensing, marketing and financing. Presently, roughly 40 innovative firms are member of Stockholms Teknikhöjd.

- **Stockholm IT Region:** is a joint venture between several public and private players, including Kista Science City AB, which aims to enhance competitiveness for the ICT sector in the Stockholm region. In practice, work in Stockholm IT Region is run as working groups. The project focuses on the following strategic areas: Skills-provision: Skills-provision in the short and long term in the ICT sector is a high-priority issue. (Electrum Foundation, is convenor); Marketing: Stockholm IT Region actively markets Stockholm as a world-leading ICT region (Stockholm Business Region Development, is convenor); Infrastructure: Stockholm IT Region makes an inventory of IT infrastructure in the Stockholm region and illustrates future developments in the region (Stokab is convenor).

5.1.3. Cooperation With Academia and Local Government

In 1980, the Royal Institute of Technology (KTH), Ericsson and the City of Stockholm launched a programme for an electronics centre in Kista. The foundation called the Electrum was a result of the cooperation between the municipality, researchers and companies among. Electrum is a home place of several research institutes including The Swedish Institute for Computer Science (SICS), KTH's engineering school and one of the top research companies in Sweden Acreo AB. Parts of the electronics department and courses in computer and systems sciences run in Electrum premises by Stockholm University and the KTH Several spin-off companies have been formed there.

Another major investment in Kista, was the establishment of the Campus IT University – a joint venture between KTH and Stockholm University – in 2002. Higher education institutions is a local job market for many Kista companies: 17 per cent of the establishments surveyed had recruitted former Kista students to permanent jobs, and a slightly lower percentage worked with them through degree projects or other short-term jobs. However, the local R&D cooperation between the university and companies is rather limited: only some 12 per cent of the Kista establishments cooperated actively with the universities and 6 per cent with other research institutes. Even though, a greater interaction occurred between companies than between companies and universities, almost half of establishments thought that Kista fully met the condition of close proximity to universities and research institutes (Sandberg et al. 2007).

In terms of the collaboration with local government offices, only 13 per cent of the companies said that they had been in contact with municipal business development officers Kista (Sandberg et al. 2007).

The survey data doesn't include more informal contacts and networks at individual level in Kista region. Certainly, Kista's facilities provides a platform for spontaneous meetings and knowledge sharing, e.g., Kista Galleria is a centre for lunching, shopping and public transport.

5.2. Venture Capital

The venture capital sector in Stockholm is very dynamic and among the fastest growing in the world. The last 5 years it has grown by more than 200% per year. The size and activity of the venture capital industry has increased sharply in recent years. In Sweden today there are about 130 venture capital companies that, combined, have more than SEK 80 billion in funds under management. The majority of the Swedish venture capital firms are naturally based in Stockholm. The range of companies is large, from a number of individual business angels to large companies like Investor and SE-Banken. The amount of business angels has dramatically increased in Sweden during the last 3-year period. A number of actors such as ALMI and the Connect-network create platforms and events with the aim of making business angels and entrepreneurs meet.

5.3. National and Regional Cluster Support Policies – Case of Sweden

Sweden offers several programmes for cluster policies on regional level. The government asked each region to prepare Regional Growth Programs for 2004-2007 (Regionala tillväxtprogram). The programmes are set up by the autonomous administration in each region on of the three strategic areas in the RTPs are Innovation Systems and Clusters. The regions' growth policies focus strongly on clusters. Nutek has the task to evaluate the regions RTPs.

There are several national initiatives and relative agencies dealing with promotion of regional clusters in Sweden. In general, Näringsdepartementet (Ministry of Enterprise, Energy and Communications) has the overall patronage over the cluster policy in Sweden. There are two authorities that work with the implementation of the cluster policies - Nutek and Vinnova. Nutek work with entrepreneurship, business development and regional development, whereas Vinnova has a focus on innovation and knowledge spillover. The third body dealing to some extent with cluster policy is Invest in Sweden Agency (ISA) (functioning under Ministry of Foreign Affairs).

The Stockholm region is one of the most competitive knowledge-based regions of Sweden. Clusters policy make up a big part in the Regional Growth Program for 2004-2007 (RTP 2004-2007) of the Stockholm region. The RTP 2004-2007 emphases the alreading existing strong clusters in the region, e.g., Kista cluster. The RTP promotes and suports new and emerging clusters as well as their infrastructure and regional education.

The support to the clusters in Stockholm region is conditioned by their establishment of the region's own network administration so as the partner to work with. The Government of Stockholm works actively to promote a cooperation between local administration, universities and clusters. One of the problems of Stockholm's clusters is their high dependancy on one or two dominating companies and thus limited competition within the clusters.

Business Region Stockholm (BRS) is one of the most active actors working to promote clusters and Triple Helix principles in the region. Stockholm Business Region Development (SBRD) - subsidiary to Stockholm Business Region (http://www.stockholmbusinessregion.se/) - is owned by the City of Stockholm and is an official investment promotion agency of Stockholm. SBRD aims to the marketing and development of Stockholm region as a business destination.

Globaliseringsrådet is another institution called up to promote the competitiveness of Sweden. It was founded in 2006 and followed the examples of already existing Finnish and Danish institutions. It consists of representatives from the government, public administration, academia, the business world, trade unions and the media. One of their missions is to come up with the ways in which Sweden can improve its innovation systems and improve its business leadership in the world.

Last but not least important actors promoting cluster policies in Sweden is The Swedish Institute for Growth Policy Studies (ITPS). The ITPS aimes to help Swedish authorities to understand better patterns of growth and evaluate the government policies. It has prepared several publications about cluster policies and regional growth policies[5].

Foreign direct investments (FDI) are attracted to the Swedish regions via the efforts of Invest in Sweden Agency (ISA) (http://www.isa.se/), which was also one of the founding partners in the Visanu programme. ISA was one of the first actors emphasizing the role of clusters for regional development, in the late 1990s. There is a number of sectors which ISA attracted foreign capital due to the developed a useful cluster navigation tool. The sector selection is based on the country's existing comparative advantage.

Summing up, innovation system and cluster policy have been priorities at the national level for some 10 to 15 years now in Sweden. The importance of the regional dimension of inno-vation and cluster policies increased due to the Regional Growth Plans (RTP). The latter puts an emphasis on all regions to demonstrate the ways in which they are promoting clusters.

5.3.1. The EU Structural Funds Support for Stockholm Region

The EU Structural Funds contributed with euro 2.25 million for a regional programme of innovative actions in Stockholm[6]. During the period 2003-2004, the European funding was expected to attract further investment from the public sector in the amount of 0.99 million euro and 1.55 million euro from the private sector creating total resources of 4.78 million euro. The programme aimed at strengthening the region's role as a world-leading "environment for establishment and development of companies, based on innovation and new technology". The more specific programme objectives included: 1) Systematic growth of intellectual capital in the region, 2) Further development of the entrepreneurial spirit in the region and the quality of relevant framework conditions, 3) Integration of isolated networks and sub-clusters to a holistic system, 4) Stimulation of a commercial market for technology–based solutions and 5) Foster a learning innovation system[7]. One of the important programme's missions was to extend the innovation ability within the central parts of Stockholm region to the more peripheral parts.

[5] *Country Report: Sweden,* http://www.clusterobservatory.eu/
[6] http://ec.europa.eu/regional_policy/innovation/pdf/programme/stockholm.pdf/
[7] Ibidem.

Figure 9. The Programme Coveres the Following Actions

The intellectual capital of Stockholm	**Commercial market for technology-based solutions**	**High-density TIME-environments**	**Market-oriented innovation system for the development of knowledge and ideas to start new companies**
Aim: to improve the Stockholm region's intellectual capital. Main target groups: • Small and medium sized companies. which together test methodologies for measuring intellectual capital and elaborate action-plans for improving the situation. •Existing knowledge-structures, e.g., science and technology parks and clusters.	Aim: to promote increased growth of traditional firms by promoting a higher degree of integration of high-tech solutions in the production- and product development processes. • to increase growth of high-tech firms by providing support for the development of new products and markets based on the needs of the traditional manufacturing and service companies.	Aim: to create innovation fostering platforms for new media, communication, and entertainment. • explore methods for finding new ways for identification of and realisation of innovative environments within the area of region's growth and innovative capabilities.	Aim: to increase the number of knowledge-intensive and well financed enterprises in the region by elucidate, complement and qualify business ideas so that they can be assessed by venture capitalists for further financing. • to create a seed-focused and open innovation system for the development of knowledge and new business-ideas characterized by quality, flexibility, transparency, simplicity, effectiveness, diversity and good capacity. • to achieve the above aims a pool of business advisors will be created, which will complement the existing supply of such services.

Source: http://ec.europa.eu/regional_policy/innovation/pdf/programme/stockholm.pdf

In August 2007, European Commission approved a Regional Operational Programme (OP) for the region of Stockholm for the 2007-13 period. The OP Stockholm is co-funded by the European Regional Development Fund (ERDF)under the Regional Competitiveness and Employment Objective (with the total budget of around 94 million EUR). The European Community assistance through the ERDF amounts to some 38 million EUR, which is 2.0% of the total EU investment for Sweden under the Cohesion Policy for 2007-2013.

The programme aims to strengthen the international competitiveness of the Stockholm region, with special emphasis on SMEs and the increased cooperation between the industry, the R&D institutions and the public sector. The Programme suports also entrepreneurship, innovativeness, knowledge development and integration of immigrants as well as increasing export and stimulating effective energy use.

In sum, the Programme envisages to create 1300 new jobs, 300 new businesses and the involvement of 400 businesses in the development of markets, product development or lowering energy consumption). All projects include at least 40% of participation of women.

The following priorities OP Stockholm promotes the development of clusters and regional innovation system. The meeting places are to be created for supporting innovation and development through advice and counselling and provision of risk capital. The Priority 2 - Business development - aims to provide information, training and counselling for SMEs and entrepreneurs, strengthen the co-operation between academy and industry as well as financial engineering and access to capital (32.0% of total funding). The third priority - Accessibility -aims to improve the accessibility of the larger Stockholm region, assure housing and transportation to meet the population growth, improve co-operation with regions beyond the Stockholm region (24.0% of total funding). The fourth priority - Technical assistance – addreses the suport for management, monitoring and evaluation of the operational programme, and the associated communication and publicity activities(approximately 4.0% of total funding)[8].

Summing up, it is important to underline that networks and trust-based relationships can only be developed over long time periods. Most networks FP6comprise at least at their core already existing networks that they support and stimulate (Werker 2006). Yet, it is hardly possibile to build a network where there were no previous networks. One of the positive role of EU regional innovation policies is their contribution to the regional development and growth through enriching the human capital and regional knowledge transfer as well as stimulation of SMEs.

6. The Silicon Valley Cluster in California

Silicon Valley has become the symbol of one of the most dynamic and successful high-tech regions in the world, whose example have been followed by many regions around the world.

The story of Silicon Valley starts with Stanford University and the University of California at Berkeley during World War II, when The Federal Government sought the development of high technology weaponry at top US universities. The research during the war was carried out in R&D units set up within the these universities but physically separated from the campuses for security reasons, e.g., Lincoln Laboratory at MIT. Later on, these research laboratories were made more independent of their universities and began to function as businesses, yet with government contracts playing a key role (Saxenian 1994).

It was widely considered by many subject related authors, that the creation of Fairchild Semiconductor was the crucial catalyst in the development of the Silicon Valley. The company

[8] http://www.ec.europa.eu/, Regional Policy – InfoRegio.

became the training platform for technological entrepreneurs, e.g., their cooperation and sharing of experience. In several cases their business relationships was a continuation of relationships that had originated during their studies at Stanford and other top universities (Saxenian 1994).

Figure 10. Some Milestones in Silicon Valley's History



Silicon Valley and Environs

1930's Encouraged by Prof. Frederick Terman, William Hewlett and David Packard start a company to produce their audio-oscillator.

1937 Stanford professor William Hansen teams with brothers Sigurd and Russell Varian to develop the klystron tube.

1946 The Stanford Research Institute is founded.

1951 Stanford Industrial Park is established.

1952 IBM locates a key research facility to the valley.

1956 William Shockley founds Shockley Transistor Corporation to produce semiconductor-based transistors. In 1958, engineers from Shockley Transistor found Fairchild Semiconductor.

1958 NASA moves a research facility to the valley.

1968 Gordon Moore and Robert Noyce found Intel.

1976 Steve Wozniak teams with Steve Jobs to form Apple Computer and build the first microcomputer.

1982 The Stanford University Network is the catalyst behind the founding of Sun Microsystems.

1993 Stanford Professor Jim Clark hires Mark Andreesen to found Mosaic Communications, predecessor to Netscape Communications Corporation and the browser that made the Internet an everyday tool.

1994 Jerry Yang and David Filo, graduate students at Stanford University, start a directory of websites, later on transformed into Yahoo.

Source: http://www.siliconvalleyonline.org/

Second import ant event in Silicon Valley's history was the creation of the Stanford Industrial Park in 1951. It was the first technology and science park in the world. The Industrial Park

became an attractive location for start-ups, specialised laboratories, offices and production facilities. One of its first tenants were Varian Associates, Hewlett-Packard, Eastman Kodak and Lockheed. By 1960 the technology park grew up to 40 companies (Hulsink et al. 2007). Whereas, the high-tech employment of Silicon Valley increased from 17,000 in 1960 to 268,000 in 1990 (Saxenian 1994).

The growth was fueled by the emergence of the venture capital industry that replaced the military as the leading sourcę of financing for Silicon Valley start-ups. In her 1994 book, *Regional Advantage: Culture and Competition in Silicon Valley and Route 128,* Saxenian reports that "cooperation among Silicon Valley's venture capital community was always tempered by the reality of intense competition". "Competition in computing was increasingly based on the ability to add value-to identify new applications and improvements in performance, quality, and service-rather than simply on lower cost" (Saxenian 1994).

Another important event, strengthening the role of region as a leading scientific and high-technology center in the world was the establishment of NASA Research Park. It has enlarged the investment pools, technical infrastructure and skill base of the Silicon Valley by attracting new engineering talent into the region.

Silicon Valley's success story (see more milestones in Figure 10) has made it an attractive place for people and firms from all over the world.

6.1. Brief Companies Profile

The industrial structure that emerged in Silicon Valley was highly fragmented, with increasingly specialized products and services. By the late 1950s, the semiconductor industry was dominated by over 100 competitors. Yet, the Silicon Valley was yet to boom in the late 1970s and early 1980s.

By the end of the 1970s Silicon Valley was populated by close to 3000 electronics manufacturing firms, including producers of semiconductors, computer systems, software, telecommunications equipment, medical electronics, and military and aerospace equipment. The industry was dominated by small companies: 70 percent had fewer than l0 employees and 85 percent had fewer than l00. It was also time of the largest wave of start-ups in Silicon Valley's history (Saxenian 1994).

By the end of 1980s Silicon Valley was the home for such software producers as Conner Peripherals, Maxtor, Quantum, networking and communication equipment producers as 3Com, Excelan, Cisco, Bridge Communications, computer design and engineering systems as Saisy Systems, Cadence Design, Valid Logic Systems and other Digital technology related companies as SuperMac, Radius, RasterOps, etc.

During the semiconductor recession many semiconductor firms shifted from commodity chips to microprocessors. During the 1990 defense and aerospace recession, Valley entrepreneurs

turned the ARPANET (Advanced Research Projects Agency Network) - sponsored by the U.S. Department of Defense - into a platform for thousands of network-based applications[9].

In 2000, more than half a million engineers, scientists, managers, and operators in industries ranging from electronic components to computers were employed in the high tech firms in Silicon Valley. In 2000-2002, The Silicon Valley region generated about 23,000 net new firms. Almost half of all firms in Silicon Valley was started in the five years starting from 1998 to 2002[10]. Its geography extends across 30 cities, including San Jose, the third-largest city in California, and parts of four counties; Santa Clara, San Mateo, Alameda and Santa Cruz. The economy of Silicon Valley is connected with other regional economies in California, the nation and the world.

Silicon Valley continues to reinvent itself and shift to new areas. In 2005, six of top 10 U.S. cities for patents were located in Silicon Valley (*Index of Silicon Valley 2007*). Venture capital investment has experienced a boom period (peaked in 2000 at $34.5 billion followed) by a bust between 1998 and 2003. In 2003, after a smooth growth, venture capital investment declined by 80% to $6.7 billion. Similar trend has occurred regarding the rate of employment. Between 2001 and 2004 Silicon Valley lost 16% of its jobs[11].

6.1.1. Structure and Types of Collaboration Networks

This sense of community that existed, since the early history of the Silicon Valley, among the business and technical people enabled the firms to solve technical problems more easily and rapidly than their counterparts elsewhere.

Saxenian (1994) demonstrates how decentralized regional network-based system emerged in Silicon Valley influenced the region's competitive advantage (in comparison with the independent firm-based system represented by Route 128).

In a network-based industrial system region is organized to adapt continuously to fast-changing markets and technologies. The system's decentralization encourages the pursuit of multiple technical opportunities through spontaneous regroupings of skills, technology, and capital, its production networks promote a proccess of colllective technological learning (Saxenian 1994:9).

Cooperation among Silicon Valley firms took various forms, e.g., from cross-licensing and second-sourcing arrangements to technology agreements and joint ventures. Agreements were made between firms participating in the same market, between suppliers and customers, and between firms wishing to share financial risk. Some agreements were short-term and others lasted for many years.

[9] http://www.siliconvalleyonline.org/
[10] Ibidem.
[11] Ibidem.

As Saxenian (1994) reports the success of technical people who left career jobs to become entrepreneurs made it easier for others to take the risk of starting their own companies. The frequent changes of jobs in the Silicon Valley necessitated and re-enforced the community of relationships that existed. There was also more of a willingness to invest in startup companies. Often those providing the venture capital were the successful entrepreneurs of the past. The office complexes on Sand Hill Road near the Stanford campus became a major center of venture capital. Saxenian quotes Wilf Corrigan, the founder of LSI Logic, who expresses it in terms of people thinking of themselves as working for Silicon Valley rather than a particular company.

Region's culture shaped the regional industrial system – industrial structure and corporate organization, and vice-versa regional industrial system influence the local culture (labor market behavior and attitudes toward risk-taking). Brown and Duguid, while investigating knowledge networks in Silicon Valley, concluded that "(…) small groups working closely together, sharing insights and judgement, both develop and circulate knowledge inevitably as part of their practice." They have refered to this phehomenon as communities of practice (BrownandDuguid 2000).

Regional institutions, such as universities, business associations, and local governments, as well as professional societies, and other forums that created and sustained social interaction in a region and its innovative culture. Some most active of them are the following: Silicon Valley Community Foundation, Joint Venture: Silicon Valley Network, Sustainable Silicon Valley, The Churchill Club, etc. The main goal of thesef organizations is to gather leaders from business, government, the universities, and the non-profit sector to think how to promote actions that encourage social inclusion, equality of opportunity and regional growth.

6.1.2. Cooperation with University and Local Government

Silicon Valley is one of the most highly-educated regions in the country, with 40% of its population with at least a Bachelor's Degree. Despite the region's own well developed educational infrastructure over half of its science and engineering (SandE) talent was born abroad. In 2000, this group constituted 49%, and by 2005, it expanded to 55% of the region's science and engineering occupations. Foreign-born talent in Silicon Valley represents roughly three-times the national shares in SandE and in all occupations (*2007 Index of Silicon Valley*).

The contributions of region's universities to Silicon Valley success took different forms, starting from the faculty and students' employment, R&D funding, talent attraction and development through startup company generators, business assistance services and special initiatives and policy leadership.

The phenomenon of Silicon Valley was originated above all as bottom-up social and business networks, with the leading role of Stanford University in shaping the social and intelectual capital of the region. Having played a role in the birth of Silicon Valley, Stanford presently offers educational, professional excellence and consulting services for many of Silicon Valley's firms. Many of the current initiatives are hosted under Stanford Entrepreneurship Network, such as: Stanford Technology Ventures Program, Center for Entrepreneurial Studies, BASES, Office of

Technology Licensing, Stanford Biodesign Network, Stanford School of Medicine, Stanford School of Law, Society of Women Engineers, Asia technology Initiative and others. Here is short description of some of them:

- **Stanford Technology Ventures Program** (http://www.stvp.stanford.edu/) is an entrepreneurship center within the School of Engineering offering courses, conferences, web sites and research activities designed to promote entrepreneurship education. Students of the progarmme apply for the summer jobs and interships in Silicon Valley.

- **Center for Entrepreneurial Studies** (http://www.gsb.stanford.edu/) offers courses on the key subjects for the Silicon Valley firms, such as: "Benchmark Capital: The International Expansion of a Silicon Valley Venture Capital Firm" (2006) John W. Glynn Jr., Katherine Rudolph Bose; "Silicon Valley Social Venture Fund" (2005) Laura K. Arrillaga, Victoria Chang; "Valley Fire Protection" (2005), Joel C. Peterson, Mike Harkey; "Community Foundation Silicon Valley" (2003), Laura K. Arrillaga; David Hoyt; "Silicon Valley Bank and Bladerunner Technologies"(2003), H. Irving Grousbeck, Jamie Earle; "Valley Fire Protection" (2003), H. Irving Grousbeck, Alicia Seiger; "Joint Venture: Silicon Valley" (2001), William F. Meehan; Brian Trelstad; "Silicon Graphics, Inc." (2000), Mary E. Barth, Justin J. McEntee.

- **BASES** (http://www.bases.stanford.edu/) a student-run organization and one of the largest professional groups in the San Francisco Bay Area. It hosts educational and motivational programs to provide employment resources, business plan development assistance and company start-up seminars. BASES has more than 5,000 members, half of whom represent about 15 percent of the Stanford population.

- **Office of Technology Licensing** (http://www.otl.stanford.edu/) provides one point of contact for all entrepreneurship-related activities, resources, and networking opportunities on campus.

- **Stanford Biodesign Network** (http://www.biodesign.stanford.edu/) encourages and facilitates invention, patenting and early stage development of medical devices. "With a member base of nearly 900 academic and industry participants, the Biodesign Network website provides a mechanism for networking among individuals who work in the biomedical technology industry, particularly medical devices, diagnostics, tissue engineering and related areas."

Many researchers and lecturers from Stanford Biodesign Network working for Silicon Valley companies, act as speakers or offer consulting services on bio-engineering management and high-technology issues.

The role of Berkeley University in Silicon Valley, although less significant, shouldn't be underestimated. "Earlier Berkeley engineers brought water to California's great agricultural lands,

pioneered the microelectronics that seeded Silicon Valley, and helped build the unbuildable in structures like Hoover Dam and the Golden Gate Bridge"[12].

Today, Berkeley College of Engineering plays an important role growing regional advantage and promoting the region's competitiveness at various academic and professional meetings. In recent years, Berkeley Engineering has been involved in the Annual Berkeley in Silicon Valley Symposiums, during which Berkeley engineering professors and students answered important questions on how to use engineering for the better world, e.g., sources of energy and clean water, homeland security and privacy, medical breakthroughs, advancement in information technologies, etc. The symposiums were hosted by Sun Microsystems and were sponsored by the Colleges of Chemistry and Engineering of Berkeley University.

In addition to Stanford and the University of California at Berkeley, San Jose State University has been a major supplier of trained technical personnel for the Silicon Valley (Saxenian 1994). By the 1970s San Jose State University trained as many engineers as either Stanford or Berkeley. Other region's community colleges offered technical programs that were considered among the best in the U.S. (eg. Foothill College in Los Altos Hills offered the two-year A.S. degree in semiconductor processing, whereas De Anza College in Cupertino similarly conducted extensive electronics training programs and maintained links with local firms) (Saxenian 1994):

> "They contracted with local companies to teach private courses for their employees, even holding courses at company plants to enable employees to attend after hours. Local technology firms in turn provided consultants to develop the electronics curricula as well as large numbers of part-time and moonlighting teachers. Many firms also contributed equipment to local schools, while some allowed community college students to use their equipment during the evenings".

In the late 1990s, engineers within the UC system started looking for theways to not just develop new and innovative technologies, but also apply these technologies to improve quality of life. The first public-private partnership The Center for Information Technology Research in the Interest of Society - CITRIS was established. CITRIS incorporates over 300 faculty members, thousands of students at four UC campuses (Berkeley, Davis, Merced and Santa Cruz) as well as industrial researchers from over 60 corporations. The objective of CITRIS partnership was to offer IT solutions to the current social concerns, such as environment, sustainable energy alternatives, healthcare delivery, secure electronic medical records and remote diagnosis, etc.

The funding for the CITRIS comes from various sources: state funds, industrial gifts and UC campus funds. Approximately 28% of its budget is spent on operations, and 72% on research including seed money for innovative projects. During its first years of existence CITRIS has provided funding for research in such areas as distance learning, digital libraries and data mining,

[12] Great Reasons to Consider Berkeley Engineering, http://www.coe.berkeley.edu

experimental social sciences laboratory, nutrition, video conferencing, and deployment of sensors[13]. CITRIS constitutes a foundation for the long-term sustainable growth in the region.

6.2. Venture Capital

Silicon Valley has been traditionally very strong in attracting venture capital investment. In the last observed year 2007 venture capital (VC) investments were up almost 11%, comparing totals from the first three quarters of 2006 and 2007 (*Silicon Valley Index 2007*). This is the most postive trend since the dotcom boom. For the first time Silicon Valley May be able to receive 30% of the nation's total venture capital funding. The top two destinations of the VC investment have been observed in energy and in medical devices. Also telecom and software equipment continues to attract the most investment. Major portion of venture capital investment origanates from the U.S., with a small share of the local venture capital financing. The year of 2000 was exceptionally fruitful in the drawing the nation wide investment capital to the Valley.

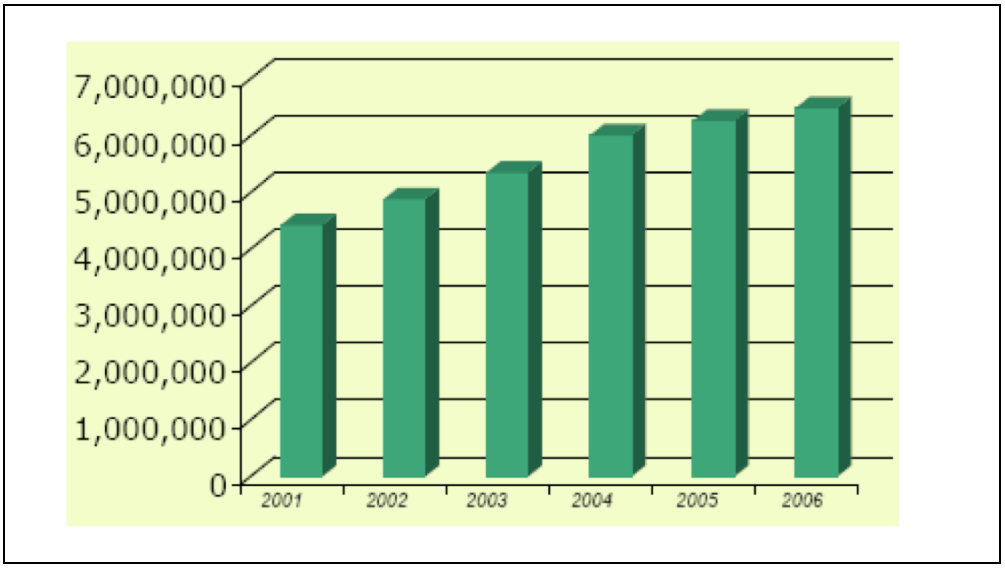
6.3. Federal and State R&D Support Policies – Case of California

Approximately one fifth of all federal funds spent in California (not including direct support of individuals) goes toward R&D. Most major federal agencies provide funding for California R&D, foremost of which is the Department of Defense (DOD) (ASTRA 2003). In 2004, California alone accounted for approximately one-fifth of the $300 billion U.S. R&D total in 2000, exceeding the next highest state (Michigan). The top four states in terms of federal R&D (Maryland, California, New Mexico, and Virginia), along with the District of Columbia, account for two-thirds of all federal R&D performance. Computer and electronic products manufacturing industries perform 19% of the nation's total industrial R&D, but they perform a larger share of the industrial R&D in California (33%) (ASTRA 2004). The R&D services sector, which consists largely of biotechnology companies, contract research organizations, and early-stage technology firms, is even more concentrated geographically, with California and Massachusetts accounting for more than 40% of R&D in this sector. The companies in this sector maintain strong ties to the academic sector and often are located near large research universities (*Science and Engineering Indicators 2008*).

As the primary source of funding for university research, the federal government is critical to the production of the nation's future scientists and engineers (Figure 11). California is driven largely by investment in scientific R&D — particularly investments in the physical sciences, mathematics and engineering. Over the last 10 years, while federal funding for health science research has increased, federal support for most other scientific disciplines has actually declined in constant dollars. Four federal agencies are responsible for almost 90% of federal support for physical science, mathematics, and engineering — DOE (28%), NASA (23%), DOD (23%) and NSF (13%) (ASTRA 2004).

[13]The Center for Information Technology Research in the Interest of Society – CITRIS, http://www.citris-uc.org/about/

Figure 11. Federal R&D Funding to California Colleges and Universities FY 2001-2006 ($ thousands)



Source: *Survey of Research and Development Expenditures at Universities and Colleges*, National Science Foundation, Division of Science Resources Statistics, 2006.

The California State Economic Development Strategic Plans

In 1996, California's undertook the first-ever statewide economic development strategic planning called *The Collaborating to Compete in the New Economy: An Economic Strategy for California*. The Strategy was developed by The California Economic Strategy Panel was created "to develop an overall economic vision and strategy to guide long-term policy affecting our economy". The Panel initiated discussions with economists, demographers, planners and economic development practitioners representing diverse views, aiming at examining competitiveness, local and state economic development strategies; state government plans for physical and economic infrastructure development of the California. The Panel completed series of working documents. Based on common themes experts defined the following key objectives for the initial planning cycle:[14]

1) Understand how government can facilitate economic growth, especially by examining industry clusters;

2) Institute a process that: 1) defines public policy objectives and goals; 2) uses a local, bottom-up perspective; 3) listens to business, government and the community; 4) is inclusionary; and, 5) provides opportunities for collaboration;

[14] *Collaborating to Compete in The New Economy*, California Economic Strategy Panel, February 1996, http://http://www.labor.ca.gov/panel/pdf/ESPneweconomy.pdf

3) Develop a mechanism for continuous evaluation and assessment of the economy that can be replicated at local and regional levels.

Since the Panel was created, a number of collaborative regional initiatives have emerged across the state to address economic vitality and quality of life issues. These include Joint Venture: Silicon Valley, the Economic Alliance of San Fernando Valley, Sierra Business Council, San Diego Dialogue, and the Institute for the North Coast, among others. Leaders from these groups meet annually at a Civic Entrepreneur Summit, sponsored by The James Irvine Foundation. The Panel has provided one of the only state-level organizations that serves as a link between state and regional efforts. The Panel's major innovation is its approach, which emphasized traveling throughout the state and listening to more than 600 leaders from California's industry clusters and diverse regions in a "bottom-up approach."[15]

The Small Business Technology Transfer Program (STTR)

The Small Business Technology Transfer Program (STTR), with a budget of nearly $65 million, is seen as ‘en efficient vehicle for moving ideas to market’, through the funding of partnerships between small businesses and non-profit research institutions, including universities. STTR requires five federal departments and agencies to reserve a portion of their R&D funds for award to small business/nonprofit research institutions partnerships. Whereas SBIR funds R&D projects at small firms and limits the participation of research institutions to a subcontracting or consulting role, STTR funds cooperative R&D projects between a new technology based firm and a research institution. Ten states concentrate two thirds of all STTR awards (approximately 220), with California and Massachusetts getting over one third of the total (Landabaso 2000).

R&D Tax Incentives in California

The federal and state governments use business tax credits to promote R&D. In 2006, at least 32 U.S. states offered credits for company-funded R&D. Federal R&D tax credit reached an estimated $5.5 billion in 2003 compared with the all-time high of $7.1 billion in 2000 (*Science and Engineering Indicators 2008)*.

California offers a 15% credit on research (12% until 2000) and 24% for university research (Figure 12). The California R&D Credit reduces income or franchise tax. The company can qualify for the credit if it paid or incurred qualified research expenses while conducting qualified research in California. The company receives 15 percent of the excess of current year research expenditures over a computed base amount (minimum of 50 percent of current year research expenses). The company can claim the credit on the return for the taxable year you incurred the qualified expenses (http://www.ftb.ca.gov/).

Manufacturing and Research Equipment Credit reduces the state’ s corporate franchise tax, and can be used to reduce the sales tax on the acquisition of qualified property. Taxpayers are

[15] *Collaborating to Succeed in The New Economy. Principles from the La Jolla Retreat.* California Economic Strategy Panel, May, 2000, http://www.labor.ca.gov/panel/pdf/principleslajollaretreat.pdf

entitled to 6% of the amount paid for equipment placed in service in California (Landabaso 2000).

Figure 12. The Changes in Research Credit Rates Since 1987

Tax Years Beginning	Qualified Research	Basic Research
1987-1996	8%	12%
1997	11%	24%
1998	11%	24%
1999	12%	24%
2000 and later	15%	24%

Source: Research Credit References, State of California Franchise Tax Board, San Francisco 2009, http://www.ftb.ca.gov/

The "qualified research" is a research activity that is to be undertaken to discover information that is technological in nature; be undertaken to discover information intended to be useful to develop a new or improved business component of the taxpayer. Approximately, 80 percent or more of the research activities involve a process of experimentation (*Research and Development Credit: Frequently Asked Questions*, Research Credit References, State of California Franchise Tax Board, San Francisco 2009, http://www.ftb.ca.gov/)

SandT Initiatives for Economic Development at the Local Level

The following do not represent the whole list of state and federal programmes aiming to increase the competitiveness of California and Silicon Valley region in particularly. Rather, they serve as a comparison with already mentioned Sweden initiatives.

1) CalTIP – California Technology Investment Partnership

California Technology Investment Partnership (CalTIP) is a program that aims to increase the competitiveness of California companies by providing a state matching grants to small and medium sized businesses to match federal funding for R&D. The program is administered locally through the Los Angeles Regional Technology Alliance (LARTA) Institute. CalTIP offers awards of up to $250.000 per firm provided that it does not exceed 25% of the project cost. In addition, the federal government must cover a minimum of 20% of this cost (Landabaso 2000).

2) Project Mercury of San Diego Regional Technology Alliance

San Diego, California - $5 million Project Mercury, run by San Diego Regional Technology Alliance (SDRTA)[16] provides small business assistance by local experts in areas ranging from accounting to marketing. The Financial Assistance area provides information on grant

[16] The San Diego Regional Technology Alliance is a non-profit organization dedicated to providing assistance to the region's technology community, http://http://www.sdrta.org.

opportunities and other financial information for high-tech startups (http://www.sdrta.org). The Project helps firms to develop business plans and bring technology based products to commercial markets. The Financial Assistance area provides information on grant opportunities and other financial information for high-tech startups (helps to provide free business assessments and planning services, identifies business and financial needs, etc.). The Project delivers its services through advanced Web applications.

3) Silicon Valley 2010: A Regional Framework for Growing

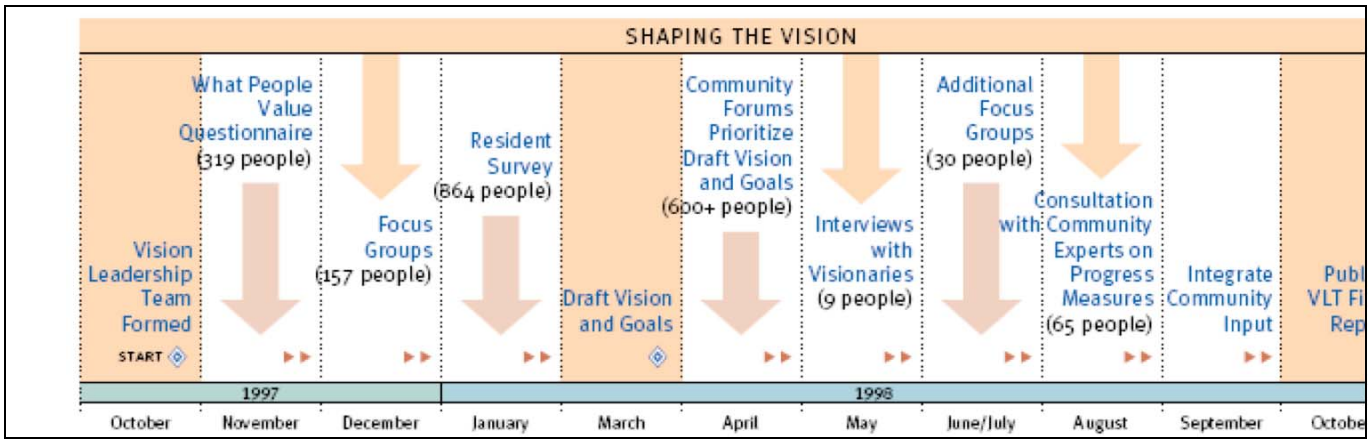
The Silicon Valley 2010 is a call to action to create a better future in the Silicon Valley region. The Action has been endorsed by the Joint Venture Silicon Valley Network Board of Directors[17]. The Joint Venture: Silicon Valley Network serves as convenor for a collaborative processes that create a vision for 2010 in Silicon Valley. The group of civic entrepreneurs, led by co-chairs from the private and public sectors - The Vision Leadership Team (VLT) - takes responsibility for developing the vision. The VLT is accountable to and receive support and assistance from Joint Venture, e.g., Joint Venture staff person, researchers and facilitators. The team is expected to get broad and deep input from the community and access "best practice" experts and research (*Silicon Valley 2010*).

The visioning process for the Silicon Valley region was built on dialogue involving thousands of residents and leaders of region's diversity (Figure 13). In accordance with the belief that a shared vision for the region's future must be built upon broadly shared values, the VLT distributed an open-ended questionnaire aiming to understand what people value about Silicon Valley as a place to live and work.

To further explore what residents value, fear and desire for Silicon Valley's future, a series of focus groups were conducted by the independent consulting firm MIG, Inc., throughout the region to engage community members in a dialogue. The objectives of the focus groups were to: 1) ensure that the Silicon Valley 2010 vision is inclusive in reflecting the values, fears and desires of the Silicon Valley population; 2) increase public awareness of the Silicon Valley 2010 project; 3) begin to develop community networks for sustaining a dialogue about the future of the region (Silicon Valley 2010).

[17] Joint Venture: Silicon Valley Network is a nonprofit regional collaborative established to enhance the economic vitality and quality of life in Silicon Valley. It brings people together from business, government, education and the community to identify and to act on regional issues. The network aims to improve training, communication and the finance infrastructure for the region's advanced technology clusters. It includes the participation of public sector – Chamber of Commerce, City of San Jose , http://http://www.jointventure.org/

Figure 13. Community Participation in Silicon Valley 2010



Source: Silicon Valley 2010, Vision Leadership Team (VLT), Joint Venture: Silicon Valley Network, http://www.jointventure.org/

Telephone survey was conducted by The Holm Group for Joint Venture in order to explore new areas based on attitudes, values and issues, and quantify them with the findings from the focus groups. A total of 864 adult residents of Silicon Valley were interviewed in February 1998 (*Silicon Valley 2010*).

As part of the process of creating a shared vision for Silicon Valley 2010, the Vision Leadership Team organized ten Community Forums throughout Silicon Valley region. The Forums enabled to: 1) prioritize 51 potential goals for the future of Silicon Valley; 2) engage a critical mass of people in prioritizing potential goals for Silicon Valley 2010; 3) educate Forum participants about the region's strengths and challenges, choices and opportunities and the context for the Visio; 4) i improve the civic climate of Silicon Valley. More than 600 members of the community participated in the ten Community Forums (*Silicon Valley 2010*).

Based on the feedback received from the above surveys and initiatves the following strategic directions were suggested by the 2010 framework (Figure 14).

Figure 14. Strategic Directions Suggested by the 2010 Framework

The Innovative Economy	From	To
	Quantitative Growth	Qualitative Growth
	Growing Apart	Broadening Prosperity
Livable environment	Sprawling Development	Efficient Land Re-use and Livable Communities
	Using Up Nature	Protecting Nature
Inclusive Society	Fragmented Social Networks	Connected Social Networks
	Barriers to Access	Bridges to Opportunity
Regional Stewardship	Fragmented Actions	Transcending Boundaries
	Reliance on a Few Civic	Engagement of Many
	Unreliable Public Revenue	Reliable, Adequate Public Revenue

Source: Silicon Valley 2010, Vision Leadership Team (VLT), Joint Venture: Silicon Valley Network, http://www.jointventure.org/

The Vision Leadership Team members urged a shift from evaluating the success of the Silicon Valley economy from quantitative indicators , such as more jobs, more consumption of resources, more congestion to qualitative growth indicators, such as enhanced competitiveness, better use of resources and jobs with advancement potential open to more residents (*Silicon Valley 2010*). They also suggested to integrate natural habitats and natural systems into the region's urban areas to preserve the ecological heritage of the region.

To sum up, all the above mentioned programs and initiatives tend to confirm the trend that the regional communities of California took a larger and more proactive role in the promotion of innovation, in close cooperation with the federal and state levels. Their collaborative efforts promote and encourage regional success through different measures, ranging from raising the public awareness up to financial incentives and technical assistance to business and academia.

7. Conclusions and Policy Implications

The recent EU and U.S. innovation policies are characterized, on one hand, by many differences, yet on the other by significant coincidences, especially in terms of objectives, methodological principles and the role of the public sector in regional innovation processes.

The policy approaches in both continents tend to promote a dynamic, bottom-up and demand-led regional planning process, supported by the regional cooperation among key public and private actors. The major differences, however, result in the role of public sector in promoting networking and a regional cooperation. In the U.S., various programmes and initiatives on state and regional levels would rather aim at helping communities to help themselves. In the other words they support building the critical mass and innovation capacity of regions to face the global competition in a given area, e.g, the collaboration of Esprit or other EU funded programmes might seem very different from the personal information networks of Silicon Valley.

Whereas in the EU public support to states and regions positive discrimination for certain categories of firms and/or types of policy interventions, such as technology promotion, are much more widely acknowledged. Many EU programmes contribute with high spending on R&D projects and improving scientific capacity of regions, yet not necessarily leading to economically valuable innovations. Furthermore, many EU regions rank high on the quality of their institutions and knowledge inputs, yet low on its ability to mobilize the inputs through regional entrepreneurship and new firm formation. As a result, European regional economy has become even more unequal.

In terms of the support for the regional network structures, learning and knowledge-transfer the EU regional policy follows the systemic approach, in comparison with the "interrelated" approach applied by the U.S. policy makers. The systemic approach originates from the innovation-system approach at the national, regional or local levels, e.g., Regional Innovation Systems. Yet, the example of Silicon Valley show that eventhough the region doesn't have its Regional Innovation Strategy in the European sense, many leading regional organizations, such as Joint Venture: Silicon Valley Network (Vision Leadership Team), influence the strategic development of region by building a common vision for the region, e.g., Silicon Valley 2010, which draws the Vision for the region development from the bottom-up approach.

Silicon Valley, which has a long tradition of advanced technology and well-established universities in the region (with a strong tradition of spin-offs and new enterprise), is very different from Kista case. The latter refers both to the current problems and opportunities of both clusters. Therefore, the lessons to be learned for European and Kista region policy makers must be consider the region's specific conditions.

The significant differences in institutional environments across both sides of the Atlantic, as well as the differences and similarities in the experiences of one of the leading clusters in both continents - Silicon Valley and Kista region - makes it even more important for both European and American policy makers, academics and consultants to share the experience on the role of governments in supporting economic development and regional competitiveness.

One of the main conclusions of the presented case studies highlights the importance of personal networks for improving competitiveness and innovation results, especially in high-velocity markets such as ICT.However, the emerging technologies are now less frequently produced and located within single locations and are increasingly distributęd across a range of firms and locations. it is clear evidence that our region faces substantially greater challenges in maintaining our position of preeminence as an innovation-driven economy. So if the clusters have an impact on regional economies greater attention should be paid to their capabilities to maintain the regional competitiveness and a quality of life, that will make the regions attractive place to live, study and work. This is a challenge to local politicians and decision-makers in both regions - Kista and Silicon Valley.

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