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Evaluating and comparing the innovative performance of the United States and the European Union

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Abstract

There are significant differences in the innovative capacities between the economies of the United States and European Union. The US was able to gain and maintain technological leadership, whereas most of the EU member states (with the exception of some Scandinavian economies) still lag behind in the competitiveness and innovation rankings.

Several factors lie behind the differences in the US and EU innovative performance: the nature and dynamics of the R&D investments; differences in industrial structure of R&D; degree of internationalization and location of R&D investments; the linkage between inventions and the science base; the value of venture capital investment; geographical concentration of innovation activities. Thus, the evaluation of the differences in the competitiveness and innovation performance of the US and the EU must consider differences in their subject and space dimensions.

1. Introduction

Innovation capacity of the economy can be defined as the ability “to manage knowledge creatively in response to market-articulated demands and other societal needs” (OECD, 1999, p. 9). Innovation is a result of both explicit knowledge and intangible resources (tacit knowledge), such as human capital. Explicit knowledge can be made freely available to the world (e.g. it can be formalized, codified, and communicated via Internet). In contrast, tacit knowledge is grounded in experience and is difficult to codify; it is embedded in the minds of individuals, in the routines of organizations, and is passed along to others through direct experience (Polanyi 1973; Reed & DeFillippi 1990). If economies employ their explicit knowledge and intangible resources, they gain an advantage over their competitors, which, if sustained, may lead to higher performance and long-term competitive ability of firms, sectors and economies (see Romer (1994); Peteraf (1993), Schoenecker & Cooper (1998)). However, there is interdependence between explicit and tacit knowledge (e.g. in order to take full advantage of the explicit innovations provided in a patents, one needs also to have the complementary tacit knowledge to apply it to a particular product or process) (Pavitt 1992).

The innovation gap between the US and the EU, even though decreasing in the past few years, still remains significant. Only five out of 27 EU members states - Sweden, Finland, Denmark, Germany and the UK – were named “innovation leaders” along with the US and Japan (*European Innovation Scoreboard 2007*). The causes of the differences in innovation performance among the US and the EU can be explained by the following factors: 1) nature and dynamics of the R&D investments; 2) differences in industrial structure of R&D; 3) degree of internationalization of R&D investments location; 4) the value of venture capital investment; 5) geographical concentration of innovation activities, 6) character of linkage between inventions and the science base. Thus, the evaluation of the innovation performance of the US and EU must consider different dimensions that are interacting.

The paper evaluates and compares the sources of innovative performances of the US and the EU economies. In particular, it discusses the comparative performance of both continents in terms of innovation inputs and outputs. The first part of the paper presents selected theoretical concepts that explain the role of innovation in building competitive advantage and sustaining growth. The second part of the paper analyzes the differences between the two regions in terms of the major inputs and outputs of innovation. The third part focuses on the geographical concentration of innovation activities in the US and the EU. Finally, the fourth part of the article explains the differences in university, industry and government relationship in the US and EU. The paper ends with a summary and with important conclusions for the innovation policy of the EU.

The period of analysis covers the years 2000-2007. The empirical subject data, however, is constrained by the limited availability of comparable data at the sub-national level for the US and the EU. The geographical level of analysis covers metropolitan statistical areas (MSAs) for the US and NUTS (Nomenclature of Territorial Units for Statistics) level 2 regions for the EU.

2. Innovation As Driver of Growth and Competitiveness

An early attempt to understand how nations compete and what determines their growth was expressed in Ricardo’s classical growth theory on comparative advantage. Assuming that countries differ in their production technologies, the author argues that each country enjoys a comparative advantage in the production of at least one good. In the early twentieth century, Heckscher and Ohlin postulated that patterns of trade and comparative advantage depend on the relative abundance of factor endowments or production factor availability. Countries would benefit from trade by exporting the good that is intensive in its abundant factor -- capital or labor (DeNisi et al. 2003). Thus, competitive advantages of firms were explained by the distribution of resources in competing firms. Yet, the important conclusions of Solow's studies of the growth factors of US economy between 1948 and 1982 demonstrated the "fundamental role of technological innovation and increased know-how in an economy" (DeNisi et al. 2003). In the 1950s, Solow built a model that added technical knowledge to capital and labor, to spur economic productivity and growth. Solow viewed technology as a continuous set of knowledge that became evident over time and was not created by economic forces. Solow's model is often referred to as an "exogenous" model of growth (Cortright J. 2001) (Table 1).

Table 1. Classical (neoclassical) Growth Theories vs. New Growth Theory

Classical and neoclassical growth theories	New growth theory
- comparative advantages approach to specialization patterns of regions based on lower relative prices of goods/abundant production factor, - markets are competitive and market processes usually result in optimum levels of production and allocation - diminishing returns - additional unit of capital (labour) input yields less and less additional output. - long-run rate of growth is exogenously determined by either savings or technical progress (Solow); on regional level presence of a dominant firm; diffusion of innovation produced elsewhere; installation of new infrastructures. - there are relatively limited opportunities for government to promote economic ends, other than encouraging market competition, providing adequate schooling and encouraging savings and investments.	- competitive advantage is driven and sustained by endogenous factors and intangible resources, such as human capital, e.g. knowledge and skills (microeconomic foundations of growth), - information and ideas can be shared and reused indefinitely they cannot be a subject of "diminishing returns," e.g. the cost of developing a programming for Software or Internet website is initially very high, but costs of serving an additional user is almost equal to zero. - emphasis on investments into knowledge that drives productivity and economic growth via increasing returns and collective learning. - intensification of competition, especially in a service sectors economy (new product design, marketing methods, etc.)

Source: own elaboration

New Growth Theory, developed by Paul Romer (Table 1), departs from the traditional emphasis on the accumulation of capital and underlines that knowledge drives productivity and economic growth. Since ideas can be shared and reused indefinitely, they cannot be a subject of "diminishing returns." This way, the increasing returns to knowledge drive economic growth. For example, the cost of developing a software program or Web site is initially very high, but the costs of serving an additional user is almost zero.

Moreover, new technology and knowledge provide spillover benefits, or positive externalities, which are the strongest impetus for growth. When someone creates a new product or process, others not only copy it, but also use it as a springboard for other ideas

(Easterly, 2002). Thus, it leads to a process of learning and enriching the intangible resources of the society. Careful econometric studies have consistently shown that the social rate of return to research (the value of all of the economic benefits received by society) is typically two to five times higher than that private rate of return (the profits accruing to the individual or the company that pioneered the innovation) (Jarboe & Atkinson 1998)[1]. The research and development (R&D) based innovation does not only affect the performance of those actually undertaking these activities but gives rise to important external effects ("R&D spillovers").

An important source of diversity of R&D spillovers is related to the roles of the firms, universities, government and other institutions in the process of knowledge production, diffusion and utilization. The final economic impact of R&D will depend on how these actors interact within the industry structure, the education and training system, the human resources and labor market, the financial system (Figure 1) (*Towards a European Research Area Science, Technology and Innovation, Key Figures 2007*). From this perspective, the performance of an economy depends not only on how the individual institutions perform in isolation, but also on how they interact as elements of a collective system of knowledge creation, diffusion and use, and on their interplay with other institutions.

Schumpeter argued that the innovation and technological change comes from the entrepreneurs, who by carrying out "new combinations of resources" increase their competitive advantage and the economic growth of nations. More importantly, Schumpeter argued that certain changes in the economy are caused endogenously and that actual economic developments consist of a sequence of historical states and enhanced by "internal dynamics" (Witt 2002, p.7-22).

Porter (1998) assumes that every country follows the path of evolutionary development, consisting of the three stages related to development of competitive advantage. Every country begins by utilizing simple work and resources, producing the resource-consuming and/or labor-intensive goods, then moving towards production of more capital-intensive goods and finally to the production of goods requiring skills and technology. At the innovation-driven stage the country has a high innovative capacity, or an ability to create new products and processes using the latest knowledge of technologies, possesses highly qualified human capital and supports active policy in the R&D field.

"National innovative capacity depends in part on the technological sophistication and the size of the scientific and technical labor force in a given economy, and it also reflects the array of investments and policy choices of the government and private sector that affect the incentives for and the productivity of a country's research and development activities. National innovative capacity is also distinct from both the purely scientific or technical achievements of an economy, which do not *necessarily* involve the economic application of new technology (..)" (Porter & Stern, 2001).

According to Porter and Stern (2001), national innovative capacity depends on three elements: *common innovation infrastructure, the cluster-specific environment for innovation and the quality of linkages*. A nation's *common innovation infrastructure* is a set of investments and policies supporting innovation throughout an entire economy. It includes the human and financial resources that a country devotes to scientific and technological advances,

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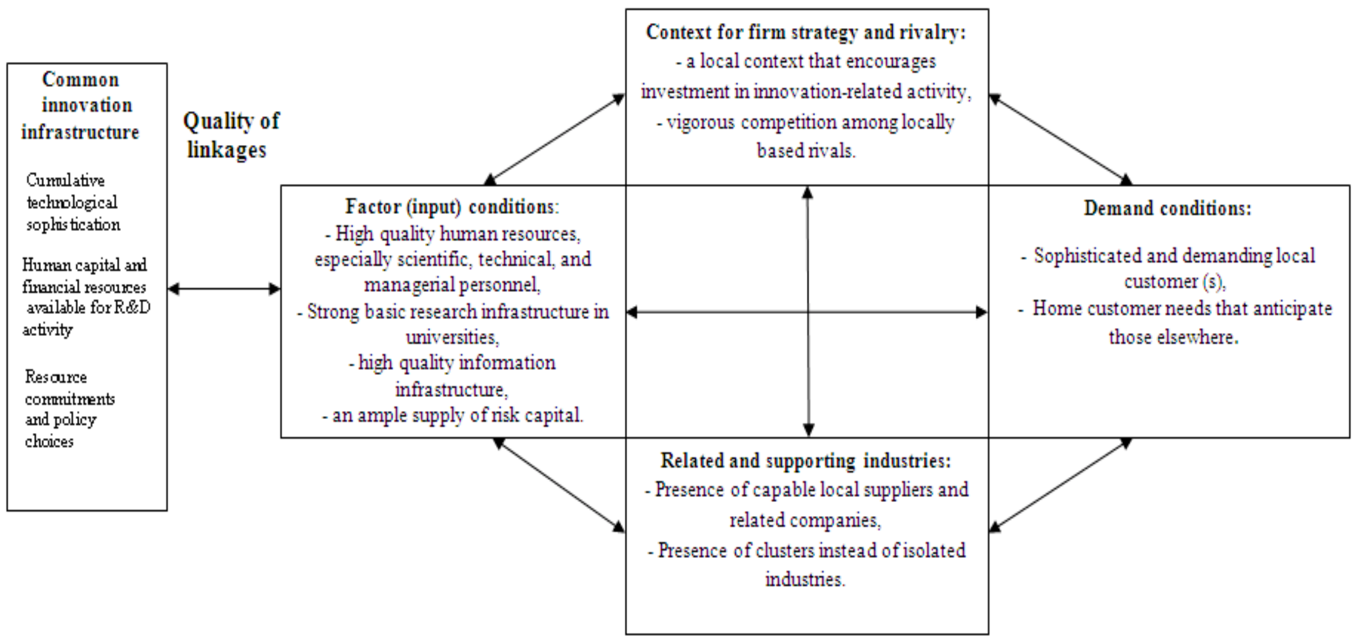
[1] Property rights for an invention, may influence negatively the knowledge-driven growth, e.g. patent on a specific element of a computer program may slow down the development of technology.

public R&D policies (including basic research) and a level of technological sophistication (its pool of scientists and engineers available to contribute to innovation throughout the economy). An innovation capacity is also determined by the system of intellectual property protection, the extent of tax-based incentives for innovation, the degree of antitrust enforcement encouraging innovation-based competition as well as the openness of the economy to trade and investment.

Furthermore, the commercialization of new technologies takes place in clusters or *geographic concentrations* of interconnected companies and institutions in a particular field. The cluster-specific innovation environment for innovation is captured in Porter`s "diamond model" framework (Figure 1).

The four areas of the diamond are factor conditions, demand conditions, context for firm strategy and rivalry, and supporting industries. Demand conditions are the availability of channels for internationalizing local demand (multinationals), the nature of the market, the sophistication of local buyers; innovative pressure on local suppliers resulting from global trends and markets (pressure is bigger in case of qualitative not quantitative factors). The efficiency of the tacit knowledge depends on the business sophistication in the economy, and on the quality of a country's business networks. The third factor, *related and supportive industries*, is the "presence in the nation" of internationally competitive suppliers who are generating new ideas and stimulating innovation (usually via *clusters*). Finally, the last factor - *firm strategy, structure, and rivalry* - constitute the national environment, such as institutions, governmental policy and network of suppliers, buyers, competitors stimulating each other through rivalry. It is evaluated on the basis of the qualitative characteristics of business operations and decision-making, including their social context. Clusters offer firms potential advantages in perceiving both the need the opportunity for innovation, by both their flexibility and their capacity to act rapidly to turn new ideas into reality. All of this is possible

Figure 1. Elements of the National Innovative Capacity Framework



Source: Porter M., & Stern S. 2001, *Innovation: location matters*, MIT Sloan Management Review, pp.28-29.

due to the access to the new machinery, services, components, and other elements to implement innovations within a cluster.

The quality of linkages and interactions of these factors with common innovation infrastructure determines the pace of a country`s transition *from a resource-driven to an innovation-driven growth competitive advantage.* Innovation is particularly important for economies as they approach the frontiers of knowledge and the possibility of integrating and adapting exogenous technologies tend to disappear (*World Economic Forum 2007*).

3. Global Competitive Standing and Innovative Performances of the US and EU

Despite significant appraisal of some of EU economies in the global competitiveness ranking (GCR) US still retains its position as the world's most competitive economy, according to the renowned Global Competitiveness Report for 2007-2008 (Table 2). This is despite an oncoming recession of the US economy, caused by the drop of the US dollar and unbalanced financial and stock markets. Only five of the 27 EU countries – Sweden, Denmark, Finland, Germany and United Kingdom – are placed among the ten best world performers in the Global Competitiveness Index in 2007-2008. Among many areas in which these countries outperform the US economy is a positive macroeconomic environment (with the exception of Germany), as they run budget surpluses and have achieved very low public indebtedness and display the most efficient institutions in the world.

A relatively smooth and successful transition from communism to capitalism and EU membership of Central East European (CEE) economies created countries with a variety of standings in the GCI ranking. In general, all EU10 group countries (ten new member states of EU, except Bulgaria and Romania) witnessed a significant drop in their 2007-2008 GCI ranking from 2005-2006 (World Economic Forum 2008) (Table 1). As in previous years, Estonia maintains the position of the best performing EU10 country, whereas Poland, Cyprus, Malta and Greece remain the worst . Poland's weakness stems from its highly protected labor markets and high unemployment. In addition, all transition economies have weak institutions and weak property rights regimes.

Research and innovation as well as training and education policies have had a strong impact on the competitiveness of the US and EU economies. The US has a stable rank (4^{th}) in innovation and sophistication due to its world-class scientific research institutions, high company spending on R&D and excellent research collaboration between the business and university sectors. Nordic countries (Sweden, Denmark, and Finland) and Germany are also highly assessed in the innovation and business sophistication indicators, with Germany a particularly strong and stable third with regard to the sophistication of its business sector.

The EU10 economies are among the few post-socialist European countries with the best prospects for growth and innovation (OECD, 2000). Yet, according to the Global Competitiveness Report 2007-2008, the overall growth competitiveness rank of all new members states of EU declined in 2007/2008 in comparison to 2005/2006. The seventh edition of the European Innovation Scoreboard (EIS[2]) has placed the US and several EU states - Denmark, Finland, Germany, Sweden, Switzerland and the UK - among the world's

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[2] initiated by the European Commission, under the Lisbon Strategy, to provide a comparative assessment of the innovation performance of EU Member States.

top *innovation leaders*, along with Japan and Israel. Among them, Sweden was considered the most innovative country due to its strong innovation inputs. Despite its leadership in

Table 2. Innovation and Business Sophistication Factors of EU and US Economies in 2007/2008 and 2005/2006

Country/ economy	Overall index				Innovation and sophistication* factors			
	2007/2008		2005/2006		2007/2008		2005/2006	
	Rank	Score	Rank	Score	Rank	Score	Rank	Score
United States	1	5.67	6	5.61	4	5.68	4	5.75
Denmark	3	5.55	4	5.70	8	5.36	7	5.40
Sweden	4	5.54	3	5.74	5	5.62	5	5.66
Germany	5	5.51	8	5.58	3	5.70	3	5.89
Finland	6	5.49	2	5.76	6	5.56	6	5.65
United Kingdom	9	5.41	10	5.54	14	5.10	10	5.36
Netherlands	10	5.40	9	5.56	12	5.21	11	5.35
France	18	5.18	18	5.31	16	5.08	13	5.28
Belgium	20	5.10	20	5.27	15	5.09	14	5.21
Ireland	22	5.03	21	5.21	22	4.80	19	4.96
Luxemburg	25	4.88	22	5.16	24	4.57	23	4.81
Estonia	27	4.74	25	5.12	35	4.07	32	4.24
Spain	29	4.66	28	4.77	31	4.20	30	4.34
Czech Republic	33	4.58	29	4.74	28	4.33	27	4.47
Lithuania	38	4.49	40	4.53	44	3.94	44	3.96
Slovenia	39	4.48	33	4.64	30	4.20	34	4.18
Portugal	40	4.48	34	4.60	38	4.04	37	4.14
Slovak Republic	41	4.45	37	4.55	52	3.84	43	3.96
Latvia	45	4.41	36	4.57	72	3.55	58	3.74
Italy	46	4.36	42	4.46	32	4.18	31	4.29
Hungary	47	4.35	41	4.52	43	3.98	39	4.08
Poland	51	4.28	48	4.30	61	3.66	51	3.80
Cyprus	55	4.23	46	4.36	55	3.75	49	3.81
Malta	56	4.21	39	4.54	58	3.70	53	3.79
Greece	65	4.08	47	4.33	59	3.68	45	3.89

* Business sophistication is the quality of a country's business networks, and the quality of individual firms' operations and strategies. This pillar is particularly important for economies in the innovation-driven stage of development.
Source: *Global Competitiveness Index 2007-2008*, World Economic Forum.

innovation performance, Sweden had the lowest efficiency in applications of innovation inputs[3]. Similarly, the UK had a relatively low efficiency in transforming inputs into intellectual property outputs. This may be because their innovation activities do not lead to

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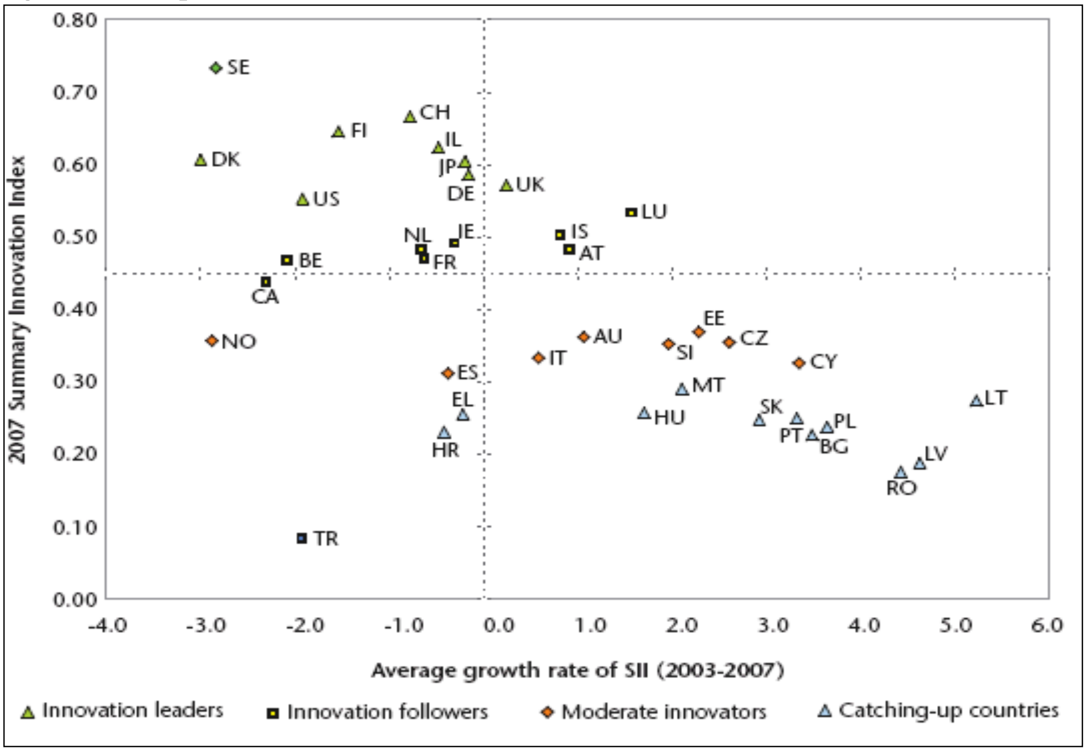
[3] *Applications* measures the performance expressed in terms of labor and business activities and their value added in innovative sectors, and *Intellectual property* measures the achieved results in terms of successful know-how, *European Innovation Scoreboard 2007* .

formal IPRs but it could also indicate that these countries could be creating more IPRs for their level of inputs. Among the EU innovation leaders only Germany showed a high efficiency in generating intellectual property (Figure 2).

Most of the other EU member states (with the exception of the EU10 group, Italy, Greece, Spain and Portugal) belonged to the group of *innovation followers*, with above-average efficiency in transforming inputs into applications. Luxembourg and Belgium show the highest efficiency rates, whereas Austria, the Netherlands and Luxembourg show above average efficiency in intellectual property, and Belgium and France could seek to improve their efficiency rates by generating more IPRs from their innovation inputs.

Figure 2. European Innovation Scoreboard 2007



Source: *European Innovation Scoreboard 2007*, PRO INNO Europe paper N° 6, European Commission, Directorate-General for Enterprise and Industry, Brussels 2008.

Italy, Spain and Portugal as well as some of the EU10 members, such as Cyprus, Czech Republic, Estonia and Slovenia, were *moderate innovators*. Cyprus has moved from catching-up to the moderate countries group (compared to EIS 2006). The moderate innovators show different levels of efficiency, ranging from above or below average efficiency performance (e.g. Czech Republic shows above average efficiency in applications of intellectual property inputs, whereas Estonia and Slovenia run at below average efficiency in both applications and intellectual property).

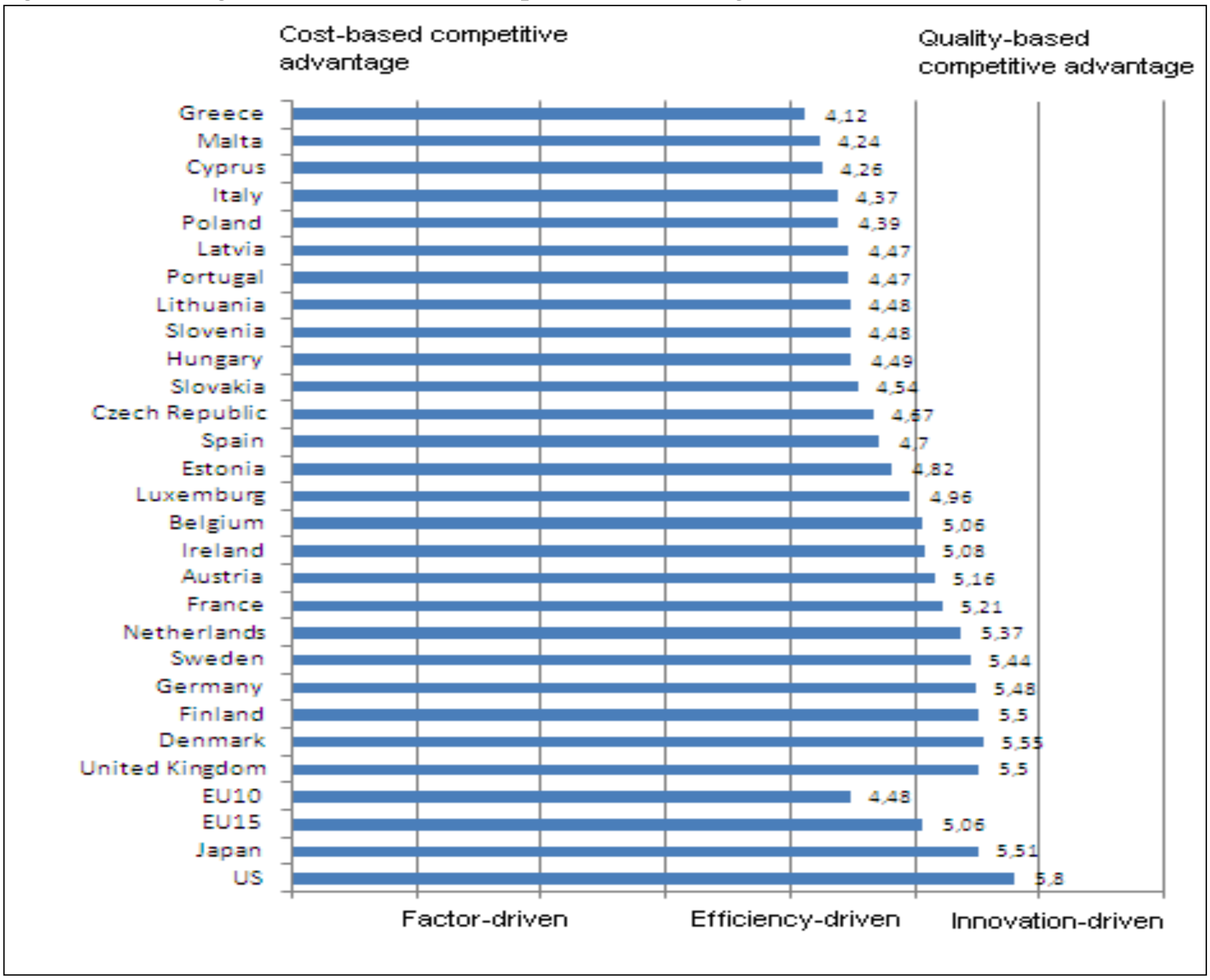
The *catching-up countries* include the remaining new member states of Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Bulgaria, Romania in addition to one old member state, Greece. All of the *catching-up countries* show the lowest intellectual property efficiency (with the exception of Portugal). Some of these countries are still in a process of replacing national patent applications by European Patent Office (EPO) patent applications.

4. **Applying Porter`s Diamond Model in Analyzing the US and EU Innovative Performance**

Integrating Porter's concept of stages of development into the GCI Index places the US and most of the old member states of the EU (EU15) on the innovation-driven stages. Their economies are characterized by an excellent capacity for innovation (excellent scientific research institutions and high spending R&D) and a sophisticated business culture.

At the innovation driven-stage, companies compete by producing new and different goods using the most sophisticated production processes. Strong collaboration between the academic and business sectors ensures that much of this basic research is translated into useful products and processes on the market, buttressed by strong intellectual property protection.

Figure 3. The Stage of Transition of Competitive Advantage in the US and the EU, 2007/2008



Note: 7 – the best result, 1 – the worst result;
factor-driven (interval from 0- 3), efficiency driven (interval 3 - 5) and innovation-driven (interval 5 - 7).
Source: World Economic Forum 2007, www.wef.org

Based on the analysis of sources of competitive advantage, US and most of the EU15 states seem to enjoy the innovation-driven competitive advantage. However, differences between EU15 member states and US index components are quite significant. Apparently, where the

US economy is most advantageous - market size (6.83) and labor market efficiency (5.71) EU15 best performing economies, such as Denmark, Sweden and Finland, seem to be less disadvantageous - market size (4.19, 4.47 and 4.08 respectively) and labor market efficiency (4.61 and 4.75 (except Denmark (5.52)). The sole area where the US and EU achieve the highest scores and, thus, might compete is higher education and training (the US - 5.68, Sweden - 5.98, Denmark - 5.96 and Finland - 6.01). The US, however, takes the highest scores in innovation rank (5.77), followed by Denmark (5.11), Finland 5.67, Sweden 5.53.

According to the World Economic Forum 2007 Report estimates EU10 group`s relative advantage is due to macroeconomic stability (e.g. Estonia, Slovenia), market size (e.g. Poland) and higher education and training (Hungary). Their main disadvantages result from the unfavorable institutional environment for competitiveness; property rights; legal framework; corporate governance as well as insufficient investments into R&D, especially by private sector and a low level of collaboration between universities and industry. The latter disadvantages of EU10 competitiveness index contributed to the low rankings of these countries in the 2007-2008 Global Competitiveness Index (World Economic Forum 2007).

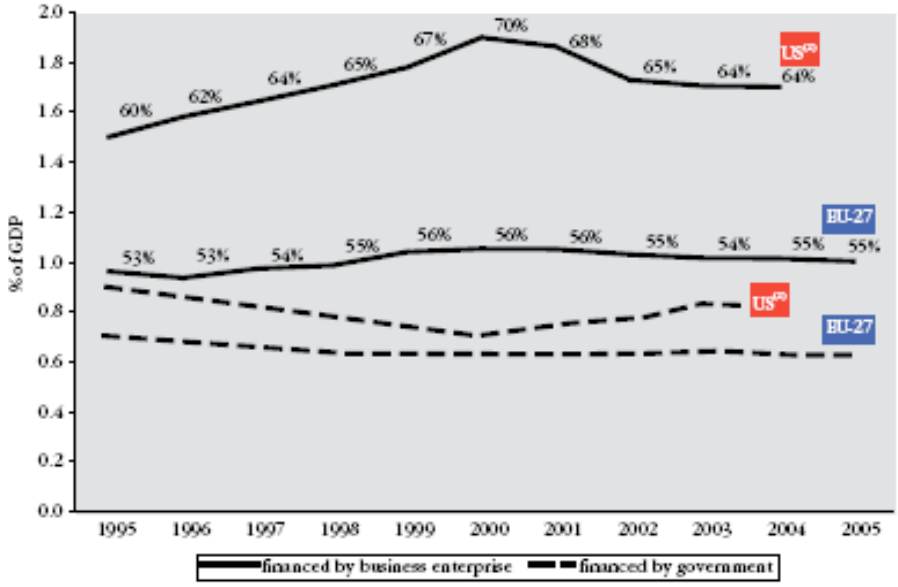
5. Sources of Innovation Gap Between the US and the EU

A closer look at the causes of different innovation and competitiveness performances of the US and the EU reveals the significant structural differences between the two regions, such as major inputs to innovation: nature, structure and dynamics of R&D investments, linkage between patented inventions and the science base, the amount of venture capital and the spatial organization of innovative inputs.

The analysis of the empirical literature has disclosed some significant differences in the nature and dynamics of the EU's 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 5). In 2004, the private sector financed 64% of total R&D in the US, 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,* www.cordis.europa.eu). Second, growth of business R&D is much more dependent on business cycles in the US than in the EU. The growth of business R&D in the US was two to three times higher than overall GDP growth and dropped sharply than in 2000-2002 to again recover stronger in 2003.

In the EU, the regions that invest the most on R&D did not file the highest number of patents (Table 4). 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 US, 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 US 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 US 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 5. 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 US and the EU largely emanate from differences in industrial structure of R&D. In the US, 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 US was carried out in high-tech industries (2003)). Therefore, in the US, high-tech industries account for a larger share of industrial value added and GDP than in the EU. In the US, 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) (*Key Figures 2007*).

When examining differences within high-tech industries between the EU and the US, it appears that ICT (*information and communication technology*) manufacturing industries explain almost the entire R&D funding gap between the EU and the US. The ICT sector also tends to be more R&D-intensive in the US. 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.' Similarly, the gap in R&D funding between the US and EU results from the larger size of the US industrial sectors, whereas in the EU SMEs constitute a higher share of total business R&D expenditure.

The weak attractiveness of the EU as a location for R&D investment, compared to the US, widens the innovation gap between the two regions. In fact, many European companies carry out their R&D activities in the US. 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 US rose from 9.9 to 18.7 billion PPPUSD. Furthermore, the US 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*).

EU also tends to have a weaker linkage between patented inventions and the science base, especially in fields such as lasers, semi conductors and biotechnology. Moreover, US 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 US 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 US. American venture companies were more active in exploiting breakthroughs in electronic, medical or data-processing technologies. In 2005, the US's total venture capital investment was 1.8 euro per thousand GDP, almost 40% higher than the amount invested in the EU. The US-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 US compared to 0.21 in the EU, a difference of 64% (*Key Figures 2007*).

6. Spatial Analysis of Innovation Gap in the US and the EU

The last, but not the least important factor in the differential innovative performances of the US and EU is the spatial organization of their innovative inputs. 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 US 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).

Studies of the patterns of innovation activities conducted by Caniels (1997) prove that patent activity is geographically concentrated. Similarly, 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 (Audretsch 1998). Furthermore, the study results presented by Crescenzi et al. (2007) show that the dispersion of innovative activities seems to be less accentuated in the US than in the EU. The convergence parameter appeared to be smaller and less significant in the US than in the EU. Thus, according to Crescenzi et al. the production of knowledge and innovation are more localized in the US than in the EU.

The empirical data on the US 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 (Table 3 and 4). This is because average labour productivity is significantly greater where employment density is higher (Sedgley & Elmslie 2004). 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 US 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. 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).

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

In the EU, the regions that invest the most on R&D did not file the highest number of patents (Table 4). 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 US, 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 US 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 US 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).

Migration flows contribute to the creation of new knowledge at the local level, by enriching it with new skills and cultures (De Blasio 2005; Ottaviano & Peri 2006). Yet, migration trends are determined by both institutional incentives to labour mobility and a total costs of mobility, which include culture, identity or social links. The US has experienced higher rates of labor mobility than the EU (Puhani (2001),Vandamme (2000), Zimmermann (1995 and 2005). A relatively higher rate of net domestic migration in the US exerts a positive and significant effect on patent growth rates in MSAs. Moreover, a high rate of capital, population and knowledge mobility in the economically and culturally integrated US regions has shifted the frontiers of production frontiers and enabled the full exploitation of local innovative capacities. The EU regions cannot benefit from this due to lower domestic labor mobility. In addition, the US has much larger flows of immigrants (in absolute and relative terms) than the EU. The inflow of skilled labor into the US economy results in higher productivity and innovation (Crescenzi et al. 2007).