The IT development in the European Union

A comparative study between the European Union and the United States

Name: L.H. Rossingh
Student number: S1434039
Supervisor: J. Oster
European Union studies

Content

Introduction

Over the last two decades the productivity gap between the United States and the European Union has increased. In the 1980´s the USA had a productivity slowdown and there was the fear that the United States would be overtaken by countries like Germany and Japan. However, the European "catch-up" was short-lived and after the 1990s the productivity of the USA grew rapidly while the development in the EU was lagging behind. Raquel Ortega-Argiles speaks about a "transatlantic productivity gap" which is caused by the so called "new economy" or knowledge economy.[1] Productivity, or output per hour worked, is important because productivity growth allows durable income and consumption growth. To understand the productivity miracle of the USA it is important to understand the development of the IT, because the IT-producing and IT-using sectors are partly responsible for the increase in productivity.[2]

In the 1990s the EU was one of the leading countries in the IT (information technology) development. With huge firms like Nokia who introduced the GSM standard for mobile telecommunication the European Union was a significant player. However, since the 1990s the EU lost its important market positions to countries like the USA and China. Dominant companies like Google, Amazon, Facebook and Microsoft all have their roots in the American soil. To make things even worse Nokia, the former pride of the European continent, was sold to Microsoft in 2013 after their market share was drastically reduced. Neelie Kroes, the former European commissioner for digital agenda stated that "*Our telecommunications firms have gotten comfortable, and have lost their power for innovation. They were preoccupied with defending the old business models, instead of swiftly recognizing new trends. And they lacked the courage to invest*".[3]

The statement of Kroes suggests that the European Union ones had a leading role in the IT sector but lost their position due to the lack of innovation. In fact the EU was never the leader in the IT branch and was only able in the 1990s to come close to the development of the USA. After the 1990s, when the European Union had a process of deregulation and integration, the European share of the IT market was reduced. At the same time the USA made a giant leap forwards and was able to become the undisputed leader in the IT sector. The expanding difference between the two continents gave room for discussion, because the expanding productivity gap showed that there where important different mechanisms between the two.

[1] R. Ortega-Argiles, The transatlanctic producity gap: A survey of the main causes, in *The journal of economic surveys* Volume 26, issue 3, 395.
[2] N. Bloom, R. Sadun, and J. van Reeven, Nobody does IT better, in *CEPR policy insight* June 2007, 2.
K.J. Stiroh, Are IT spillovers driving the "new economy"?, in *Review of income and wealth* 48(1), 24.
[3] M. Rosenbach, EU's Digital Czarina: Europe Must 'Wake Up' to Tech Shortcomings, http://www.spiegel.de/international/europe/interview-with-european-commissioner-for-digital-agenda-neelie-kroes-a-929055.html

Different studies suggest that one of the main factors that cause the productivity gap is because the economy of the United States has a higher level of investments in the IT.[4] These investments would not only create more innovation but also provoke a 'new economy' effect. Because of the high level of investment the USA has in comparison more new firms in new grown sectors. However, a strong growth in the average labour productivity does not automatically imply new economy forces. An increase in productivity can also occur within the old traditional economic framework covering technological progress, price-induced input substitution, and capital deepening.[5] It is still unclear to which extend the leader role of the United States in the IT market is responsible for the exponential increase in productivity. According to many studies the IT sector played an important role in the growth differential between the USA and the EU.[6]

To study the effects of the IT development it is important to make a distinction between the IT sector that produces IT products and sectors that use IT products. This latest category plays an important role in estimating the average labour productivity, but the technological development from the IT sector is not the only factor that played a role. The entrepreneurial culture of the United States, the flexible labour markets and the up-skilling labour force where also elements which ensured that the US could widen the productivity gap with the European Union.[7]

The lagging position of the IT in the European Union is something that also got attention from the European commission. The commission has set itself the goal to get a single market in telecommunications, which is currently not yet the case.[8] Like Neelie Kroes stated herself in her press conference about the telecom market, it is not about one sector; it is about how digital technology can boost all economic sectors.[9] The loss of competitiveness in the IT sector is a major problem for the European Union. According to the IMF the EU was no longer the largest economy in 2012 (EU28 share dropped to 19,2% and the USA became the new largest economy with a share of 19,5%).[10] The prediction for 2018 are even less positive, EU's economy will drop to 16.7% and will be overtaken by China. According to the OECD the development of the IT sector can play a big part in the economic development of nations.[11] To prevent the EU's economy from shrinking even more, the EU cannot afford to pass up further opportunities in the IT sector. Therefore the main question this paper wants

[4] R. Rogerson, Structural transformation and the deterioration of European labor market outcomes, in *Journal of political economcy* 166(2), 260.
N. Bloom, R. Sadun, and J. van Reeven, Nobody does IT better, in *CEPR policy insight* June 2007, 2.
[5] K.J. Stiroh, Are IT spillovers driving the "new economy"?, in *Review of income and wealth* 48(1), 1.
[6] Paul J.J. Welfens, Cilian Ryan, Franz Knipping, EU-ASEAN: Facing economic globalisation, 8.
[7] R. Ortega-Argiles, The transatlanctic producity gap: A survey of the main causes, in *The journal of economic surveys* Volume 26, issue 3, 395.
[8] Regulation (EU) No 531/2012.
[9] Neelie Kroes, press release 13 September 2013, Telecom single market.
[10] IMF, World Economic Outlook, October 2013, database. See annex table 1.
[11] OECD, The new economy: Beyond the hype, 2001.

to answer is: Why is the European Union lagging behind the United States in the development of the IT market?

The paper is organized as follows; the first chapter gives an explanation about the effects of IT development, and why this is important to ensure economic growth in the future. The second chapter is a historical comparison between the United States and the European Union about the arise of the productivity gap. Followed by the third chapter which gives an overview of the influence of structures within a society that influences the innovation process. Section four discusses the effects of the current patent systems in the United States and the European Union. The filth chapter is about divergences in IT development between various member states. In the last chapter the role of the European Union on the innovation process and IT development will be explained.

Chapter 1: The effects of IT development

Why is a good development of the IT sector important for the European Union? The IT sector is a sector that influences a lot of other economic activities. Varies studies show that IT should been seen as a general purpose technology and that its effect can influence multiply aspects of society.[12] The effects which derive from development of the IT sector goes therefore beyond capital deepening. Measuring IT development on firm level is complicated because while hardware is often on the balance sheet, IT software can have a complex development track which makes it difficult to estimate the yield.

IT productivity research often sees IT capital as an economic input, treated as an independent variable. Treating IT capital as an independent variable has its disadvantages, like Brynjolfsson *et al* stated: "*A computer that is integrated with complementary organizational assets should be significantly more valuable to a business than a computer in a box on the loading dock*".[13] They argue that in order to use IT capital in an effective way, you need more than only IT capital input. In a company with a complementary organisational structure like decentralized decision making, IT management skills and specialized procedures the effects of IT investment will be more profitable than in comparison with a firm where this is not the case. This, of course, also works in the opposite direction: In order for a company to create a climate were IT investment will be profitable, it might be necessary to reorganize. It can be the case that the actual costs of a successful IT implementation may be considerable higher than the initial technological investment. Firms that only implement IT stock without worrying about human capital and the structure of the organization may eventually be less productive than before the implementation of IT.

According to Kleis, IT influences firms innovation activities through three channels;[14] First of all a good developed IT sector makes it possible to storage information and to distribute this information easily to other firms. It enables firms to improve the management of the knowledge used in the innovation process. E-mail systems, electronic databases and internal networks make it possible for innovation participants to communicate with each other. IT can help to spread internal information throughout a firm, but especially the access to external information proved to be very helpful in the innovation process.

[12] R.G. Lipsey, K. Carlaw, and C.T. Bekar, Economic transformation: general purpose technology and long term economic growth, 12.
[13] E. Brynjolfsson, L. Hitt, and S. Yang, Intangible assets: computers and organizational capital, in *Brooking papers on economic acticity: Marcroeconomics* 1, 191.
[14] L. Kleis, P. Chwelos, R. Ramirez and I. Cockburn, Information technology and intangible output: The impact of IT investment on innovation productivity, in *Information Systems Research* 23(1), 42-59.

Communication with external partners is the second channel where IT can effect innovation in a positive manner. IT enables more effective cooperation with external companies, because IT can facilitate the communication with partners who are located far away. Over the last twenty years the cooperation between companies has been a source for new knowledge and these external collaborations are also becoming more common. In the case of the European Union, IT can play an important role in decreasing the distance between collaborating partner countries and increase the efficiency of the single market. These two previous channels show the indirect effect of IT on the innovation process. The theory is confirmed by the data research of Campisi *et al* who concluded that countries with a high level of fixed telephony, mobile telephony, international internet bandwidth, households with computer and households with internet have also a high level of technological efficiency.[15] An overall digitalization of society will increase the efficiency and therefore influence economic development indirectly.

The third channel exists of the direct influence of IT on the process. Kleis makes a distinction in the innovation process were IT can contribute directly. IT can have a huge positive effect on the stage of generating ideas, IT makes it possible to analyse costumer communication and transaction data which can lead to ideas of new products of adaption of the existing products. Besides IT can help in the development in new product design with technologies as computer aided design (CAD) and computer aided manufacturing (CAM).

These three channels of Kleis show that there are different levels where a broad development of IT can lead to indirect and direct increase of efficiency. An important indicator for measuring the information society is the ICT development index (IDI), which is an index published by the United Nations international telecommunication union. The index is based on 11 different indicators, divided in three groups; IT readiness, IT use and IT capability. These three indicators show the three stages of evolution towards an information society.[16] First a country needs IT readiness, which means that there must be access to the IT infrastructure. The second stage of measurement is the IT use, the intensity. In order for the intensity to be high, the capability of people to work with IT must be high, which is the third measurement. With this approach the IDI is a good indicator to compare the broad IT development among different countries.

In the IDI of 2011 some countries in the European Union score above the average, with Sweden on the second place of the list, followed by Denmark on the third place. The IDI shows that the European Union has certain countries with a high developed information society. The United States only knows to pick the fifteenth spot in the rankings, just above Germany. However, the IDI

[15] D. Campisi, A. de Nicola, M. Farhadi and P. Mancuso, Discovering the impact of IT, FDI and human capital on GDP: a cross-sectional analysis, 4.
[16] International telecommunication union, Measuring the information society 2012, 16.

ranking shows clearly that there are huge differences between the various member states within the European Union. While Sweden is on the top of the list, Bulgaria dangles at the 52nd position quite underneath. These regional differences also exist within the United States, but the IDI is measured by country and not per state.

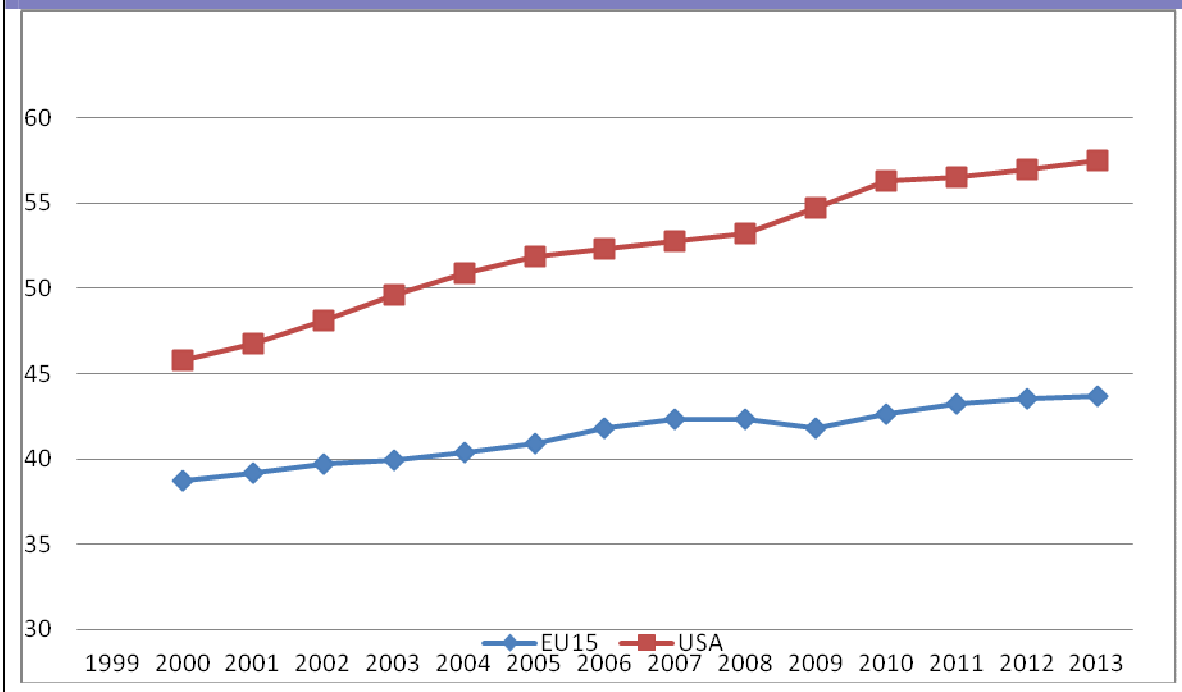
This makes it impossible to give an overview of the regional differences within the USA. The average score of the European Union on the IDI ranking is 6.68, which in 2011 would be good enough for the 26th place. This score is significantly lower than the score of the United States. From this data the conclusion is that the development of the information society is broader developed in the United Sates then in the European Union. However, the IDI data show that regional differences have a significant impact on the overall outcome of this conclusion. Therefore the fifth chapter of this research paper will investigate the reasons and consequences of this internal diversity.

Country	Rank	IDI
Sweden	2	8.34
Denmark	3	8.29
Finland	5	8.04
Netherlands	6	7.82
Luxembourg	7	7.76
United Kingdom	9	7.75
United States	15	7.48
Germany	16	7.39
France	18	7.30
Austria	19	7.10
Ireland	20	7.09
Belgium	23	6.89
Estonia	24	6.81
Slovenia	25	6.70
Malta	26	6.69
Spain	28	6.62
Italy	29	6.28
Poland	31	6.19
Czech republic	32	6.17
Greece	33	6.14
Lithuania	35	6.06
Latvia	36	6.06
Portugal	37	6.05
Slovakia	39	5.86
Hungary	41	5.77
Croatia	42	5.75
Cyprus	44	5.73
Bulgaria	51	5.20
Romania	52	5.13

Chapter 2: The evolution the productivity gap

Productivity growth is an important indicator of the technological development of a country. Scholars did not find evidence in the eighties and the first half of the nineties that the productivity gap between the United States and the European Union was a contribution of the IT's on productivity growth.[17] However, after 1995 the productivity gap between the USA and Europe became wider again and more studies started to link the increasing gap to the development of the IT sector. In the current scientific discussion there is a clear connection between the growth rate of productivity and the development of the IT sector. It is therefore important to investigate the aspects of productivity growth more detailed.

Graph 2.1. Level of GDP per capita and productivity 1999-2013.[18]



Productivity growth is not only caused by IT related factors, Timmer and Ark make a distinction between IT and non-IT contribution to increase in the productivity growth. In the period 1980-1995 the USA has an average productivity growth of 1.4% of GDP, 0.5% of this growth is caused by IT in comparison to 0.2% growth due non-IT. In the same period the European Union has an average of 2.3% productivity growth, but only 0.3% of this growth is due IT development (see table 2.1.). In order to draw conclusions from the development of productivity growth for the development of the IT it is important to estimate which percentage of productivity growth derives from the input of IT's.

[17] S. Oliner, D. Sichel, Computers and output growth revisited: how big is the puzzle?. In *Brookings Papers on Economic Activity 2*, 273-317.
[18] OECD statistics, http://stats.oecd.org/Index.aspx?DataSetCode=PDB_LV 18-07-2014.

If we look back at the past of the evolution of the European productivity growth, we can make a distinction in three time periods: The first period is 1950-1973, which is generally characterized by a traditional catching up pattern of imitation and adaption of foreign technologies.[20] The financial crisis of the 1930s, followed by the devastating Second World War placed Europe economically in a bad position. However, before the Second World War Europe did already have a sufficient educated population who were accompanied by strong developed institutions. The only thing that Europe needed was a high level of investments to implement new technologies from the United States and develop their human capital. Rebuilding Europe led to a high level of investments and also the concept of wage bargaining was introduced. Wages where kept artificial low in order to improve the competitiveness.

Table 2.1. percentage contribution to labour productivity growth 1980-1995 and 1995-2001 [19]

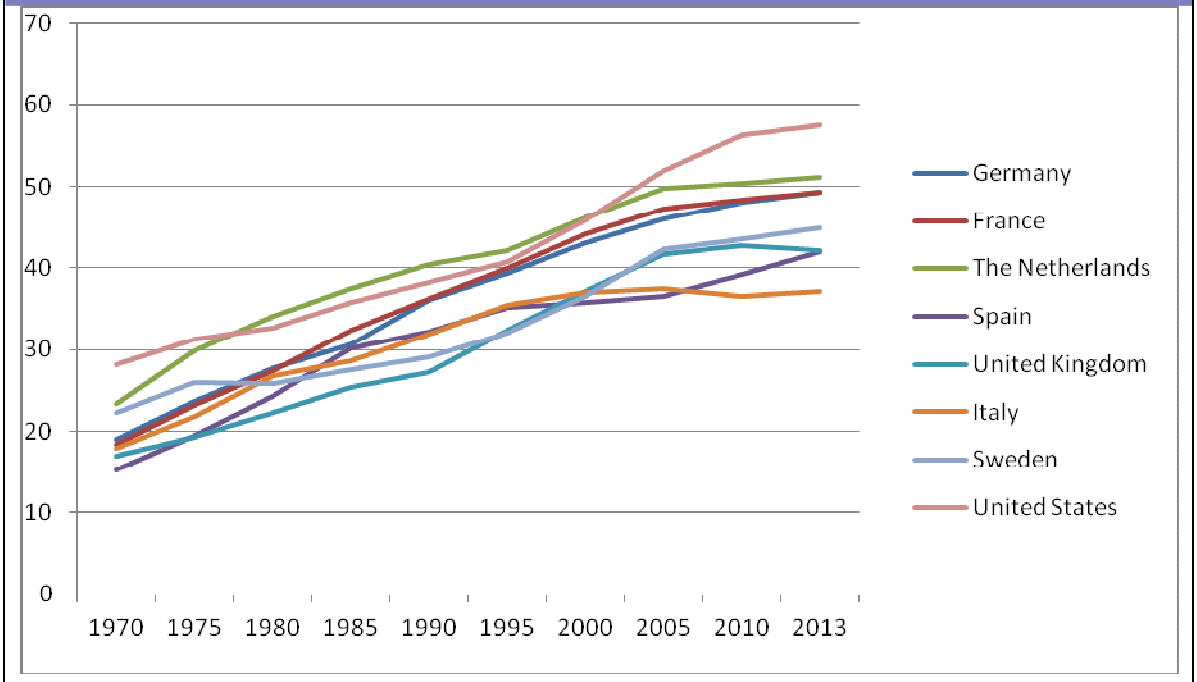
	IT per hour	Non-IT per hour	TFP	GDP per hour
1980-1995				
USA	0.5	0.2	0.7	1.4
EU	0.3	0.9	1.1	2.3
1995-2001				
USA	0.7	0.3	0.8	1.8
EU	0.4	0.5	0.5	1.4

Graph 2.1. shows that from the seventies the level of GDP per capita and productivity in Europe rose but that only the Netherlands was able to overtake the United States for a while. The rise in productivity was possible because there was a higher level of investments and new foreign technologies where implemented.[21] The dependence of foreign technologies, which was primarily originated from the United States, made it however impossible for Europe to overtake the USA.

Timmer and Ark concluded that the European catch up after the seventies was not based on IT development but on non-IT factors.[22] Especially in countries like Ireland, Greece, and Portugal, there was a lot of productivity growth but mainly in the non-IT sectors. While the United States has a higher level of IT development but less productivity growth in total. Despite the fact that Europe was doing a productivity catch up after the second world war, the growth rates derive not from "new economy" developments like IT's. In the seventies the catch up process stopped and there was no longer that much convergence between Europe and the USA.

[19] M.P. Timmer, and B. van Ark, Does information and communication technology drive EU-US productivity growth differentials? In *Oxford Economic Papers* 57: 706.
[20] B. van Ark, M. O'Mahony and M.P. Timmer, The Productivity Gap between Europe and the United States: Trends and Causes, in *Journal of Economic Perspectives, Volume 22, Number* , 26.
[21] M.P. Timmer, and B. van Ark, Does information and communication technology drive EU-US productivity growth differentials? In *Oxford Economic Papers* 57: 694.
[22] M.P. Timmer, and B. van Ark, Does information and communication technology drive EU-US productivity growth differentials? In *Oxford Economic Papers* 57: 706.

Graph 2.2. Level of GDP per capita and productivity 1970-2013 [23]



In the second time period, between 1973-1995, the productivity growth in Europe and the United States began to slow down. In comparison with the United States Europe did relatively well, in 1995 countries like Belgium, the Netherlands, France and Italy had a GDP per hour worked that was 10% above the level of the United States. But the productivity growth of Europe decreased because there was a decline in labour force participation visible and workers started to work fewer hours. Working hours per capita in countries of the European Union was only 76% of U.S. level in 1995.[24] The development of the welfare state in Europe had as a consequence that the balance between work and leisure was filled in differently than in the United States.

Besides the fact that in Europe the working hours were declining, they had relative more growth of productivity than the USA. However, table 2.1. show that the relative more growth of productivity in Europe derives from non-IT developments. This can be explained in the context of the declining workings hours in EU countries. A result of the decreasing labour input was a fast increase in the capital intensity, the rising wages forced producers to invest in capital instead of labour.[25] The consequence was that the productivity per hour worked increased, but this was mainly on areas outside the IT sector. Between 1973-1995 the productivity growth in the EU was no longer part of a catch up caused by faster innovation but rather a consequence of the development of an inflexible labour market.

[23] OECD statistics, http://stats.oecd.org/Index.aspx?DataSetCode=PDB_LV 18-07-2014.
[24] B. van Ark, M. O'Mahony and M.P. Timmer, The Productivity Gap between Europe and the United States: Trends and Causes, in *Journal of Economic Perspectives, Volume 22, Number* , 29.
[25] B. van Ark, M. O'Mahony and M.P. Timmer, The Productivity Gap between Europe and the United States: Trends and Causes, in *Journal of Economic Perspectives, Volume 22, Number* , 30.

In the nineties productivity boomed in the United States, between 1990-1995 there was an increase of 1.1% and between 1995-2000 this increase accelerated to a growth of 2.5%.[27] For the first time there where clear sings that Europe was no longer catching up and that a productivity gap between the USA and Europe was emerging. Ortega-Argiles stated that the increasing gap between the EU and the USA was caused because the United States was setting the technological frontier in terms of productivity efficiency while Europe was lagging behind (with Norway and Sweden as the exception).[28] The United States could take the role of forerunner because their productivity growth was predominantly based on IT developments. In the nineties the influence of the IT sector on productivity growth increased, while non-IT factor got less important. In the time period after 1995 the productivity growth of the United States began to escalate again, while in the same period the productivity growth in Europe decreased.[29]

The increasing productivity growth in the USA gave a sharp contrast in comparison to the development of the European countries, which had a productivity slowdown in the same period. The differences in development in both continents gave a burst in academic research on both sides of the Atlantic. Generally the lack of investment in the IT sector was seen as a main cause for the poor performance of the EU countries.[30] In Table 2.2 Timmer and Ark show that the EU between 1980 and 2001 had a considerable lower level of IT investments then the USA.

In the nineties the productivity

Table 2.2. IT investments as % of GDP [26]

	1980	1985	1990	1995	2001
Sweden	1.6	2.5	2.7	3.4	4.7
Finland	1.1	1.5	1.9	2.9	4.3
Belgium	1.7	2.9	3.1	2.6	3.6
Denmark	1.5	2.3	2.9	3.1	3.6
Greece	0.7	1.0	1.3	1.7	3.3
UK	0.8	1.6	2.3	2.8	3.0
Netherlands	1.6	1.9	2.4	2.1	2.9
Germany	1.3	2.2	2.4	2.0	2.5
Italy	1.5	1.9	2.3	2.0	2.5
Austria	1.3	1.6	1.9	1.7	2.4
Portugal	1.2	1.7	1.8	1.8	2.1
Spain	0.9	1.5	2.5	1.7	2.1
France	1.0	1.4	1.5	1.4	2.1
Ireland	0.9	1.6	1.2	1.9	1.9
EU	1.2	1.9	2.2	2.1	2.6
USA	2.5	3.4	3.3	3.7	4.2

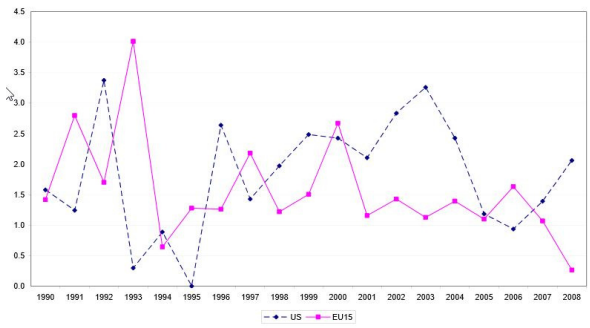
[26] M.P. Timmer, and B. van Ark, Does information and communication technology drive EU-US productivity growth differentials? In *Oxford Economic Papers* 57: 7.
[27] B. van Ark, R. Inklaar and R.H. McGuckin, IT and productivity in Europe and the United States: Where do the differences come from?, 2.
[28] R. Ortega-Argiles, The transatlanctic producity gap: A survey of the main causes, in *The journal of economic surveys* Volume 26, issue 3, 398.
[29] B. van Ark, M. O'Mahony and M.P. Timmer, The Productivity Gap between Europe and the United States: Trends and Causes, in *Journal of Economic Perspectives, Volume 22, Number ,* 26.
[30] A. Colecchia and P. Schreyer, The Contribution of Information and Communication Technologies to Economic Growth in nine OECD Countries, in *OECD Economic Studies* ,no.34, p. 153-172.
F. Daveri, The New Economy in Europe (1992-2001), in *IGIER Working Paper*, no. 213, April.

growth was mainly visible in IT producing industries, but in 2000 this picture changed because user industries also increased their productivity. Ark and Inklaar show in their study that the higher level of investment not only gave a rise in productivity in the IT producing sector itself but that the largest positive effect derived from IT applications in other processes, products and services.[31] Ark and Inklaar proved that this was the case on a macroeconomic level, Brynjolfsson and Hitt confirmed that this was also the case on micro level.[32] Investment in IT goods in a firm would directly lead to an increase in the overall productivity of that firm.

The spread of new technologies accelerated faster in the USA than in the EU, resulting in a wider gap in the total factor productivity (TFP) as shown in graph 2.3. TFP is a variable that measures output that is not caused by tradition input, like capital or labour. TFP consists of technological development and efficiency contributions. The variable is used to measure long-term technological change and efficiency increase in an economy. One of the patterns of TFP is that in case of technological gain there is often a negative contribution of efficiency. A likely explanation is that this effect is caused because the introduction of new technology is accompanied with the movement of resources to other sectors. The technological effect is beneficial but because it takes time to adjust the efficiency drops temporarily.[34] Overall the conclusion is that the contribution of technology has a bigger impact on efficiently in the long-term than the temporary decrease of the total factor productivity.

Graph 2.3. pictures the growth of TFP in Europe and in the United States between 1990-2008. The United States shows a different behaviour in TFP growth than the European countries in the European Union. The USA its TFP development between 1980-2005 had a relatively stable contribution for GDP growth.[35] While the overall development of European countries had a declining contribution of the total factor productivity to GDP growth.

Graph 2.3. TFP growth in the US and the EU15: 1990-2008.[33]



The dominant idea in the scientific discussion is that IT investment is at the root of the productivity gap between the United States and the European Union. The lower investment level in

[31] B. van Ark, R. Inklaar and R.H. McGuckin, IT and productivity in Europe and the United States: Where do the differences come from?, 3.
[32] E. Brynjolfsson, and L. Hitt, Computing Productivity: Firm-Level Evidence, in *MIT Sloan Working Paper,* No. 4210 01, June
[33] R. Ortega-Argilés, M.C. Piva and M. Vivarelli, The Transatlantic Productivity Gap: Is R&D the Main Culprit?, 5.
[34] J. Amador and C. Coimbra, Total factor productivity growth in the G7 countries: Different of alike? 14.
[35] J. Amador and C. Coimbra, Total factor productivity growth in the G7 countries: Different of alike? 17.

the IT sector is important for the development of productivity. It is therefore not surprising that the increase of research and development has been the main target of European policy of the last decade.[36] The focus on research and development investments is understandable but R&D investments are not the only cause of the lagging position of Europe. There are other factors that also play a major role in the development of IT's, like the quality of human capital, rigidity of European labour markets, the role of diffusion IT´s and the importance of new managerial practices and organizational investments. To answer the question why the members of the EU are structural lagging behind the USA we have to take a closer look at these factors.

[36] European Commission, More research for Europe. Towards 3% of GDP, COM(2002) 499 final.
European Commission, Analysis of the 2007 EU Industrial R&D Investment Scoreboard.
European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, 2010.

Chapter 3: structures in society

3.1. The quality of human capital

There is a long known tradition in the scientific literature about the influence of human capital and economic growth. The main theory is that the existence of a well-trained labour force makes it easier for individuals to adapt to new technology. This will lead to an increase in productivity of a company, resulting in more economic growth in the end.[37] It is very difficult to measure the true quality of human capital; therefore years of schooling will be used as a proxy for quality. The theory about human capital is based on theories of Schultz and Becker, who both have the main argument that investment in human capital will lead to more efficient use of production input.[38] Campisi *et al* compared data from 20 OECD countries and 24 non-OECD countries and could not find a direct relationship between human capital and technological efficiency. However, they did state that human capital influences indirectly the ability of a country to exploit innovation.[39] Human capital is therefore not a production factor but an essential part determining in the capacity of a country to innovate new technology which is suited to domestic production.

Romer goes in his research *Increasing returns and long-run growth* a step further by saying that human capital is the generator of innovation and therefore essential for long-term economic growth.[40] However, this bold statement is not were scientific literature unanimous agrees on. From the perspective of the neoclassical growth theory there are only two elements that influence long-term economic growth; population growth and technological process.[41] An investment in human capital is in this view only a way to increase the production in a temporary fashion. However, this vision is limited, because in the neoclassic view every country has access to the world technology. Knowledge is something that spreads around the world automatically. With these assumptions the theory predicts that poor countries will grow faster then rich countries. Rich countries will invest in poor countries because capital is scarcer in developed countries and the marginal returns to investments are high. However, this prediction is not backed up by the available data because it does not take the effects of human capital into account. In practice knowledge does not spread around

[37] S.P. Dimelis and S.K. Papaioannou, Human capital effects on technical inefficiency: a stochastic frontier analysis across industries of the Greek economy, in *International review of applied* economics, 797.
[38] T. Schultz, Investment in human capital: The Role of education and of research, in *New York: Free Press*
G. Becker, Human capital: A theoretical and empirical analysis, with apecial reference to education
[39] D. Campisi, A. de Nicola, M. Farhadi and P. Mancuso, Discovering the impact of IT, FDI and human capital on GDP: a cross-sectional analysis, 7.
[40] P. Romer, Increasing returns and long-run growth, in *Journal of Political Economy* 94: 1002-1037
[41] E. Canton, B. Minne, A. Nieuwenhuis, B. Smid and M. van der Steeg, Human capital, R&D and competition in macroeconomic analysis, 3.

the world, resulting in different levels of human capital per country. Capital tends to move towards countries with more human capital, which are often the more developed countries.

Since the emerging of international databases it is possible to investigate the empirical relationship between growth and major economic variables. Barro and Sala-i-Martin where the first to find a positive relationship between education and economic growth.[42] They did not find a significant relationship with education on primary level but they did prove that investment in secondary and tertiary education will lead to more economic growth in the case with males. Striking about their research is that male attendance to educations leads to more economic growth while female attendance leads to less economic growth. Barro and Sala-i-Martin explain this result by stating that less female attainment implies more backwardness of a country, and these types of countries have a higher growth potential.

A problem with measuring human capital is that there is a time gap between the investment and the time that the capital can be used for productive purposes.[43] This time lag depends on the level of schooling. Investment in primary education will lead to a higher output of schooled workers between ten and fifteen years, while in the case of tertiary education results will be visible between four and six years. Barro and Sala-i-Martin could not find a relationship between primary education and economic growth, a possible explanation for this is that the time lag is too big. Statistically it is only profitable to invest in secondary and tertiary education, but in practice a good primary education is necessary to increase the quality of secondary education.

The effect of investment in human capital depends on the quantity and quality of the human capital on macro-economic level. Vandenbussche, Aghion and Meghir show that the effects of human capital may vary by country. The closer a country is to the technological frontier, the more economic growth skilled labour will generate.[44] This is caused because innovation is simple more labour intensive than when you are able to imitate from other countries. Another explanation is that a younger generation is not able to expand its human capital when the older generation has a small human capital stock. The argument behind this is that the human capital factors of the old generation are complemented to the human capital factors of the young generation.[45] This theory is best explained with a football team as example, where the players are the young human capital and the coach the old. In order for the team to play at the maximum level of their abilities, the players and the coach need knowledge and skills. When the coach has a low level of training, meaning not a

[42] R.J. Barro and X. Sala-i-Martin, Economic Growth, 78.
[43] E. Canton, B. Minne, A. Nieuwenhuis, B. Smid and M. van der Steeg, Human capital, R&D and competition in macroeconomic analysis, 5.
[44] J. Vandenbussche, P. Aghion and C. Meghir, Growth, distance to frontier and composition of human capital, 39.
[45] M. Kremer and J. Thomson, Why isn't convergence instantaneous? Young works, old workers and gradual adjustment, in *Journal of economic growth* 3, 24.

high level of human capital stock, the players in the team will perform less. This example shows that development of human capital is gradual and increasing of the human capital stock calls for a long-term perspective.

Investment in human capital will generate more economic growth in the United States than in the European Union because the United States is closer to the technological frontier. Europe has in comparison to the USA a lower output per capita, but the productivity per worker is about 5% higher.[46] The labour markets of the United States and the European Union are fundamentally different, in de next chapter their will be more about the rigidity of European labour markets. One of the effects of these different structures is that in Europe employees have more possibilities to specialize in their human capital needed for their job because they work longer on the same job. They can afford to invest in their job and firm, resulting in an increasing in productivity which will lead to higher wages. However, this does not mean that employees invest more in human capital in the EU compared to the United States. Wasmer states that employees in the USA invest more in general human capital while European employees invest more in specific human capital.[47] From this perspective it is clear that the European Union has a higher productivity per worker. The consequence of this system is that when an employee loses its job it is harder to find a new job with the same wage level. The rigid European labour market leads to a higher level of productivity but also increases the level of unemployment.

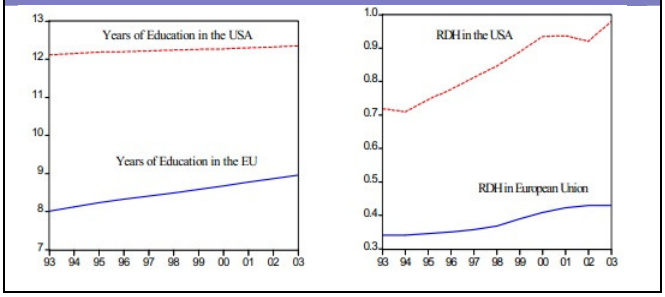
Most of the research done on Human capital lay a positive relationship between human capital and economic growth, however Greece is a clear example of a country with a high level of investment in human capital but a stagnant economy. In 2005 was Greece within the European Union one of the nations with the highest level of hours worked by high skilled workers.[48] Striking is the fact that Finland scores the highest rates of hours worked by high skilled workers, namely 35%. In comparison, in the USA only 31% of the hours worked are performed by high skilled workers. Greece comes with 22% on the third place, a remarkable high score. Especially because countries like Germany (9%) and Denmark (8%) score significantly lower. Having a high percentage of skilled labour per hour does not make a country automatically efficient. However, Dimelis and Papaioannou prove in their research that a high educated labour force does have a significant positive contribution to the overall efficiency of various sectors. They therefore conclude the following:

[46] E. Wasmer, Interpreting Europe and US labor markets differences : the specificity of human capital investments, 21.
[47] E. Wasmer, Interpreting Europe and US labor markets differences : the specificity of human capital investments, 1.
[48] S.P. Dimelis and S.K. Papaioannou, Human capital effects on technical inefficiency: a stochastic frontier analysis across industries of the Greek economy, in *International review of applied* economics, 798.

"*In light of the rapid structural change witnessed in recent decades, the importance of human capital has increased as a key factor for technological progress and innovation. In this context, Greece, having already developed a well-educated labor force, should not compete with other countries through a policy of continuous reduction of wages, since this would result in losing a significant part of its skilled workforce and in a reduction of its long-term potential output. Instead, exploitation of the existing capabilities and further accumulation of skills and knowledge should be the basis for future growth of the Greek economy*".[49]

So a well-developed human capital stock does not mean automatically that a country generates economic growth, because there are plenty of other factors that play a role in generating growth. Nevertheless, human capital does give a positive contribution to economic growth and in order for the European Union to generate long-term economic development investment in human capital is crucial. The development of a better human capital stock could help Europe to close the productivity gap with the United States. However, in Graph 3.1.1. can been seen that USA has average more years of schooling than the EU. If we take years of schooling as a proxy for the quality of human capital we can concluded that the United States has a considerable higher human capital stock than the European Union. The European Union is lagging behind the United States, not only in years of education but also in the spending on research and development.

Graph 3.1.1. Years of education and R&D.[50]



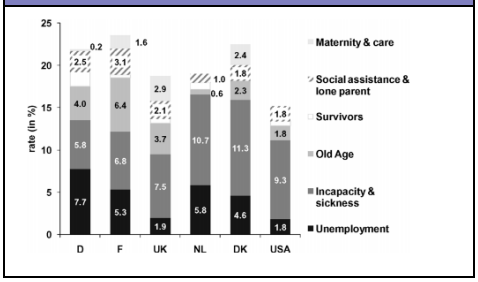
If the European Union seriously wants to be an economic competitor of the United States than the union needs a constructive long-term vision on education investment. Increasing the human capital stock is a process which will take decennia and is therefore not a model whereby investment is quickly recovered.

[49] S.P. Dimelis and S.K. Papaioannou, Human capital effects on technical inefficiency: a stochastic frontier analysis across industries of the Greek economy, in *International review of applied* economics, 810.
[50] M.C. Guisan and E. Aguayo, Wages, productivity and human capital in the European Union: Econometric models and comparison with the USA 1985-2005, in *Applied economics and international development* Volume 7-1, 49.

3.2. Rigidity of European labour markets

In the European Union the overall structure of the labour market is more rigid than in comparison with the United States. The common idea is that this rigidity causes high unemployment in the European Union, well in the United States where there is a more flexible market there is less unemployment. There are different definitions in use about what is meant with unemployment, in this research the broad definition is used. With a broad definition is meant that this research will not only look at unemployment levels but also includes all categories of the working age population who are not at work.[52] For instance, a woman who chooses to take care of the household and her children falls within the definition of unemployment, even if it is here voluntary decision and she is not receiving any social benefits. The use of this broader definition will give a better picture of the effects of the institutional differences between the European system and the North American system.

Graph 3.2.1. Percentages of working-age population receiving social benefits, by type of benefit in 2004.[51]



The structure of the labour market is organised on national level in the European Union. This means that every country has a different structure with different consequences. In graph 3.2.1. we see an overview of the distribution of different social benefits in Germany, France, United Kingdom, The Netherlands, Denmark and the United States. Looking at the graph it can be concluded that the distribution of social benefits is very different per country, but the overall benefit dependency is more or less the same. Why there is unemployment is a really complex matter which can not only be based on unemployment rates but also on national family policies. In this research the emphasis is not on unemployment but on the effects of certain institutional structures on the process of innovation and IT development. However, unemployment and the social benefits that are connected with unemployment are a part of the explanation.

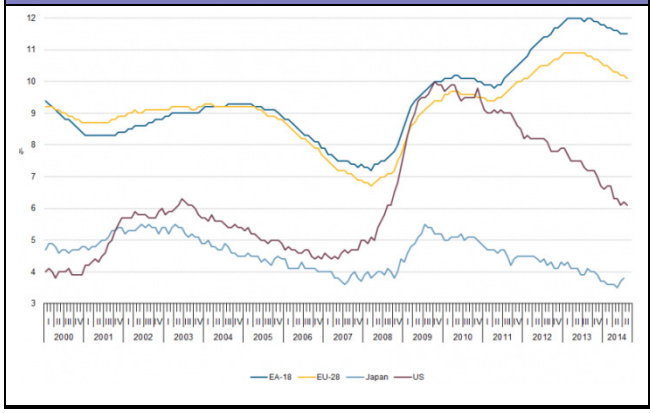
Europe introduced the welfare state after the Second World War, and made the choice to follow a different path than laissez faire approach of America. In the 60s and 70s there was a relatively low unemployment and unemployment levels in Europe were comparable with the rest of the OECD countries. However, in the 80s the welfare state would an increase in unemployment. The system caused especially a high level of structural long term unemployment, while in countries like the United States the number of people who were unemployed for a longer period was relativity low. The high level of unemployment in the European Union got a lot of scientific attention, with

[51] OECD database on recipients of social benefits 2004.
[52] M. Erlinghagen and M. Knuth, Unemployment as an institutional construct? Structural differences in non-employment between selected European countries and the United States, in *Journal of social policy* 39, 1., 71.

explanations as adjustments costs for firing and hiring, lack of wage flexibility, shortage of physical capital etc.[53] However these problems are all part of the demand side, Ljungqvist and Sargent are the first to take a closer look on the supply side of the labour market.

They came to the conclusion that the welfare state causes longer unemployment than a country with a *laissez fair* approach. Employers are longer "out of business" and in this period they can lose in essential skills.[54] The time that an individual is sitting at home he or she is not developing job specific skills and is no longer up to date about the latest trends. Basically, the unemployed is losing human capital and the longer the person is unemployed the harder it gets to find a new job. In a time where information technology becomes more important, this is a serious issue for the welfare state. Innovation will caused more rapid changes in the working environment of employees; the effects of longer unemployment will only get worse. If the European Union wants to be prepared for the future, the national governments have the address the problem of rigid labour markets. In order to make the labour market more flexible the problems on the demand side must be solved.

Graph 3.2.2. Unemployment rates EU-28, EA-18, US and Japan, 2000 - 2014[55]



In the previous chapter the effects of the different institutional structures between the EU and the USA and the effects on human capital where discussed. European employees are more protected by a dismissal law than employees in the United Sates. In the USA it is possible to fire an employee without a day noticed, in the EU this is unthinkable. This has to do with the fact that in the USA you don't need a contract to work, a working position is based on a will-to-will basis and therefore an employer does not need a specific reason for letting somebody go. This is completely the opposite in the European Union, were employees and employers have a mutual contract and were the employer can only fire somebody if he or she has a good reason for this. In Practice this means that in the European Union employers are more cautious in hiring employees, but when they do the employee will be difficult to fire. The result of this rigid structure is that the European labour market has a higher level of unemployment, but

[53] L. Ljungqvist and T.J. Sargent, The European unemployment dilemma, in *the journal of political economy* Volume 106, Issue 3, 546.
[54] L. Ljungqvist and T.J. Sargent, The European unemployment dilemma, in *the journal of political economy* Volume 106, Issue 3, 546.
[55] Eurostat, Unemployment rate by sex and age groups - monthly average, %. http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=une_rt_m&lang=en

when employees do have a job it is steadier than in the United States. Graph 3.2.2. shows the different responses of unemployment rates on the financial crisis. In 2008 the United States had a dramatic increase in unemployment, but the overall level is lower than that of the Euro zone (EA-18) and the European Union (EU-28).

One of the effects of these different structures is that in Europe employees have more possibilities to invest in their job-related human capital because they work longer on the same job. They can afford to invest in their job and firm, resulting in an increase in productivity which will lead to higher wages. However, this does not mean that employees invest more in human capital in the EU compared to the United States. Overall employees in the USA invest more in general human capital while European employees invest more in specific human capital.[56] The consequence of this observation is that European employees are more connected to the company that they work at. Within the company they develop themselves and when they lose their job this can have major personal consequences.

Various empirical studies have found a negative relationship between rigid labour markets and productivity performances.[57] Parello investigated which policy was the most successful in generation more productivity. His model shows how labour market policies can increase employment and stimulate long-run productivity growth. Labour market policies (LMP) are government programmes who have the goal to increase unemployment and underemployment, these policies are at the core of the European employment strategy. The European employment strategy is trying to help individual member states to create more and better jobs. Parello makes the assumption that when innovation occurs, this innovation will create a mismatch between the knowledge that is needed and the knowledge employees have. For example, when new software is invented companies need employees who can work with this program, but with new invented software it is difficult to find an employee who has these specific skills. Employees who are not able to adjust themselves to innovation will because of the mismatch in knowledge lose their jobs.

How can this knowledge mismatch be addressed? The logical assumption is that employees who are not able to keep up with changes need extra training so they can adapt to the new situation. However, Parello found out that strengthening labour market services is more successful than contrasting the technology mismatch. With labour market services is meant active job-search workshops, social and vocational orientation services, etc. nevertheless; both policies have the effect of enhancing growth and innovation in an economy. If LMP are the right tools to increase productivity and employment depends on the situation in a country and the political priorities:

[56] E. Wasmer, Interpreting Europe and US labor markets differences : the specificity of human capital investments, 1.
[57] C.P. Parello, Labor Market Rigidity and Productivity Growth in a Model of Innovation-Driven Growth, 1.

"*…decision makers should clearly focus on the type of program in designing their labor market policy portfolio. If the target of governments is to improve unemployment, a well-balanced mix of labor market services and measures should be able to go a long way towards improving the growth-unemployment mix of the economy. But if the unemployment rate is not at the top of a governments agenda, other macro-policies, such as R&D subsidies and incentives, would be much more successful in raising productivity growth than LMP (Labour market policies)*".[58]

LMP are competences of the national governments in the European Union, the European employment strategy is therefore not more than an open method of coordination where EU member can share information and coordinate their policies.[59] There is not a single policy on the labour market in the European Union, decision on LMP are made on national level. A European policy on labour market policies would be difficult to implement because of the huge regional differences among the different member states. Like Parello mentioned in the previous quote, it depends on the priority of the national government which policy is preferable.

[58] C.P. Parello, Labor Market Rigidity and Productivity Growth in a Model of Innovation-Driven Growth, 18.
[59] European commission, European employment strategy.
http://ec.europa.eu/social/main.jsp?catId=101&langId=en

3.3. Research and development

Innovation can be created by development of a research and development program but there are also ways of informal knowledge gathering. "Learning by doing" is for instance an informal method of creating innovation in the IT-sector by mainly first-movers. The problem with research and development is that it is very difficult to measure, because measuring the input and output does not cover the whole story. It is very complex to determine the informal input and even the formal input is difficult to obtain because companies often want to protect the size and nature of their research and development program.

An important contribution in understand the process of innovation is the knowledge production function (KPF) created by Pakes and Griliches in 1984, which is a model based on the Cobb-Douglas production function.[61] In this production function $k_{i,t}$ shows the output of knowledge generation for firm *i* at time $_t$. Because it is impossible to measure the output of knowledge of a certain firm, the output of patents is used as a proxy for $k_{i,t}$. By using patents as an output indicator, Pakes and Griliches where able to find a significant relationship between research and development expenditures and patent output.[62] They confirmed their outcome both on firm level and industry level. The problem with this knowledge production function is that the use of patents as an output indicator makes it difficult to compare outcomes across firms, industries, years and countries. Patents are not a reliable indicator for a comparative research between the European Union and the United States because conditions and procedures are too different. Despite the limitations, the knowledge production function does show the clear relationship between research and development and innovation.

$$k_{i,t} = a_i + \gamma t + \sum_{r=0}^{5} \theta_r RD_{i,t-r} + u_{i,t}$$

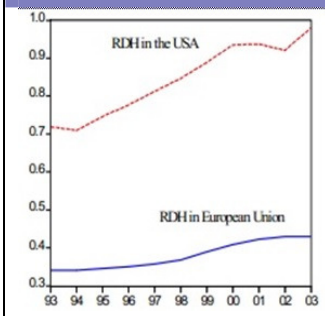
$K_{i,t}$ = the output of knowledge generation for firm *i* at time *t*

RD $_{i,t-r}$ = research investment over the past five years

a_i = firm specific differences in research development

$u_{i,t}$ = stochastic component

Graph 3.3.1. R&D. [60]



Graph 3.3.1. illustrates that the USA has a substantially higher investment in research and development than the European Union. Different studies suggest that

[60] M.C. Guisan and E. Aguayo, Wages, productivity and human capital in the European Union: Econometric models and comparison with the USA 1985-2005, in *Applied economics and international development* Volume 7-1, 49

[61] L. Kleis, P. Chwelos, R. Ramirez and I. Cockburn, Information technology and intangible output: The impact of IT investment on innovation productivity, in *Information Systems Research* 23(1), 52.

[62] A. Pakes and Z. Griliches, Patents and R&D at the firm level: A first look, in *R&D patents and productivity* , 55-72.

especially private investment in research and development has a fundamental effect on productivity growth, both at the macro and microeconomic level.[63] Precisely on this aspect is the EU is not doing well. In 2009 2.82% of GDP in the USA is research and development financed by the industry itself, in the European Union (EU27) this is only 1.54%. This is exacerbated because European governments spend average less money in research and development then the government of the United States.[64]

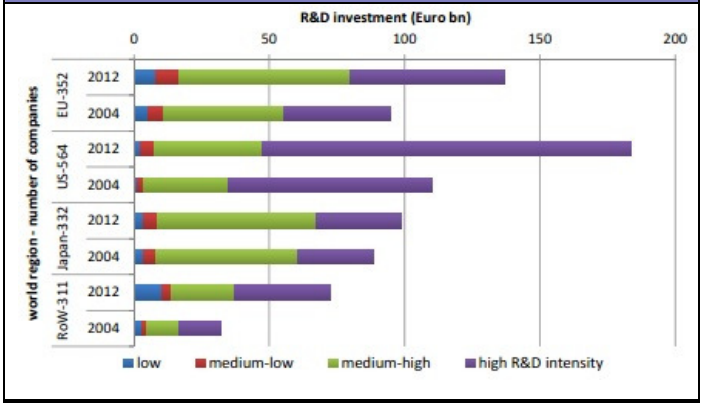
Ortega-Argilés *et al* show in their research that not only the lower investment in R&D is the problem why the European productivity is lagging behind. They reveal that the EU invest less in R&D but also get less productivity advantages from these investments than the USA.[65] The United States is more efficient in translating findings from R&D into their economy. This conclusion gives also an explanation why the industries themselves invest less in research and development in Europe, after all R&D activities is not converted into the industry as fast as in the USA and therefore less profitable. Despite the fact that the research of Ortega-Argilés *et al* does not give a clear explanation why Europe is less effective in translating R&D to its economy, it does show that research and development investments are not the sole source of productivity increase.

Within the European Union the lack of investment in research and development got attention because of the increasing productivity gap between the United States and the EU. In 2000 the Lisbon agenda was introduced, which had the goal to make the EU the most dynamic knowledge economy in the world by 2010. In the Barcelona targets the goal was set that there should be a minimum of 3% of the GDP invested in R&D, two third of this investment should derive from the private investments.[66] In 2010 it became clear that the Lisbon strategy had mostly failed, the member states did not achieve the target to invest more in research and development. The failure of the Lisbon strategy was largely due to the changing times. The treaty was drawn up when the economy was doing well in Europe, but this economic prosperity turned into an economic crisis. In the years the followed the European Union was too busy saving the Euro and national governments had to contend with high public debt and banks that were in trouble. Investment in human capital was no longer a priority.

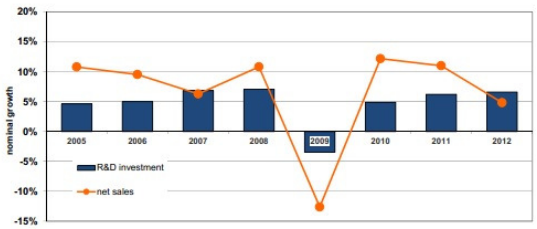
[63] R. Ortega-Argilés, M.C. Piva and M. Vivarelli, The Transatlantic Productivity Gap: Is R&D the Main Culprit?, 7.
[64] OECD, Main Science and Technology Indicators, Volume 2011 Issue 2, 57.
[65] R. Ortega-Argilés, M.C. Piva and M. Vivarelli, The Transatlantic Productivity Gap: Is R&D the Main Culprit?, 29.
[66] The Lisbon strategy, http://www.ipe.ro/rjef/rjef1_06/rjef1_06_6.pdf.

Graph 3.3.2. and 3.3.3. show that the European response to investment less in R&D because of the economic crisis was not a unique one. Both in the EU and in the USA the investment by companies in research and development decrease drastically in 2009. In the European Union in 2012 companies invest 6.3% above world average on research and development, in the United States this was 8.2%. Most of the investments in Europe are from Germany in the automobile industry, while in the USA emphasis is on IT and health. In Graph 3.3.4. this is clearly visible; the European companies invest in comparison to the United States less in sectors with a high R&D intensity. Sectors with a high research and development intensity are IT, health, biotechnology etc. Electronics, automobile and machinery are examples of sectors with a medium-high research and development intensity.

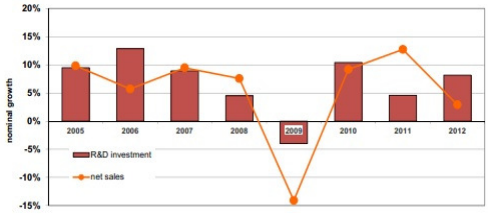
Graph 3.3.4. R&D investment companies by region[69]



Graph 3.3.2. Research and development investment by EU companies[67]



Graph 3.3.3. Research and development investment by US companies[68]



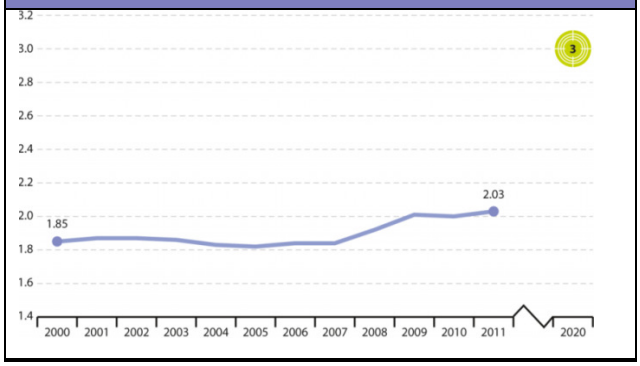
In 2012 in the top 100 of companies who invest most in research and development are five of the largest IT companies in the United states; Google, Oracle, qualcomm, Apple and Broadcom. These companies stand out because they have the best performances, with a high level of investment but also a high increase in net sale. The list of companies who achieved the best performances over the last ten years contains not a single European company. Nine of the fourteen companies on that list are American companies. These numbers confirm the absolute superiority of the United States in the case of research development investments by private companies. The European commission is aware of the problems, that is why the commission set the goal in the Horizon 2020 programme to make private investment in R&D more profitable. Findings should be

[67] European Commission, The 2013 EU Industrial R&D Scoreboard, 8.
[68] European Commission, The 2013 EU Industrial R&D Scoreboard, 8.
[69] European Commission, The 2013 EU Industrial R&D Scoreboard, 27.

faster translated to the market, and more cooperation between the EU and companies should boost investments in research and development.[70]

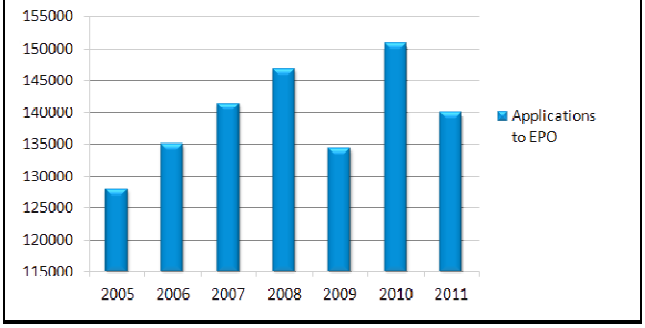
In the period that European industries struggle with their research and development investments, the domestic expenditure on R&D increases. In het beginning of the Lisbon strategy the gross domestic expenditure was 1.85% of GDP, this percentage increased to 2.03% in 2011. However, these figures distort because GDP decreased significantly after 2009. Basically the investments in research and development decreased less than the GDP, and some national governments used investment in R&D as a tool to counter the crisis. The result is that graph 3.3.5 shows an upward trend after 2009.

Graph 3.3.5. Gross domestic expenditure on R&D (R&D intensity), EU-27, 2000-2011 (% of GDP)[71]



What are the effects of these research and development investments? Like the above charts showed private investments have a different trend than government investment. But graph 3.3.6. shows that the trend of the private investments is a trend that is also visible in the patent output in the EU. Since 2008 is it possible to file a European patent at the EPO (European patent organisation), this is a patent that is valid for all EPO partners in Europe. The EPO applications are a good indicator for the output of the research and development investments. In 2009, when the crisis emerged, there is a direct drop in patent applications. In 2010 there is a rise in applications, but this is only temporarily because in 2011 the patents applications drop below its level of 2007. This trend is also visible in the private IT investment in that period, which confirms the theory that private investment has a greater influence on patent output then public investments.

Graph 3.3.6. Applications filed at EPO.[72]



[70] European commission, Horizon 2020, Information and communication technologies, http://ec.europa.eu/programmes/horizon2020/en/h2020-section/information-and-communication-technologies

[71] Eurostat online data code, http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&plugin=1&language=en&pcode=t2020_20.

[72] Norwegian industrial property office, annual report 2013.

3.4. Organizational structures

If a company wants to increase its productivity by investing in IT, they need more than only IT investments. In a company with a complementary organisational structure like decentralized decision making, IT management skills and specialized procedures the effects of IT investment will be more profitable than in comparison with a firm where this is not the case.[73] Organizational structures, "*involves how a firm is organized and governed, and how decision actually are made and carried out*".[74] The form of organization can be efficiency-based or institutional-based.[75] When a firm is efficiency-based the organization is designed with the goal to be as efficient as possible, the structure fits best with the goals and strategy of the company. A firm that has an institutional-based structure had external influences which affect the organizational structure. External factors can be legal factors, resources or social factors.

A company that operates with a structure that is based on efficiency will automatically be more successful in the implementation of IT investments. This has to do with the fact that everything is arranged in the holding, with the aim to be as efficient as possible. In contrast, a company that is institutional based is limited in its efficiency because there are factors that restrict the company. An example is a company which is situated in a country with a high level of protection of employees, with the result that is it more difficult for a company to fire and hire individuals. The consequence of the institutional design of a country is that the company may not be as efficient as possible. Besides it does not only affect the overall productivity but also the structure within an organization.

An institutional based organization will be troubled faster with a bureaucratic burden. Therefore institutional limitations to a company will lead to overall more bureaucratic companies. Mintzberg, a renowned management theorist, states that bureaucratic companies are like "machines" and like machines they produce a consistent result.[76] However, these companies are very limited in generating new ideas because the bureaucratic structure restricts the openness of a company. The bureaucratic company is organized strictly, every individual is divided in a department and is part of a bigger orderly scheme. This is the opposite of an innovation based company, where decentralized decision-making is the key to success. The structures within an innovation based company are therefore more unclear, which may lead to potential leadership conflicts but what also increases efficiency and innovation.

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[73] E. Brynjolfsson, L. Hitt, and S. Yang, Intangible assets: computers and organizational capital, in *Brooking papers on economic acticity: Marcroeconomics* 1, 191.
[74] R.R. Nelson, Why do firms differ, and how does it matter? In *strategic management journal* Issue 12, 61-74.
[75] S. Belenzon, P. Bolton and U. Tsolmon, the organization of innovation across countries and industries, 7.
[76] H. Mintzberg, Structure in fives: Designing effective organizations, 16.

Within the European Union and the United States there are wide varieties of different structured companies. Like described above, companies can be limited by external factors like government regulations, which may lead to different structured companies per country. However, the size of a company and the field of specialisation is also in important factor in the design of an organization. Generally it is possible to divide companies into three categories;[77]

- Conglomerates, a large multi-unit firm operation in several industries: Conglomerates are often divided in several divisions, who are legally connected to the conglomerate. Because divisions do not disclose an independent financial report and the possible intervention of headquarters can result in a weakened link between performances and reward. The distortion of incentives can lead to less innovation in the individual divisions. Because of the hierarchical structure it is easy to allocate resources between different divisions.
- Corporate groups, collection of legally independent firms who are linked by social ownership and under control of an ultimate owner: Overall corporate groups are more decentralized in comparison with conglomerates because the different divisions have legal independency. A division of a corporate group can therefore behave as an independent stand alone firm. Because corporate groups have a shared ownership, there is no strict hierarchy which makes the allocation of resources more rigid.
- Standalone firms, independent entities with no connection to other firms: The interaction with other firms is completely market based. This ownership structures gives the highest incentive for innovation, especially when the mangers hold shares of the firm. In their resources the standalone firm is dependent for external firms, and therefore more vulnerable for fluctuations in their environment. Standalone firms have the highest incentive for innovation but have more problems with raising capital for research and development. The effect of the constrain will increase when the environment has an inefficient labour market and when there is not a strong enforcement of property protection.

The IT market is a sector were innovation is a major important factor, the standalone firm is in that view a proper category because the incentive for innovation is the highest among the three. Nevertheless, the most successful IT companies are not stand alone firm, because the standalone firm has more difficulties to allocate resources and invest in research and development. The incentive of innovation is there, which can lead to great ideas, but the implementation of these innovative ideas is more difficult for a standalone firm. During the innovation convention Ann Mettler (Former the executive director of the Lisbon Council) explains the power of innovative standalone firms;

[77] S. Belenzon, P. Bolton and U. Tsolmon, the organization of innovation across countries and industries, 8-9.

"*Innovation is not just about new products, it can be about new processes, new business models, new ways of collaborating. It's a much more open understanding of innovation. I often describe it as a democratisation of innovation – it involves many more people, but with that comes more complexity. If you think, for instance, what has revolutionised telephony, Skype, which was originally an Estonian company, if you think about how we consume music, Spotify, which is a Swedish company, these have completely changed things. That's what I'm talking about, these are not companies that did heavy-duty R&D (research and development) in the traditional sense, but they have nonetheless led to seismic shifts in business models and consumer behaviour. It is important to understand that many of these disruptive innovations are driven by young companies, so not by big established incumbents. It's really new, entrepreneurial endeavours that are driving forward the disruptive innovation that we would like to see*".[78]

A standalone firm is however limited its resources to further develop an innovative idea. If a standalone firm has a new idea the idea has to be matched with the right persons and companies in the concept phase. When the idea is really innovate and not part of the conventional repertoire, the process of finding the right matching skills cannot be planned. The result is that a broad circulation of ideas is fundamental for the innovation process, without the circulation of ideas the right partners for the right idea will not be found. According to Saxenian the main reason why Silicon Valley is so successful with innovation is because of the open networking structure where ideas are shared.[79]

This brings us to the dilemma of sharing; Sharing of ideas is a great engine of innovation and will increase the change of success of a specific idea. However, sharing innovative ideas also can lead to stealing or sharing of the idea by third parties. Hellman concludes in his research that firms will automatically look for a natural symbiosis between these two areas of tension.[80] Companies will for example create controlled circulation of a certain idea were only a limited group has access, or set legal boundaries. Because of the fear that the concept idea will be taken over by another company, firm will naturally limit the process of innovation. The problem with concept ideas is that the idea is in an early process of development and can therefore not be protected by patents. The patent system of the United States is organized that an inventor is allowed to talk about his invention

[78] B. Deighton, Innovation convention interview: Europe needs a digital single market to stimulate innovation. http://horizon-magazine.eu/article/europe-needs-digital-single-market-stimulate-innovation-ann-mettler_en.html

[79] A.L. Saxenian, Regional Advantage: Culture and Competition in Silicon Valley and Route, in *Harvard Business School Press*, 128.

[80] T. Hellman, The circulation of ideas in firms and markets, in *Institutions and market* series, 34.

without loosing its patents rights for a year, in the European Union this is not the case.[81] Making an invention public in the European Union automatically ensures that the inventor looses the patents rights of the invention. So the incentive to share a concept idea with other parties is limited.

For a standalone firm it is very important that an economic environment has strong enforcement of property protection. The great strength of a standalone firm is the creation of ideas, to ensure the survival of the standalone firm these ideas need to be protected. Without the property protection the incentive of innovation will disappear.[82] So in order for a company to create innovation, there has to be legislation that also limited the process of innovation by property rights. In the legislation there has to be a fine balance between protections of property rights without disrupting the process of innovation too much. The ongoing lawsuits between Smartphone manufactures, which is called "the Smartphone wars", shows that this fine balance is difficult to find.

2009 was the start of the Smartphone war when Nokia started suing Apple over ten patents, as a respond Apple accused Nokia of stealing thirteen patents. It was the time when the Smartphone market was developing rapidly which leaded to a lot of new patents and developments. The quickly evolving market made it unclear who created certain ideas and concepts because the companies where via the global economy connected and influenced each other. Also worrying was the emerge of "patent-trolls", which are companies who only exist for creating patents without actually developing the idea. These companies use their patent to extort money from companies with legal treats.[83] The occurrence of the patent wars showed that the current systems of property protection is out dated and does not exceed the innovation process anymore but rather slows it down. In chapter 4 this paper will give a more comprehensive explanation about the current patent system and its effects.

The patent system is an external factor that can affect the innovation output of a certain firm. However, there are also internal aspects that play a role in the creation of innovation. Recent studies show that the effect of diversity within the workforce can have a positive effect on the market share and increase the change that a firm can capture a new market.[84] There are two types of diversity: Inherent and acquired. Inherent diversity is something were and individual is born with, such as gender, ethnicity and sexual orientation. Acquired diversity is diversity which a person gains by experience. Someone who is selling products to woman can gain experience and can get gender smarts for example. In order for a company to profit from their diverged workforce they need both

[81] Leahy-Smith America invents act, public law 112-29-Sept. 16, 2011. http://www.uspto.gov/aia_implementation/20110916-pub-l112-29.pdf

[82] N. Gallini and S. Scotchmer, Intellectual property: when is it the best incentive system?, in *Innovation policy and the economy*, Volume 2, 71.

[83] C. Cookson, Patent reforms aim to protect and encourage progress

[84] S.A. Hewlett, M. Marshall and L. Sherbin, How diversity can drive innovation in *Harvard business review*. https://hbr.org/2013/12/how-diversity-can-drive-innovation/ar/1

acquired and inherent diversity, which is called two-dimensional diversity. Companies with the right amount of diversity are 45% likelier to report that their firm's market share grew over the previous year and 70% likelier to report that the firm captured a new market.

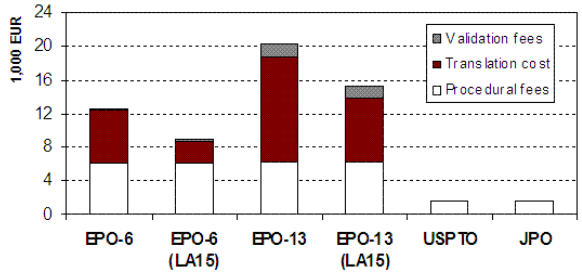
Chapter 4: Patents

What is the relation between a patent system and innovation? A patent is a direct stimulation of innovation, basically the world we know is built with patents and rest on them. Intellectual property (IP) is essential for economic wellbeing of a country. Ian Harvey explains through history how IP stimulates innovation:

"*History shows how IP has helped create today's world. Take James Watt, inventor of the steam engine. Of course, he was not the inventor of the steam engine – there had been many before him, ranging from Hero of Alexandria to Newcomen in Britain – but Watt invented the first economically viable steam engine. And even though he invented and patented it, he couldn't make it work. His first backer, John Roebuck, was bankrupted because of all the money he poured into Watt's unworkable engine. It was the "angel" investor Matthew Boulton who persuaded Watt to extend his patent life from 14 to 30 years through Act of Parliament. Only then was Boulton prepared to fund the invention that, technically "perfected" three years later, soon initiated the steam age. Few people know the central role that Watt's patent played in triggering the Industrial Revolution*".[85]

In 1973 the European Patent convention was signed in Munich, which laid the framework of harmonizing the national patent system in the European Union. The convention leaded to the establishment of the European patent office but not to a European patent system because the holders still had to register on national level. In comparison with the United States the European Union has an expensive and inefficient patent system because the system is not unified.

Graph 3.4.1. The London agreements cost reduction.[1]



"*A well-known drawback of the European patent system is the prohibitive cost of protection. Beyond its legal complexity, the fragmented patent system is costly. In contrast to other large regional or national patent offices in the world, payment of national validation and renewal fees and the frequent translation requirements must be multiplied by the number of countries where the applicant*

[85] I. Harvey, Do intellectual property rights stimulate or threaten innovation? In *Europe's World.* http://europesworld.org/2014/06/11/do-intellectual-property-rights-stimulate-or-threaten-innovation/#.VGJeTsmiAlU

wants her patent enforced. This makes European patents at least five times more expensive than those in the US".[86]

Graph 3.4.1 illustrates that the costs of patents in Europe are considerable higher then in comparison with the USA (USPTO) and Japan (JPO). EPO-6 is the patents costs for Switzerland, Germany, France, Italy, The Netherlands, and the UK. EPO-13 covers Austria, Belgium, Switzerland, Denmark, Germany, Spain, Ireland, Finland, France, Italy, The Netherlands, Sweden and the UK. The 15-state London agreement (LA15), which was a patent agreement in London in the year 2000, caused a slight decrease in costs of a European patent. In the 15-state London agreement fifteen countries agreed that patents only had to be translated in an official language; English, French or German. Before this agreements it was required that every patent was translated into the official language of every European country, otherwise "*the European patent shall be deemed to be void ab initio in that State*".[87] So the 15-state London agreement was a first step in the reduction of patent costs, however with only 15 European member states that participated the actually decrease in costs was limited.

The complexity of the European patent system prevented the emerging of patent-trolls so far, mainly because of the high level of procedural fees. It was not only expensive to request a patent, but also to maintain its validity. In the United States the overall price of a patent is much lower and is part of an old unified functioning system, which made it easier for patent-trolls to operate. It was necessary for the White House to create legislation which made it harder for the patent-trolls to enforce action in court. With a unified European patent system on the way, patent-trolls can also become a problem in the European Union in the future.

Basically the complex patent system in the European Union affects the innovation process on three different levels;[88]

- The antitrust or competition authorities are organized on European level, while the intellectual property policy is run on national level. Europe has a fragmented system with central leadership, which may lead to a lot of misconceptions.
- A producer has to protect its product from infringement, in the case of the European Union this protection can go through 34 different national courts. Because patents are national organised it will costs the producer a lot of time and money to work all the different systems.

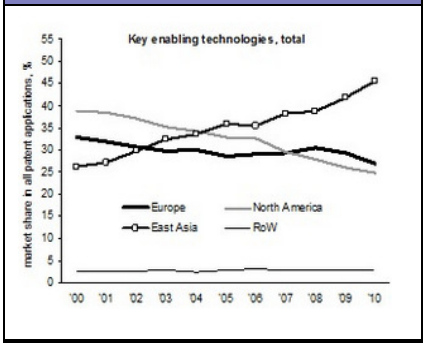
[86] B. van Pottelsberghe de la Potterie and M. Mejer, Beyond the prohibitive cost of patent protection in Europe. http://www.voxeu.org/article/europe-s-costly-fragmented-patent-system
[87] The European patent convention, artikel 65. http://www.epo.org/law-practice/legal-texts/html/epc/2013/e/ar65.html
[88] B. van Pottelsberghe de la Potterie and M. Mejer, Beyond the prohibitive cost of patent protection in Europe. http://www.voxeu.org/article/europe-s-costly-fragmented-patent-system

- The European patent system has a big time paradox, in the system it can take three years for third parties to challenge the patent. This was for example the case with Senseo coffee pads competitors, these companies had to pay infringement fees while the patent would later be held invalid.

For the last 40 years attempts have been made to construct a European Patent System which is no longer based on national institutions. In 2012 the EU signed the agreement which enables the EPO (European patent office) to grant a single unitary patent. The UPC (Unified patent court) was introduced as the new institution for the enforcement of the European patent. However, the unified European patent is only valid when all the members of the European Union have ratified the agreement. The goal was to have a unified patent system available from January 2014, but this deadline is already exceeded.

European firms have an evident disadvantage compared to firms in the United States because of the higher costs for patents. This is especially the case for the stand alone firms, the firms with the highest incentive for innovation but with relatively less resources then bigger multinationals. The inefficient patent system of the European Union can slow the innovation process down considerable. The competitiveness report of the European Commission shows that the European Union has a decrease in patent applications since 2008 (see graph 3.4.2.). However this decline is considerably larger in the United States, where since 2006 patent applications are fewer. The decline in patents application in the United Sates is caused by the changing attitude within USPTO (United States Patent and Trademark Office). From the nineties the USPTO always had a very high level of approved applications rates; in 2001 this was almost 100%. The emerging of the patent-trolls and its effects on innovation changed the attitude of the USPTO towards approving patents. The more critical attitude of the USPTO made it more difficult to get a patent approved, a completed application had to meet certain standards and therefore cost more time and energy to fill in.[90] The result was less applications from patent-trolls but also a relatively overall decline in patent applications.

Graph 3.4.2. Shares of patent applications in Europe and other countries.[89]



[89] European Commission, Competitiveness report 2013: no growth and jobs without industry. http://europa.eu/rapid/press-release_MEMO-13-815_en.htm

[90] U.S. patent and trademark office, U.S. Patent Statistics Chart Calendar Years 1963 - 2013 http://www.uspto.gov/web/offices/ac/ido/oeip/taf/us_stat.htm

The explanation of the declining patents applications of the United Sates shows that patent output is not the same as innovation and job creation. A high number of patent outputs by certain patent-trolls can even limit the innovation process. The European commission states the following about this:

"*It is widely accepted that Europe does not lag behind the US in terms of scientific excellence. For example, in the sector of key enabling technologies, European patent applications are increasing year to year and the share of European applications remains relatively stable. But knowledge production is not synonymous with job creation and growth. In order to turn patents into marketable products based on key enabling technologies, manufacturers need to be ideally positioned in terms of the technology content of their products and in relation to the competition they face on the global market*".[91]

[91] European Commission, Competitiveness report 2013: no growth and jobs without industry. http://europa.eu/rapid/press-release_MEMO-13-815_en.htm

Chapter 5: the divergences between member states

In 2004 the European Union had the largest enlargement in the short period of its existence. This "big bang" changed the European Union fundamentally because it would ensure that the differences between the economies of various members were larger than before. To overcome these differences the European Commission investigated what the potential of IT development could be. The conclusion of the report was that IT could play a major role in improving the productivity in Central and Eastern European countries (CEE) in comparison with the EU15 and the United States.[93] The research also has the not to startling conclusion that intensive use of IT could lead to faster productivity growth. Interesting was however the conclusion that the use of IT does not have the same effect on every member states. Between 1995-2001 IT contributed to a narrowing of the income gap between five leading CEE countries and the older member state. But, for countries like Bulgaria and Romania IT caused an opposite effect by widening the income gap.

Because IT development had different effects on the various member states, it is important to look at the multiple indicators in the economies of these member states. Van Ark and Piatkowski investigate the economies of the European member states by looking at the new economy indicators. These indicators consists of; Regulations and law enforcement, infrastructure, trade openness, financial system, R&D spending, human capital, labour market flexibility, product market flexibility, openness of foreign investment and macroeconomic stability.[94] These new economic indicators give an impression how economic policy can contribute to growth of the "new economy". The findings of van Ark and Piatkowski show that in member states where these new economic indicators are well developed, IT development leads to more productivity growth. This is the case with countries like

Table 4.1. The New economy Indicator: values for the CEE countries, EU-15 and the US, 1995-2001 average. [92]

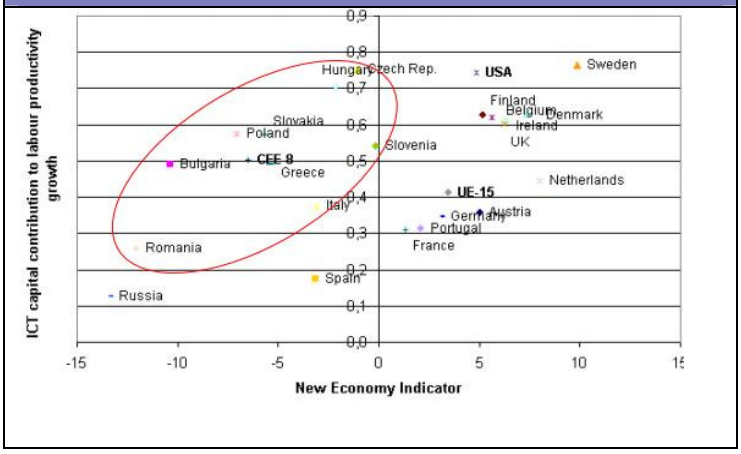
Country	Rank	Value 1995-2001	Regulations and law enforcement	Infrastructure	Trade openess	Financial system	R&D spending	Human Capital	Labor marker flexibility	Product market flexibility	Openness to foreign investment	Macroeconomic stability
Sweden	1	9,882	0,818	1,724	- 0,067	0,541	2,273	1,884	0,334	0,641	1,257	0,476
Netherlands	2	8,001	1,035	0,765	0,975	1,197	0,513	- 0,195	1,099	0,641	1,600	0,370
Denmark	3	7,331	0,914	1,439	- 0,278	- 0,217	0,614	2,453	0,898	0,641	0,462	0,404
Ireland	5	6,343	0,830	0,300	2,102	0,554	- 0,262	- 0,213	0,245	1,240	1,228	0,318
UK	4	6,210	0,977	0,710	- 0,716	1,395	0,393	- 0,403	0,634	1,539	1,283	0,397
Belgium	6	5,624	0,254	0,257	1,843	0,253	0,467	0,810	0,161	0,142	1,006	0,430
Finland	9	5,162	1,109	1,268	- 0,355	- 0,271	1,544	1,048	- 0,687	0,342	0,744	0,420
Austria	8	5,021	1,108	0,439	0,163	0,840	0,283	0,643	1,095	0,641	- 0,625	0,433
USA	7	4,857	0,754	1,260	- 1,615	1,510	1,201	- 0,239	1,098	1,040	- 0,540	0,387
Germany	10	3,105	0,720	0,526	- 0,708	1,166	0,928	- 0,416	0,120	0,641	- 0,319	0,446
Portugal	11	2,076	0,215	- 0,187	- 0,347	0,854	- 0,860	0,422	0,902	0,342	0,390	0,345
France	12	1,340	0,160	0,410	- 0,929	0,439	0,784	0,659	- 0,509	- 0,057	- 0,083	0,466
Slovenia	13	- 0,180	- 0,406	- 0,243	0,925	- 0,865	- 0,054	0,540	0,445	0,442	- 0,930	- 0,034
Czech Republic	14	- 1,060	- 0,482	- 0,714	1,148	- 0,043	- 0,309	- 0,485	0,711	- 0,856	- 0,218	0,187
Hungary	15	- 2,163	- 0,202	- 0,880	0,483	- 1,029	- 0,792	- 0,331	0,295	0,442	0,085	- 0,233
Italy	17	- 3,102	- 0,273	0,199	- 0,890	- 0,072	- 0,468	- 0,298	- 0,488	- 0,257	- 0,942	0,386
Spain	16	- 3,141	0,244	- 0,282	- 0,797	0,477	- 0,647	- 0,499	- 2,182	0,442	- 0,255	0,358
Greece	18	- 5,399	- 0,382	- 0,117	- 0,936	- 0,527	- 0,946	- 1,409	- 0,240	- 0,157	- 0,975	0,290
Slovakia	19	- 5,670	- 1,051	- 1,060	1,306	- 0,857	- 0,717	- 0,531	- 1,323	- 0,856	- 0,593	0,012
Poland	20	- 7,042	- 0,674	- 1,352	- 0,707	- 1,212	- 0,828	0,107	- 0,616	- 1,255	- 0,405	- 0,099
Bulgaria	21	- 10,372	- 1,355	- 1,197	0,611	- 1,284	- 0,319	- 1,427	- 1,470	- 1,913	- 0,500	- 1,517
Romania	22	- 12,063	- 1,670	- 1,653	- 0,504	- 1,438	- 1,025	- 1,388	0,482	- 1,913	- 0,763	- 2,191

[92] B. van Ark and M. Piatkowski, Productivity, Innovation and IT in Old and New Europe' in *Research Memorandum GD-69, Groningen Growth and Development Center*, March 2004, 38.
[93] European Commission, The potential of IT for the development of economic restructuring of the new EU member states and candidate countries, 3.
[94] B. van Ark and M. Piatkowski, Productivity, Innovation and IT in Old and New Europe' in *Research Memorandum GD-69, Groningen Growth and Development Center*, March 2004, 38.

Sweden, The Netherlands and Denmark. However, countries like Romania, Bulgaria and Poland score between 1995-2001 low on the indicators of the new economy, therefore investment in IT in these countries did not have the same effect, explaining the IT diffusion among member states.

In Figure 4.1. is displayed how the ratios between IT capital contribution to labour productivity growth and the new economy indicator are. Like the figure shows, there are also countries, like for example Spain, who score not bad on the new economy indicator scale but have considerable low IT capital contribution to labour productivity growth. Just like there are countries like Hungary and the Czech Republic who score average on the new economy indicator scale but where IT capital has a big contribution to labour productivity growth. So development of the IT sector without sufficient developed new economy indicators as environment is possible. However, countries who score low on the new economy indicator develop the IT's less in a sector like services. More IT in the service sector is one of the big beneficiaries of increasing IT investment, because it can lead to faster economic growth, more factor productivity growth and an increasing growth in labour productivity.[96] In order for the CEE countries to converge with the older member states in the future, the development of these new economy indicators is important.

Graph 4.1. Relationship between the IT capital contribution to labour productivity growth and the value of the "new economy indicators" between 1995-2001 average.[95]



The example of the IT development of Ireland and Costa Rica show the importance of the development of the new economy indicators. Ireland was a country that position itself as the ideal country to establish foreign IT firms because Ireland would be the perfect European base. The Irish government wanted more IT investments and set therefore the taxes for IT companies on 12,5% (the lowest rate in the EU).[97] The result was the especially American companies found Ireland, which boosted the Irish IT sector. The core of this success was the high development of human capital in Ireland, which made it possible for the local firms to adapt and specialise in specific sectors so that

[95] B. van Ark and M. Piatkowski, Productivity, Innovation and IT in Old and New Europe' in *Research Memorandum GD-69, Groningen Growth and Development Center*, March 2004, 25.
[96] D.W. Jorgenson, Information Technology and the U.S. Economy in *American Economic Review*, vol. 91, no.1, 7.
[97] IT and its role in T&T's economic diversification: The national innovation system, 2. http://www.planning.gov.tt/sites/default/files/content/mediacentre/speeches/IT%20and%20its%20role%20in%20T.pdf

they were not pushed out by foreign companies. In Costa Rica the software development was also an important driver of economic growth, however the effects of foreign investments had a different result in that country. Just like Ireland Costa Rica started to encouraging FDI, but the foreign firms brought the small local software companies in trouble.

The country did not have the high skilled labour force like Ireland, and because of the expansion of the IT sector the demand for software engineers rose. This resulted in the rise of wages for software engineers, which forced small companies this rise their wages also. The relatively small size of Costa Rica's national pool of software engineers contributed to the negative effects of FDI's entry into the industry.[100] That is why the European commission states that "*industrial policy has to be attentive to the different needs of countries and regions at different levels of economic development*".[101]

Figure 4.1.1. Regional innovation performance groups (RIS 2014).[99]

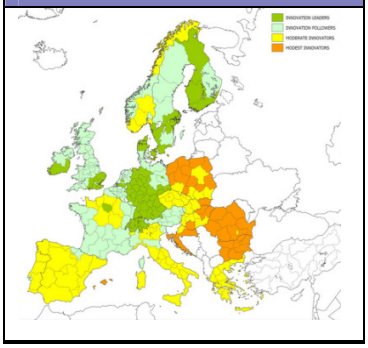
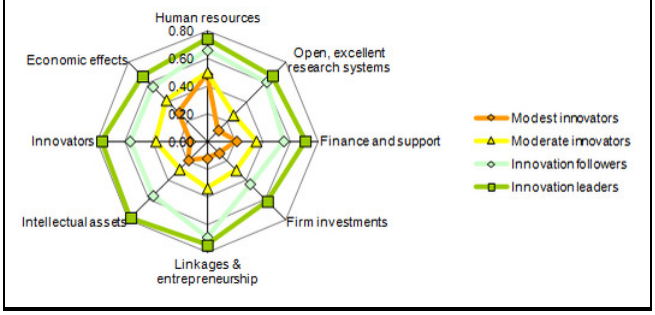


Figure 4.1.1. shows the countries within the four different innovation performances groups of the regional innovation scoreboard of the European Commission; the green countries are the innovation leaders, the light green group are the innovation followers. Followed by the yellow group, the moderate innovators. The Orange group are the modest innovators, this group shows the least innovation.

What have innovation leader member states in common? All these countries score high on all the performances dimensions of the European scoreboard. The European commission concludes the following in relation with the external innovation leaders:

Graph 4.1.2. Country groups: innovation performance per dimension.[98]



"*The top innovation leaders US, Japan and South Korea are particularly dominating the EU in indicators capturing business activity as measured by R&D expenditures in the business sector, Public-private co-publications and PCT patents*[102] *but also in*

[98] European Commission, Innovation performance: EU member states, international competitors and European regions compared. http://europa.eu/rapid/press-release_MEMO-14-140_en.htm
[99] European Commission, Innovation performance: EU member states, international competitors and European regions compared. http://europa.eu/rapid/press-release_MEMO-14-140_en.htm
[100] IT and its role in T&T's economic diversification: The national innovation system, 3. http://www.planning.gov.tt/sites/default/files/content/mediacentre/speeches/IT%20and%20its%20role%20in%20T.pdf
[101] European Commission, Competitiveness report 2013: no growth and jobs without industry. http://europa.eu/rapid/press-release_MEMO-13-815_en.htm
[102] A PTC patent is a patent filed under the international patent law treaty, an international application.

educational attainment as measured by the Share of population having completed tertiary education".[103]

[103] European Commission, Innovation performance: EU member states, international competitors and European regions compared. http://europa.eu/rapid/press-release_MEMO-14-140_en.htm

Chapter 6: What should the EU do?

What is the right policy for the European Union to have a positive influence on the IT development? From 2007 till 2013 the European Union had the Competitiveness and Innovation Framework Programme (CIP) which divided in three sub programmes; The Entrepreneurship and Innovation Programme (EIP), the Information Communication Technologies Policy Support Programme (IT-PSP) and the Intelligent Energy Europe Programme (IEE). The goal of the IT-PSP was to improve the environment for developing IT based services and reduce the barriers like lack of interoperability and market fragmentation.[104] The programme ended in 2013 and was followed-up by the EU programme for the Competitiveness of Enterprises and Small and Medium-sized Enterprises (COSME) which started in 2014 and will end in 2020. 2,3 billion euro is reserved for the coming years to support better access to finance small and medium-sized enterprises, to support entrepreneurs, improve the market access and enhance the conditions for business creation and growth.[105] With these goals the European Commission acknowledges that the small and medium-sized enterprises are important to create innovation. The goal of COSME is to lightening the administration burden of these companies, by for example simplifying of start-up procedures.

With the Europe 2020 initiative there was also the launch of the digital agenda in 2012 which set out 13 specific goals;[106]

- The entire EU to be covered by broadband by 2013.
- The entire EU to be covered by broadband above 30 Mbps by 2020
- 50 % of the EU to subscribe to broadband above100 Mbps by 2020
- 50 % of the population to buy online by 2015
- 20 % of the population to buy online cross-border by 2015
- 33 % of SMEs to make online sales/purchases by 2015
- The difference between roaming and national tariffs to approach zero by 2015
- To increase regular internet usage from 60 % to 75 % by 2015, and from 41 % to 60 % among disadvantaged people.
- To halve the proportion of the population that has never used the internet from 30 % to 15 % by 2015
- 50 % of citizens to use eGovernment by 2015, with more than half returning completed forms

[104] European Commission, Information and Communication Technologies Policy Support Programme (IT-PSP). http://ec.europa.eu/cip/IT-psp/index_en.htm
[105] European Commission, COSME. http://ec.europa.eu/enterprise/initiatives/cosme/index_en.htm
[106] European commission, Digital agenda: about our goals. http://ec.europa.eu/digital-agenda/about-our-goals

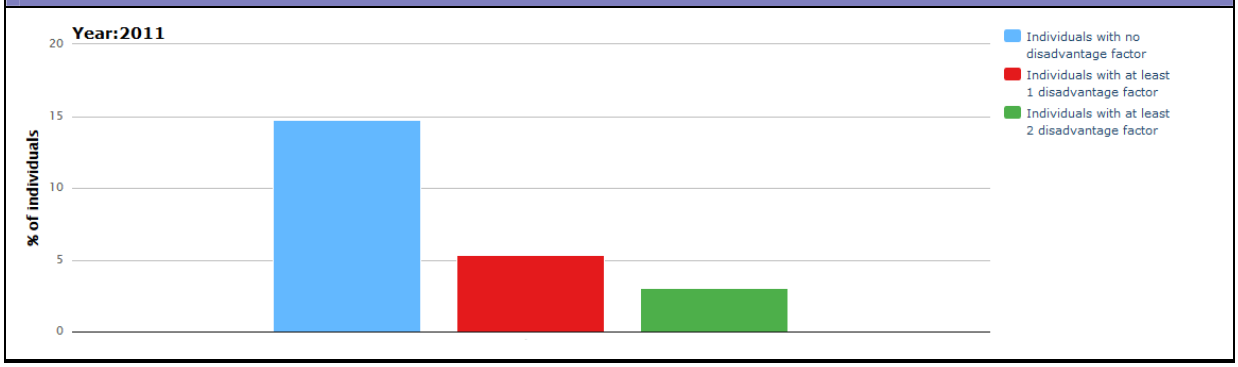
- All key cross-border public services, to be agreed by Member States in 2011, to be available online by 2015
- To double public investment in IT R&D to € 11 billion by 2020
- To reduce energy use of lighting by 20% by 2020

Within the digital agenda there are seven main pillars where this paper will focus on.

6.1. Digital single market

One of the goals of the digital agenda is to update the EU single market rules for the digital era, because many online services are blocked by national borders. The goal is to boost the music download business, establish a single area for online payments, and further protect EU consumers in cyberspace.[107] One of the great examples of services that were blocked by national borders was the abnormal high costs of roaming, in the 2020 Agenda difference between roaming and national tariffs have to be zero by 2015.

6.1.1 Individuals ordering goods or services online, from sellers from other EU countries, by disadvantage factors.[108]



Graph 6.1.1 shows that disadvantage factors influence the percentage of individuals who order online from seller outside their own country. With disadvantage factors is meant; 55 to 74 years old; low education; unemployed or inactive or retired. From the individuals with no disadvantage factors 15% orders goods or services online from another EU country.

Right now the European Union has over 100 telecommunication companies, while the United States has only four or five big companies.[109] The numerous companies in the EU show that there is

[107] European commission, Digital agenda for Europe: Pillar I: Digital Single Market. https://ec.europa.eu/digital-agenda/en/our-goals/pillar-i-digital-single-market
[108] European commission, digital agenda scoreboard December 2011.
[109] B. Deighton, Innovation convention interview: Europe needs a digital single market to stimulate innovation. http://horizon-magazine.eu/article/europe-needs-digital-single-market-stimulate-innovation-ann-mettler_en.html

still not a digital single market in Europe. The integrated market that the EU has for goods is not the case with digital services and products. There are still too many small players who cannot compete on a global level.

6.2. Interoperability and standards

In this digital era interoperability is becoming more important, different devices and applications are working together anywhere in the world. How can the European Commission improve interoperability? By setting and improving standard settings for new applications, devices, data repositories and services. This second pillar of the digital agenda set out standard frameworks and worked together with national governments to improve the interoperability. A specific example is the adoption of the Malmö declaration (which promotes EU public administrations to address open standard to ease the path for the new products) and the Granada declaration (encouraging the development of more efficient interoperable public services that promotes the re-use of public sector information).[110]

6.3. Trust and security

Trust and security is a major problem with online transactions, only 12% of the internet users feels completely safe making online transactions.[111] Because cyber-crime in not limited to national borders a European approach is important in tackling the cyber criminals. However, improving the security is contested on two sides: making the web-user more aware of the dangers and combating cyber criminals. Over the past years the European Commission cooperated with the national governments by setting up alert platforms and simulation cyber-attacks in an attempt to make the user more aware of the dangers. On European level the commission did set up network and information security policy and modernise the European Network and Information Security Agency (ENISA).[112]

6.4. Fast and ultra-fast internet access

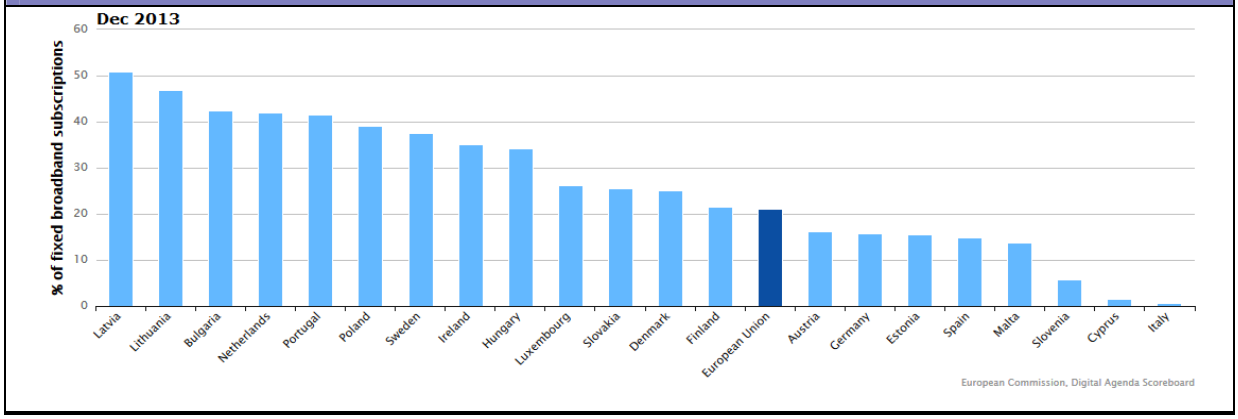
[110] European commission, digital agenda for Europe: Pillar II: Interoperability and standards. https://ec.europa.eu/digital-agenda/en/pillar-ii-interoperability-standards/action-27-member-states-implement-malmo-and-granada

[111] European commission, digital agenda for Europe: Pillar III: Trust and security https://ec.europa.eu/digital-agenda/en/our-goals/pillar-iii-trust-security

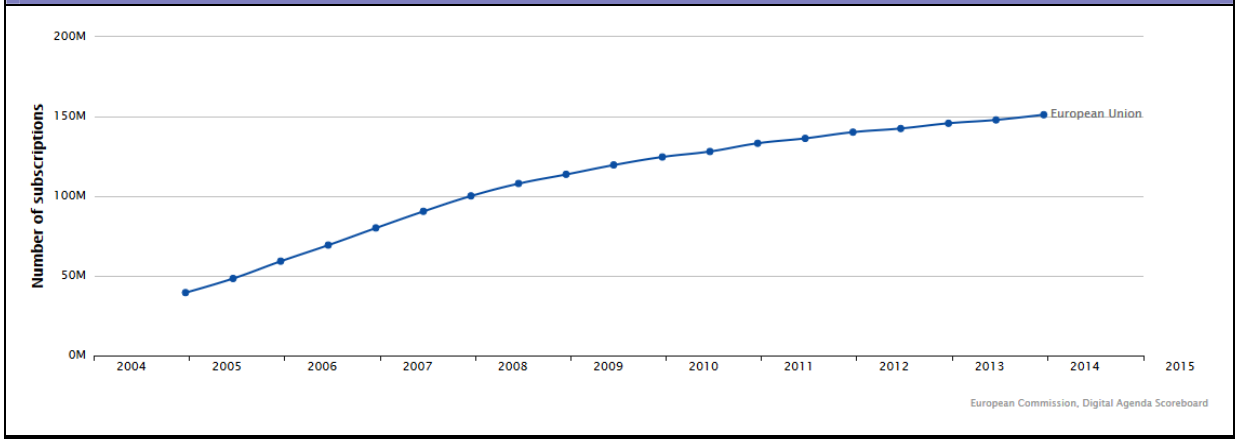
[112] European commission, digital agenda for Europe: Pillar III: Trust and security https://ec.europa.eu/digital-agenda/en/pillar-iii-trust-security/action-28-reinforced-network-and-information-security-policy

Having no access to ultra-fast internet connection can limit the availability of new services like high definition television or videoconferencing. The goal is therefore to get "*rates of 30 Mbps for all of its citizens and at least 50% of European households subscribing to internet connections above 100 Mbps by 2020*".[113] The European commission tries to achieve this goal by encouraging of national governments to develop national broadband plans, arrange funding for high speed internet etc.

Graph 6.4.1. Share of fixed broadband subscriptions > = 30 Mbps – advertised download speed.[114]



Graph 6.4.2. Fixed broadband subscriptions 2004-2014.[115]



Graph 6.4.2. shows that the fixed broadband subscriptions are rising between 2004 and 2014. This growth takes place in the less developed European member states, because these countries have growth possibilities. Countries like Sweden and the Netherlands do not grow in their fixed broadband subscriptions because these countries have already a fully developed fixed broadband. Graph 6.4.1. gives an overview of the countries with an internet speed higher than 30 Mbps. Striking is the fact that the countries with the highest speed are former communist countries like Latvia, Lithuania and Bulgaria. An explanation for this could be the `Law of the handicap of a head start`, which is a theory which suggest that getting the head start in a certain area may be a disadvantage in the long run.

[113] European commission, digital agenda for Europe: Pillar IV: Fast and ultra-fast internet access https://ec.europa.eu/digital-agenda/en/our-goals/pillar-iv-fast-and-ultra-fast-internet-access
[114] European commission, digital agenda scoreboard December 2013.
[115] European commission, digital agenda scoreboard December 2014.

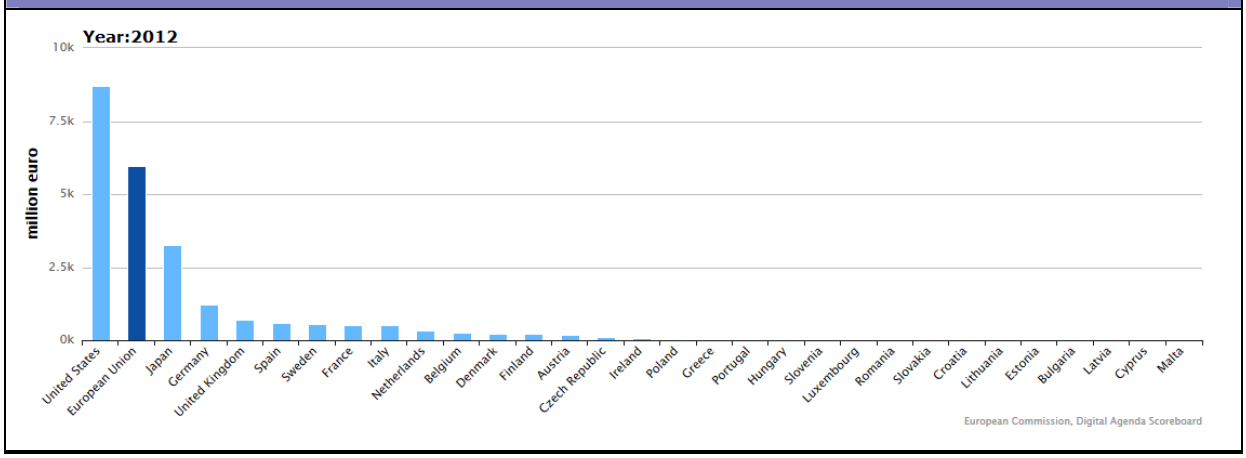
Countries with already an extensive network of fixed broadband have a disadvantage because they have to replace or adapt their network, while countries with no fixed broadband at all can go for the most effective and fast solution.

The European Union is lagging behind in mobile and a fast internet speed. The targets that are set on the 2020 agenda are far from reaching. Can you expect a successful digital economy which is built on a poor infrastructure? In order for the EU to get fast broadband there needs to be invested for around 200 billion euro. The European commission tried to get an investment of 9.2 billion to expand the network but this plan was degraded by less than a 1 billion by the council.[116] The digital infrastructure is a key element in the development of the digital economy, and should therefore be a priority for the national governments.

6.5. Research and innovation

In the fifth pillar the agenda 2020 acknowledge that the research and development investment are lower in the European Union then in the United States. Their goal is to increase funding but also to improve the coordination and bundle the fragmented efforts together.[118] The increase in funding is attempted by encouraging national governments to rise public spending on research and development and to motive more private spending on research and development on IT research and development. The European commission acknowledges that "*the lack of investment in IT R&D is a*

Graph 6.5.1. Public IT spending in the field of IT.[117]



[116] B. Deighton, Innovation convention interview: Europe needs a digital single market to stimulate innovation. http://horizon-magazine.eu/article/europe-needs-digital-single-market-stimulate-innovation-ann-mettler_en.html

[117] European commission, digital agenda scoreboard 2012.

[118] European commission, digital agenda for Europe: Pillar V: Research and innovation. https://ec.europa.eu/digital-agenda/en/our-goals/pillar-v-research-and-innovation

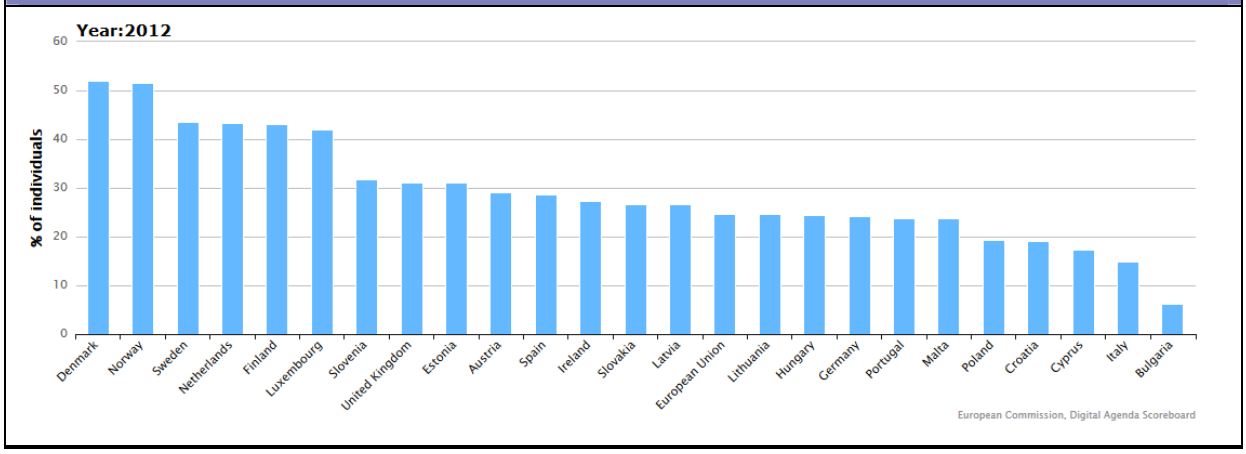
threat to the entire European manufacturing and service sectors".[119] To increase the public spending on research and innovation the commission has the following plans;

- Increase the use of pre-commercial procurement, this is a tool to share the risks of prototyping and testing of new products and services with suppliers and designing.
- Encourage public-private partnership, with this tool the public investments can stimulate the private investors to participate.
- Provide attractive conditions for investors who want to invest in small to medium sized firms.
- Make more us of the regional and structural funds for IT development.

Graph 6.5.1. illustrates that the public IT spending in the field of IT is in 2012 still considerable lower than that of the United States. Especially the governments of former communist countries invest little in the IT.

6.6. Enhancing digital literacy, skills and inclusion

Graph 6.6.1. Digital skills indicator, digital skill level above basic.[120]



[119] European commission, digital agenda for Europe: Pillar V: Research and innovation. https://ec.europa.eu/digital-agenda/en/pillar-v-research-and-innovation/action-50-leverage-more-private-investment-IT-research-and

In a society where technology plays an important role, there is a risk that people without digital skills are shut out from certain areas of society. In the European Union 30% of the population never used internet before, especially disabled people face extra difficulties.[121] At first sight this pillar does not have a big influence on innovation, however it can stimulate the diversity within the IT sector. Recent studies have found a relation between diversity within a company and expanding of the market share and even capturing a new market.[122] Graph 6.6.1. shows the digital skill indicator for the year 2012 per country. The Scandinavian countries together with the Benelux show a high level of digital skills throughout the population.

6.7. IT-enabled benefits for EU society

IT can have positive benefits for the society as a whole. IT can connect people and tackle social problems, reduce energy consumption, support ageing citizens their lives etc.[123] There is a big social aspect in this last pillar of the digital agenda, however this pillar has a minimal contribution in generating innovation.

These seven Pillars are the fundamental goals of the digital agenda for 2020. According to King the main goal of the 2020 agenda is to generate smart growth, the smart growth pillar is the driver of the entire strategy and is focussing on innovation and education.[124] If the commission can succeed in this goal then the other pillars will follow, because it will set Europe back on a growth trajectory. If the EU wants to develop a digital economy innovation and research and development investments should be the top priority.

The digital agenda is not the only field where the European Union is involved and affects the innovation process of high-tech firms. The two most important fields are the competition laws and the property rights. The problem with competition law is that it tries to eliminate monopolies within certain markets. The goal with this elimination is to improve the competiveness of the market. However, especially high-tech firms profit from a temporary monopoly when they created a new market. If this temporary monopoly is contested the incentive for research and development investment will decrease, because the dominant position in the new market and the associated

[120] European commission, digital agenda scoreboard 2012.
[121] European commission, digital agenda for Europe: Pillar VI: Enhancing digital literacy, skills and inclusion. https://ec.europa.eu/digital-agenda/en/our-goals/pillar-vi-enhancing-digital-literacy-skills-and-inclusion
[122] S.A. Hewlett, M. Marshall and L. Sherbin, How diversity can drive innovation in *Harvard business review*. https://hbr.org/2013/12/how-diversity-can-drive-innovation/ar/1
[123] European commission, digital agenda for Europe: Pillar VII: IT-enabled benefits for EU society. https://ec.europa.eu/digital-agenda/en/our-goals/pillar-vii-IT-enabled-benefits-eu-society
[124] C. King, Mental Models and the Europe 2020 Strategy: Neo-schumpetarian Ideas in Innovation and Education, 7.

profits justify the heavy investments in R&D.[125] The competition law of the European Union can increase the competiveness in a market but may cause less innovation overall. European competition laws have been adapted over the past decades, but the commission its approach towards dominant firms did not really evolve. Article 82 of the EC treaty states that "*Any abuse by one or more undertakings of a dominant position within the common market or in a substantial part of it shall be prohibited as incompatible with the common market insofar as it may affect trade between Member States*".[126] This means that certain strategies are unlawful for firms with a dominant position, while firms who do not have a dominant position are allowed to use this strategy.

The European commission has an interpretation of article 82 whereby a domination position, which means 50% or more of the market share, can never be in the interest of the consumer. This interpretation does not take the role of temporary market power and its influence on innovation into account. The problem with the IT market is that firms often cannot help it to get a dominant position in a market, because they create the market by innovating. This dominant position is short-lived in the IT sector, because rival companies will quickly jump in the new market and compete with the dominant firm. The temporarily dominant position of the firm is not a sign that the competition is not working, but a reward for the investment in research and development of that firm.

In 2004 the European commission imposed a record fine on Microsoft because according to the commission, Microsoft did not give its competitors enough information about their operating system Windows. Microsoft was forced to share information with its competitors so that they could build programmes which would run smoothly on windows.[127] The US Association for Competitive Technology responded on the fine by stating that Microsoft was punched by the EU for being successful and by forcing Microsoft to share its information with competitors the commission would stunt innovation.[128] Especially the part were Microsoft had to share its intellectual property is problematic, because it implies that successful firms with a dominant position should share their intellectual property. In the IT sector firms compete with each other by investing in research and development, if these companies are forced to share this information they will stop with their research programmes.

[125] S. Tilford, Is EU competition policy an obstacle to innovation and growth?, 1. http://www.cer.org.uk/sites/default/files/publications/attachments/pdf/2011/essay_competition_st_20nov08-1359.pdf
[126] Article 82 of the EC Treaty
[127] Commission Decision of 24 May 2004 relating to a proceeding pursuant to Article 82 of the EC Treaty and Article 54 of the EEA Agreement against Microsoft Corporation (Case COMP/C-3/37.792 — Microsoft).
[128] S. Tilford, Is EU competition policy an obstacle to innovation and growth?, 5. http://www.cer.org.uk/sites/default/files/publications/attachments/pdf/2011/essay_competition_st_20nov08-1359.pdf

With the 2020 agenda the EU wants more public investment in research and development, but how can this goal correspond with the current competition law? If the European commission wants more private investments in the IT sector it will have to acknowledge that the nature of the IT market is not comparable with that of mature industries. A dominant position in the IT market is not the same as a dominant position of a firm in the Tabaco industry for example. The punishment of dominant positions in the IT market will inhibit innovation and will directly affect the private investment on research and development. The current position is that only firms from the United States were able to establish a dominant position in IT markets in the European Union. In the United States there is less emphasis on the dominant position of firms but rather on the patent misuse.

Like explained in chapter 4 patents can stimulate innovation, if the patent system is working properly. In 1990 South Korea implemented a full and strong patent law. This was the same year when the company Samsung started to invest huge amount of money in their research and development department.[129] The implementation of the patents law in South Korea gave a boost to innovation. Both the European Union and the United States have a problem with their patent systems on the moment. In the USA many poor patents have been granted which leaded to misuse of these patents. However, the USA remains faithful to a strong patent framework. In the European Union the problem is the inefficient national framework for patent edition. Europe does not have the same affection towards patents as the United States. The core idea that patents create innovation is not rooted in Europe as it is in the USA. With the creation of a single EU patent and a Unified patent court the EU needs to set strong standards for patent laws. Intellectual protection is fundamental if the EU wants to evolve from an innovation follower to an innovation leader. Besides strong laws it is also important to have a strict policy in the granting patents, to prevent the emerging of patent-trolls.

[129] I. Harvey, Do intellectual property rights stimulate or threaten innovation? In *Europe's World.* http://europesworld.org/2014/06/11/do-intellectual-property-rights-stimulate-or-threaten-innovation/#.VGJeTsmiAlU

Conclusion

The question this paper wants to answer is: Why is the European Union lagging behind the United States in the development of the IT market? The problems of the European IT market takes place at multiple levels. Development of the IT sector can have positive effects on the overall efficiency of an economy. In the European Union there are some member states with a high developed information society, but the average development is considerable lower than that of the United States.

From 1995 the productivity gap between the United States and the European Union emerged. This gap was mainly caused by the fact that Europe was lagging behind in the development of the IT sector. In the seventies it seemed that Europe was working on a comeback. However, the development of the welfare state in Europe had as a consequence that the balance between work and leisure was filled in differently than in the United States. The hours that people worked decreased which slowed down the productivity growth. The dominant idea in the scientific discussion is that a lack of IT investment is at the root of the productivity gap. The focus on research and development investments is understandable but R&D investments are not the only cause of the lagging position of Europe. There are other factors that also play a major role in the development of IT's, like the structure of a society.

The United States has a higher quality of human capital, because the average worker has more years of educations in comparison with the EU. Development of the human capital stock will generate more economic growth because new technologies can be implemented faster. The closer a country is to the technological frontier, the more economic growth skilled labour will generate. The USA is closer to the technological frontier and has therefore more economic profit from investments in human capital. Because the USA has a less rigid labour market structure the development of human capital is different. In Europe employees develop more specific human capital at their firm, while in the USA they learn more general knowledge. The result is that European workers have a higher level of productivity, but will be longer unemployed when they lose their job because adaption is more difficult.

The rigid labour market structure of the European Union has the consequence that there is a high level of unemployment. For an individual who is unemployed, it is harder to keep up with new innovations in his work field and the person looses human capital because of that. The result is that long-term unemployment is a structural problem in the European welfare state. In the digital era technological innovation will cause more rapid changes and the adaptability of workers will be tested. The rigid labour markets in the EU have not the design to adjust fast to new circumstances, and the problems with the labour markets will therefore only grow and limit technological development.

There is a clear relationship between research and development investment and patent output. The USA has a substantially higher investment in research and development than the European Union. Different studies suggest that especially private investment in research and development has a fundamental effect on productivity growth. In Europe there is less private investment in R&D than in the USA, also the public investment is lower. Besides the United States is more efficient in translating findings from R&D into their economy, because of this public investment for research and development gives companies more profits in the USA than in the EU.

If a company wants to increase its productivity by investing in IT, they need more than only IT investments in research and development. In a company with a complementary organisational structure like decentralized decision making, IT management skills and specialized procedures the effects of IT investment will be more profitable than in comparison with a firm where this is not the case. Companies who are limited by regulations are on average less efficient than companies who do not have these limitations because legislation will trouble companies faster with a bureaucratic burden. For innovation an economy needs standalone firms with an open organization, many innovations are driven by young companies. To increase the innovation process an open networking structure between companies is preferred, because without sharing the right partners for an idea will not be found. However, the willingness to share concept ideas is limited because making an invention public in the European Union automatically ensures that the inventor looses the patents rights of the invention. In the USA it is allowed to share ideas for the first year, without loosing the property rights.

Patents have an important connection with innovation, with the right property rights the incentive for innovation will increase. In comparison with the United States the European Union has an expensive and inefficient patent system. Both the EU and the USA patent systems have problems. The USA has the problem with patent-trolls while in the EU the costs of a patent are too high. Both these problems limit the innovation process and need to be solved. In the European Union it is essential that there will be a unified patent system for the union, and that the costs of this unified patent will be lower than it is on the moment.

With the enlargement of the European Union in 2004 the mutual differences between member states increased. IT could play a major role in improving the productivity in Central and Eastern European countries (CEE) in comparison with the EU15 and the United States. Intensive use of IT could lead to faster productivity growth but IT investments will have different effects in different member states. In order to generate a positive effect of IT investment member states should focus on the development of the new economy indicators like law enforcement, trade openness, R&D spending, human capital etc. In order for the CEE countries to converge with the older member states in the future, the development of these new economy indicators is important.

With the Europe 2020 initiative, which includes the digital agenda, the European Union set itself the goal to transform the economy to an information economy. The smart growth pillar is the driver of the entire strategy and is focussing on innovation and education. The digital agenda is however not the only field where the European Union effects the innovation process of high-tech-firms. The two most important fields are the competition laws and the property rights. The interpretation of the European commission on the competition law is problematic because it implies that successful firms with a dominant position should share their intellectual property. This development will stunt innovation because in the IT sector firms compete with each other by investing in research and development. If these companies are forced to share this information they will stop with their research programmes. The European commission wants more private investments in the IT sector, in order to achieve this goal it will have to acknowledge that the nature of the IT market is not comparable with that of mature industries. The punishment of dominant positions in the IT market will inhibit innovation and will directly affect the private investment on research and development.

With the creation of a single EU patent and a Unified patent court the EU needs to set strong standards for patent laws. Intellectual protection is fundamental if the EU wants to evolve from an innovation follower to an innovation leader, strong patent regulations will give a boost to innovation. Besides strong laws it is also important to have a strict policy in the granting of patents, to prevent emerging of patent-trolls in the future.

The reason why the IT sector in the European Union is developing less than in the United States is for a big part caused by the different structures of society. The development of the welfare state ensured that the European economic is less adaptable to technological changes. The European commission does not have the competence to eliminate social securities of member states and is therefore limited in its power to transform Europe to an information economy. A broad collaboration between the commission, council and parliament is needed in order to achieve the objectives that where set in the 2020 initiative. Achieving an information economy demands more than just investment in research and development. The problem is broader and more complex than just insufficient IT investment in research and development. If the EU truly wants to turn thing around, full political commitment is needed on national and EU level.

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