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Tesi di laurea

Links and Impacts: The Influence of Public Research on Industrial R&D

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Abstract

In un mondo che cambia sempre più velocemente e in ambiti competitivi più ampi e vari che mai, con una concorrenza sempre più organizzata e specializzata, distinguersi dagli altri e trovare un vantaggio competitivo sta diventando enormemente difficile e complesso.
In questo contesto si inserisce l'innovazione che, (anche) attraverso i programmi di Ricerca e Sviluppo, permette alle aziende di differenziarsi rispetto ai competitori e di guadagnarne in efficienza e efficacia.

Il ruolo del settore pubblico nell'incentivare l'innovazione aziendale è fondamentale: l'articolo "Links and Impacts: The Influence of Public Research on Industrial R&D", anche se datato 2002, dimostra l'alta influenza che la ricerca pubblica esercita nel suggerire nuovi progetti di R&S alle aziende e, soprattutto, nel completarne di già iniziati, il cui proseguo sembrava difficile. Questa influenza risulta empiricamente maggiore in settori altamente specializzati e ad alta tecnologia come ad esempio quello farmaceutico, energetico e health and care; il sondaggio inoltre dimostra come le aziende che ne traggono maggiormente beneficio siano quelle di grande dimensione o le start up.

L'Europa è conscia del ruolo fondamentale che l'innovazione esercita nella nostra società ed economia, per questo negli ultimi vent'anni non sono mancati istituzioni, trattati e progetti in materia di innovazione; la situazione non è facilissima ma il percorso fatto fino ad ora e le prospettive future sembrano poter portare al meglio, certo è che le future scelte politiche prese dall'Unione, non solo in innovazione, saranno fondamentali per il futuro a lungo termine.

In Italia la situazione non è così rosea: la maggior parte degli indicatori testimoniano un livello di innovazione sotto la media europea nonostante la discreta crescita degli ultimi anni, i noti problemi strutturali e le ampie differenze all'interno del paese sono un enorme freno ed è necessario un repentino cambio di rotta per non continuare a perdere terreno vorticosamente.

Introduction

"Innovation is the process of creating something new that makes life better" (Ryan Allis, The Startup Guide)

During our school career we all studied that at certainly point of the human history there have been some turning points that have changed forever human existence. The use of fire for heating and cooking (around 400.000 BC), the discovery of the wheel (3400 BC) and the use of steel are probably the most famous discoveries in the ancient world, while the light Bulb (1800), the telegraph (1809), penicillin (1896) and the Internet (1969) are some of the most recent "innovative moments"

All these dates and facts have something in common: someone, after long time of studying or just luckily, discovered something that improved the human quality of life forever. And thanks to these discoveries someone else could continue the researches and learn something new.

Nowadays everything has an economical value and this is also true for research, development and innovation; in a world where competition is incredibly strong and where the competitors are always more and more efficient, doing research is more and more expensive and it needs a wide range of resources and competences.

That is why R&D in the last 20 years has become one of the most strategic competences: a company or a country that is able to innovate has a great competitive advantage compared to the competitors.

But the advantages that come from innovation are not just economical: a man that is innovating is someone that is able to imagine the future and try to build his perfect one, innovation allows you to be part of the changes you want to live.

That is why I decided to work on research, development and innovation because I like to think at the economical world not just like a cash machine that counts the gain and the losses, but also as a reality that looks at the future in order to make it a little better, step by step.

I will then start my thesis with the presentation of an article that analyzes the effects of public R&D on industrial R&D; after having understood the fundamental importance of public research I will discuss the history of innovation in Europe in the last 20 years with the present policies; finally I will conclude with a focus on Italian situation.

“According to the dictionary, the opposite of innovation is “archaism and routine”. That is why innovation comes up against so many obstacles and encounters such fierce resistance. It is also why developing and sharing an innovation culture is becoming a decisive challenge for European societies.” (Green paper on innovation, 1995)

1. The Influence of Public Research on Industrial R&D

1.1. The survey

The article from where my thesis starts: "Links and Impacts: the influence of Public Research on Industrial R&D" (Wesley M. Cohen, Richard R. Nelson, John P. Walsh; Carnegie Mellon University, Pittsburgh, Pennsylvania 2002) analyzes the effects of public research, considering both universities and government R&D laboratories, on the industrial R&D and how the private companies can take advantages from it. The authors of the article, studying all the different dimensions of innovation process, try also to figure out if exists a model able to explain how innovation process operates in the industries in parallel with the other core activities and the influence of public research on it.

The article uses data from a survey, taken by the University itself in 1994, where the population of the sample are all the R&D units located in the U.S. conducting R&D in manufacturing industries as part of manufacturing firms. They sampled 3240 laboratories and received 1478 answers, then they restricted the sample to firms not owned by foreigners and to firms whose focus was in the manufacturing sector, obtaining a final sample of 1267 samples.
Table 1 presents the distribution of the final sample.

Table 1: Size Distribution of Business Units and Firms (by Employment)

(A) Business Units	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Less than 100	262	24.2	262	24.2
100–500	302	27.8	564	52.0
500–1,000	114	10.5	678	62.5
1,000–5,000	229	21.1	907	83.6
5,000–10,000	71	6.5	978	90.1
10,000+	107	9.9	1,085	100.0
Frequency missing = 276				
(B) Firms				
Less than 100	215	17.7	215	17.7
100–500	212	17.4	427	35.1
500–1,000	64	5.3	491	40.3
1,000–5,000	229	18.8	720	59.1
5,000–10,000	111	9.1	831	68.2
10,000+	387	31.8	1,218	100.0
Frequency missing = 49				

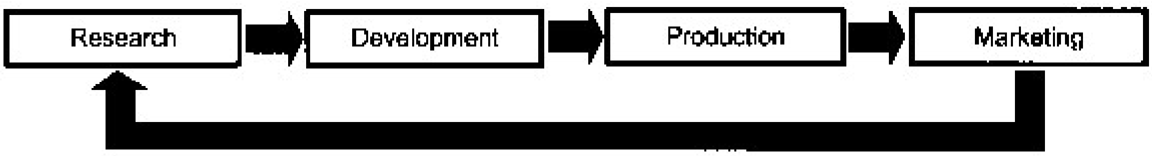
1.2 The linear model of innovation

One of the most important question that the authors of the article want to answer is if the external sources of information and knowledges (in the survey they included public research, competitors, customers, suppliers, consultants/contract R&D firms, joint or cooperative ventures and the firm's own manufacturing operations) are more important in a firm in suggesting new R&D projects, or if they are more useful in order to implement the existing plans.

They want to respond to that question because the common theory of the scholars after the Second World War, in innovation and R&D field, was called "linear model of innovation" where the research activity was the initial phase for every production process, followed in a linear and direct way by the development, the production and, finally, all the marketing activities.

In the linear model, research and development has a fixed position in the producing cycle of a firm and it is at the start of every product's production, this because mid-20th theorists needed to give R&D a specific and fixed role in order to take quick political choices during a historical period with a lot of economic uncertainties and difficulties and a social situation in which governments needed to boost immediately internal production and GDP. They needed to give R&D a rigid task owing to the difficulties (that today still remain) in the creation of a model able to explain effectively how the flow of information works considering the direct and indirect effects of information spill over in short and long run. Even though they knew that the most important feedback and information in a product cycle come from the entire development of the final outcome, in particular from the customers, the users and from a lot of other external sources (the ones that the survey has identified) they gave R&D a fixed and well defined role at the beginning of the production process.

Figure 1: linear model of innovation



1.3 The role of public research in the innovation process

After having understood the importance of research and development, also according to the linear model, the authors wanted to have empirical evidences whether public research plays a key role in initiating industrial innovation or if other external sources have a more relevant function.

They inquired directly R&D managers; the results are strongly relevant and reveal that a preponderance of industrial R&D projects are initiated in response to information from buyers or from the firm's own manufacturing operations (as shown in Figure 1), with “just” a 31.6% of firms that get ideas for new projects from universities and government labs.
What is interesting to notice, also according to the authors, is that in some sectors as oil industry, steel, machine tool, semiconductors, and aerospace industries, public research is still very relevant, with 50% of the managers answering that universities and public R&D laboratories still suggest new projects and more significantly we can note that in the pharmaceutical sector it happens in the 58% of the cases.
This because probably the customers and other non-specific, for the sector, external sources don’t have the skills and the knowledge to produce or suggest new ideas for new projects: it seems that public research is essential when what is needed are specific skills, the role of universities and public labs is to give the companies what they will not be able to find in other situations or from other sources.

What I would like to consider analyzing Figure 2 (information sources contributing to project completion) is the little importance given to the external source of information *customers* in contributing to projects completions compared to the value of the same source in suggesting new ideas, this is clearly because customers are the final objective of all companies activities. To satisfy their need is the aim and the purpose of all the production and this means that if a firm wants to give consumers what they ask for, they should start analyzing and asking the consumers themselves through the different marketing activities (the results of the survey show that 90,4% of the enterprises affirm they get new ideas from customers).
The goal of every firm, however, is to give the clients a surplus value with their competences, know-how and daily activities, if the customers had it, they would never need companies activities; that is why we find that just 59,1% of the respondents claim that they use customers information to complete their projects (it is 31,3 percentage points less), and that’s why we

can notice also the increasing importance in this phase of the production of the own operations each company's.

Figure 2: Information Sources Suggesting New Projects
(% of Respondents Indicating Source Suggested New R&D Projects)

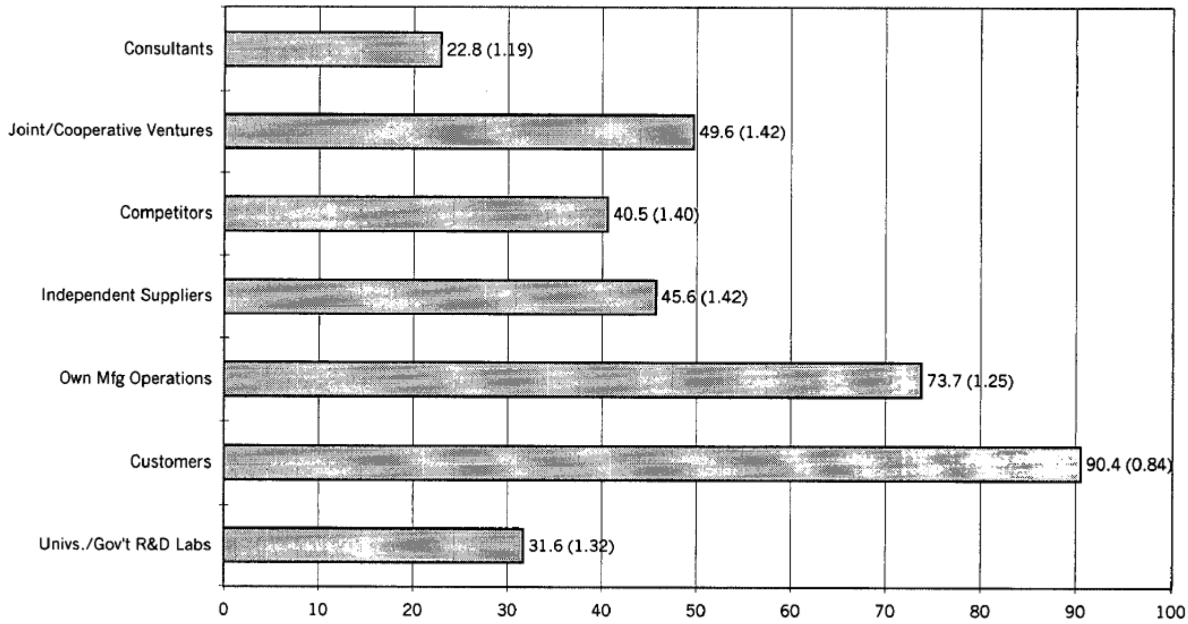
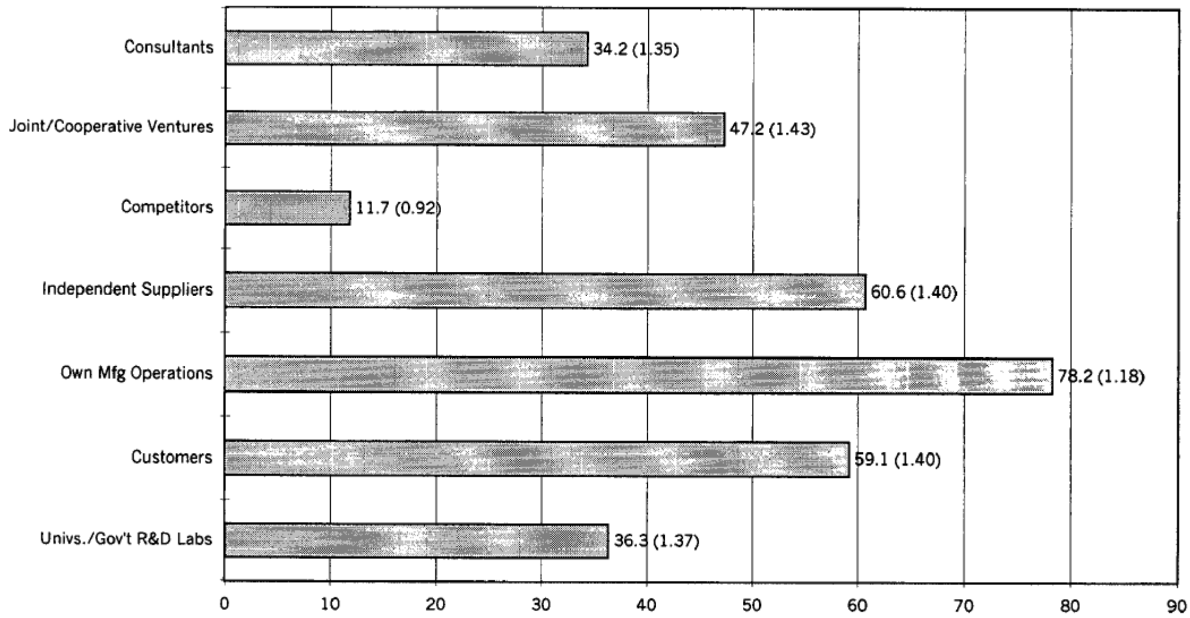


Figure 3: Information Sources Contributing to Project Completion
(% of Respondents Indicating Source Contributed to Project Completion)



That is also the reason why (figure 3) we can see a growing importance of more specialized external sources as consultants and independent suppliers: in this group we can also consider public research with a gain of 4,7 percentage point (it may seem that it is just a small difference but in a general vision of the results and in comparison with the other values it is a relevant result). It may be interesting also to consider the differences between the sources that can be recognized as part of the vertical chain of production of every firm (suppliers, own manufacturing laboratories…) and sources that are external from the enterprises (as consultants, joint ventures, public research..) and pointing out also this difference we can stress even more the importance of public research as external source in completing projects.

1.4 Outputs of Public Research

What does it mean that industrial R&D takes advantages form public research? The Authors of the survey have identified three possible ways in which universities and public laboratories contribute to the industrial R&D, the three options are: *research findings*, *prototypes* and *new instruments and techniques*. They asked the R&D managers which percentage of their researches (in the different manufacturing industries) in the previous three years (1991-1993) used those three public outputs, in this way they could also quantify the real provision of public researches in a practical and not only theoretical way.

Apart from the differences in percentage between the different sectors, what I would like to underline is the value, estimated in constant 1992 dollars, of the contribution of public R&D for these three years; In the 1991-1993 period, the U.S. manufacturing sector performed an average of $88 billion of R&D per year.

Considering that the survey revealed the weighted average for the percentage of R&D projects using prototypes generated by public research is 8.3%, in research findings the average is 29.3% and in instruments and techniques 22.2%, the authors estimated that public research generated, in these tree years, respectively about $7.3 billion, $26 billion and $20 billion dollars, on average per year, worth of industrial R&D.

As the authors claim, may be that these figures do not exactly correspond with the reality, they are just an estimation, but they can help us in understanding the importance of public research in every of its facets and types, and these numbers are so significant that they cannot be ignored, they are signals of the importance of public research in manufacturing industries and, as a consequence, in our daily lives.

Once it has been understood that public research affects the work of manufacturing enterprises through these three output types, the authors started to consider if there are other ways in which that impact in project completion may occur, in this way the data of the influence previously found would have been understated and the influence could be even stronger.
They asked the firms how much relevant (following a scale) were other ten information sources in order to complete their projects, even though this public research outputs are less direct than research findings, prototypes and new instruments and techniques; the ten new sources are patents, informal information exchange, publications and reports, public meetings and conferences, recently hired graduates, licenses, joint or cooperative ventures, contract research, consulting, and temporary personnel exchanges.

In Table 2 we can find the percentage of firms (divided by sector) that affirm that these sources are for their production at least “moderately important”, the comment of the authors of the survey is: “these aggregate scores show that the most important channels of information flow between public research institutions and industrial R&D labs are the channels of open science, notably publications and public meetings and conferences. Moreover, these channels, as well as the next most important channels of informal information exchange and consulting, are relatively decentralized in the sense that they do not typically reflect formal institutional links. With the exception of consulting, these most important channels are also not mediated through any sort of market exchange.”

Table 2: Importance to industrial R&D of Information Sources on Public Research

Industry	N	Patents	Pubs./ Reps.	Meetings or Conferences	Informal Interaction	Recent Hires	Licenses	Coop./ JV's	Contract Research	Consulting	Personnel Exchange
			Percentage of Respondents Indicating Research "Moderately" or "Very" Important								
1500: Food	93	9.7	51.6	37.6	44.1	21.5	10.8	22.6	30.1	46.2	7.5
1700: Textiles	23	13.0	26.1	26.1	21.7	21.7	0.0	13.0	8.7	13.0	0.0
2100: Paper	31	9.7	45.2	35.5	32.3	9.7	0.0	19.4	35.5	22.6	3.2
2200: Printing/publishing	12	16.7	33.3	25.0	16.7	8.3	8.3	0.0	16.7	25.0	0.0
2320: Petroleum	18	0.0	38.9	50.0	27.8	11.1	11.1	11.1	22.2	44.4	0.0
2400: Chemicals, nec	73	24.7	35.6	28.8	20.6	16.4	8.2	15.1	20.8	24.7	9.6
2411: Basic chemicals	41	17.1	36.6	26.8	39.0	17.1	2.4	14.6	17.1	34.2	2.4
2413: Plastic resins	28	14.3	35.7	32.1	21.4	21.4	0.0	3.6	10.7	14.3	0.0
2423: Drugs	68	50.0	73.5	64.7	58.8	30.9	33.8	41.2	52.9	58.8	8.8
2429: Miscellaneous chemicals	32	25.0	34.4	25.0	31.3	21.9	3.1	3.1	12.5	25.0	0.0
2500: Rubber/plastic	35	5.7	17.1	14.3	11.4	14.3	2.9	11.4	8.6	22.9	0.0
2600: Mineral products	19	5.3	26.3	21.1	21.1	31.6	5.3	10.5	10.5	26.3	10.5
2610: Glass	6	33.3	50.0	50.0	50.0	50.0	16.7	50.0	33.3	33.3	0.0
2695: Concrete, cement, lime	10	30.0	50.0	30.0	20.0	30.0	30.0	10.0	10.0	10.0	10.0
2700: Metal, nec	8	25.0	62.5	62.5	87.5	25.0	0.0	25.0	37.5	50.0	12.5
2710: Steel	11	18.2	36.4	54.6	45.5	18.2	18.2	36.4	54.6	36.4	18.2
2800: Metal products	51	19.6	25.5	13.7	25.5	17.7	7.8	13.7	9.8	21.6	3.9
2910: General purpose machinery, nec	76	15.8	30.7	26.3	30.3	14.5	7.9	10.5	13.2	31.6	1.3
2920: Special purpose machinery, nec	72	19.4	33.3	33.3	27.8	16.7	11.1	16.7	15.3	30.6	2.8
2922: Machine tools	11	9.1	36.4	45.5	45.5	18.2	0.0	9.1	18.2	36.4	0.0
3010: Computers	29	13.8	41.4	37.9	34.5	34.5	3.5	6.9	6.9	24.1	3.5
3100: Electrical equipment	23	8.7	30.4	21.7	21.7	0.0	0.0	8.7	13.0	8.7	0.0
3110: Motor/generator	25	4.0	40.0	36.0	44.0	12.0	0.0	20.0	12.0	28.0	4.0
3210: Electronic components	27	18.5	37.0	33.3	33.3	29.6	11.1	14.8	11.1	30.8	3.7
3211: Semiconductors and related equipment	25	20.0	60.0	48.0	54.2	36.0	12.0	20.0	20.0	40.0	4.0
3220: Comm equipment	37	5.4	48.7	32.4	32.4	27.0	8.1	8.1	16.2	29.7	18.9
3230: TV/radio	9	22.2	66.7	33.3	33.3	33.3	11.1	33.3	22.2	22.2	11.1
3311: Medical equipment	74	27.0	40.5	36.5	47.3	18.9	17.6	23.0	23.0	44.6	6.8
3312: Precision instruments	39	23.1	46.2	41.0	41.0	10.3	12.8	18.0	7.7	33.3	5.1
3314: Search/navigational equipment	40	7.5	52.5	50.0	50.0	20.0	12.5	27.5	32.5	42.5	12.5
3410: Car/truck	9	33.3	33.3	11.1	33.3	11.1	11.1	22.2	33.3	22.2	11.1
3430: Auto parts	32	9.4	43.8	31.3	25.0	18.8	9.4	21.9	18.8	21.9	9.4
3530: Aerospace	49	14.3	57.1	51.0	55.1	20.4	8.2	40.8	36.7	40.8	6.1
3600: Other manufacturing	93	12.9	33.3	34.4	31.2	17.2	5.4	9.7	16.1	19.4	7.5
All	1,229	17.5	41.2	35.1	35.6	19.6	9.5	17.9	20.9	31.8	5.8

What I think it may be interesting to discuss is the result of the survey concerning the source "recent hires", with just 19.6% of firms claiming that new hires are moderately important for their research programs. I would like to have recent data concerning this score for Italy, because in my opinion the situation may be similar or the percentage could be even smaller;

it is one of the most difficult step as far as education is concerned, to conciliate the education of a person with the perspective of what happen in the world of work: who should bring new ideas in an enterprise if not the new graduates? Are Universities not able to prepare correctly the students or are the firms that are not prepared to receive new ideas? Certainly R&D is a really sensitive sector in a firm and probably it is not easy to trust a new employed, even more if he is newly graduated and has not working experience, but I think that if we succeed in conciliating public education with the needs of the companies and vice versa, national economy would gain a lot in efficiency.

Another way in which universities affect research is the creation of start-ups; start-ups are firms with less than 5 years of activity and less than 500 employers that usually bring new ideas and new energy in the enterprise's world compared to the old and already established firms. The majority of start-ups are founded by young people just graduated and this is another way in which universities influence industrial research; Cohen, Nelson and Walsh in their article tried to understand if the dimension of a firm influences the use of public research and they found out that start-up and the large companies are the ones that benefit more from public research, with on average 72% of start-ups firm project that make use of research findings.

1.5 Considerations on the survey

In conclusion of the presentation of the article we can say that the authors have demonstrated that public research affect in large scale industrial R&D, and even though their studies included only the direct and short run effects, and not the repercussion that external spillover has in the long run, they succeeded in showing that almost a third of industrial R&D projects made use of research findings, in those three years, from public research, and over a fifth made use of instruments and techniques.

In my opinion these evidences are not insignificant, they point out and witness to the importance and the role of public research as a fundamental boost for innovation and the whole economy, we cannot hope to improve of our social and economic conditions without a raised and improved quality of our public research and all the linked activities with the endless possible external spillovers. What is difficult in improving the performances in public innovations is that all the investments produce positive results in the long run and in a political situation where the politicians are always under a magnifying glass, there are few who have the possibilities and the courage to issue high investments with no evident results in the short run.

But the paper we have just discussed is eloquent and that is why I want to analyze our real situation, a situation in which (in my personal idea) the European Union may be the solution of our national problems and also open us an infinite horizon of future possibilities.

That is why in the next pages I will try to focus my attention to the reality of innovation of Europe we are facing nowadays; I would like then to point out the Italian situation with its characteristic weaknesses and strengths, because I think that only in this way we can improve the private innovation with all the positive consequences for our lives.

2. Innovation and Europe

2.1 History

On 3 March 2010, on occasion of the end of the Lisbon strategy, the European Commission proposed "**Europe 2020**" : the EU's growth strategy for the decade 2010/2020.
After the beginning of the world economic crisis in 2008, which wiped out years of economic and social progress, EU felt the need to promote a ten-year program in order to face the actual situation and the "long term challenges such as globalization, pressure on natural resources and an ageing population are intensifying".

The official website of the "Europe 2020" project claims "In a changing world, we want the EU to become a smart, sustainable and inclusive economy. These three mutually reinforcing priorities should help the EU and the Member States deliver high levels of employment, productivity and social cohesion." In order to carry out that intents "Europe 2020" set 5 practical, verifiable and ambitious objectives for employment, innovation, education, social inclusion and climate/energy.
The second official target of the European projects declares "getting 3 % of the EU's GDP invested in research and Development", and to achieve that target EU Commission created "**Innovation Union**", a Europe 2020 flagship initiative aimed at securing Europe's global competitiveness and a financial instrument called "**Horizon 2020**" to finance the practical project in the period 2014-2020 that are part of the program. We will analyze those instruments later.

Europe 2020 is not the first attempt that Europe to take into consideration innovation, research and development; as we have seen in the short but practical and real example of the article by Cohen, Nelson and Walsh, public research and development have been, for a long time, considered essential in order to improve economic performances over a geographical region, something that Europe has always been conscious of with several political and economic initiatives.

The binomial Europe-research has a long history and it begins with the setting of Europe itself, we can find the early intents about research with the first treaties signed during the years '50 of the last century and the institution of the **European Coal and Steel Community** and **Euratom** that contained the first dispositions about research; then with the constitution of the **European Economic Community** the founders gave life to the first effective research programs in the sectors thought as essential at that time as energy, environment and biotechnologies.

In 1984 the **First EU Framework Programme for Research** was born: the first of eight (the last one is “Horizon 2020” for the period 2014-2020) plurennial programs to finance research and make Europe more competitive in key technologies. The special issue of March 2015 of the magazine “Horizon”, edited by the European Commission, on occasion of the presentation of “Horizon 2020” and the celebration of the 30th anniversary of the “EU Framework Programme for Research” says “since then, the Framework Programmes have become a major part of research cooperation in Europe, growing progressively in size, scope and ambition. Their objective has also evolved from supporting cross-border collaboration in research and technology to now encouraging a truly European coordination of activities and policies. The reason for this is simple: research, technology and innovation are at the core of Europe’s economy and are vital for a successful society.”

When the leaders of the EU tried to give a unique Constitution to the Union in 2004, the article I-3 of the Constitutional Treaty(it has never been ratified but it is included in the Lisbon Treaty) that presents the objectives both internal and external to the Union, include explicitly the sustainable development and the promotion of scientific and technological progress.

In 2008 in Budapest the **European Institute of Innovation and Technology (EIT)** was founded, the first attempt to conciliate and integrate totally the three aspects of the “Knowledge Triangle and Innovation” (research, institution and innovation) with the help of the Union.

I just wanted to mention some of the fundamental steps with which EU constantly tries to give value to innovation, research and development, the examples that may be mentioned are endless and what I said before is just to present as Europe consider innovation.

To conclude this brief excursus in the European innovation history, I would like to point out how many organs EU instituted in the sector of research and development, to stress the importance given by the Union to innovation: Joint Research Centre (JRC),European Research Council (ERC), Research Executive Agency (REA), Executive Agency for Small and Medium-sized enterprises, Innovation & Networks Executive Agency, European Institute of Innovation and Technology (EIT).

2.2 European Paradox

In December 1995 the European Commission published the "**Green Paper on Innovation**", a document that aimed to "identify the factors - positive or negative - on which innovation in Europe depends, and to formulate proposals for measures which will allow the innovation capacity of the Union to be increased."

This paper describes innovation as "a synonym for the successful production, assimilation and exploitation of novelty in the economic and social spheres. It offers new solutions to problems and thus makes it possible to meet the needs of both the individual and society."

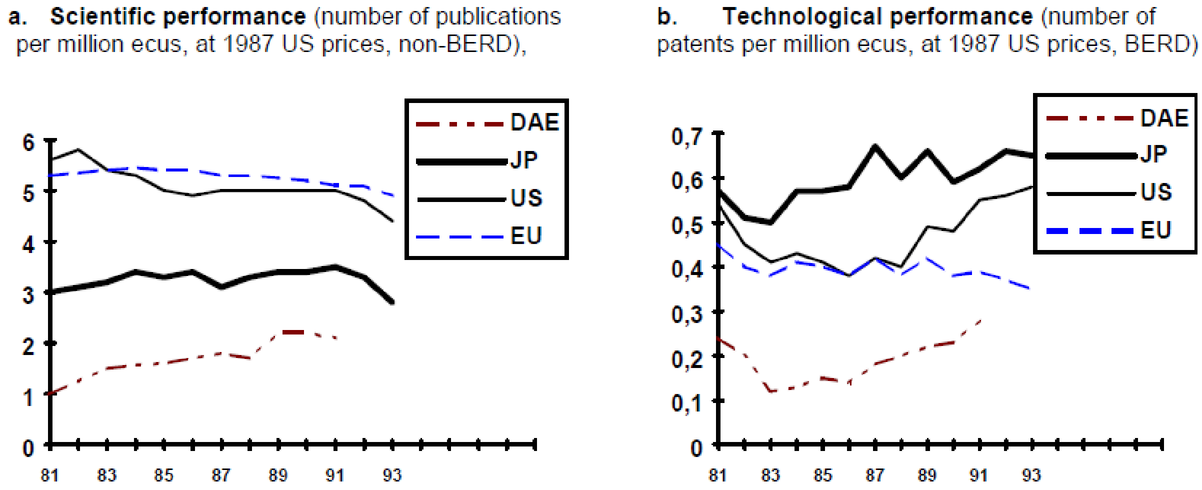
The reason for this document is really interesting because, through the analysis of the economic and social period, it explains for the first time in one document of the Commission the **"European paradox",** i.e. the situation for which Europe plays a leading world role in terms of scientific performances, measured in this occasion in terms of the number of publications, but lacks the entrepreneurial capacity to transform this excellent performance into innovation, growth, and jobs. The major weaknesses that the innovation paradox points out lie in Europe's inferiority in terms of transforming the results of technological research and skills into innovations and competitive advantages.

To explain the paradox the paper reported this graphic (figure 4) that compares E.U. performances in 1994 (measured in number of publication per million ecus, non-BERD where BERD means Business enterprise intramural expenditure on R&D) and those of the US, JP and the DAE with the technological performances of the same countries (measured in number of patents per million ecus, BERD).

As we can see in 1994 the EU were the best performer in number of publication but our number of the patents were largely overcome by the performances of the US and Japan.

"The greatest weakness, however, is the comparatively limited capacity to convert scientific breakthroughs and technological achievements into industrial and commercial successes." (White Paper "Growth, Competitiveness, Employment. The Challenges and Ways Forward into the 21st Century", Chapter 4, European Commission, 1994).

Figure 4: Propensity of the EU, US, Japan and the DAE to produce results



Source: First European report on science and technology indicators, summary, EUR 15929, 1994

Furthermore, in the ”Green paper” the Commission underlines, as a big problem of the Union, the existence in 1993 of a big gap between our efforts measured by the percentage of total research and development expenditure as a share of European GDP (2%) - and those of our main partners: the United States (2.7%) and Japan (2.8%), this because this difference combined with the inability to transform the research efforts in competitive advantages creates big obstacles to our competitiveness, growth and employment.

These weaknesses that bring to the paradox were identified in a lower degree of specialization in both high-tech products and sectors with high growth rates; a lower presence in geographical markets which show strong development; productivity which was still inadequate; a research and development effort which was non homogeneous and fragmented; insufficient capacity to innovate, to launch new products and services, to market them rapidly on the world markets and, finally, to react rapidly to changes in demand.

The non perfect common market (of goods and capital) in Europe that increase the prices and the high level of real interest rates causing difficulties in long term investments especially in the non tangible assets are seen also as impediment to the capacity in transforming the research investments into innovation, growth, and jobs.

“Over the last ten years, Europe has devoted most of its efforts to increases in productivity, which have assumed what amounts to cult status. However, these increases can be negated if they are used in conjunction with a technology which is obsolete or obsolescent. (...) Innovation must be the driving force behind the entire business policy, both downstream and upstream of the actual production of goods and services. (...) Innovation can be successful if all the skills in the firm are mobilised. Conversely, it can fail when this cohesion is lacking.” (Edith Cresson, Compiègne, 6 September 1995.)

2.3 Present situation and main competitors

These data and references are really dated and maybe destitute of every meaning nowadays: they date back to more than 20 years ago, during this period a lot has changed in the world: improvements in technology, globalization, the 11th September 2001 with all the consequences in the Middle Est world’s policy, the constant progress in the creation of EU institutions, the crisis of the 2008 and so on, but I consider them very useful as a starting point in order to analyze our reality as they explain us the reason for the political choices that have brought us to that point and the foundation in which our European society is established.

But what is the actual situation in Europe about innovation, research and development?
As we have closely seen, European politics has continued in the last 20 years on the traces of the “Green paper on innovation” trying to implement research and innovation and to improve the efficiency of the investments made.

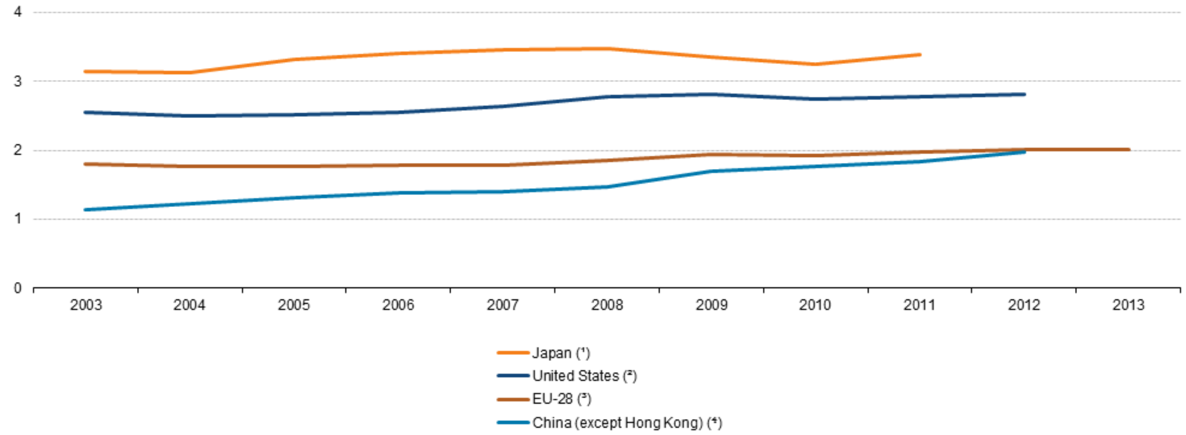
According to the data of Eurostat, gross domestic expenditure on R&D (GERD) was EUR 272 billion in the EU-28 in 2013, which meant an increase of 0.7 % compared to the previous year, and 43.8 % higher than 2003); note that these rates of change are in current prices and so they reflect price changes as well as real changes in the level of expenditure.
GERD is often expressed in relation to GDP, as in the graph below, or in relation to population. The percentage of GERD to GDP, as seen before one of five key Europe 2020 strategy indicators (3% in 2020), is also known as R & D intensity. This indicator shrunk slowly in the EU-28 during the period from 2003 to 2005, moving from 1.80 % to 1.76 %. From 2006 it started to go up, arriving at 2.01 % in 2012, despite a small decline in 2010; it remained constant in 2013 at 2.01 %, even if it is not in the table in 2014 was at 2.03% (Eurostat). Despite the recent increase, the EU-28’s R & D expenditure relative to GDP still remains well below the corresponding ratios recorded in Japan (3.38 %, 2011 data) and the United States (2.81 %, 2012 data), by 2012 the R&D intensity in China had almost reached the level in the EU-28.

As shown by the graph and the tables below (figure 5, table 3) given by the Eurostat too, in the Japanese economy Between 2004 and 2008 there was an increase in the relative level of GERD, as its ratio to GDP rose by 0.34 percentage points during this period. However, in the period between 2008 and 2010 the ratio of GERD to GDP in the Japanese economy decreased by 0.22 percentage points, in consequence of the international crisis, before restarting to grow up in 2011.

The level of GERD to GDP grew in the United States from 2.49 % in 2004 to a maximum of 2.82 % in 2009, an increase of 0.33%. In 2010, R&D intensity in the United States fell back to 2.74 % before increasing in 2011 and 2012 to reach 2.81 %.

China's R & D intensity increased rapidly during the period since 2003, rising from 1.13 % to 1.98 % in 2012, an increase of 0.85 percentage points.

Figure 5: Gross domestic expenditure on R&D in the Triad and China, 2003–13 (% of GDP) (Eurostat)



(¹) 2008: break in series.
(²) Excludes most or all capital expenditure. 2012: provisional.
(³) 2003 and 2013: estimates.
(⁴) 2009: break in series.
Source: Eurostat (online data code: tsc00001)

Table 3: Gross domestic expenditure on R&D, 2003–13 (% of GDP) Source: Eurostat

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
EU-28	*1.80*	1.76	1.76	1.78	1.78	1.85	1.94	1.93	1.97	2.01	*2.01*
Euro area (EA-19)	*1.81*	1.78	1.78	1.80	1.81	1.89	1.99	1.99	2.04	2.09	*2.09*
China (except Hong Kong) (⁸)	1.13	1.23	1.32	1.39	1.40	1.47	1.70	1.76	1.84	1.98	:
Japan (²)	3.14	3.13	3.31	3.41	3.46	3.47	3.36	3.25	3.38	:	:
Russia	1.29	1.15	1.07	1.07	1.12	1.04	1.25	1.13	1.10	1.13	1.11
South Korea (¹)(⁹)	2.49	2.68	2.79	3.01	3.21	3.36	3.56	3.74	4.04	:	:
United States (¹⁰)	2.55	2.49	2.51	2.55	2.63	2.77	2.82	2.74	2.77	*2.81*	:

A further relevant indicator is the source of funds from where the GERD on R&D come from; the analysis from Eurostat shows (table 4) that more than half (55.0 %) of the total amount of research and development expenditure in 2012 within the EU-28 was funded by business enterprises, while the 32.8 % was funded by public expenditure, and a further 9.7 % from abroad (foreign funds). Among the countries considered in the survey, Japan has the highest percentage of Business-funded R&D accounted for 76.5 % of total R & D (2011 data), business enterprises funded the 74.0 % in China and the 59.1 % in the United States.

What I would like to underline is the significant difference in foreign investments on R&D between Europe and the other countries: if the EU presents 9.7% of funds from abroad, the US has just a 3.8% and Russia a 3% but what is really interesting is the 1% in China, the 0.5% in Japan and the 0.2% in South Korea (the country with the highest level of GERD to GDP).

In the period after the world crisis 2008-2013 (data not available for the US) Russia lost 2.9 percentage points on the expenditure on R&D from abroad, probably caused by the oil crisis and the political tensions with the rest of Europe (Ukrainian crisis) and the USA; China, Japan and South Korea foreign funds were practically stable and only Europe succeeded in increasing its foreign investments by almost 1%, probably the international investors are recognizing the work that the EU is doing in innovation even though the tough period and the future perspective are such to attract more foreign funds compared to the direct competitors.

Table 4: Gross domestic expenditure on R&D by source of funds, 2008 and 2013 (% of total gross expenditure on R&D) Source: Eurostat

	Business enterprise sector		Government sector		Abroad	
	2008	2013	2008	2013	2008	2013
EU-28 (1)	*54.8*	*55.0*	*33.8*	*32.8*	*8.8*	*9.7*
Euro area (EA-19) (1)	*56.3*	*56.9*	*34.6*	*33.4*	*7.2*	*7.8*
China (except Hong Kong) (1)(4)	71.7	74.0	23.6	21.6	1.2	1.0
Japan (2)(5)	78.2	76.5	15.6	16.4	0.4	0.5
Russia	28.7	28.2	64.7	67.6	5.9	3.0
South Korea (2)	72.9	73.7	25.4	24.9	0.3	0.2
United States (1)(7)	63.5	*59.1*	30.4	*30.8*	:	3.8

2.4 European Innovation Scoreboard 2016

Every year the European Commission publishes a document called **"European Innovation Scoreboard (EIS)"**that analyzes deeply, with data from Eurostat and other institutional database, the actual situation of Europe in its totality, the position of each Member State, the performances of the Union in comparison to the major competitors and the future perspectives and plans.

Today statistic surveys have improved their ability to compare different indexes and the availability of data is incredibly grown up too, compared to 20 years ago it is now possible to have more accurate comparisons between different geographical areas.

In figure 6 European Commission uses a composite indicator, the “innovation index”, to compare innovation performance in 2016 between Europe and the other major economic powers: build with other 12 indicators (and not just with the number of publications or the GERD to GDP, even though these indicators are included) it permits to have a wider comparison on the innovation status around the world.

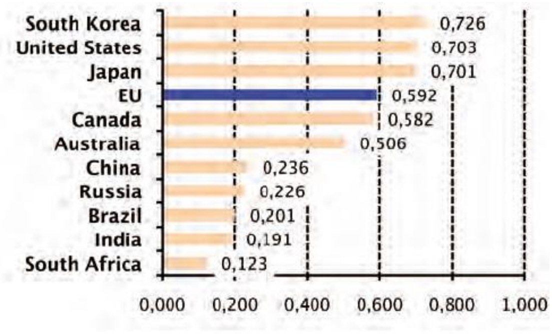
One necessary consideration to make is that the European Union in 1994 was really different from the EU in 2016, as we know now there are 28 Member States but in 1994 the Union was composed by just 12 nations, I think this is relevant but we will analyze the differences inside Europe later.

The graph shows us that the best innovators in the world are also the best performers in the GDP, I don’t have the knowledge and the data to determine if it is this innovation that makes a country rich, or if only wealthier states can allow to finance innovation, but certainly a government that invests in research and development lays the foundations to its improve economic and social performances in the future.

The innovation index used in the international comparison includes other 12 indicators in 7 different categories: human resources; open, excellent and attractive research systems; finance and support; firm investments; linkages & entrepreneurship; intellectual assets and economic effects of the outputs.

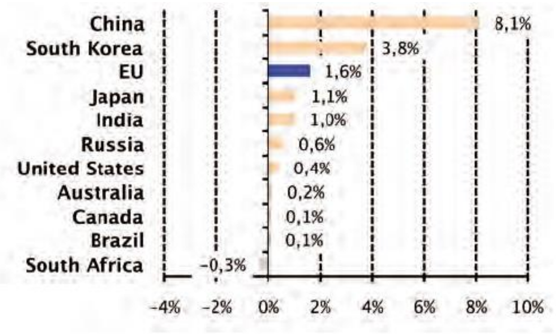
As Figure 7 shows, the 4 best innovators in 2016 are South Korea, United States, Japan and the EU and these countries were the best also in 1994 according to the “Green paper”, with South Korea leading this year the ranking; EU is in 4th position with a relevant distance from Japan, but as Figure 7 testifies last year Europe grew more than Japan (and also more than the US), shortening the distances.

Figure 6: Global Innovation performance



Average performance is measured using a composite indicator - the innovation index - building on data for 12 indicators ranging from a lowest possible performance of 0 to a maximum possible performance of 1.

Figure 7: Global Innovation growth rates



Average annual growth rates of the innovation index have been calculated over an eight-year period. Due to a smaller set of indicators the EU growth rate shown in this figure is not comparable to that in Sections 2 and 4.

If in 1994 the comparison that brought to the definition of the European paradox was made simply comparing the number of publications and number of patents, in 2016 the European Commission is able to have wider opportunities of observation, this permits us to have a larger horizon of opportunities even though it makes the comparison more complex.

In general the analysis that the Commission does is :"the three global top innovators are dominating the EU particularly on indicators capturing business activity as measured by R&D expenditures in the business sector, Public-private co-publications and PCT patents, especially in social challenges, but also in educational attainment as measured by the Share of population having completed tertiary education. Enterprises in these countries invest more in research and innovation, and collaborative knowledge creation between public and private sectors is better developed. The skilled workforce in these countries is also relatively larger than in the EU."

What we can add, inspecting the data of the EIS, the EU continues to have innovation performances in comparison to Australia, Canada, and all BRICS countries. Of these countries, only China has managed to grow at a (much) higher rate than the EU. Performance growth for Canada, Brazil, and South Africa has been close to zero.

What I personally think is that Europe is on the right way to improve its innovation and efficiency; EU is not as every other state with a unique government and Parliament with full powers and so on with all the other political and economic institutions: Europe is the greatest political project in the history but it is still raw and unfinished and the road is still incredibly long. What has happened in the last few years didn't help: in the last period the dreamers of a perfect Union are finding a lot of obstacles along the road but still these data from this document show us the potentiality of our reality.

The instruments that the Commission is issuing always seems to be more and more conscious of the world situation and of the aims they want to achieve with concrete and practical operating means.

Europe is growing up and so also its goals to achieve are changing from those of the "Green paper on innovation": the initiative "Innovation Union" (already mentioned before) identifies as actions that Europe needs to undertake nowadays to face the actual challenges are those to create job opportunities for all, especially the young; to get the economy back on track; to make companies more competitive in the global market; to solve the challenges of an ageing population; to secure resources like food and fuel; to fight global warming and to improve smart and green transport.

One of the biggest worries of the EU today is that developing countries as China, India and Brazil have started to catch up with Europe by improving their economic performance faster than the EU , and future expectations for 2050 Europe's share of world GDP are likely to be half of today's 29%.

In 2014 "Horizon 2020" was created, the eighth Framework Programme, the biggest and most ambitious with a budget of EUR 80 billion, it represents a significant step forward because it brings all EU support for research and innovation together within a single programme. With Horizon 2020, research and innovation will play a vital role in European Commission agenda to strengthen Europe's competitiveness and boost jobs and growth, and will help Europe to find the answers to major social challenges such as health, climate change and energy security.

European innovation is growing, as it is always more and more part of the European ideology itself.

"Innovation is the ability of individuals, companies and entire nations to continuously create their desired future"

John Kao, "Innovation Nation" (2007)

2.5 The differences between the Member States

We have seen the European performances in innovation and research and the strategies that the Union, after a deep analysis on its economical and social situation, has adopted or will adopt to achieve its targets.

Europe is strongly different from its direct competitors, it is still a non finished project with a lot of non solved issues (which we have already mentioned before) that slow our growth; these simple data may help us in understanding the situation: in Europe we have 28 countries with 28 different governments (27 after Brexit), 10 currencies (9 after Brexit), 24 different official languages, over 510 millions of inhabitants and10.180.000 km² of land, is obvious that this situation affects and conditionates also our economical results (also in innovation).

The differences inside the Union are often huge in the economic, all the countries have a different history that has brought them to the present situation, and all the burdens that each Member State brings affects the situation of all the EU, due to that Europe at the moment is not homogeneous as the other states around the world can be, and that is why a cumulative indicator for all the Union is not totally explicative of the social and economical situation; this is actually happening in innovation, research and development too.

With the "European Innovation Scoreboard 2016" the European Commission published the annual data of every Member State in the field of innovation. To measure the state of innovation has been used a composite indicator called **"Summary Innovation Index (SII)"**that summarizes the results of three main types of indicatorsand eight innovation dimensions, capturing in total 25 different indicators over the year's performances(updated to April 2016).

The three main types of indicators are: Enablers, Firm activities and Outputs. "The Enablers capture the main drivers of innovation performance external to the firm and cover three innovation dimensions: Human resources, Open, excellent and attractive research systems, as well as Finance and support. Firm activities comprise the innovation efforts at the level of the firm, grouped in three innovation dimensions: Firm investments, Linkages &entrepreneurship, and Intellectual assets. Outputs cover the effects of firms' innovation activities in two innovation dimensions: Innovators and Economic effects". (EIS 2016)

The results of the year's Summary Innovation Index are used by the Commission to divide the Member States into the following four performance groups (as shown on the graph below):

• The groupof Innovation Leaders includes Member States which innovation performance is more than 20% above the EU average. Denmark, Finland, Germany, the Netherlands, and Sweden belong to this group.

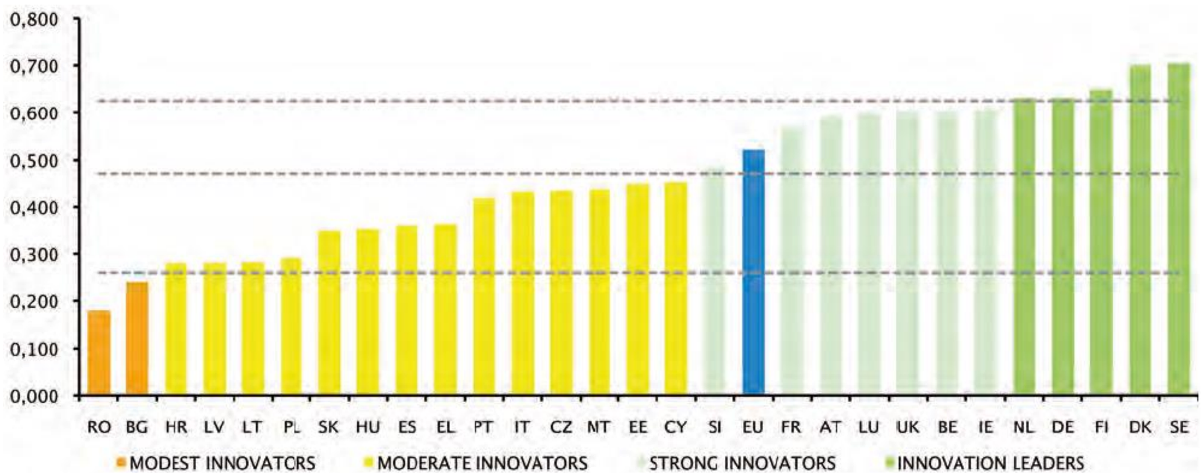
• The second group is the one of Strong Innovators and includes Member States with a performance between 90% and 120% of the EU average. This group comprises Austria, Belgium, France, Ireland, Luxembourg, Slovenia, and the UK.

• The third group of Moderate Innovators includes Member States where the innovation performance is between 50% and 90% of the EU average. Croatia, Cyprus, Czech Republic, Estonia, Greece, Hungary, Italy, Latvia, Lithuania, Malta, Poland, Portugal, Slovakia, and Spain take part in this group.

•The fourth group of Modest Innovators includes Member States that show an innovation performance level that is less than 50% of the EU average. Only Bulgaria and Romania belong to this group

The only two countries that succeeded in improving their group compared to the previous year are the Netherlands, that passed to be a Strong Innovator to a Innovation Leader and Latvia, that now is a Moderate Innovator instead of a Modest Innovator.

Figure 8: Member States' innovation performance (EIS 2016)



2.6 Growth in the last years

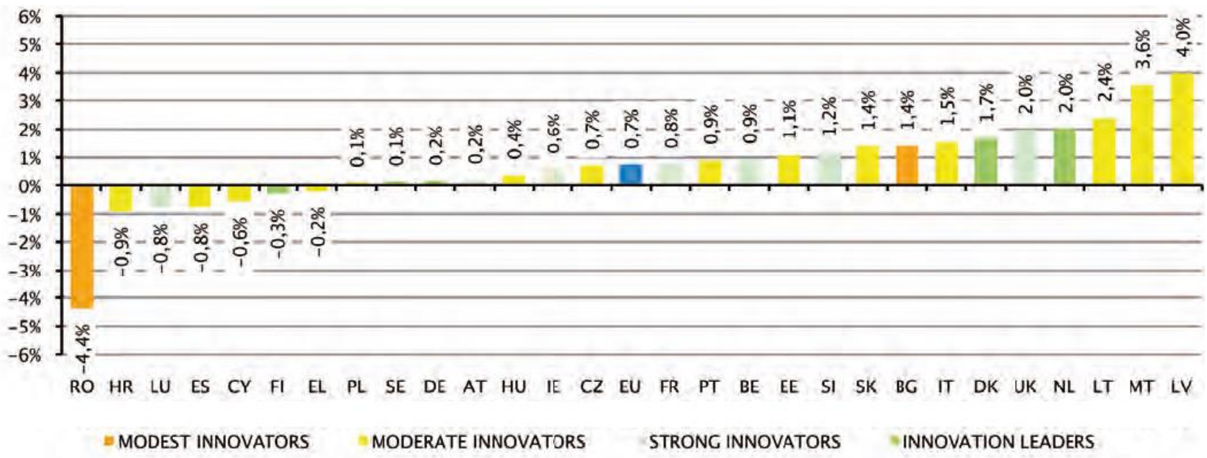
What is interesting to analyze is also the performance changes over the last years and the graph below (figure 9) shows the average annual growth rate for the 28 countries of the Union during the period 2008-2015, the different colors indicate also the Member States by group of innovation level.

The whole Union has grown of 0,7% in the period; 21 countries have registered a positive growth while Greece, Finland, Cyprus, Spain, Luxembourg, Croatia, and Romania have had a negative growth, with Romanian innovation level that has decreased by 4.4%.Best innovator has been Latvia (that has also improved his group) with an average annual growth rate of 4% followed by Malta with a 3.6% of growth for the period. In the group of Innovation Leaders the Netherlands has the best result growing of the 2.0% while Finland has been the unique Innovation Leader that has a negative average annual growth rate (-0.3%).

In figure 9 below we can control the performance of each Member state in every year of the period considered, a green circle indicates a positive annual growth, a yellow circle a neutral growth rate and the red one indicates a year with a negative growth rate in that state. Even though considering the whole period, 21 countries have registered a positive average annual growth rate; the trend of the performances hasn't been constant along the period: as we can note in the years 2008-2009, 2009-2010, 2010- 2011 and 2012-2012 the general trend was positive, starting in 2008-2009 with just 4 Members (Greece, Hungary, Croatia and Bulgaria) that registered a decrease in the Summary Innovation Index, 2 Members (Lithuania and the Czech Republic) had a neutral growth and the other 22 a positive one.
In 2012 the general performances of the Union in innovation started to decline with, in 2012-2013, just 12 Member States that registered a positive SII (15 negative and one neutral) to arrive in 2014-2015 (the last year considered in the Table) with only 7 countries (Denmark, Ireland, United Kingdom, France, Montenegro, Latvia) with a positive growth in innovation.
Considering the four levels about innovation performances given before, in 2013-2014 even the Innovation Leaders and the Strong Innovators considered as unique group registered a neutral growth and the following year they both had a red circle in innovation growth (while Moderate Innovators had a neutral change in the level of SII).

But what are the specific indicators that determined that negative results? This is the answer from the European Innovation Scoreboard: "The large number of Member States whose performance declined in 2013 and 2015 can mostly be attributed to a relatively small number of indicators. In 2013, performance declined for a large number of Member States in Public-private co-publications (25 Member States), Non-R&D innovation expenditures (23), Venture capital investments (19), Sales of new-to-market and new-to-firm innovations (19), SMEs with product or process innovations (16), and PCT patent applications in social challenges (15). In 2015, performance declined for a large number of Member States in PCT patent applications in social challenges (24), SMEs with product on process innovations (22), Sales of new-to-market and new-to-firm innovations (21), SMEs with marketing or organizational innovations (20), SMEs innovating in-house (19), PCT patent applications (19), Innovative SMEs collaborating with others (18), and Public-private co-publications (17). In particular, using more recent CIS data (CIS 2010 instead of CIS 2008 data in 2013, and CIS 2012 instead of CIS 2010 data in 2015) has a significant negative impact on Member States' innovation performance. In addition, PCT patent applications and Public-private co-publications contribute negatively to Member States' innovation performance in 2013-2015, with declines in performance for more than half of the Member States". (EIS 2016)

Figure 9: EU Member States' performance growth (EIS 2016)



Average annual growth rates of the innovation index have been calculated over an eight-year period (2008-2015).

Figure 10: Performance changes over time (EIS 2016)

2.7 General situation in Europe

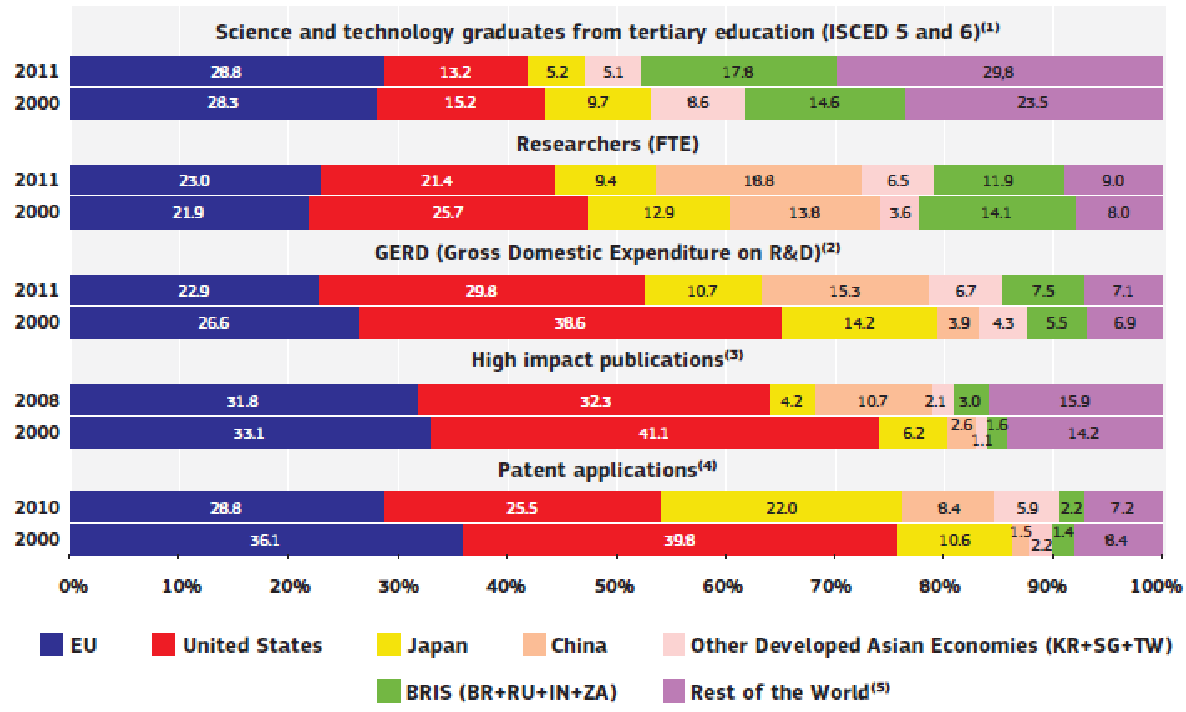
In conclusion what we can say about innovation in Europe?

The EU is facing an increasing in the range of its competitors, Asian countries and BRICS are growing always more and more and also in the "innovation world" they are reclaiming their space. "Europe remains however today the main knowledge production centre in the world, accounting for almost a third of the world's science and technology production. The EU has managed to maintain its competitive knowledge position to a greater degree than the United States and Japan and is making progress towards its R&D intensity target of 3% by 2020. The EU also remains a very attractive location for R&D investment. In 2011, the EU was the main destination of FDI in the world, receiving around 30% of FDI inflows worldwide, more than the United States or Japan." (Innovation Union Competitiveness, 2013).

Going back to the "Green paper on innovation" published we can find some differences with the last publication of the European Commission: the biggest problem underlined in 1994 was the European paradox, that is the inability in transforming the results of technological research and skills into innovations and competitive advantages, this empirical phenomenon was visualized comparing the high level of European publication and the low production of patents compared to the other competitors. We can try to verify if this paradox still affects Europe using the same term of comparison (I think this may be limiting but explanatory) of the Green paper.

We can use the data from the "Innovation Union Competitiveness Report 2013" (figure 11 below), the graph asserts that the EU in 2008 presents the 31.8% of the Top 10% most-cited publications, just 0.5% less than the US top performer, on the other side in 2010 the Union registered the 28.8% of patent applications. If we rely only on these data we could affirm that the EU doesn't suffer anymore from "its" paradox considering that it is the best percentage in the whole world and that it is just below the share of most cited publications.

Figure 11: World shares of science and technology graduates, researchers, GERD, high-impact publications and patent applications, 2000 and the latest available year



Source: DG Research and Innovation - Economic Analysis Unit

Data: Eurostat, OECD, UNESCO, Science Metrix / Scopus (Elsevier)

Notes: (¹)Tertiary graduates in science and engineering: (i) Data are not available for China; (ii) Other Developed Asian Economies does not include SG and TW; (iii) BRIS does not include India and South Africa. (²)GERD: Shares were calculated from values in current PPS€. (³)(i) Top 10% most-cited publications - fractional counting method, scientific publications 2008: citation window 2008-2011; (ii) Other Developed Asian Economies does not include SG and TW; (iii) BRIS does not include South Africa. (4)Patent applications under the PCT (Patent Cooperation Treaty), at international phase, designating the EPO by country of residence of the inventor(s). (5)The coverage of the Rest of the World is not uniform for all indicators. (6)Elements of estimation were involved in the compilation of the data.

Figure 12: R&D investment as share of the economy (GDP) R&D intensity trends and targets, 2000-2020

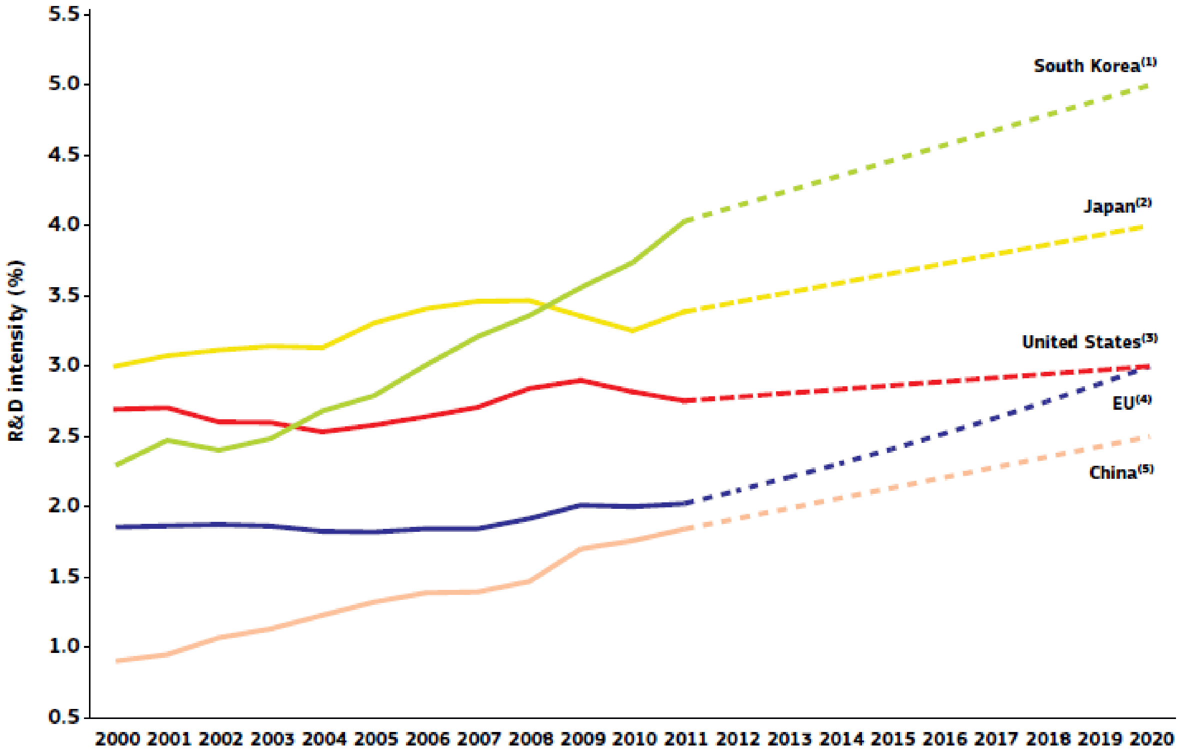


Figure 13:Gross domestic expenditure on R&D, 2003–13 (% of GDP) Source: Eurostat

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
EU-28	1.80	1.76	1.76	1.78	1.78	1.85	1.94	1.93	1.97	2.01	2.01
Euro area (EA-19)	1.81	1.78	1.78	1.80	1.81	1.89	1.99	1.99	2.04	2.09	2.09
Belgium	1.83	1.81	1.78	1.81	1.84	1.92	1.97	2.05	2.15	2.24	2.28
Bulgaria	0.47	0.48	0.45	0.45	0.44	0.46	0.51	0.59	0.55	0.62	0.65
Czech Republic	1.15	1.15	1.17	1.23	1.31	1.24	1.30	1.34	1.56	1.79	1.91
Denmark (1)	2.51	2.42	2.39	2.40	2.51	2.78	3.07	2.94	2.97	3.02	3.06
Germany	2.46	2.42	2.43	2.46	2.45	2.60	2.73	2.72	2.80	2.88	2.85
Estonia	0.77	0.85	0.92	1.12	1.07	1.26	1.40	1.58	2.34	2.16	1.74
Ireland	1.13	1.18	1.20	1.21	1.24	1.39	1.63	1.62	1.53	1.58	:
Greece (2)	0.55	0.53	0.58	0.56	0.58	0.66	0.63	0.60	0.67	0.69	0.80
Spain	1.02	1.04	1.10	1.17	1.23	1.32	1.35	1.35	1.32	1.27	1.24
France (3)	2.11	2.09	2.04	2.05	2.02	2.06	2.21	2.18	2.19	2.23	2.23
Croatia	0.95	1.03	0.86	0.74	0.79	0.88	0.84	0.74	0.75	0.75	0.81
Italy	1.06	1.05	1.05	1.09	1.13	1.16	1.22	1.22	1.21	1.27	1.26
Cyprus	0.32	0.34	0.37	0.39	0.40	0.39	0.45	0.45	0.46	0.43	0.48
Latvia	0.36	0.40	0.53	0.65	0.56	0.58	0.45	0.60	0.70	0.66	0.60
Lithuania	:	0.75	0.75	0.79	0.80	0.79	0.83	0.78	0.90	0.90	0.95
Luxembourg	1.65	1.63	1.59	1.69	1.65	1.65	1.72	1.50	1.41	1.16	1.16
Hungary (4)(5)	0.92	0.87	0.93	0.99	0.97	0.99	1.14	1.15	1.20	1.27	1.41
Malta (4)	0.24	0.49	0.53	0.58	0.55	0.53	0.52	0.64	0.70	0.86	0.85
Netherlands (6)	1.81	1.82	1.81	1.77	1.70	1.65	1.69	1.72	1.89	1.97	1.98
Austria	2.18	2.17	2.38	2.37	2.43	2.59	2.61	2.74	2.68	2.81	2.81
Poland	0.54	0.56	0.57	0.55	0.56	0.60	0.67	0.72	0.75	0.89	0.87
Portugal (2)	0.70	0.73	0.76	0.95	1.12	1.45	1.58	1.53	1.46	1.37	1.36
Romania (6)	0.38	0.38	0.41	0.45	0.52	0.57	0.46	0.45	0.49	0.48	0.39
Slovenia (2)(6)	1.25	1.37	1.41	1.53	1.42	1.63	1.82	2.06	2.43	2.58	2.59
Slovakia	0.56	0.50	0.49	0.48	0.45	0.46	0.47	0.62	0.67	0.81	0.83
Finland	3.30	3.31	3.33	3.34	3.35	3.55	3.75	3.73	3.64	3.42	3.31
Sweden (7)	3.61	3.39	3.39	3.50	3.26	3.50	3.42	3.22	3.22	3.28	3.30
United Kingdom	1.67	1.61	1.63	1.65	1.69	1.69	1.75	1.69	1.69	1.63	1.63

3. Italy - The challenge of structural

3.1 Italian GERD to GDP

In the previous chapters we discussed about the importance of Research & Innovation in all their shapes and features, beginning from the 1994 in the US, moving in the same years to Europe, analyzing the last 20 years in innovation's policies in the EU and looking at the present situation between Europe and the other world competitors and the differences inside Europe itself; now it is time to focus on Italy and its situation in R&I.

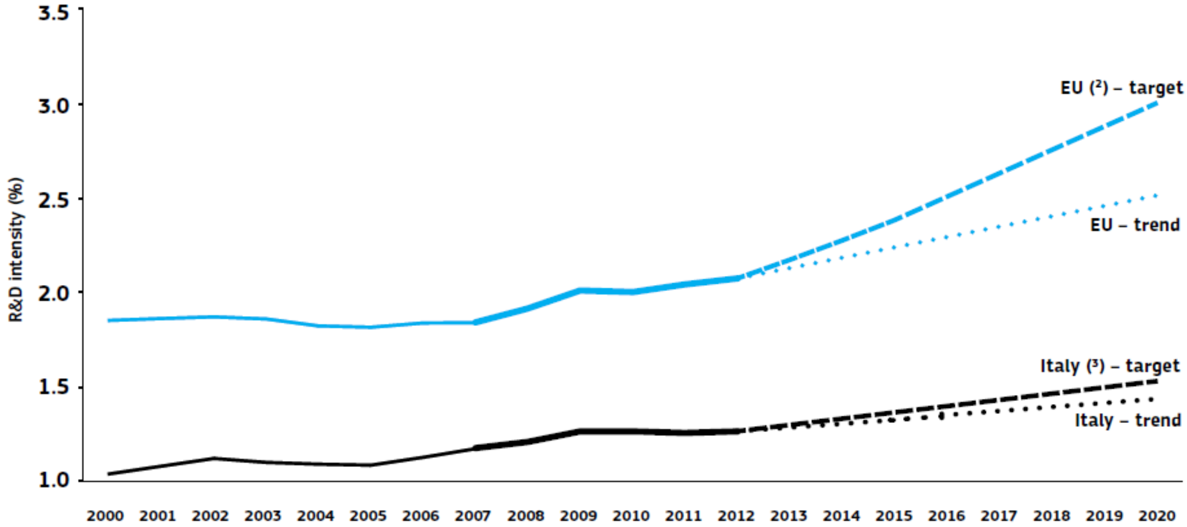
Italy is one of the founders of the European Union that begun with the creation of the European Economic Cooperation in 1957 with the Treaty of Rome and, as part of the Union, it shares the majority of the policies and the targets of the EU; even though the enormous differences that we present compared to the rest of the Union, we share the communitarian believes in term of Research & Innovation and we are continually trying to improve our efforts and efficiency in this field.

As in the rest of Europe, Italian R&D has been affected by the recent world crisis, the reduction in public expenditure associated to austerity programmes, and the fall of private R&D and investment efforts (HIT 2020 R&I 2013).

Italian GERD to GDP, which is an explanatory indicator for the R&D expenditure in the public sector, has been lower than the EU28 average even before the crisis and has set as a target to achieve, within 2020, 1.53% of public expenditures on the national GDP, while the European target is 3.0% (even though the projections in the figure 14 below show that both targets will hardly be achieved) (IUC 2016) (Eurostat).

Slowly but constantly Italian GERD to GDP has been growing for the period 2003-2013 (as shown in the figure 13 above) starting in 2003 at a level of 1.06% and arriving in 2013 at 1.26, with 2010, 2011 and 2013 as the most difficult years (Eurostat); but, considering that Italian economy is facing a relevant broke since then and that the national Real GDP average variation for the period 2004–14 faced an annual decrease of 0.5%(% change compared with the previous year) with as worst results -1.0 % in 2008, -5.5 in 2009, -2.8 in 2012, -1,7 in 2013 and -0.4% in 2014 (Eurostat), we can affirm that the slow growth of Italian GERD to GDP is due more to the decrease of the GDP than to an increase of R&D expenditure in the public sector.

Figure 14: Italy – R&D intensity projections: 2000–2020 (1) (IUC progress report 2014)



Source: DG Research and Innovation – Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, Member State
Notes: (¹) The R&D intensity projections based on trends are derived from the average annual growth in R&D intensity for 2007–2012.
(²) EU: The projection is based on the R&D intensity target of 3.0 % for 2020.
(³) IT: The projection is based on a tentative R&D intensity target of 1.53 % for 2020.

3.2 Italian performances in innovation

European Innovation Scoreboard 2016 identifies Italy as a Moderate Innovator with a performance relative to the EU in 2015 of 83%; the Summary Innovation Index (just to remember a composite index made calculated with 25 indicators) has increased steadily until 2011, experienced a decline in 2012, and increased again in 2013-2014, its performance declined slightly in 2015.

"Italy performs below the EU average in most dimensions, in particular in Finance and support and in Firm investments, with the worst relative performance in Venture capital investments and License and patent revenues from abroad. In the Innovators dimension, Italy performs better than the EU average." EIS 2016

Most of the indicators performed a growth last year, those that presented the biggest positive variation are *International, scientific co-publications* with a growth of 6.9%, *Non-EU doctorate students* with 13,9% (even though we are still really under the EU average performance) and *Licence and patent revenues from abroad* that grew of 19.3% (also in this indicator we are still 29% of the European performances); the indicator that registered the worst performance last year is *Venture capital investments* with an annual decrease of 19.3% (EIS 2016).

3.3 Italian structural weaknesses

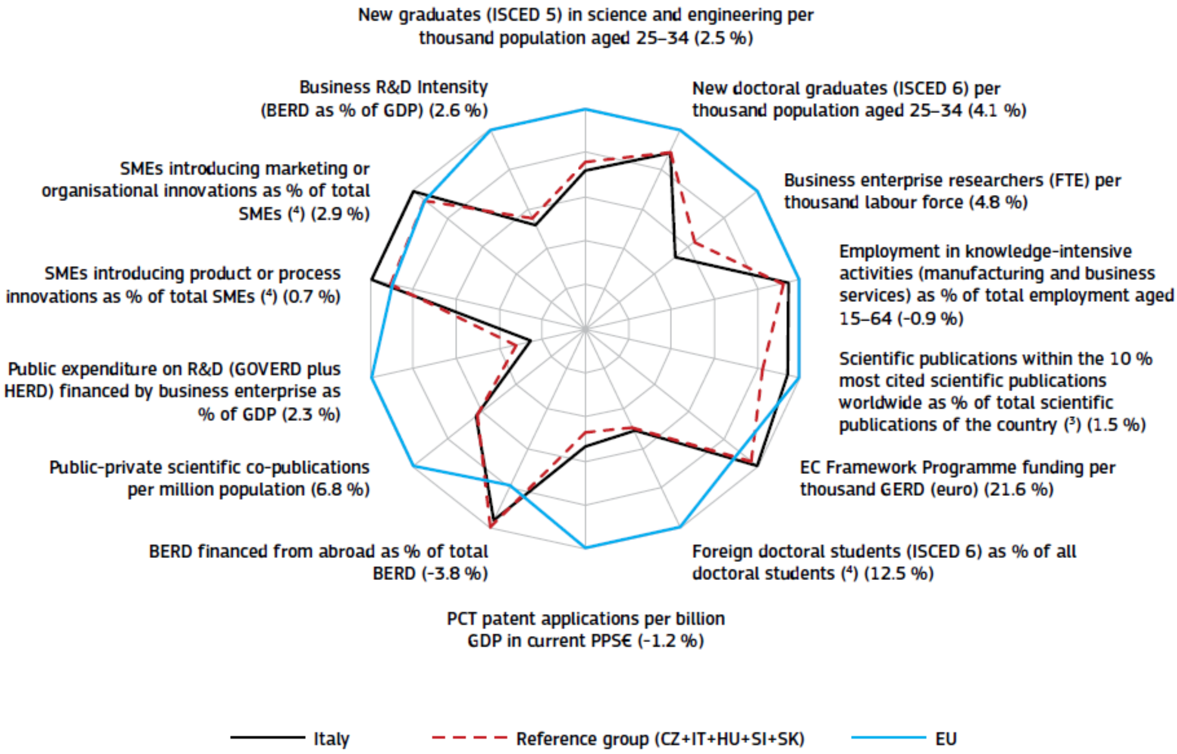
While reading the **"Innovation union progress at country level 2014"** I found the comment of the data about Italian R&I made by the author of the paper, commissioned by the European Commission, and it really impressed me because they used the identical words that we listen everyday in our news, they affirm: "both public and private R&D intensities remain a long way from those of its competitors at the technology frontier, thus undermining progress made towards a more efficient research system, and missing the opportunity for the country to move away from specialisation in low-technology-intensive products. Therefore, Italy should commit it self to increasing R&D intensity and improving business framework conditions for innovation and economic structural changes.
The Italian R&I system is still suffering from structural weaknesses, such as a low proportion of people with tertiary education and insufficient orientation of the education system towards technology intensive specialisations. Recent budget cuts have made this situation worse: the number of university professors has fallen across all departments, while the Italian system is no longer able to retain national researchers or attract foreign ones. At the same time, Italy's business environment is stifled by complex bureaucratic procedures. This causes significant delays which have a very negative impact on innovation, in particular, when market advantages are considered. In addition, the low availability of venture capital, and the difficult commercialisation of results are further obstacles to innovation. For all of these reasons, Italy remains a moderate innovator."

Despite the general situation is not satisfactory (our innovation performances are much under the EU's average) we have some positive features in R&I that encourage us in continuing on the road we are following:during the period 2008-2015 Italian innovation level has grown of 1,5%, the 7th best performance in the Union (EIS 2016);moreover, the innovativeness of small and medium-sized enterprises (SMEs) and the excellent quality of scientific outputs remain two important strengths within Italy's R&I system. This clearly indicates that the country has huge innovation potential which simply needs additional support to be fully exploited. (IUC 2014).

The graph below (figure 15) illustrates the strengths and weaknesses of the Italian R&I system (IUC 2014). Italian strength, as widely debated also in the national politics, is the economic structure composed by a lot of efficient SMEs (in absence of the big multinationals, which we are not able to attrract, the large business capacity of small territorial firms is still what characterizes our economy) with a great innovative attitude: Italy scores above the EU average for both SMEs introducing marketing and organisational innovations, and those bringing in product and process innovations (with a moderate but costant growth also in the period between 2017 and 2012); despite the great performances that our SMEs are producing how can we expext that a small familiary-run firm invests high share of revenues in R&I? This is shown in the graphic with the very low level in *expenditure on R&D financed by business enterprises as % of GDP*(only 0.013% of GDP, EU: 0.052%) and is affected also by the bad performance in *public-private scientific co-publication*, that are widely below the EU average. Public-private cooperation often occurs on an ad-hoc basis in the absence of well-developed networks and formal structures (i.e. knowledge-transfer offices) which could act as intermediaries between the public research sector and businesses.

The Italian economical system still suffers from a lack of skilled human capital: although the number of new graduates in science and engineering and new doctoral graduates increased between 2007 and 2012, Italy is still a long way from the EU average. This may also be related to the generally low share of citizens with higher education qualifications, which is a traditional weakness of the Italian system: in 2012, the proportion of people aged 30-34 years with tertiary education qualification was only 21.7 % (EU-28: 35.7 %). Furthermore, there is still a relatively high share of Italian researchers working in other EU countries and a relatively low share of non-national researchers in Italy. This alarming brain drain may become a further barrier to efforts to shift Italy's economy towards more knowledge-intensive and innovative activities. (IUC 2014)

Figure 15: Italy, 2012 (1) (In brackets: average annual growth for Italy, 2007–2012) (2) (IUC 2014)



Source: DG Research and Innovation – Unit for the Analysis and Monitoring of National Research Policies

Data: DG Research and Innovation, Eurostat, OECD, Science-Metrix/Scopus (Elsevier), Innovation Union Scoreboard

Notes: (1) The values refer to 2012 or to the latest available year.

(2) Growth rates which do not refer to 2007–2012 refer to growth between the earliest available year and the latest available year for which comparable data are available over the period 2007–2012.

(3) Fractional counting method.

(4) EU does not include EL.

4. Conclusions

Research, development and innovation are huge topics that contain several and different subtopics in them; I have tried to treat those that I consider the most important of these arguments, those that the paper of Cohen, Nelson and Walsh proposed.

Innovation is difficult to study because it is hard to quantify the exact output it produces: the external spillovers are endless and the results are relevant even more in the long run than in the short, that is why innovation is fundamental in our societies and it is so essential to study it.

Research and Development can bring to social progress and, above all, high revenues and profits to the companies that promote it and realize it with success; so, considering that, all companies should be really active in projecting and in putting into practice a R&D program; the problem is that it is very difficult to do so as it is incredibly expensive and requires enormous economical and intellective resources.

The fact that a firm innovates (with success) is an added value to the Region and the State where this company is located. The growth of revenues (with the connected taxes), the possibility of more hires, the growth of GDP, the attractiveness of new capitals, the possibilities of connections with the local educative system, the indirect spillover of knowledges and so on. In conclusion what is actually the role of the Public Institutions in this process?

The paper "Links and Impacts: The Influence of Public Research on Industrial R&D" demonstrated that public research is essential in the completion of the industrial projects and is not irrelevant even in suggesting new projects, moreover in manufacturing sectors that require high level of technology as pharmaceutical, mining and high tech. They showed that research findings, prototypes and new instruments and techniques produced by public research contribute to industrial R&D.

Analyzing the situation in Europe concerned with R&D, EU is well behaving in the field of innovation with a constant growth of the ambitiousness of the commitments and of innovation level in the majority of the Union; differences inside Europe are still evident but the political situation from which we come make homogeneity impossible. My opinion is that innovation in the EU is following the status of the Institutions and that will improve following the completion of the Union project; the process we are going through is long and difficult but I think it is the correct one. When we have central Institutions with full power also innovation will benefit from this and all the Member State will face a batter situation in the world of innovation.

The situation in Italy is different: we are slowly growing but our level of innovation is still under the European average; public expenditure is very low and we don’t have big firms in strategic sectors, for example high technologies, able to lead national R&D; we don’t attract FDI due to our slow bureaucracy, high level of taxes and corruption; the level of human resources with the numbers of new doctorate graduates is worrying, the population that completed tertiary education and the youth with upper secondary level of education are widely under the European average.

Our strengths are still our SMEs that innovate better than its European competitors, but it is impossible to ask them to invest even more, the solution could be a better cooperation with the public structures or a stronger collaboration between them.

5. References

EUROPEAN COMMISSION, 2016. *European Innovation Scoreboard 2016*.

EUROPEAN COMMISSION, 2014. *European Research Area, Facts and Figures 2014, Italy*.

EUROPEAN COMMISSION, December 1995. *Green Paper on Innovation*.

EUROPEAN COMMISSION, March 2015. *Horizon Magazine, Special Issue, EU Research Framework Programmes, 1984-2014.*

EUROPEAN COMMISSION, 2013. *Innovation Union, A pocket guide on a Europe 2020 initiative.*

EUROPEAN COMMISSION, 2013. *Innovation Union Competitiveness report 2013*.

EUROPEAN COMMISSION, November 2014. Le Politiche dell'Unione Europea, Ricerca e Innovazione.

EUROPEAN COMMISSION, 2014. Research and Innovation performance in the EU, Innovation Union progress at country level, 2014.

EUROPEAN COMMISSION, November 2014. *The European Union Explained, Europe 2020: Europe's growth strategy*.

EUROSTAT POCKETBOOKS, 2013. *Science, technology and innovation in Europe. 2013 edition*.

ORLANDO MICHAEL, 2002. *Measuring R&D spillovers: on the importance of geographic and technological proximity*.

RODRIGUEZ-POSE, ANDRES AND CRESCENZI, RICCARDO (2008) *Research and development, spillovers, innovation systems, and the genesis of regional growth in Europe*. Regional studies, 42 (1). pp. 51-67. ISSN 0034-3404.

RON BOSCHMA, 2005. *Proximity and Innovation: A Critical Assessment.*

RUSTEN GRETE, OVERA RAGNHILD, 2014. *Local and Global Geographies of Innovation: Structures, Processes, and Geographical Contexts from a Firm Perspective.*

WESLEY M. COHEN, RICHARD R. NELSON, JOHN P. WALSH, 2002. *Links and Impacts: The Influence of Public Research on Industrial R&D*.

Websites

http://ec.europa.eu/eurostat/statistics-explained/index.php/R_%26_D_expenditure

http://ec.europa.eu/eurostat/statistics-explained/index.php/National_accounts_and_GDP

http://startupguide.com/tag/history-of-innovation/