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The Digital Basic Capacities in the Innovation Union Scoreboard: Exploring Key But Yet Directly Missing Inputs

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Abstract: The Innovation Union Scoreboard is an instrument of the European Commission developed under the Lisbon Strategy to provide a comparative assessment of the innovation performance of EU Member States. It can be observed that this composite indicator does not take into account any digital related data, though it has been revised after the adoption of the Europe 2020 Strategy, that do consider the digital economy as a crucial innovation factor for Europe. Indeed, the digital agenda is one of the 7 strategic pillars of the Horizon2020 European policy. The methodology consists of the analysis of the correlations between the Innovation Union Scoreboard database and the database of another European Commission's composite indicator: An early analysis confirms the weight of the digital human capital in the national Innovation Systems and further analyses should pave the way for a better understanding of the relations between the basic digital capacities and the actual Innovativeness

Key words: innovation system; digital data; innovation performance; indicators; Europe; ICT
JEL codes: O30, O34, O35

1. Introduction

The annual Innovation Union Scoreboard provides a comparative assessment of the research and innovation performance of the EU Member States (European Commission, 2011). The Scoreboard is a useful, non-binding tool that helps Member States to assess the strengths and weaknesses of their research and innovation systems and see where to concentrate efforts to boost their innovation performance (European Commission, 2013a). On a more limited number of indicators, available internationally, it also covers Australia, Brazil, Canada, China, India, Japan, Russia, South Africa, South Korea and the US. The Innovation Union Scoreboard 2015 comes with an additional analysis that ranks the Member States on individual indicators.

The Innovation Union Scoreboard aims to cover the innovation system as a whole, analyzing both public and private sectors' innovation capacities. The scoreboard captures a total of 25 different indicators, which aims at encompassing the external conditions for innovation, the level of firms own innovation activity and how this is translated into benefits for the whole economy (European Commission, 2013b).

The Digital Agenda presented by the European Commission forms one of the seven pillars of the Europe 2020 Strategy which sets objectives for the growth of the European Union by 2020. The Digital Agenda proposes

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to better exploit the potential of Information and Communication Technologies in order to foster innovation, economic growth and progress. The Digital Single Market strategy aims to open up digital opportunities for people and business and enhance Europe's position as a world leader in the digital economy.

The digital agenda tackles a set of problems that have been identified as barriers to generate smart, sustainable and inclusive growth in Europe:

- fragmented digital markets;
- lack of interoperability;
- rising cybercrime and risk of low trust in networks;
- lack of investment in networks;
- insufficient research and innovation efforts;
- lack of digital literacy and skills;
- missed opportunities in addressing societal challenges.

Having said this, the great lines of this Agenda can be presented:

- Achieving the digital single market

A Digital Single Market is a market in which the free movement of persons, services and capital is ensured and where the individuals and businesses can seamlessly access and exercise online activities under conditions of fair competition, and a high level of consumer and personal data protection, irrespective of their nationality or place of residence.

- Enhancing interoperability and standards

The EU must enhance the interoperability of devices, applications, data repositories, services and networks. In order to do this, it is essential that the Commission continue the review of its standard-setting policy. Moreover, it must promote appropriate rules for intellectual property rights.

- Consolidating online trust and security

Europe must strengthen its policy in order to be able to avoid the proliferation of child pornography, the appearance of breaches of privacy, to fight against cybercrime, and to ensure a proper protection of personal data. The Commission has presented measures on network and information security and the fight against cyber-attacks. Related to data protection, following the Snowden and the NSA scandals, the European Union has recently adopted the new directive 2016/679, which modifies substantially the rules governing the treatment of personal data, and enhances the cooperation between the Member States. Another significant move has been the annulation by the European Court of Justice of the Safe Harbor Treaty laying down rules concerning data protection imposed on Americans companies. Since then, a new settlement has been adopted, more protective towards the personal data of Europeans. In parallel, Member States should take measures to establish a well-functioning network at national level and carry out large-scale cyber-attack simulations. National alert platforms should be adapted to the Europol cybercrime platform.

- Promoting fast and ultra-fast Internet access for all

Europe needs competitively priced fast and ultra-fast Internet access for all. In this regard, the EU is to establish next generation access networks (NGAs). The Commission intends to use European funds (ERDF or EAFRD, in particular) in order to finance investment in broadband. The Commission will also reinforce its radio spectrum policy.

- Investing in research and innovation

Europe must make up for its lack of investment in research and development in ICTs, which is still insufficient in Europe compared to its major trading partners. The Commission therefore intends to encourage private investment and to double public expenditure to develop ICTs.

- Enhancing digital literacy, skills and inclusion

Although the Internet is part of daily life for many European citizens, some categories of the population are still excluded from media literacy in the digital environment. Furthermore, the EU is hampered by a shortage of ICT practitioner skills. In order to promote employment in the ICT field, the Commission proposes to give priority to digital literacy and skills through the European Social Fund. It also wishes to develop tools to identify and recognize the skills of ICT practitioners and users. The aim is to set up a European framework specially designed for ICT professionalism. In order to overcome unequal access to digital literacy by European citizens, Member States should promote e-accessibility in particular when applying the Audio-visual Media Services Directive.

- Leveraging smart use of technology for society

The European Union must exploit the potential offered by the use of ICTs in climate change — through partnerships with emitting sectors; in managing ageing populations — through e-health and telemedicine systems and services; in digitalization of content and in intelligent transport systems.

Taking into consideration that the Digital Agenda is a key part of the European Horizon2020 strategy, it must be pointed out that the Innovation Union Scoreboard, though updated every year, does not take into account any digital related indicator. Furthermore, a simple quote analysis of the one hundred-page 2015 Innovation Union Scoreboard report, that is published with the composite indicator and aims at giving a first general interpretation, reveals that:

- The word digital is not mentioned,

- Neither is the word internet.

It can be concluded that the digital considerations are totally absent from the elaboration and analysis of the scoreboard. And thus, it seems that a first incoherence appears here between the European priorities and its favorite tool to monitor innovation in the Zone.

2. Theoretical Framework

This paper is not the first investigation work questioning the Innovation Union Scoreboard elaborated by the European Commission (Archibugi et al., 2009; Zabala-Iturriagagoitia et al., 2007b; Grupp & Mogee, 2004). Indeed, as a composite indicator, many papers have already demonstrated the limits of such an indicator. For example, Foray and Hollanders (2015); Mahroum and Al-Saleh (2013); Nuno Buavida (2011); Zabala-Iturriagagoitia et al. (2007a) showed that:

- Innovation composites are being constructed according to several different debatable methodologies. Composites are designed not to measure innovation but to raise social awareness and/or influence decision making.
- Innovation composites measure a simplified non-possible to isolate part of a complex reality. The abstraction presents dangers to society.
- Innovation composites influence technology decisions. This influence varies according to the social and political status of actors and with different levels of complexity.
- The political choices for composite indicators set will frame technology policy options and decisions (e.g., SII's public-private co-publications of ISI papers).

- The ability to properly deal with innovation metrics will depend on the expertise available to technology decision makers (e.g., experts and consultants in the Portuguese Technological Plan).

Also, the recent paper from Charles Edquist and Jon Mikel Zabala-Iturriagagoitia (2015) called The Innovation Union Scoreboard is Flawed: The case of Sweden — not being the innovation leader of the EU showed that one had to take some distance with this scoreboard that for example ranked Sweden in 2015 as the first country whereas if one considers as a right indicator for the efficiency of the innovation system the ratio of output indicators to input indicators, Sweden not only would lose the first place but would sink to the bottom of the ranking.

Thus this investigation work falls within this context.

There is in the scientific literature of Innovation systems (Gómez Uranga et al., 2014; Samara et al., 2012; Edquist, 2011, 2005; Hagedoorn & Cloodt, 2003; Furman et al., 2002) understanding a classic distinction of two different elements that drives Innovation: on the one hand the pure creation of new ideas, technologies, processes, knowledge and on the other hand the absorption of outside pre-existing technologies. Both contribute to the innovation of the countries even if the absorption of outside existing technologies is often forgotten (Bresciani et al., 2016; Cao et al., 2013).

This work will not deal with the latest digital technologies but on the contrary with the basic digital technologies and skills a country must have to be innovative. In this line it can be cited as an example one of the most famous: Absorptive capacity: A new perspective on learning and innovation of WM Cohen and DA Levinthal (1990). In what follows, it will be used as measures of this basic digitalization of European countries another indicator developed by the European Commission: The Digital Economy and Society Index (DESI). It is a composite index that summarizes relevant indicators on Europe's digital performance and tracks the evolution of EU Member States in digital competitiveness.

3. Investigation Objective, Investigation Methodology

The main objective of this paper is to investigate the relation between the basic digital capacities of a European country and the performance of its national innovation system. Also, this work aims at questioning the favorite European Commission tool to monitor the Innovativeness of its countries regarding the absence of direct digital-related indicators. Thus a last objective would be to study the potential integration of digital data in the Innovation Union Scoreboard.

This methodology used is a mix of a quantitative and qualitative approach. Indeed, this work consists of confronting two similarly structured databases with a simple correlation method and then analyzing what those databases point out in the light of the established scientific literature.

3.1 Databases

As already said, the two databases that are going to be confronted are on the one hand the Innovation Union Scoreboard database and on the other hand the DESI database. There are some great advantages of using these data:

- They have the same structure which permits us to have a better understanding of the results and to adopt a more efficient comparative approach,

- Both present robust and verified data. Indeed, they come from reliable sources and enable us to construct an analysis based on solid and concrete information.

- The European Commission is the one diffusing the whole dataset, and it makes sure to include the raw data and not only the standardized indicator,

- We have access to a couple of years' time set, which can help us verify the data,

- Both indicators come with a great report, that helps us understand every indicator. Indeed, as an example, the Innovation Union Scoreboard 2015 consists of a document of almost a hundred pages. Every indicator is thus explained and analyzed, helping us to have a better understanding of the situation laid down.

- The Innovation Union Scoreboard database:

The Innovation Union Scoreboard 2015, the 14th edition since the introduction of the European Innovation Scoreboard in 2001, follows the methodology of previous editions. Innovation performance is measured using a composite indicator — the Summary Innovation index – which summarizes the performance of a range of different indicators. The Innovation Union Scoreboard distinguishes between 3 main types of indicators — Enablers, Firm activities and Outputs — and 8 innovation dimensions, capturing in total 25 indicators.

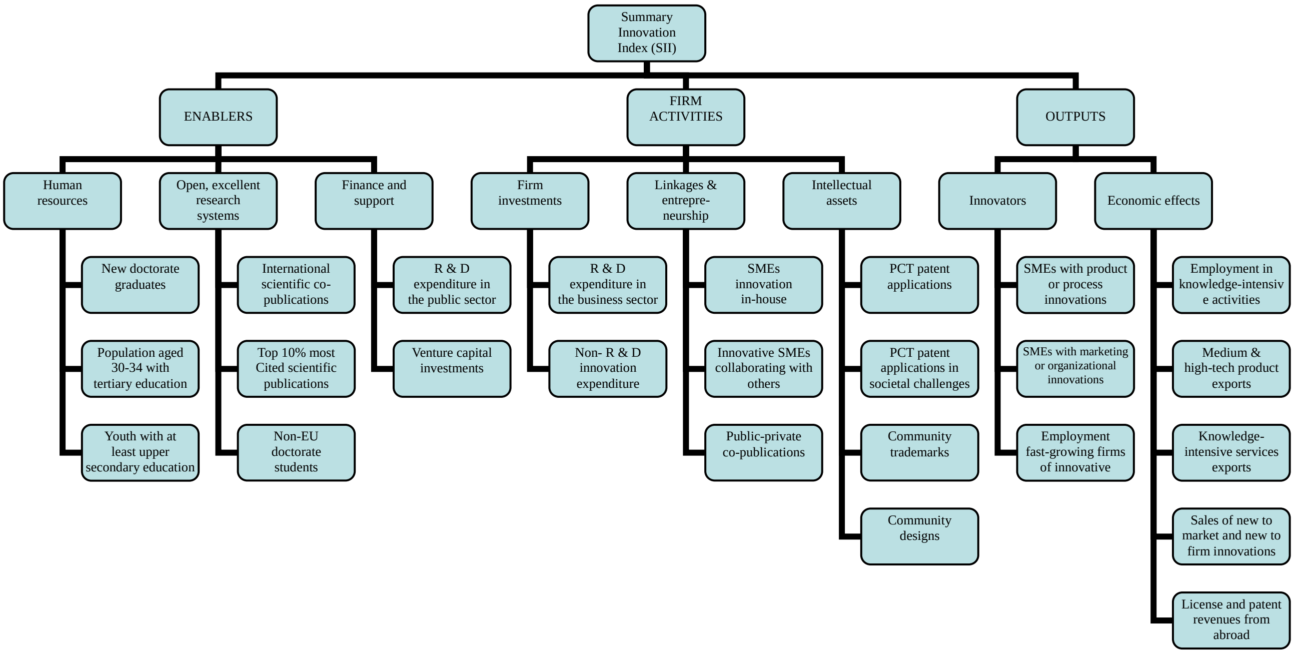

Figure 1 The Measurement Framework of the Innovation Union Scoreboard

Source: European Union (2014, p. 8).

- The Enablers capture the main drivers of innovation performance external to the firm and differentiate between 3 innovation dimensions.

The first innovation dimension is "Human resources" and it includes itself 3 indicators. It measures the availability of a highly-skilled and educated workforce. Data are collected on the number of new doctorate graduates, the proportion of population aged between 30-34 who have completed tertiary education and the proportion of population aged between 20 and 24 who have completed at least upper secondary education.

The second innovation dimension is "Open, excellent and attractive research systems" and includes 3 indicators. It measures the international competitiveness of the science base by focusing on International scientific co-publications, most cited publications and non-EU doctorate students. Finally, the last innovation dimension is 'Finance and support. It includes 2 indicators and measures the availability of finance for innovation projects by Venture capital investments and the support of governments for research and innovation activities by R&D

expenditures by universities and government research organizations.

- Firm activities capture the innovation efforts at the level of the firm and differentiate between 3 innovation dimensions. “Firm investments” includes 2 indicators of both R&D and Non-R&D investments that firms make in order to generate innovations. “Linkages & entrepreneurship” includes 3 indicators measuring innovation capabilities by looking at Small and Medium Enterprises (SMEs) that innovate in-house and collaboration efforts between innovating firms and research collaboration between the private and public sector. “Intellectual assets” captures different forms of Intellectual Property Rights (IPR) generated as a throughput in the innovation process including patent applications, Community trademarks and Community designs.

- Outputs capture the effects of firms’ innovation activities and differentiate between 2 innovation dimensions. The first innovation dimension is denominated ‘Innovators’ and includes 3 indicators measuring the share of firms that have introduced innovations onto the market or within their organizations, covering both technological and non-technological innovations and Employment in fast-growing firms of innovative sectors. The second innovation dimension is called “Economic effects” and include 5 indicators and captures the economic success of innovation in Employment in knowledge-intensive activities, Exports of medium and high-tech products, Exports of knowledge-intensive services, Sales due to innovation activities and License and patent revenues from selling technologies abroad.

- The DESI database:

The Digital Economy and Society Index (DESI) measures progress of EU countries towards a digital economy and society. As such, it brings together a set of relevant indicators on Europe’s current digital policy mix.

The index allows four main types of analysis:

- General performance assessment: it aims at obtaining a general characterization of the performance of individual members States by observing their overall index score and the scores of the main index dimensions.
- Zooming-in: to pinpoint the areas where member state performance could be improved by analyzing the scores of the index’s sub-dimensions and individual indicators.
- Follow-up: to assess whether there is progress over time and to make a comparison with the previous situation. It gives indication on which recommendations have been followed and applied and on which area a Member State has to keep innovating.
- Comparative analysis: It is not sufficient to focus analysis only on the evolution produced in one Member State but it is very useful to carry a comparative approach between the Member States themselves. The comparative analysis thus clusters member states according to their index scores, comparing countries in similar stages of digital development so as to flag the need for improvement in relevant policy areas.

The DESI was developed following the guidelines and recommendations in the Organization for Economic Co-Operation and Development’s “Handbook on constructing composite indicators: methodology and user guide”. The data included in the index were mostly collected by the European Commission services (DG CoNECT, Eurostat), with the exception of two indicators collected by ad-hoc studies launched by the Commission services.

The DESI has a three-layer structure as depicted in Table 1. It is composed of 5 principal dimensions, each divided in a set of sub-dimensions, which are in turn composed by individual indicators.

Table 1 DESI Structure

1. Connectivity	1a Fixed Broadband	1a1 Fixed BB Coverage
		1a2 Fixed BB Take-up
	1b Mobile Broadband	1b1 Mobile BB Take-up
		1b2 Spectrum
	1c Speed	1c1 NGA Coverage
		1c2 Subscriptions to Fast BB
	1d Affordability	1d1 Fixed BB Price
2. Human Capital	2a Basic Skills and Usage	2a1 Internet Users
		2a2 Basic Digital Skills
	2b Advanced skills and Development	2b1 ICT Specialists
		2b2 STEM Graduates
3. Use of Internet	3a Content	3a1 News
		3a2 Music, Videos and Games
		3a3 Video on Demand
	3b Communication	3b1 Video Calls
		3b2 Social Networks
	3c Transactions	3c1 Banking
		3c2 Shopping
4. Integration of Digital Technology	4a Business digitalization	4a1 Electronic Information Sharing
		4a2 RFID
		4a3 Social Media
		4a4 eInvoices
		4a5 Cloud
	4b eCommerce	4b1 SMEs Selling Online
		4b2 eCommerce Turnover
		4b3 Selling Online Cross-border
5. Digital Public Services	5a eGovernment	5a1 eGovernment Users
		5a2 Pre-filled Forms
		5a3 Online Service Completion
		5a4 Open Data

At high level the DESI addresses the five principal policy areas of concern for a digital economy and society. These are not isolated areas that contribute separately to digital development but are in fact interconnected. As a consequence of this interdependence between the areas, developments in the digital economy cannot be achieved through isolated improvements in particular areas but through concerted improvement in all areas. For methodological and data availability reasons, DESI 2016 presents structural changes when compared to DESI 2015.

- Connectivity dimension

A necessary condition for the development of a digital society is the ability of its members to enjoy a complete and efficient connection to the Internet. Nowadays however, a simple Internet connection is no longer sufficient. In order to benefit from the full spectrum of developments brought by the Internet, a high-speed Internet connection starts to be desirable, if not mandatory. Hence connectivity is a necessary infrastructure of the digital economy and society.

- Human Capital Dimension

Having a connection to the Internet is not sufficient; it must be paired with the appropriate skills to take advantage of the Internet and of the myriad of possibilities unravelled by a digital society. Those skills go from basic usage skills that enable individuals to take part in the digital society and consume digital goods and services, to advanced skills that empower the workforce to develop new digital goods and services and to take advantage of technology for enhanced productivity and economic growth. Digital skills are also a necessary infrastructure for the digital economy and society.

As an example, nowadays, digital formation is becoming a basic and indispensable subjects taught in numerous schools.

- Use of Internet Dimension

Citizens that are empowered with an Internet connection and the necessary skills to take advantage of it can engage in a wide range of online activities. These can be through consumption of online content (e.g., entertainment such as music, movies, TV or games, obtaining media-rich information or engaging in online social interaction), through modern communication activities (e.g., performing video-calls), or through e-Commerce. Nowadays this mix of activities can only be enjoyed to its fullest by using the high-speed connectivity provided by a broadband subscription. Hence, these content-rich activities are among the drivers of the development of broadband networks. On the demand side, it is the possibility to perform these activities that drives users to subscribe to broadband connections. On the supply side, it is the need for the network capacity and speed to support such services that drives the supply of faster networks and better content delivery facilities.

- Integration of Digital Technology Dimension

On the business side, digitization is one of the main contributors to enhance economic growth. Adoption of digital technology (among which are new technologies such as Cloud, Big Data, or the Internet of Things) to enhance efficiency, reduce costs or allow for closer engagement with customers, collaborators or business partners is becoming a mandatory requirement for being competitive. This, together with the ability to use the Internet as a sales outlet, can contribute significantly to the modernization of businesses and, ultimately, to their success.

However, the integration of these technologies in the business sector cannot happen without the appropriate infrastructure, whether it is the availability of fast Internet or the availability of skilled workers in the labour market.

- Digital Public Services Dimension

Business and citizen interaction with the Public Sector can be improved and made significantly more efficient through the use of digital technologies. Such efficiency gains can be seen both on the side of the Public Administration as well as on the business side. Public Administration can take advantage of technology to better address an ever more demanding set of business and citizen needs while at the same time realizing significant cost reductions. With better and more streamlined Public Services, citizens and businesses gain in efficiency, both due to more functionality as well as to reductions in time spent. Furthermore, the use of electronic systems in areas such as public procurement or taxation can lead to significant gains streamlining processes and increasing efficiency, improving transparency, and reducing the room for corruption or evasion.

3.2 Correlations and Ranking Correlations

For the moment, the study has been done with the most familiar measure of dependence, “Pearson’s correlation coefficient”, commonly called simply “the correlation coefficient”. It tests the linear hypothesis between the variables we want to explain (The Innovation Union Scoreboard indicators) and the independent variables (the DESI indicators). From a pure statistical point of view, it would be easier and more accurate to only use ranking correlations as one has not to assume a normal distribution of the considered variable. As a consequence, a further work should repeat this study with ranking correlations. But it can be fairly hoped that results will be similar. A benefit of only using Pearson's correlation is that it is more widely used and thus this work will be more easily understood. Thus the first step has been to build a table of correlation between every one of the DESI and Innovation Union Scoreboard sub-indicators. You'll find here a graphic representation of the second layer correlation table (not going down to the third layer of the indexes which is the Sub-indicator layer):

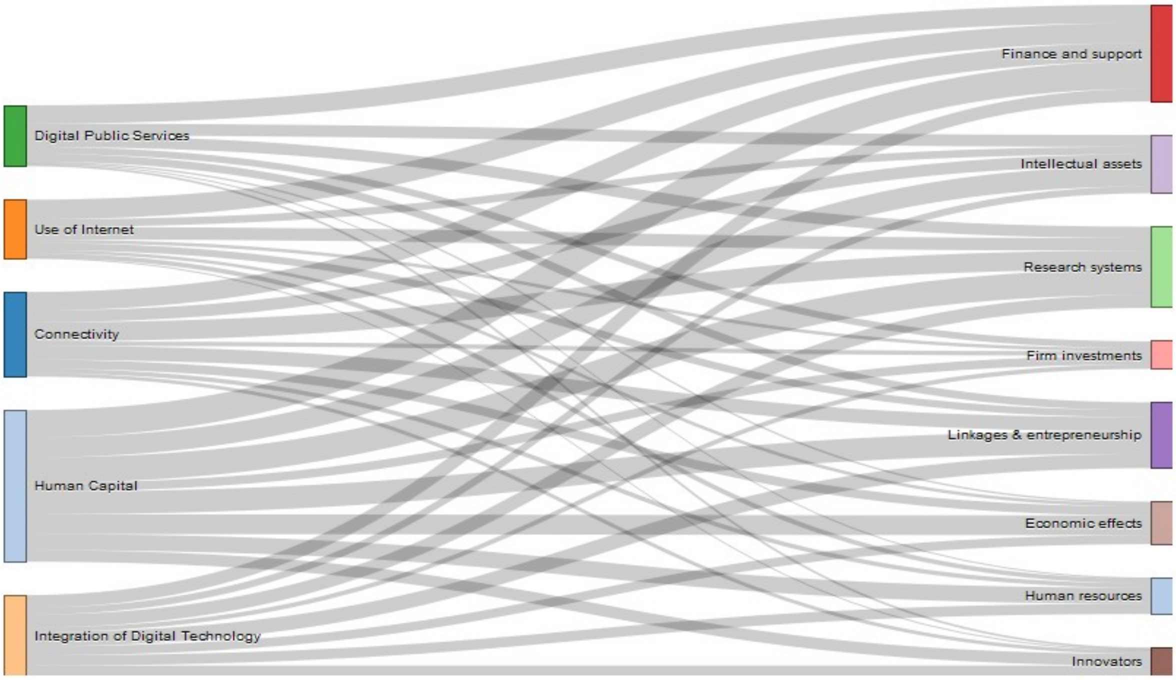

Figure 2 Graphic Representation of the Second Layer Correlation Table

3.3 Qualitative Analyses Based on Specific Literature

Then, this work keeps going back and forth between the regressions that stand out and what would have predicted by the related literature.

With these mixed quantitative and qualitative analyses and thanks to a great critical sense, this work aims at responding to the following set of investigation questions:

(1) What digital basic capacities are determinant for the innovation system of a country and how do they actually impact?

Hypothesis: The Human Capital dimension is to have a great weight in the Innovation Union Scoreboard results explanations.

(2) What Innovation Union Scoreboard sub indicators can be directly related to digital capacities?

Hypothesis: They must mainly belong to the input dimensions (enablers).

(3) How can the Innovation Union Scoreboard be redesigned to integrate direct digital input? What would that change in its analysis?

4. Results

A first result directly from the first layer analysis: the correlation between the Innovation Union Scoreboard macro-indicator and the DESI one:

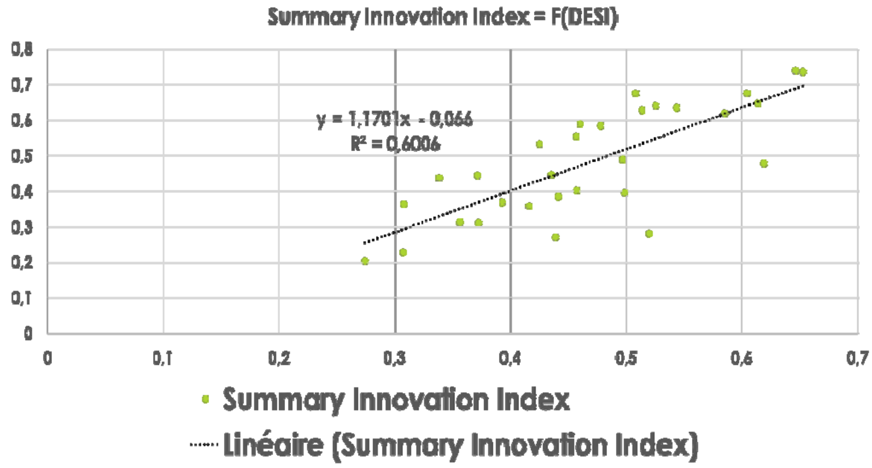

Figure 3　Linear Regression between the Innovation Union Scoreboard Macro-Indicator and the DESI One

We can observe the high correlation coefficient R2 > 0.6 confirms the genuine observation of both rankings:

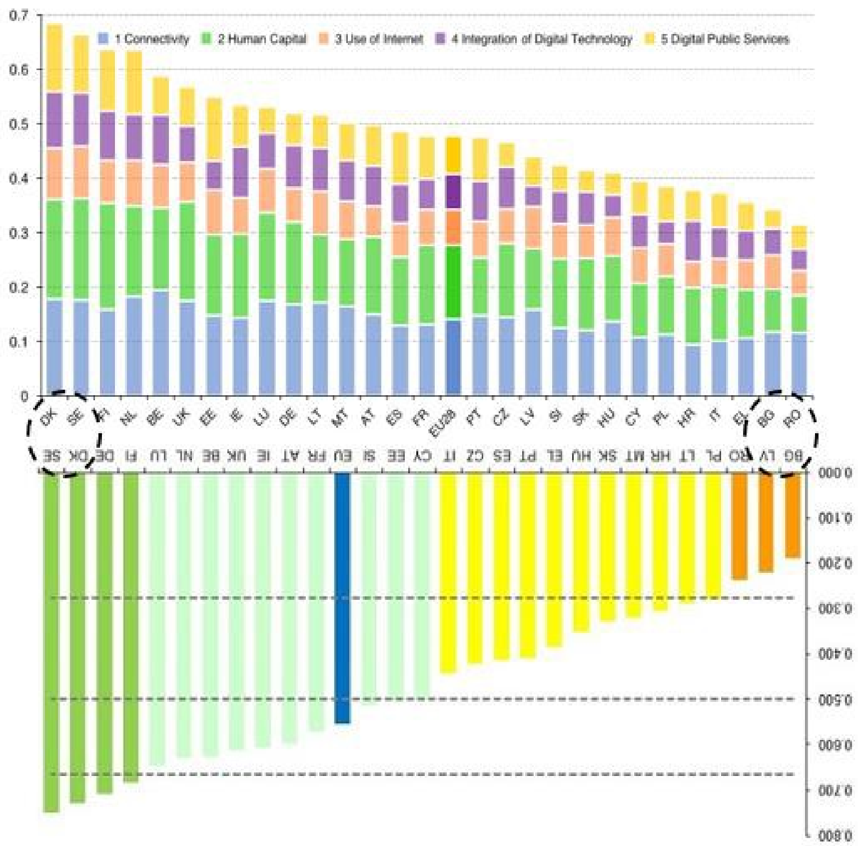

Figure 4　DESI (Top) and IUS (Bottom) Ranking Similitudes

So we can study more in the details of what relations are responsible for these high correlations.

4.1 What Digital Basic Capacities Are Determinant for the Innovation System of A Country and How Do They Actually Impact?

This question particularly aims at understanding, within the DESI dimensions and indicators, what are the key elements responsible for Innovation. In other worlds, the digital indicators that show the greatest correlations with the Innovation Union Scoreboard ones should basically be more closely related to innovation. However, one has to be careful not to claim that it means that they are the factors that impact the most on the innovation systems as the direction of the cause to consequence effect can't be proved without time sets. However, the scientific literature (Edquist, 2014a, 2014b, 2014c; Frane, 2014) can help us understand the mechanisms under these relations.

So, if one has a closer look at the Figure 3, he can observe that there is a digital dimension that clearly stands out: Human Capital.

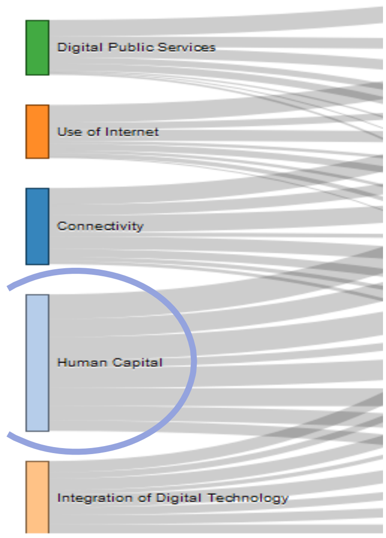

Figure 5 The Human Capital Dimension Shows the Greatest Correlation Coefficients with the Innovation Union Scoreboard Dimensions

As a reminder, the dimension englobes skills to take advantage of the possibilities unravelled by a digital society. Those skills go from basic usage skills that enable individuals to take part in the digital society and consume digital goods and services, to advanced skills that empower the workforce to develop new digital goods and services and to take advantage of technology for enhanced productivity and economic growth.

Before analyzing the specific literature or the relation between digital Human Capacity and the performance of an Innovation system, let's detail what are the indicators at stake:

- Basic Skills and Usage

The Basic Skills and Usage sub-dimension captures the digital skills level of the general population. In particular, it assesses whether citizens are able to use the Internet and use it on a regular basis through the Internet Users indicator.

- Advanced skills and Development

The Advanced skills and Development sub-dimension concerns the workforce and its potential to maintain and to help to the expansion of the digital economy. It takes into account the percentage of people in the workforce with ICT (Information and Communication Technologies) specialist skills and the share of the population with STEM (science, technology, engineering and mathematics) education.

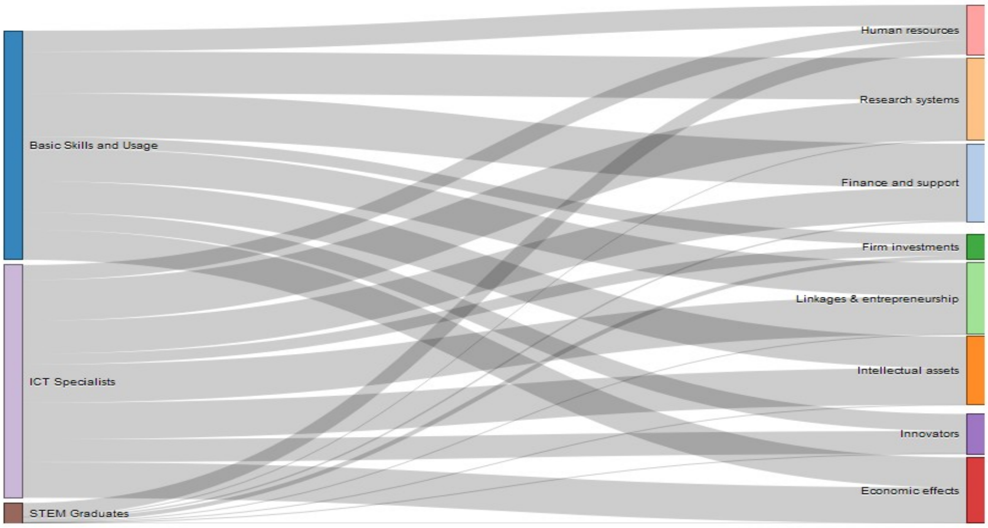

Figure 6 Human Capital Sub-Indicators Correlation Weights with the Innovation Union Scoreboard Dimensions

Here it can be pointed out that the basic skills and usage and the ICT specialist skills are highly dependent on the innovation system and that the proportion of the population with STEM (science, technology, engineering and mathematics) education has a much lower interaction.

- Basic skills and Usage: The number of internet users in the population continues to increase, with 75% of the EU population reporting that they used the internet at least weekly in 2014. For most people, the use of the Internet is a daily activity, with 65% of EU citizens reporting using it daily in 2014. The proportion of disadvantaged person using the Internet has also known a steady rise with 60% reporting using the internet at least weekly in 2014. As such, the Digital Agenda targets on Internet use have been met before the date of 2015. If past trends persist, it can be expected that by 2024, 90% of the EU population will be regular internet users.

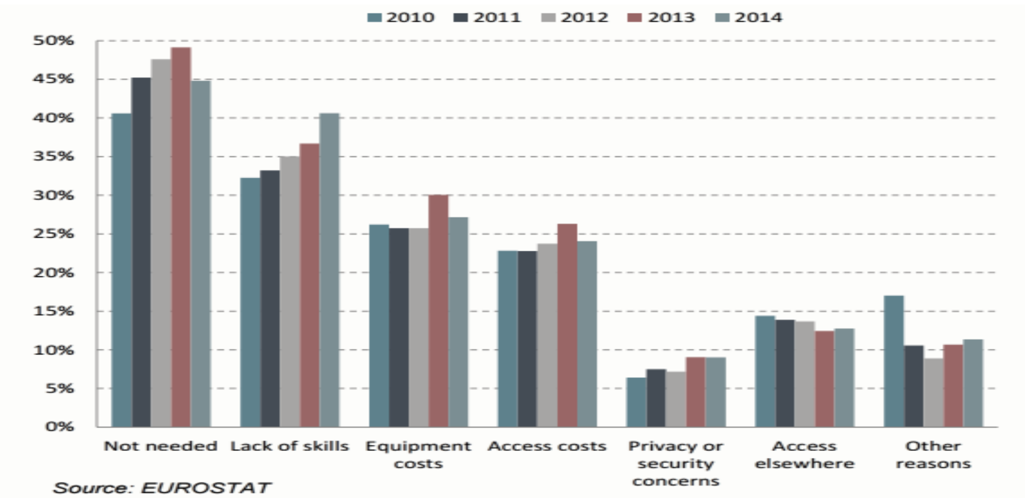

Figure 7 Barriers to Internet Access at Home in the Eu28 (% Households without Internet)

- ICT specialist skills: On average ICT specialist employment has grown over 4% a year over the last decade. By contrast, total employment has been falling since the onset of the crisis in 2008. Over the period 2004-2013 employment of ICT specialists (ISCO codes 25 and 35 plus ICT graduates in certain adjacent ISCO codes) in the EU-28 grew significantly by 2.4 million; from around 4 million in 2004 to 6.4 million in 2013. This has been provoked by an increase in the share of ICT employment in total employment from 1.9% to 3% over this period. On average, ICT employment growth was more than 4% per year over this (allowing for the break in the series in 2010-2011). By contrast, the average growth rate of total employment has been 0.4% p.a. over this period and overall employment has been continuously falling since the onset of the crisis in 2008.

This having been said, it can be observed more in detail with what Innovation Union Scoreboard dimension those digital indicators are correlated and then look into the scientific literature (Brenner, 2014; Makkonen & van der Have, 2013; Brenner & Broekel, 2009) to see whether an explanation of their inter-influence can be found.

For example, let's analyze the innovation dimensions; these two digital indicators have strong correlations with:

- Research system

As a reminder, Open, excellent and attractive research systems include 3 indicators and measures: the international competitiveness of the science base by focusing on International scientific co-publications, Most cited publications and Non-EU doctorate students. One should go down one more layer and detail how is the weight structure with these 3 indicators.

- Finance and Support

It includes 2 indicators and measures the availability of finance for innovation projects by Venture capital investments and the support of governments for research and innovation activities by R&D expenditures by universities and government research organizations. The Literature obviously gives relevant information here as it has been showed that public R&D investments directly impact on the formation of ICT specialists.

But can the relation with the basic skills be explained?

To analyze that, one can go back to the Figures.

Table 2 R2 Correlation Table

R2 coefficient	Internet users	ICT specialist skills
Venture capital	**0.56**	0.43
Public R&D expenditure	**0.45**	0.35

Surprisingly, there appears a strong relation between Public and private propensity to invest risk capital and the digital behaviour of the citizens.

Thus, literature revision has been extended in order to bring up more valuable elements of understanding.

First of all, the geography of the Internet Industry: Venture Capital, Dot-coms, and Local Knowledge develops how Venture capital does play a key role in the internet industry because of the tacit (non-codified) knowledge it transmits and leads to use. Indeed, by explaining how the regional distribution of venture capital investing plays a central role in determining the location of new Internet start-ups, the author, Matthew A. Zook, proves that Venture capital, rather than being an easily moved and fungible commodity, highly depends upon non-monetary inputs such as knowledge and digital human capital:

"They theorize venture capital as a third way in Schumpeter's dichotomy of corporate versus individual entrepreneurism (Florida & Kenney, 1988a) and argue that venture capitalists act as catalysts or "technological gatekeepers" who facilitate and direct innovation in regions with strong social structures of innovation, i.e., concentrations of human capital, universities and public research and development (Florida & Kenney, 1988a, 1988b)".

Thus, it can be pointed out that venture capital on the one hand tends to concentrate in regions where digital human capital is stronger because it relies on tacit exchanges that reduce the inner risk of this kind of investment. But also, this paper develops that venture capital generates enormous local spillovers as early knowledge ones that would provide the Internet industry with an advantage in developing quickly and more particularly an advantage in developing human capital through tacit knowledge.

Also, in order to understand the relations between digital human capital and risky investments, one has to integrate cultural factors in the analysis. If countries that have developed digital skills are more likely to have the best venture capital investment, it could be that cultures with higher tendency to take risks are more likely to absorb new technologies and use them on a daily basis. On this subject, Yvonne M. van Everdingen and Eric Waarts, in The Effect of National Culture on the Adoption of Innovations, investigate the role of national culture (i.e., a macro-level variable) to explain differences in adoption rates across countries. In particular, they investigate the effects of the five Hofstede culture dimensions and the culture dimensions proposed by Hall on country adoption rates. Results indicate that variables describing national culture have a significant influence on the country adoption rates.

Eventually, one has to have in mind a crucial paper that strongly and directly backs the correlation between the percentage of use of internet in a society and the performance of its Innovation system: Beyond the Digital Economy: A Perspective on Innovation for the Learning Society (Conceição et all, 2000). It shows that a fundamental change at the start of the new millennium is the increasing importance of knowledge for economic prosperity and the emergence of a learning society. Indeed, the analyzes argues that Innovation should be understood as a broad social and economic activity within the framework of that society: it should be tied to attitudes and behaviours oriented towards the exploitation of change by adding value. And the use of internet is typically one of those crucial behaviours that fuel Innovation.

Thus we have analyzed a correlation result that seemed interesting between Digital human capital and the Finance and support dimension. On this very model, one could extend the analyze a very high number of other surprising or consistent results either because of a relatively strong correlation coefficient or on the contrary, because of a relatively weak correlation coefficient as for example one can observe between both human capital dimensions.

4.2 What Innovation Union Scoreboard Sub Indicators Can Be Directly Related To Digital Capacities?

This second question changes its focus and now tries to investigate where the digitalization of the countries in the Innovation Union Scoreboard could indirectly hide. If we come back to the Figure 3 it can be pointed out for example that the Finance and support dimension capture a great part of the highest correlation coefficients with the digital related indicators.

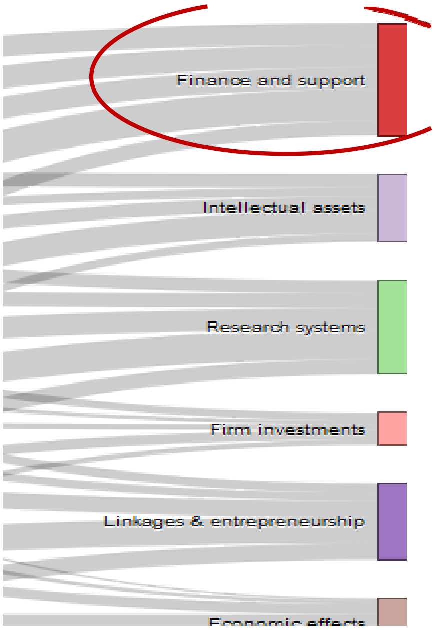

Figure 8 Finance And Support Weight

Thus, once again we go down to the Finance and support dimension:

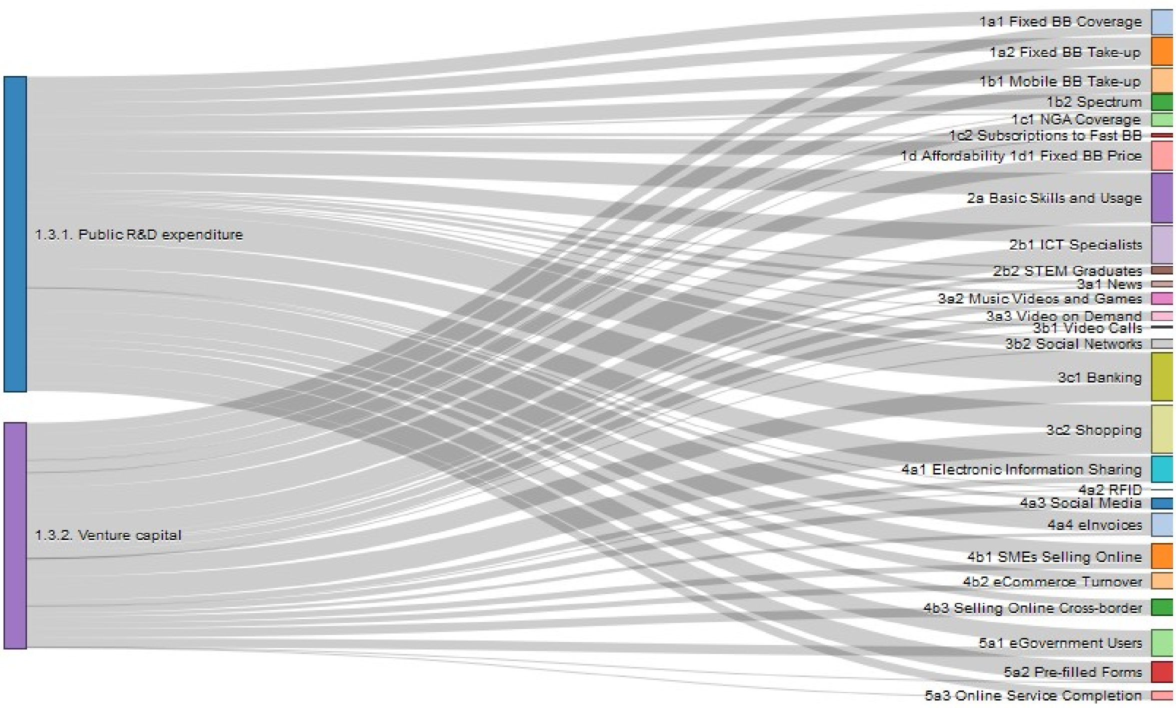

Figure 9 Finance and Support Sub-Indicators Correlation Weights with the DESI Dimensions (This Time, DESI Indicators Are Printed on the Left)

Then, the same kind of analysis can be driven now on these risk investments indicators.

For example, the relations with the e-Banking and e-Shopping behaviours stand out. These two digital indicators refer to the Transactions sub-dimension that captures the propensity of Internet users to perform transactions online. It concentrates on two indicators: whether users go online to fulfil their banking needs (e-Banking indicator), or to purchase products or services (Shopping indicator).

These kinds of results are definitely really interesting as they show unexpected correlations. Indeed, it relates directly cultural habits, linked to the way citizens of a country use the available technologies with public and private appetite for high risk investments. Thus, a new qualitative analysis based on specific literature and cases should be carried out. And with the same methodology, this kind of investigation could be repeated to every relation that stands out and can seem interesting.

Then, this Work could be expanded, taking time sets, and trying to highlight a direction for the casual relation: Do risky investments trigger more e-habits than shopping or banking? Or are countries that are more used to going online for this kind of purpose ready to invest more? How can one or the other of these two hypothesis be explained and investigated?

4.3 How Could the Innovation Union Scoreboard be Redesigned to Integrate Direct Digital Inputs? What Would that Change in Its Analysis?

Last but not least, one would have to try to fix the paradox described at the very beginning of this paper: the direct absence of a digital-related indicator in the Innovation Union Scoreboard.

To do so, a set of challenges would have to be answered:

- What would be the weight of the final indicator? If we just added one indicator, it would represent a 26th of the composite indicator. But we could actually add a whole digital dimension and consequently grant the digital factor a greater weight.

-Should a new indicator be added or just an existing one exchanged?

- Then, how should this Indictor be created? One would have to select in the literature one of the many tools that enable us to do that as for example the one grouped under dimensions' factorial technique.

This part has not been addressed yet.

5. Conclusion

The starting point of this paper was the following apparent contradiction: The European commission has set the digitalization of Europe as a top priority although its main tool to monitor the innovativeness of the member states, The Innovation Union Scoreboard, does not take into account any direct digital indicator.

This problem approach led me to question the complex relations between the digital technologies absorption in the different countries and the performance of thein Innovation System. To do so properly, we imagined an econometric analysis based on two similarly structured robust databases: The Innovation Union Scoreboard in itself and the Digital Economy and Society Index. We have been able to lead a statistical method in order to crunch both data and explain the macro results in the light of a first wide basic preliminary literature review. Then, this work would potentially call for 25*30 = 750 specific literature reviews that could address the 750 relations between the two databases, which would be similar to the example of analysis we have developed to explain the high correlation between basic digital skills and Venture capital investments.

As it is obvious that this work cannot be properly conducted in a few months, one would understand that a selection must be made. As far as we are now, we have not designed any determined strategy to do this selection other than just focus on the relationships that would seem interestingly strong or weak, trusting one's own critical spirit and the talks one can have with different experts. If this work had to be continued with another paper, I think that such methodology should be implemented.

Thus, rather than answering precise questions, this work aims at opening new Investigation lines directly related to both digital issues and innovative capacities.

As a conclusion, we hope that this work will eventually lead to a rise of consciousness from politicians and a better understanding of the mechanisms that link the basic digital capacities to the innovativeness of member states. Also, it should lead to improvements of the Innovation Union Scoreboard or at least to a more accurate understanding of its scope.

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