



ISBN: 1646-8929

IET Working Papers Series
No. **WPS03/2011**

Nuno Boavida
(e-mail: nuno.boavida@fct.unl.pt)

**How composite indicators of innovation can influence
technology policy decision?**

IET
Research Centre on Enterprise and Work Innovation
Centro de Investigação em Inovação Empresarial e do Trabalho
Faculdade de Ciências e Tecnologia
Universidade Nova de Lisboa
Monte de Caparica
Portugal



How composite indicators of innovation can influence technology policy decision? ¹

Nuno Filipe França Gouveia Boavida

Supervisor: Prof. Dr. António Brandão Moniz (FCT-UNL)

Co-Supervisor: Prof. Dr. Manuel Laranja (ISEG-UTL)

Thesis Advisory Commission:

Prof. Dr. Stefan Kuhlmann (Twente University/STePS)

Doutor Leonhard Hennen (Karlsruhe Institute of Technology/ITAS)

Doutor Tiago Santos Pereira (Universidade de Coimbra/CES)

Prof^a Cristina Sousa (UNL/FCT).

11th of February 2011

¹ Based on the Report for Project III of the PhD in Technology Assessment and Prepared for the Winter School that took place at Universidade Nova de Lisboa, Caparica Campus on the 6th and 7th of December 2010.

Abstract

This working paper is based on the development of the Thesis Plan presented for the Units Project II and Project III at the 1st Winter School of PhD programme on Technology Assessment at FCT/UNL. It focuses the methodology analysis and includes empirical information elements, in order to understand how composite indicators of innovation can influence technology policy decisions.

In order to test the hypotheses raised in the Thesis Plan, two separate phases were designed. On the first part, the work tests hypotheses 1 and partially 2, identifying the quality, depth and limitations of three famous complex indicator-based systems, namely the Science, Technology and Industry Scoreboard, the European Innovation Scoreboard 2008 and Innovation Union Scoreboard 2010. On the second phase, the remaining hypotheses are tested adding media databases analysis, which will provide complementary information to a set of interviews to policy makers, in order to understand the role of the composite indicators on technology decisions.

Key words: composite indicators, innovation, technology policy decisions, European Innovation Scoreboard, Innovation Union Scoreboard

JEL codes: C82, E61, O31

Table of Contents

1. Introduction.....	4
1.1. Indicators as a socially and culturally oriented technology	4
1.2. Indicators and indicator systems	5
1.3. Technology assessment of indicators.....	5
2. Methodology	6
3. Attributes and characteristics of indicators	9
3.1. Collection of innovation indicators	9
3.2. Construction of innovation composite indicators.....	16
3.3. Final comparisons.....	21
4. Technology policy making.....	21
Bibliography	23

How composite indicators of innovation can influence technology policy decision?

1. Introduction

1.1. Indicators as a socially and culturally oriented technology

Dictionaries and scholars have offered a variety of definitions to technology. For example, according to Merriam-Webster dictionary², technology can be define as a manner of accomplishing a task especially using technical processes, methods, or knowledge. Other example can be the Wikipedia³ where technology is defined as the usage and knowledge of tools, techniques, crafts, systems or methods of organization in order to solve a problem or create an artistic perspective.

In this context, indicators can be analysed as a technology, since the word “technology” is generally seen as representing a device or an aid used to support human capabilities or even to enable them. In fact, the term “technology” can be understood without any material foundation: as a certain approach (e.g. psychoanalytic psychotherapy), as the capability to perform abstract intellectual operations (e.g. Google’s search algorithm) or even as a form of interpersonal contact (e.g. Facebook). Therefore, indicators are understood as a “socially and culturally oriented technology”, and consequently a subject of technology assessment (Feller-Länzlinger et al. 2010⁴).

²<http://www.merriam-webster.com/dictionary/technology>

³<http://en.wikipedia.org/wiki/Technology>

⁴The abridged version «All sized up» deals with the TA-SWISS study on indicator-based decision-making systems. The study was commissioned by TA-SWISS, and is one of the first projects specifically about technology assessment in the social and cultural sciences. With this project, TA-SWISS and science are both venturing into new territory.

Elaborating the subject was anything but simple. TA-SWISS and the authors had no models to back them up. The result is a pilot study of an explorative and largely qualitative nature. It offers a view of how indicator systems are perceived in practice.

The study demonstrates the complexity and ambivalence of indicator systems and exposes the problems created by their widespread application. Its primary aim is to sensitise people to the opportunities and risks presented by such systems.

1.2. Indicators and indicator systems

The ability to draw conclusions from a figure about a certain social phenomenon (e.g. the gross domestic product, the level of education among the population, etc), presupposes the existence of a relationship between the measurement parameter and the object observed. The relationship in the figure reflects reality and can also be used to show whether a target or a specific limit value has been achieved. In addition, an indicator can be obtained from quantitative or qualitative data. For example, a simple quantitative indicator is the number of people living in a certain region, and a simple qualitative indicator is the existence of representative democracy considering the presence of ethnic minorities in a national Parliament.

However, a multifaceted phenomena cannot be understood using a single indicator, such as the performance of an innovation system, the biodiversity within a given ecosystem or sustainable development. In fact, these examples of complex phenomena require entire systems of indicators that reflect the different facets of the topics (Feller-Länzlinger et al. 2010 p.28). An indicator system signifies that the indicators can only be defined if they are based on specific social measurement parameters, which often correspond to social principles framing a systematic selection of the required indicators.

1.3. Technology assessment of indicators

Many problems in the modern world require the help of indicators in order to be understood. Nevertheless, indicators as such were rarely been a subject of extensive research, although several sciences and governmental statistical offices provided inputs in the past decades.

Furthermore, the use of indicators normally entails risks, namely: Ambivalence (e.g. ranging between easier understanding/transparency and over-simplification); Self-discipline (e.g. change motivated by an external development of indicator systems); Self-reflection (e.g. reflexive modernisation in the context of the state and individuals striving to continuously change and improve oneself); Decontextualisation (e.g. material abstraction of social phenomena blocks references to proper understanding of problems concealing an inferable reality, or used to progressively generate more indicators); International comparability (e.g. lack of comparable benchmarks and standards); and Inflationary use (e.g. by administrations over politics as well as by the unfully exhausted potential of indicators due to the use of greater the diversity of indicators (systems)). (Feller-Länzlinger et al. 2010).

2. Methodology

The following table presents the research questions and hypotheses summarized in the Thesis Plan⁵ (Boavida 2010).

Table 1 - Research questions and Hypotheses

Research Questions	Hypotheses
<i>Given the theoretical considerations presented several questions arise as a methodological point of departure for further research:</i>	<i>Accordingly, a set of hypothesis will be tested to answer the research questions as proposed explanation for the mentioned phenomena:</i>
Q1. How are innovation composite indicators being constructed? What do they measure?	H1. 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.
Q2. Can we abstract so much from reality using a composite number (unidimension)? What dangers this abstraction presents to society?	H2. Innovation composites measure a simplified non abstractable part of a complex reality. The abstraction presents dangers to society.
Q3. What is the influence of innovation composites in technology decisions? What is the extent of its use by technology policy makers?	H3. Innovation composites influence technology decisions. This influence varies according to the social and political status of actors and with different levels of complexity.
Q4. What are the effects of their increasing use in society?	H4. The political choices for composites indicators set will frame technology policy options and decisions (e.g. SII's public-private co-publications of ISI papers).
Q5. How to deal with the proliferation of composites and indexes?	H5. 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).

In order to address the posed by the above framework, the following methodology was envisaged to test the hypotheses:

⁵Presented during the 1st Winter School of PhD in Technology Assessment at FCT/UNL

On a **first phase** the work will identify the quality, depth and limitations of three famous complex indicator-based systems, namely the Science, Technology and Industry Scoreboard (OECD 2009), the European Innovation Scoreboard 2008 and Innovation Union Scoreboard 2010. In this part the work will address Question 1 testing Hypothesis 1 and provide input to Question 2 helping to test Hypothesis 2.

The analysis of a variety of single indicators (e.g. the Science, Technology and Industry Scoreboard OECD 2009) *versus* the analysis of two composites (e.g. Summary Innovation Index 2008 and 2010), will possibly reveal that the former produces information useful for the study of innovation system in Portugal, whereas the latter are designed to raise social awareness and/or influence decision making.

First, the battery of indicators of Science, Technology and Industry Scoreboard will be summarized, based on data extracted from the OECD databases, and analysed it in a Portuguese perspective (see in Table 1 - Analysis 1).

Second, the work will identify the construction of several composite indicators widely accepted, particularly in the policy making arena (Summary Innovation Index 2008 and Summary Innovation Index 2010 (constructed using a different methodology)). In the end, these composites will be analysed in a Portuguese perspective (see in Table 1 - Analysis 2 and 3).

Last, all analyses will be contrasted and integrated in the discussion around the use of complex indicators systems, particularly in decision making process.

These above-mentioned steps will be used in order to contrast different techniques of construction and use of complex systems of indicators, as summarized in Table 1 and further elaborated on sub-chapter 2.1, 2.2, 2.3 and 2.4.

Table 2 - Research path in the first phase

Name	Collection of S&T&I indicators	S&T&I composite indicators		
Output	Batery of Indicators	Composite indicator A	Composite indicator B	
Example	2009 Science, Technology and Industry Scoreboard, OECD	2008 Summary Innovation Index (SII), European Innovation Scoreboard	2010 Summary Innovation Index (SII), European Innovation Scoreboard	Final comparisons
Result	Analysis 1	Analysis 2	Analysis 3	Conclusions

On a **second phase** the remaining hypotheses will be tested adding media databases analysis, which will provide complementary information to a set of interviews to policy makers, in order to understand the role of the composite indicators on technology decisions.

On a second phase the project expects to integrate the discussion around the usefulness and dangers posed to societies, resulting from the use of these complex indicator-based systems, particularly in the decision making processes (TA-SWISS 2010). The increasing reliance on complex indicators-based systems not only improves and clarifies the rationality behind the decision making process, but also may possess some threats, as mentioned in the introduction chapter.

Furthermore, the research questions will be tested using analysis of media databases, which will provide complementary information to a set of interviews to policy makers (not yet defined), conducted to understand the role of the composite indicators on technology decisions.

3. Attributes and characteristics of indicators

This chapter address the question 1 (Q1) and tests the hypothesis 1 (H1), as well as provides inputs to question 2 (Q2) and tests the hypothesis 2 (H2).

Table 3 - Question 1 and 2 and Hypothesis 1 and 2

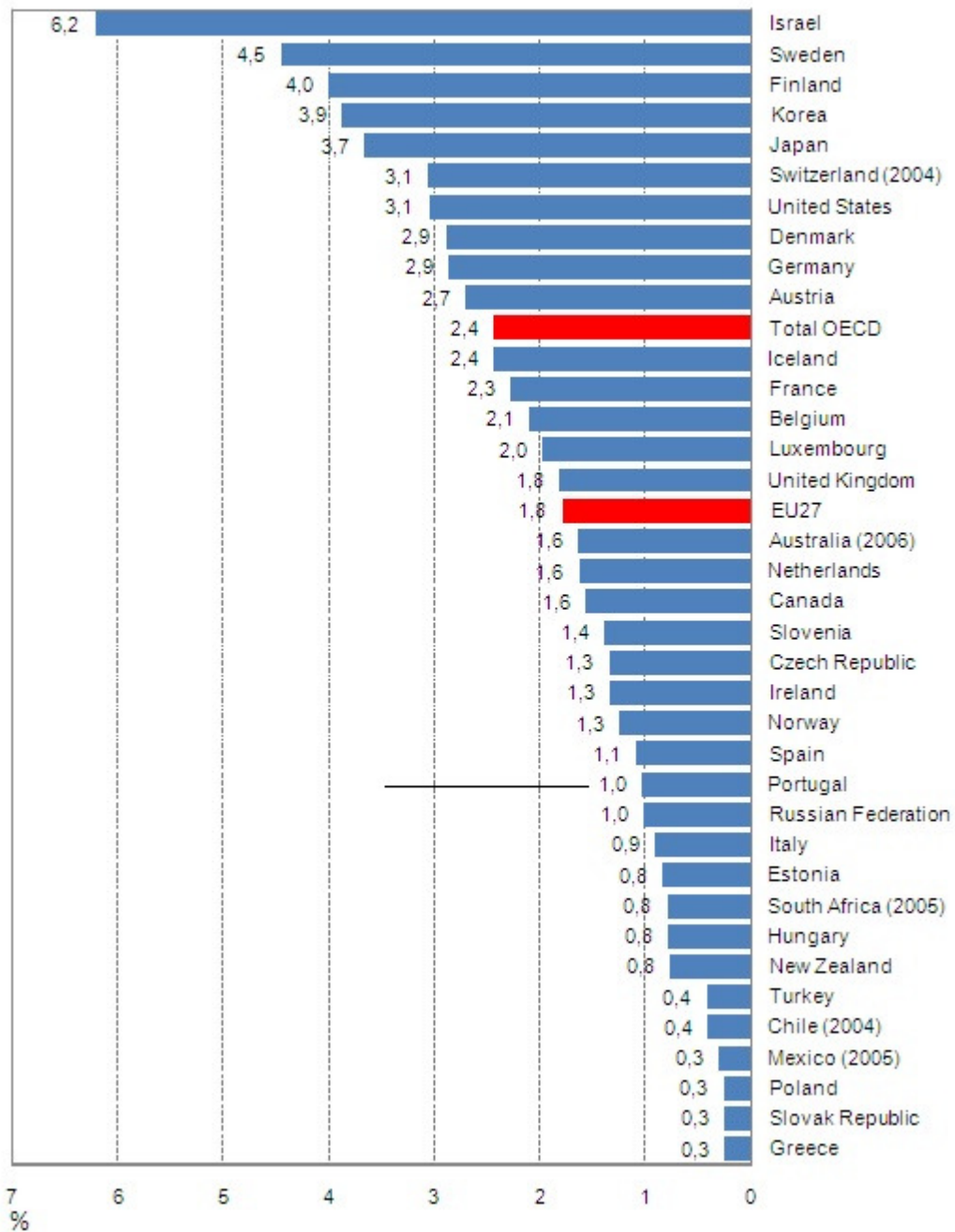
<p>Q1. How are innovation composite indicators being constructed? What do they measure?</p> <p>H1. Innovation composites are being constructed according to several different debatable methodologies. Composites are designed not to measure innovation but to raise social awareness and/or influence decision making.</p>
<p>Q2. Can we abstract so much from reality using a composite number (unidimension)? What dangers this abstraction presents to society?</p> <p>H2. Innovation composites measure a simplified non-abstractable part of a complex reality. The abstraction presents dangers to society.</p>

3.1. Collection of innovation indicators

First, a battery of indicators was collected and the recent empirical results will be analysed. The OECD publication **Science, Technology and Industry Scoreboard 2009**, enables a set of conclusions drawn from each indicator *per se* based on comments made by OECD in the text and, after, a qualitative summary of the complete indicator system content in 2009.

Figure 1 presents the latest available data (mostly 2007) of the Business Enterprise R&D (BERD) as a percentage of value added in industry in 36 economies.

Figure 1 - Business R&D intensity, 2007



Source: OECD 2009

The industrial R&D is most closely linked to the creation of new products and production techniques, as well as to a country's innovation efforts. The BERD accounts for the bulk of research and development

(R&D) activity in OECD countries in terms of both performance (close to 70% of total R&D) and funding.⁶

According to OECD (2009) the United States accounted for around 43% of OECD-area BERD, and the EU and Japan accounted for 27% and 19%, respectively. When using a percentage of value added in industry as a weight measure of intensity, the Portuguese Business R&D intensity reached 1% in 2007 and ranked 24th out of 36 studied economies (and the BERD) experienced strong growth of BERD during the last decade. In 2005 the Portuguese Business R&D intensity was 0,5% of value added in industry, and ranked 27th out of 32 economies (OECD 2007a, page 31).

One can be reasonably attribute significance to the values 1% and 0,5% to Portuguese Business R&D intensity in 2007 and 2005, respectively, in a national comparison. In fact, there was a substantial absolute growth of the Portuguese BERD intensity, which deserves further research. In a relative manner, the international comparison shows that the Portuguese BERD intensity was bellow the OECD and EU27 average, as well as ranking among the last countries both in the 2005 and 2007. One can conclu

One can methodologically attribute significance to the values collected by OECD to Portugal in 2005 and 2007, because the sources were the same, the survey methods were similar and there was no methodological difference in the data reported in the two editions of OCDE STI Scoreboard (e.g. 2007 and 2009). In fact, in both cases OCDE stated that

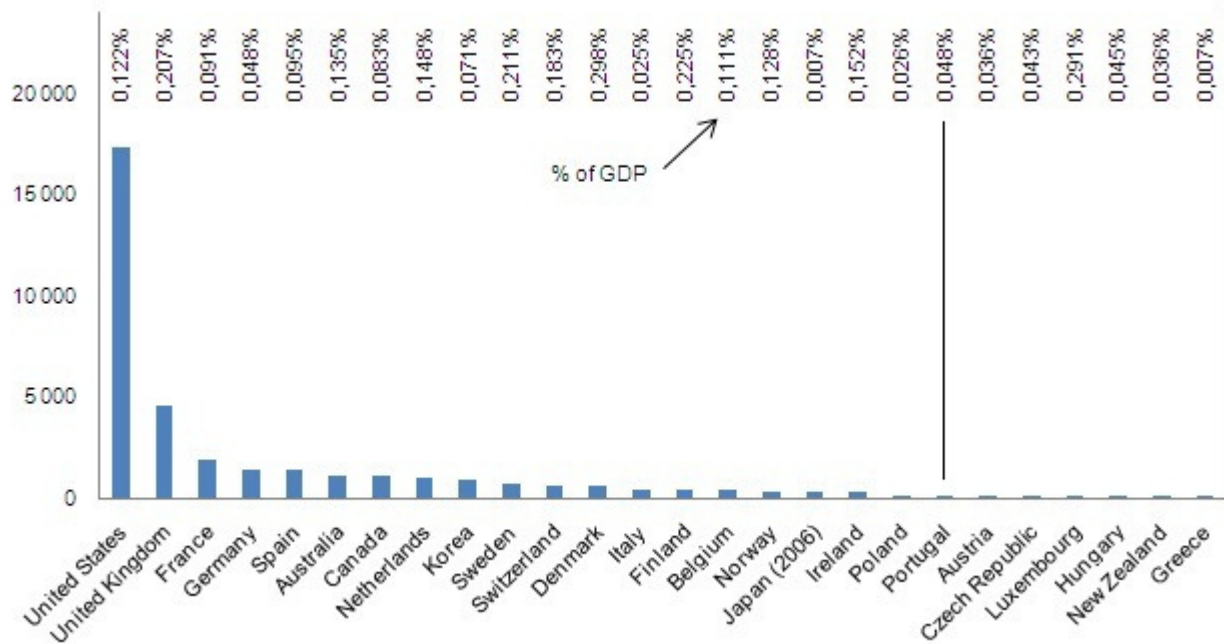
“The business enterprise sector includes all firms, organisations and institutions whose primary activity is production of goods and services for sale to the general public at an economically significant price, and the the private and not-for-profit institutions mainly serving them. The Business enterprise expenditure on R&D (BERD) covers R&D activities carried out in the business sector by performing firms and institutes, regardless of the origin of funding. When assessing changes in BERD over time, it is necessary to take account of changes in methods and breaks in series, notably in terms of the extension of survey coverage, particularly in the services sector, and the privatisation of publicly owned firms.”

Figure 2 presents the Venture capital investments as a percentage of GDP (USD millions) in the latest available year (2008) in OECD economies.

⁶The business enterprise sector includes all firms, organisations and institutions whose primary activity is production of goods and services for sale to the general public at an economically significant price, and the the private and not-for-profit institutions mainly serving them. The Business enterprise expenditure on R&D (BERD) covers R&D activities carried out in the business sector by performing firms and institutes, regardless of the origin of funding. When assessing changes in BERD over time, it is necessary to take account of changes in methods and breaks in series, notably in terms of the extension of survey coverage, particularly in the services sector, and the privatisation of publicly owned firms

Figure 2 - Venture capital investment, 2008

USD millions and as a percentage of GDP



Source: OECD calculations, based on Pricewaterhouse Coopers/National Venture Capital Association MoneyTree™ Report.

The venture capital is a significant source of funding for new technology-based firms, it can play an important role in promoting radical innovations and is one of the determinants of entrepreneurship.

The figure shows that in 2008, the United States accounted for 49% of total venture capital investments in OECD countries. The United Kingdom was the only other country where this share exceeded 10% of the OECD total. When using GDP as a weight measure of intensity, the Portuguese venture capital investments represented 0,048% of its GDP, figured in the last quartile of the graph, and ranked in 20th position out of the 26 studied economies (OECD 2009)⁷. Similarly but not fully comparable data for 2005 (or the latest available year) indicated that 0,133% of the Portuguese GDP was invested as venture capital, figured in the second quartile of the graph and above the OECD and EU average, and ranked 20th out of 27 economies studied (OECD 2007a, page 39)⁸.

Taken as a relatively plausible abstraction one can compare internationally the Portuguese relative position in each study conducted for 2008 and for 2005. However, when grossly comparing the absolute

⁷ OECD calculations, which were based on Pricewaterhouse Coopers/National Venture Capital Association MoneyTree™ Report

⁸ OECD calculations, based on data from EVCA (Europe); NVCA (United States); CVCA (Canada); AVCAL (Australia), NZVCA (New Zealand), Asian Venture Capital Journal (The 2003 Guide to Venture Capital in Asia) for Japan and Korea)

value 0,048% with 0,133% between 2005 and 2008, one should not conclude that there was supposedly a decrease on the venture capital investment in Portugal, because the sources were different in the two editions of the OCDE STI Scoreboard (e.g. 2007 and 2009). In the 2009 version the OECD sources were based on OECD calculations, which were based on the Pricewaterhouse Coopers/National Venture Capital Association MoneyTree™ Report. In the 2007 version the OECD sources were based on OECD calculations, which were based on data from EVCA⁹ (Europe); NVCA¹⁰ (United States); CVCA¹¹ (Canada); AVCAL¹² (Australia), NZVCA¹³ (New Zealand), Asian Venture Capital Journal (The 2003 Guide to Venture Capital in Asia) for Japan and Korea. Therefore, although present in the same OECD collection the two sources are different and cannot be compared.

Figure 3 presents the Information and Communication Technologies (ICT) investment by type of asset (e.g. Software, Communication equipment and IT equipment) some OECD countries in 2007, as a percentage of non-residential gross fixed capital formation in the total economy.¹⁴

⁹European Private Equity and Venture Capital Association <http://www.evca.eu/>

¹⁰National Venture Capital Association, EUA, <http://www.nvca.org/>

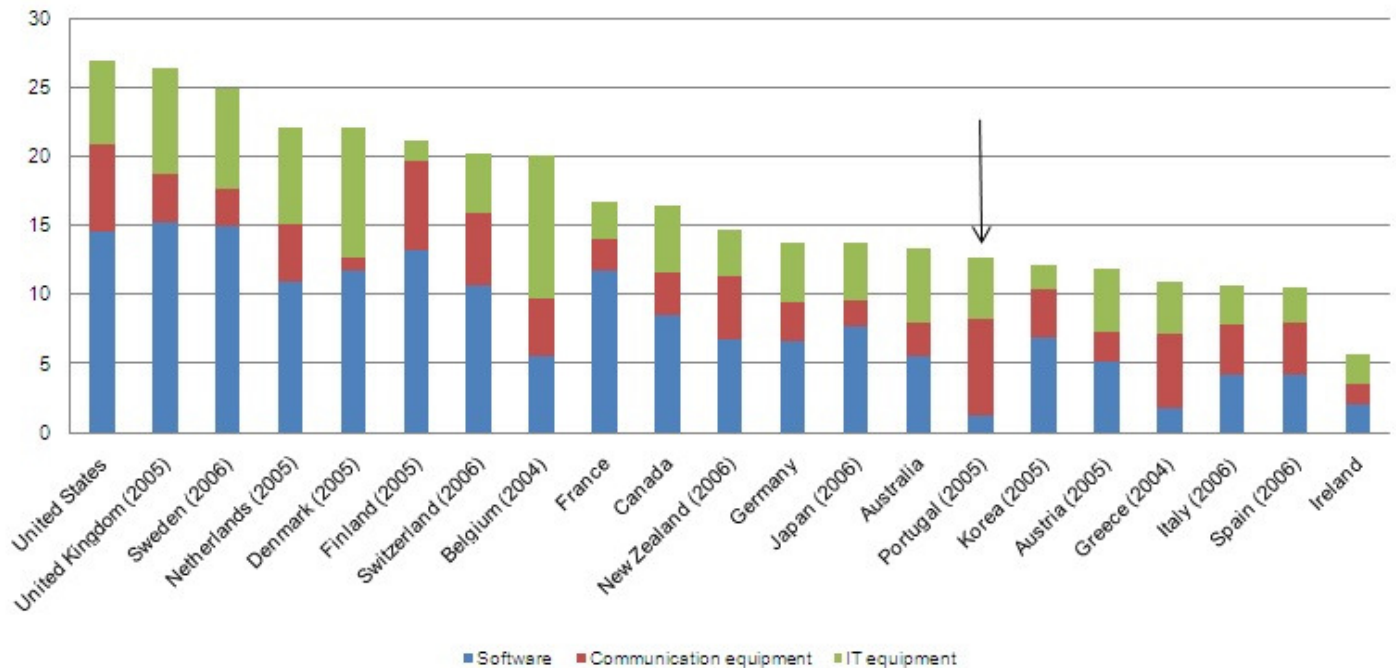
¹¹Canada's Venture Capital & Private Equity Association, Canadá, <http://www.cvca.ca/>

¹²The Australian Private Equity & Venture Capital Association, Austrália, <http://www.avcal.com.au/>

¹³NZVCA - New Zealand Venture Capital Association, Nova Zelândia, <http://www.nzvca.co.nz/>

¹⁴Correct measurement of investment in ICT in both nominal and volume terms is crucial for estimating the contribution of ICT to economic growth and performance. Data availability and measurement of ICT investment based on national accounts (SNA 93) vary considerably across OECD countries, especially as regards measurement of investment in software, deflators applied, breakdown by institutional sector and temporal coverage. In the national accounts, expenditure on ICT products is considered investment only if the products can be physically isolated (i.e. ICT embodied in equipment is considered not as investment but as intermediate consumption). This means that ICT investment may be underestimated and the order of magnitude of the underestimation may differ depending on how intermediate consumption and investment are treated in each country's accounts.

Figure 3 - ICT investment by asset in OECD countries, 2007



Source: OECD 2009

According to OECD (2009), the investment in physical capital is important for growth, as it is a way to expand and renew the capital stock and enable new technologies to enter the production process. The same publication states also that “the ICT sector has been the most dynamic component of investment from 1985 to 2000 but then started to decrease, following the bursting of the dot com bubble” (page 48). The Portuguese ICT investment (as a percentage of non-residential gross fixed capital formation in the total economy) was 12,7% in 2005, and ranked 15th out of 21 economies (although the comparison is made with data regarding 2004, 2005, 2006 and 2007)., the Portuguese ICT investment was 13,6% in 2003, and ranked 15th out of the 21 studied economies (although the comparison is made with data regarding 2002, 2003, 2004 and 2005). In the former comparison regarding broadly 2007, the Communications equipment sector was the major component of ICT investment in Portugal (55%, data for 2005) and Greece (49%, data for 2004). (OECD 2007a, page 103 and OECD 2009, page 47).

Furthermore, the OECD stated both in 2007 and 2009 that the

“Correct measurement of investment in ICT in both nominal and volume terms is crucial for estimating the contribution of ICT to economic growth and performance. Data availability and measurement of ICT investment based on national accounts (SNA 93) vary considerably across

OECD countries, especially as regards measurement of investment in software, deflators applied, breakdown by institutional sector and temporal coverage. In the national accounts, expenditure on ICT products is considered investment only if the products can be physically isolated (i.e. ICT embodied in equipment is considered not as investment but as intermediate consumption). This means that ICT investment may be underestimated and the order of magnitude of the underestimation may differ depending on how intermediate consumption and investment are treated in each country's accounts.”

However, both publications (OECD 2007a page 103, and OECD 2009 page 47) presented the exact same sources. In 2009 the OCDE publication used both “OECD, Database on Capital Services, July 2009; and OECD, Productivity Database”, and in 2007 the OECD publication used both “OECD database on Capital Services, April 2007; and OECD Productivity database”.

Nevertheless, although presenting international comparability problems, the data for Portugal is comparable alone regarding the year 2005 and 2003. However, using old data in a sector characterized by fast changes in small periods of time might present further dangers. Therefore, it seems more appropriate to complement observations with recent national level quantitative measures or even to seek further qualitative information.

To conclude the observations on these three indicators, one can state that the quality, depth and limitations of three widely accepted indicators in a prominent and renowned publication collection varied significantly, presenting different levels of consistency. First, the Portuguese Business R&D intensities (Figure 1) in 2007 and 2005 was consistent indicator for national and international comparisons. Second, the Venture capital investment (Figure 2) presents consistent data for internationally comparisons in 2008 and also in 2005, and the Portuguese data was inconsistent for national comparisons between 2008 and 2005. Last, the ICT investment indicator by asset in OECD countries (Figure 3) presented some international comparability problems and old, although comparable, data for Portugal in 2003 and 2005.

Table 4 - Summary of the consistency observed in three STI indicators

Indicator	Name	International comparisons		National comparisons	
		Year N-1	Year N	Year N-1	Year N
1	Business R&D intensity, 2007	Consistent	Consistent	Consistent	Consistent
2	Venture capital investment, 2008	Consistent	Consistent	Inconsistent	Inconsistent
3	ICT investment by asset in OECD countries, 2007	Variable years and inconsistent	Variable years and inconsistent	Old but consistent	Old but consistent

The analysis of three indicators published in the OECD Science, Technology Industry collection allowed a set of empirical conclusions about the use of single indicators to understand realities in significantly different degrees. As mentioned in the literature, an indicator presupposes the existence of a correct relationship between the measurement parameter and the object observed. First, the STI collection noticed that some countries apply different methodologies to collect the data used in the study. Second, in some comparisons the data used to countries referred to different years, which provided only a possible reliable approximation to reality. Third, in some cases the data was too old to draw relevant conclusion about the object observed. Last, some data was simple inconsistent to relative comparability and even to absolute comparisons (e.g. venture capital indicator), thus leading to very restricted conclusions.

3.2. Construction of innovation composite indicators

A second element of the work will consist on the analysis of two composite indicators, based on different techniques already established by the literature in this field, such as the European Innovation Scoreboard 2008¹⁵ and the Innovation Union Scoreboard 2010¹⁶.

¹⁵European Innovation Scoreboard 2008

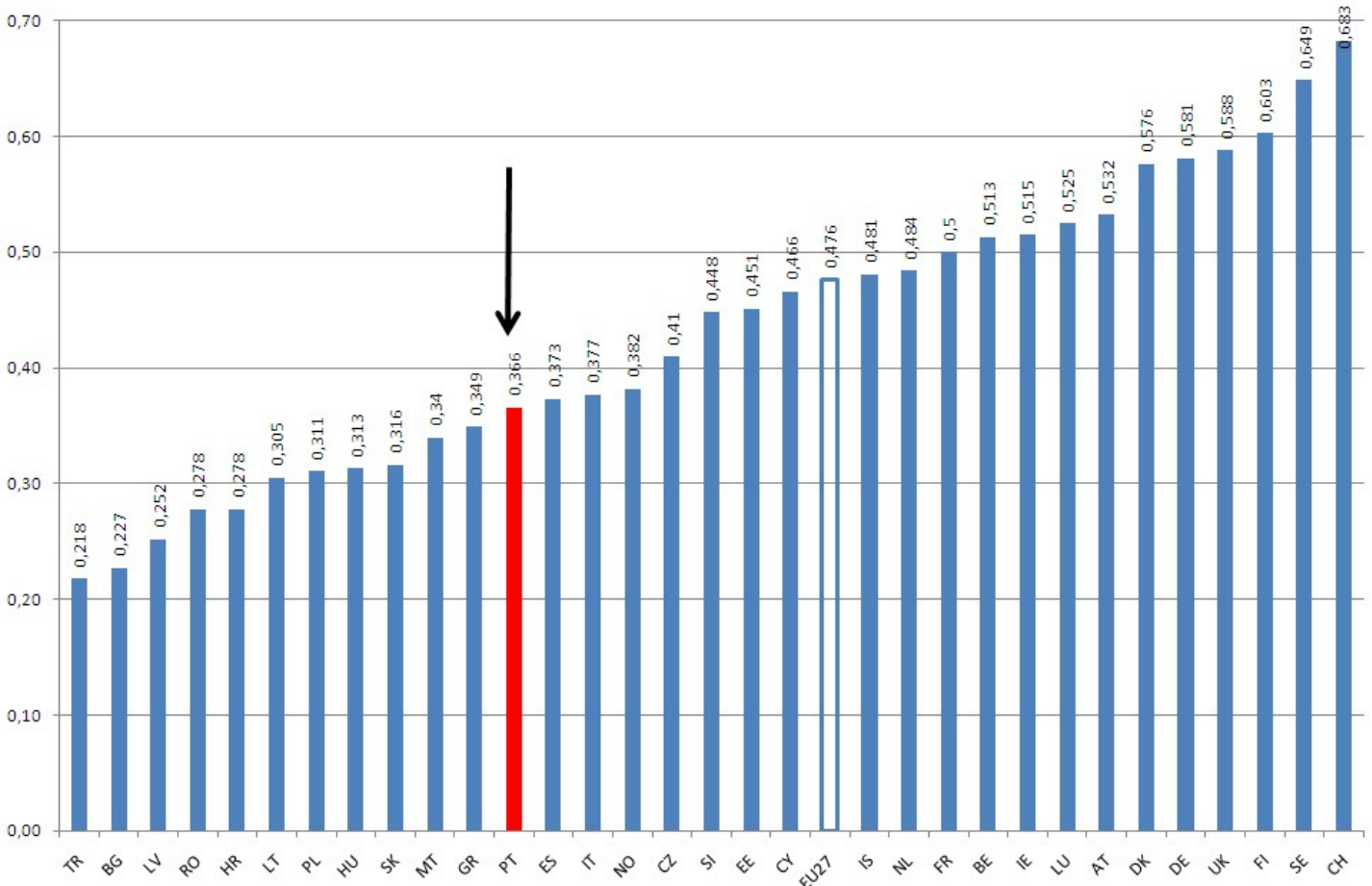
<http://www.proinno-europe.eu/page/european-innovation-scoreboard-2008>

¹⁶Innovation Union Scoreboard 2010

a) The Summary Innovation Index 2008, calculated in the European Innovation Scoreboard 2008

Figure 4 presents the results of the calculation of the 2008 Summary Innovation Index (SII2008), published in the European Innovation Scoreboard 2008.

Figure 4 - Summary Innovation Index 2008



Source: European Innovation Scoreboard Database 2009

The SII 2008 presents 0.366 points to Portugal, scored below the EU27 average and ranked 22th out of 33 economies. However, this reference point was shown in Boavida (2010) as non-comparable in absolute and relative terms with the old series, namely in 2001, 2002, 2003, 2004, 2005, 2006 and 2007. In fact,

<http://www.proinno-europe.eu/inno-metrics/page/innovation-union-scoreboard-2010>

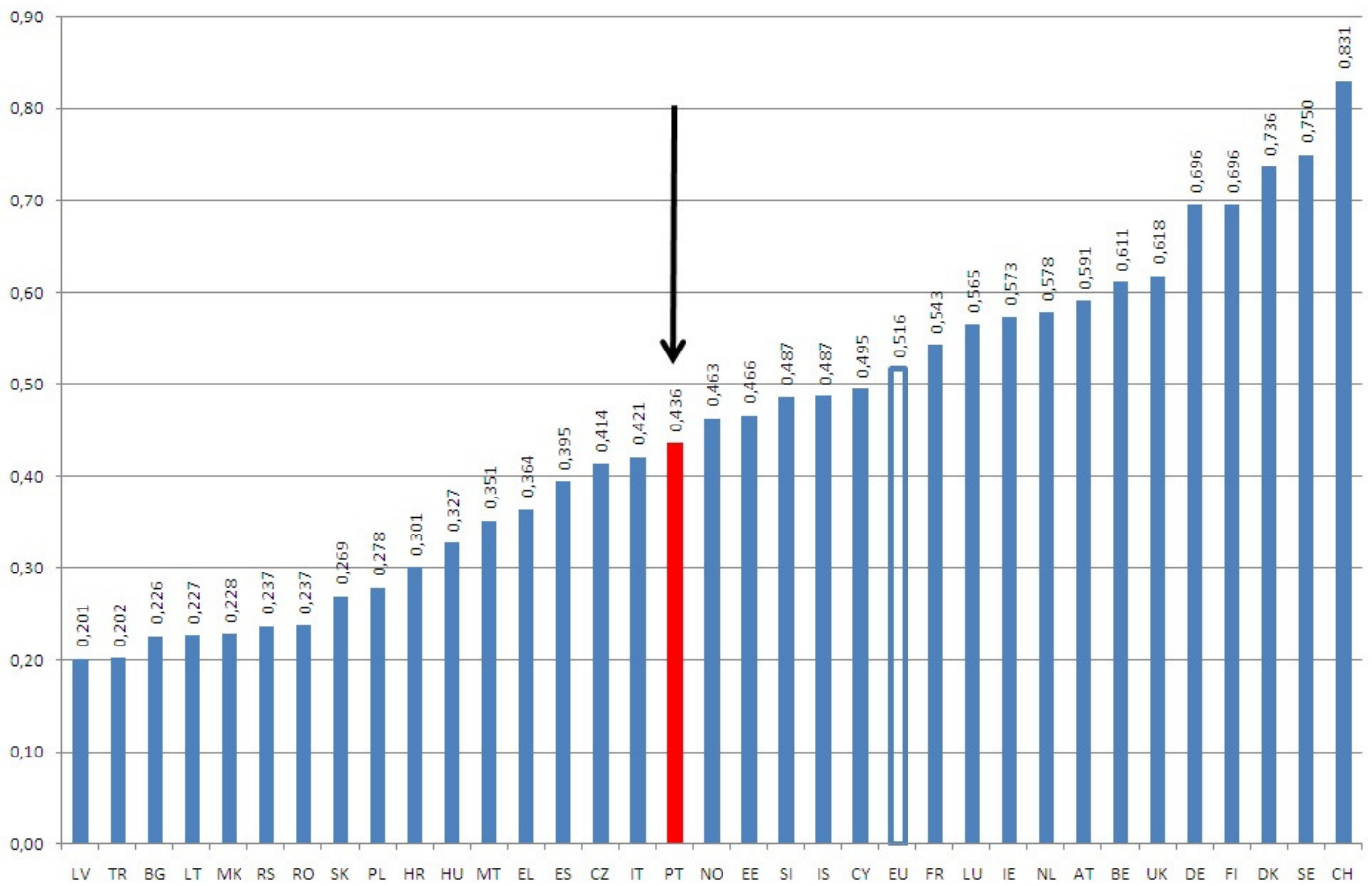
the European Innovation Scoreboard introduced significant differences in methodologies in 2003, 2005, 2008 and 2010, making the SII series unusable both relatively and absolutely.

The methodology to construct the Index will be used until 2010 in order to extent its comparability with the next composite.

b) The Summary Innovation Index 2010, calculated in the Innovation Union Scoreboard 2010

Figure 5 presents the a ranking of the countries according to the Summary Innovation Index

Figure 5 - Summary Innovation Index 2010



Source: Innovation Union Scoreboard Database 2010

Figure 5 presents the results of the calculation of the 2010 Summary Innovation Index (SII2010)¹⁷, according to the methodology set in the recent Innovation Union Scoreboard 2010¹⁸. The SII2010 presents Portugal with 0.436 points, scored below the EU27 average and ranked 18 out of 34 economies. However, the introduction of a new methodology in 2010 accounted for the non-comparability of these absolute findings with the SII in 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008 and 2009.

According to the Innovation Union Scoreboard,, the previous list of 29 indicators of the European Innovation Scoreboard 2008 and 2009⁸ has been replaced with a new list of 25 indicators, which “better capture the performance of national research and innovation systems as a whole”¹⁹. Twelve of these 29 indicators have not been changed, two indicators have been merged, five indicators have been partly changed using broader or narrower definitions or different denominators and seven new indicators have been introduced.

c) The Summary Innovation Index 2008A, calculated in the Innovation Union Scoreboard 2010

Figure 6 presents the results of the 2008 Summary Innovation Index according to the 2010 methodology.

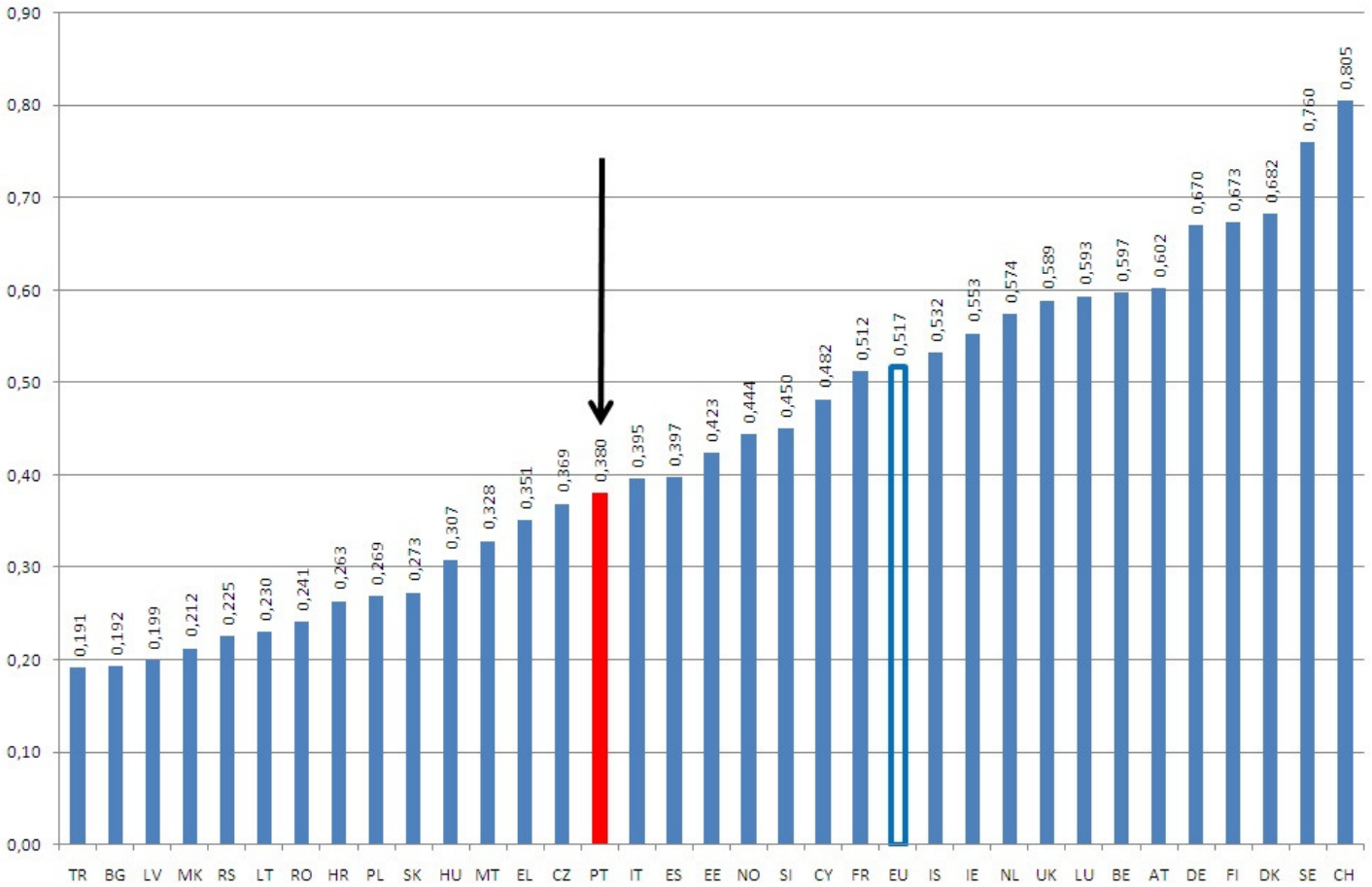
¹⁷ The Summary Innovation Index 2010 was calculated, in the re-named Innovation Union Scoreboard (2010), following broadly the methodology of the previous editions of the European Innovation Scoreboard in distinguishing between three main categories of indicator and eight innovation dimensions, capturing a total of 25 different indicators.

¹⁸ <http://www.proinno-europe.eu/inno-metrics/page/innovation-union-scoreboard-2010>

¹⁹ in MEMO/11/56, “The Innovation Union Scoreboard: Monitoring the innovation performance of the 27 EU Member States”

Brussels, 1 February 2011. <http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/11/56>

Figure 6 - Summary Innovation Index 2008



Source: Innovation Union Scoreboard Database 2010

Figure 6 presents the results of the calculation of the 2008 Summary Innovation Index (SII2008A), according to the methodology set in the recent Innovation Union Scoreboard 2010. The SII2008A presents 0.380 points to Portugal whereas according to the EIS2008 methodology the score was lower (e.g. 0.366). The methodology changes are responsible for these differences.

However, this reference point was shown in Boavida (2010) as non-comparable with the same value of SII for Portugal in SII2001, SII2002, SII2003, SII2004, SII2005, SII2006, SII2007, SII2008 and SII2009. The European Innovation Scoreboard introduced significant differences in methodologies in 2003, 2005, 2008 and 2010, making the SII series unusable.

3.3. Final comparisons

The work will compare conclusions of the analyses resulting both from the Science, Technology and Industry Scoreboard 2009 indicators and from the above-mentioned composite indicators. The quality, depth and limitations of the methods will be compared, in order to draw conclusions that could contribute to the general discussion on the purposes, construction and use of innovation indicators, particularly the composite ones.

4. Technology policy making

On this second phase one expects to integrate the discussion around the usefulness and dangers posed to societies, resulting from the use of these complex indicator-based systems, particularly in the decision making processes (Feller-Länzlinger 2010). In fact, the increasing reliance on complex indicators-based systems not only improves and clarifies the rationality behind the decision making process, but also may possess some threats, as mentioned in the literature review chapter.

The following Table presents the remaining research questions and hypotheses to conduct further research.

Table 5 - Question 3, 4 and 5 and Hypothesis 3, 4 and 5

<p>Q3. What is the influence of innovation composites in technology decisions? What is the extent of its use by technology policy makers?</p>	<p>H3. Innovation composites influence technology decisions. This influence varies according to the social and political status of actors and with different levels of complexity.</p>
<p>Q4. What are the effects of their increasing use in society?</p>	<p>H4. The political choices for composites indicators set will frame technology policy options and decisions (e.g. SII's public-private co-publications of ISI papers).</p>
<p>Q5. How to deal with the proliferation of composites and indexes?</p>	<p>H5. 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).</p>

In this context, the remaining research questions will be tested using analysis of a questionnaire and interviews, which will provide complementary information about policy makers (under construction) and aiming to understand the role of the composite indicators on technology decisions.

Bibliography

- Barré, R. (2001). Agora processes - The Agora model of innovation systems: S&T indicators for a democratic knowledge society. *Research Evaluation*, 10(1), 13-18.
- Barré, R. (2004). S&T Indicators for policy making in a changing science-society: The New Science–Society Relationship. In H. Moed, W. Glänzel, & U. Schmoch (Eds.), *Handbook of Quantitative Science and Technology Research* (pp. 115-131). Springer Netherlands.
- Benoît Godin. (2006). *The Value of Science : Changing Conceptions of Scientific Productivity , 1869-circa 1970*. Montral.
- Benoît Godin. (2008). *The Knowledge Economy: Fritz Machlup’s Construction of a Synthetic Concept*. Montréal: Institut national de la recherche scientifique - Centre Urbanisation Culture Société.
- Boavida, N. (2008). Portugal e a economia do conhecimento: A despesa empresarial em Investigação e Desenvolvimento. *IET Working Papers Series*, WPS02/2008. Monte da Caparica. Retrieved from <http://ideas.repec.org/p/ieue/wpaper/03.html>.
- Boavida, N., Cabrita, N., & Moretto, S. (2010). Análise do processo de participação pública no projecto da Alta Velocidade Ferroviária. *IET Working Papers Series*, WPS06/2010. Monte da Caparica. <http://ideas.repec.org/p/ieue/wpaper/26.html>
- Boavida, N., & Moretto, S. M. (2010). Innovation Assessment of a Portuguese railway branch of a foreign multinational - A case study. *IET Working Papers Series*, WPS05/2010. Monte da Caparica. <http://ideas.repec.org/p/ieue/wpaper/25.html>
- Cherchye, L., Moesen, W., & Puyenbroeck, V. T. (2004). Legitimately diverse, yet comparable: on synthesizing social inclusion performance in the EU. *Journal of Common Market Studies*, 42(5), 919-955.
- Feller-Länzlinger, R., Haefeli, U., Rieder, S., Biebricher, M., & Weber, K. (2010). *All sized up - Counting, calculating and controlling in the knowledge-based society*. (TA-SWISS, Eds.) *TA Swiss* (TA-SWISS Z., pp. 26-40). Bern: TA-SWISS. Retrieved from <http://www.ta-swiss.ch/en/projects/social-and-cultural-ta/indicators/>.
- Geels, F., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, 36(3), 399-417. Retrieved from <http://linkinghub.elsevier.com/retrieve/pii/S0048733307000248>.
- Giddens, A. (1991). *The Consequences of Modernity*. (S. U. Press, Ed.) *The British Journal of Sociology* (1996th ed., Vol. 42, p. 100). Cambridge, UK: Polity Press. doi: 10.2307/591454.
- Godinho, M. M. (2007). Indicadores de C&T, inovação e conhecimento: onde estamos? Para onde vamos? *Análise Social*, XLII(182), 239-274.
- Grupp, H., & Mogege, M. E. (2004). Indicators for national science and technology policy - Their Development, Use, and Possible Misuse. In H. F. M. et Al. (Ed.), *Handbook of Quantitative Science and Technology Research* (pp. 75-94). Kluwer Academic Publishers.

- Grupp, H., & Schubert, T. (2010). Review and new evidence on composite innovation indicators for evaluating national performance. *Research Policy*, 39(1), 67-78. doi: 10.1016/j.respol.2009.10.002.
- Gómez-Limón, J. a, & Riesgo, L. (2009). Alternative approaches to the construction of a composite indicator of agricultural sustainability: An application to irrigated agriculture in the Duero basin in Spain. *Journal of environmental management*, 90(11), 3345-62. doi: 10.1016/j.jenvman.2009.05.023.
- Jones, C. I. (2002). Sources of U.S. Economic Growth in a World of Ideas. *American Economic Review*, 92(1), 220-239. doi: 10.1257/000282802760015685.
- Kuhlmann, S. et al. (1999). *Improving Distributed Intelligence in Complex Innovation Systems*. *Advanced Science & Technology Policy Planning Network* (pp. 1-87). Karlsruhe. <http://ideas.repec.org/p/pramprapa/6426.html>
- Lemos, T., & Boavida, N. (2006). *Contributos para a caracterização das no TIC no Ensino Superior e no Sistema Científico-Tecnológico em Portugal*. (OCES, Eds.)OCES (p. 41). Lisboa: OCES - Observatório da Ciência e do Ensino Superior.
- Nardo, M., Saisana, Michaela, Saltelli, Andrea, & Tarantola, Stefano. (2005). *Tools for Composite Indicators Building*. (J. E. Commission, Ed.)*European Commission* (p. 134). European Communities.
- Nardo, M., Saisana, Michaela, Saltelli, Andrea, Tarantola, Stefano, Hoffmann, A., & Giovannini, E. (2008). *Handbook on Constructing Composite Indicators: Methodology and User Guide*. (J. E. Commission, with OECD, Eds.)*OECD* (p. 162). Paris: OECD Publishing. Retrieved from <http://www.oecd-ilibrary.org/oecd/content/book/9789264043466-en>.
- National Science Board. (2010). *Science and Engineering Indicators—2010*. (N. S. Foundation, Ed.)*Journal of Testing and Evaluation* (NSB 10-01 ed., Vol. 19, p. 566). Arlington, VA: National Science Foundation. doi: 10.1520/JTE12551J.
- Newman, N. C., Porter, A. L., Roessner, J. D., Kongthon, A., & Jin, X.-Y. (2010). Longitudinal assessment - Differences over a decade: high tech capabilities and competitive performance of 28 nations. *Research Evaluation*, 14(2), 121-128.
- OECD. (2007). Glossary of statistical terms. *OECD*, 863.
- OECD. (2008). *Main Science and Technology Indicators*. (N. OECD, Ed.)*OECD* (2008-2 ed., Vol. 2008, p. 104). Paris: OECD Publishing.
- OECD. (2009a). *Main Science and Technology Indicators*. (OECD, Eds.) (p. 156). Paris: OECD Publications. Retrieved February 25, 2011, from <http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Main+Science+and+Technology+Indicators#0>.
- OECD. (2009b). *Science, Technology and Industry Scoreboard 2009*. (OECD, Eds.)*OECD* (2009th ed., p. 146). Paris: OECD Publications.
- Rip, A. (2008). Processes of Technological Innovation in Context - and Their Modulation. *Festschrift* (p. 17). Louvain.

- Saisana, M, Saltelli, A, & Tarantola, S. (2005). Uncertainty and sensitivity analysis techniques as tools for the quality assessment of composite indicators. *Journal of the Royal Statistical Society Series A Statistics in Society*, 168(2), 307-323. doi: 10.1111/j.1467-985X.2005.00350.x.
- Smits, R., Merkerk, R. V., & Guston, D. H. (2010). The Role of Technology Assessment in Systemic Innovation Policy. In R. Smits, S. Kuhlmann, & P. Shapira (Eds.), *The Theory and Practice of Innovation Policy: An International Research Handbook* (Vol. 2010). Edward Elgar.
- Tijssen, R. J. W. (2003). Scoreboards of research excellence. *Research Evaluation*, 12(2), 91–103. Beech Tree Publishing. Retrieved February 23, 2011, from <http://www.ingentaconnect.com/content/beece/rev/2003/00000012/00000002/art00003>.
- Zhou, P., Fan, L.-wei, & Zhou, D.-qun. (2010). Data aggregation in constructing composite indicators: A perspective of information loss. *Expert Systems with Applications*, 37, 360-365. Elsevier Ltd. All. doi: 10.1016/j.eswa.2009.05.039.