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Creating Economic Space for Social Innovation

CRESSI Working papers

The CRESSI project explores the economic underpinnings of social innovation with a particular focus on how policy and practice can enhance the lives of the most marginalized and disempowered citizens in society.

CRESSI Working Papers
No. 24/2015

Overview of Existing Innovation Indicators

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ISBN: 978-0-9933861-5-2

CRESSI Deliverable 3.3

"Creating Economic Space for Social Innovation" (CRESSI) has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 613261.

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By Cees van Beers, Attila Havas and Enrica Chiappero-Martinetti

1. Introduction

This report investigates the current state of the art of measuring innovation.[1] In order to elaborate indicators that describe social innovation impact, this task investigates existing innovation indicators with regard to technological and social innovations.[2] The main goal of the present task is to provide an overview of current indicators on both technological and social innovations. Therefore we first provide a critical overview of existing indicators of technological innovation. It is important to emphasise that we should consider all sorts of business (or: profit-oriented) innovations on the one hand, and social (socially-oriented or societal) innovations, on the other. In other words, we take into account not only technological (product, service, and process) innovations when discussing profit-oriented innovations, but also organisational and marketing innovations.[3] Innovation studies show that it is more of an exception than a rule to introduce technological innovations without organisational innovations and in many cases marketing and market innovations are also required. Moreover, the latter ones are vital for the success of the former ones (Pavitt, 1999; Tidd et al., 1997). In particular, radical innovations often create new markets and that is, by definition, a market innovation as well.

In the last twenty years quite a number of attempts have been made to characterise technological innovations empirically through indicators. Examples of science and technological innovation indicators are: Research and Development (R&D) expenditures of the firm (can be aggregated at sectoral and country level); patent counts; revenues stemming from the sale of new products; introduction of new production processes and so on. From this research has emerged the Oslo Manual has emerged, which is the OECD standard on measuring innovations (also adopted by the United Nations). These innovations are of technological type, and they are driven by a profit motive of a private firm. The Oslo Manual is not focused on civil society organisations as key actors in innovation and, hence, does not address the measurement of social innovation. Apart from overviewing measurement approaches of technological innovation, this task takes into account on-going work on measurement of social innovations. There are a limited number of attempts to develop metrics for social innovations. Examples are the Human Development Index based on the capabilities approach and the FP7 TEPSIE project's attempts to build social innovation indicators.

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[1] This CRESSI deliverable (D3.3) was submitted to the EC on 27 July 2015. This working paper is a reformatted version.

[2] Social innovation is defined by the CRESSI project as follows: "The development and delivery of new ideas (products, services, models, markets, processes) at different socio-structural levels that intentionally seek to improve human capabilities, social relations, and the processes in which these solutions are carried out."

[3] These three types of innovations are defined by the Oslo Manual (OECD, 2005), aimed at providing guidelines to interpret and measure innovations introduced by businesses. Interestingly, market innovations, that is, entering new markets to purchase inputs or sell outputs (not to be confused with marketing innovations) are not mentioned by the Manual (although these are parts of the classic description of innovation by Schumpeter, and important ones, indeed). Perhaps it would be hardly possible to measure these crucial innovations. Further, financial innovations are not mentioned either as a separate category. Certain types of financial innovations can be interpreted as service innovations (e.g. new financial 'products'), while others (e.g. e- and m-banking) as new business practices, that is, organisational innovations using the definitions presented in the Manual.

Technological innovations, aimed at tackling societal challenges, should not be neglected when considering social innovations, either. Further, certain organisational and marketing innovations might also be useful – or even indispensible – to achieve societal goals. Hence we have to keep in mind the distinction between the nature of innovations (technological, organisational, and marketing) and the goals of innovation efforts (business vs. societal purposes).

Significant progress has been achieved in measuring R&D and innovation activities since the 1960s (Grupp, 1998; Grupp and Schubert, 2010; Smith, 2005), with the intention to provide comparable data sets as a solid basis for assessing R&D and innovation performance and thereby guiding policy-makers in devising appropriate policies.[4] Although there are widely used guidelines to collect data on R&D and innovation – the Frascati and Oslo Manuals (OECD, 2002 and 2005, respectively) –, it is not straightforward to find the most appropriate way to assess R&D and innovation performance. To start with, R&D is such a complex, multifaceted process that it cannot be sufficiently characterised by two or three indicators, and that applies to innovation *a fortiori*. Hence, there is always a need to select a certain set of indicators to depict innovation processes, and especially to analyse and assess innovation performance. The choice of indicators is, therefore, an important decision reflecting the mindset of the decision-makers who chose them.

Therefore, it is important to examine how various economics schools understand innovation and what innovation models have been proposed by various authors; this will be done in section 2. In section 3, we discuss shortly the characteristics and structure of innovation indices. Based on the contents of section 2, in section 4 two relevant knowledge-, R&D- and technology-oriented measurement indices of innovations are assessed - i.e. the Innovation Union Scoreboard and the Global Innovation Index. Section 5 turns to the Technology Achievement Index, compiled for the 2001 edition of the Human Development Report, while social innovation is the focus of section 6, which describes the composition of indices of the TEPSIE project. Section 7 discusses some further methodological issues related to the analysis of social innovations and section 8 concludes.

2. Models and economic theories of innovation

Besides Schumpeter, only a few economists had perceived innovation as a relevant research theme in the first half of the 20th century.[5] At that time, however, natural scientists, managers of business R&D labs and policy advisors had formulated the first models of innovations – stressing the importance of scientific research –, and these ideas are still highly influential.[6] Since the late 1950s, more and more economists have shown interest in studying innovation, leading to new models of innovation, as well as an explicit mention of innovation in various economics paradigms. The role of innovation in economic development, however, is analysed by various schools of economics in diametrically different ways.[7] The underlying assumptions and key notions of these paradigms lead to diverse policy implications.

[4] "The Innovation Union Scoreboard 2013 gives a comparative assessment of the innovation performance of the EU27 Member States and the relative strengths and weaknesses of their research and innovation systems." (EC, 2013a: 4)
[5] This section heavily draws on Section 2 in Havas (2015a).
[6] For further details, see, e.g. Fagerberg et al. (2011: 898) and Godin (2008: 64-66).
[7] The ensuing overview can only be brief, and thus somewhat simplified. More detailed and nuanced accounts, major achievements and synthesising pieces of work include Baumol (2002); Castellacci (2008a); Dodgson and Rothwell (eds) (1994); Dosi (1988a), (1988b); Dosi et al. (eds) (1988); Edquist (ed.) (1997); Ergas (1986), (1987); Fagerberg et al. (eds) (2005); Fagerberg et al. (2012); Freeman (1994); Freeman and Soete (1997); Grupp (1998); Hall and Rosenberg (eds) (2010); Klevorick et al. (1995); Laestadious et al. (2005); Lazonick (2013); Lundvall (ed.) (1992); Lundvall and

2.1 Linear, networked and interactive learning models of innovation and policy implications

The first models of innovation had been devised by natural scientists and practitioners before economists showed a serious interest in these issues.[8] The idea that basic research is the main source of innovation had already been proposed at the beginning of the 20th century, gradually leading to what is known today as the science-push model of innovation, forcefully advocated by Bush (1945).

It is worth recalling some of the main building blocks of Bush's reasoning:

> "We will not get ahead in international trade unless we offer new and more attractive and cheaper products. Where will these new products come from? How will we find ways to make better products at lower cost? The answer is clear. There must be a stream of new scientific knowledge to turn the wheels of private and public enterprise. There must be plenty of men and women trained in science and technology for upon them depend both the creation of new knowledge and its application to practical purposes. (…)
>
> New products and new processes do not appear full-grown. They are founded on new principles and new conceptions, which in turn are painstakingly developed by research in the purest realms of science. Today, it is truer than ever that basic research is the pacemaker of technological progress. In the nineteenth century, Yankee mechanical ingenuity, building largely upon the basic discoveries of European scientists, could greatly advance the technical arts. Now the situation is different.
>
> A nation which depends upon others for its new basic scientific knowledge will be slow in its industrial progress and weak in its competitive position in world trade, regardless of its mechanical skill." (Bush, 1945, chapter 3)

By the second half of the 1960s the so-called market-pull model contested that reasoning, portraying demand as *the* driving force of innovation. Then a long-lasting and detailed discussion have started with the intention to establish which of these two types of models is correct, that is, whether R&D results or market demands are the most important information sources of innovations.[9]

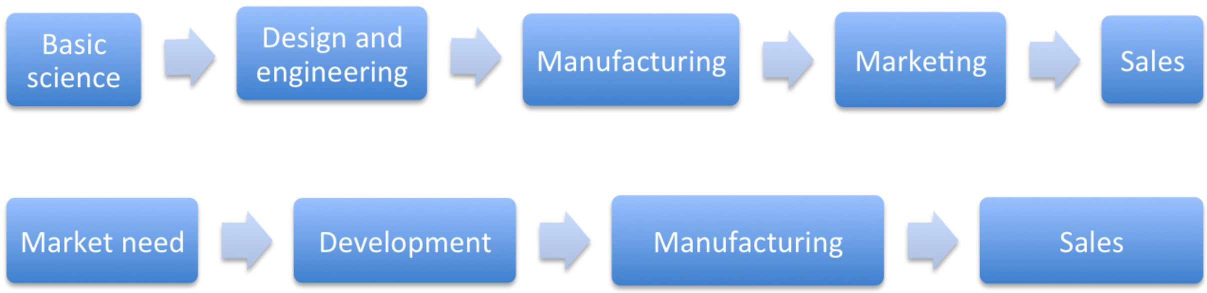
Both the science-push and the market-pull models portray innovation processes as linear ones (see Figure 1 below).

Borrás (1999); Martin (2012); Metcalfe (1998); Mowery and Nelson (1999); Nelson (ed.) (1993); Nelson (1995); OECD (1992), (1998); Pavitt (1999); Smith (2000); and von Tunzelmann (1995).

[8] This brief account can only list the most influential models; Balconi et al. (2010); Caraça et al. (2009); Dodgson and Rothwell (1994); and Godin (2006) offer detailed discussions on their emergence, properties and use for analytical and policy-making purposes.

[9] It is telling that a recent review of this discussion by Di Stefano et al. (2012) draws on one hundred papers.

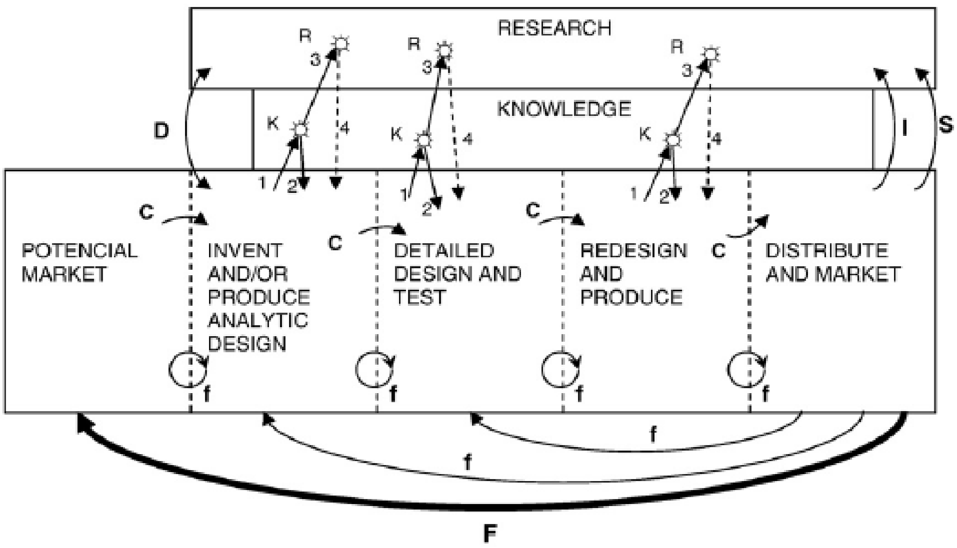
Figure 1: Linear models of innovation



Source: Dodgson and Rothwell (eds) (1994), Figures 4.3 and 4.4 (p. 41)

This common feature has somewhat eclipsed the differences among these models when Kline and Rosenberg (1986) suggested the chain-linked model of innovation, stressing the non-linear property of innovation processes, the variety of sources of information, as well as the importance of various feedback loops (Figure 2).

Figure 2: The chain-linked model of innovation



Chain-linked model showing flow paths of information and cooperation.
Symbols on arrows: C = central-chain-of-innovation; f = feedback loops; F = particularly important feedback.

K-R: Links through knowledge to research and return paths. If problems solved at node K, link 3 to R not activated. Return from research (link 4) is problematic - therefore dashed line.

D: Direct link to and from research from problems in invention and design.

I: Support of scientific research by instruments, machines, tools, and procedures of technology.

S: Support of research in sciences underlying product area to gain information directly and by monitoring outside work. The information obtained may apply anywhere along the chain.

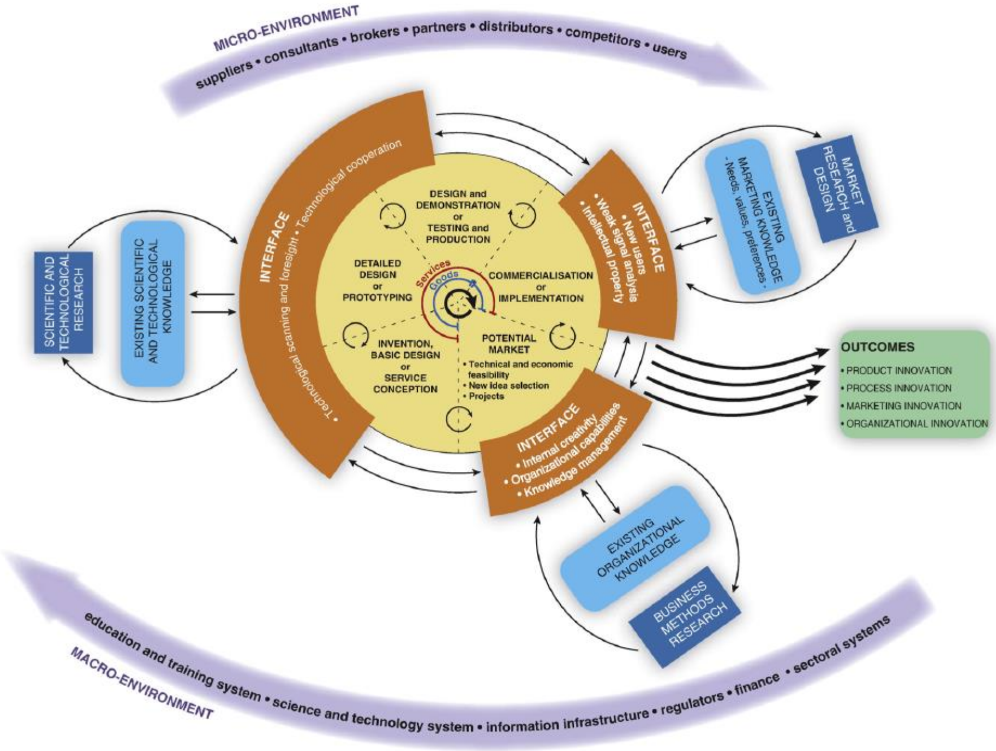
Source: Kline and Rosenberg (1986)

The chain-link model has then been extended into the networked model of innovation; its recent, highly sophisticated version is called the multi-channel interactive learning model. (Caraça et al., 2009) (Figure 3) This model "has representational purposes and not representative ones, i.e. it *does not assume that all factors have to be in place* for innovation to be realised and successful. Rather, it tries to provide a stylised representation of the main classes of variables, and their interrelationships, which are involved in the innovation process taking place in a wide array of industries. For instance, innovative firms in 'low-tech' industries such as food-processing or textiles work closely with users in order to modify their products, whereas services firms in the finance sector are relatively heavy users of economic findings (econometrics, risk theory, etc.), and, moreover, all of these are examples of industries quite dependent on equipment suppliers (machinery, information technology, and others).

Thus, the model is an analytical grid that describes and contextualises elements, but it also provides a set of flexible generalisations upon which to base our thinking when trying to explain the sources and stages of the innovation process. It points to the *ubiquitous experience-based learning processes* taking place within firms, as well as at the interfaces with users, suppliers and competitors. In addition, in the interaction with universities and other science institutions, the daily exchange of knowledge involving scholars and students in an interaction with firms is more important than when universities act as business enterprises selling knowledge in the form of patents.

The model makes it clear that *not all processes of innovation are science-based and that few of them are purely science-driven*." (Caraça et al., 2009: 864-866; emphasis added)

Figure 3: The multi-channel interactive learning model of innovation



Source: Caraça et al. (2009)

2.2 Innovation in economics paradigms

Technological, organisational, managerial changes and opening up new markets had been a major theme in classical economics – without using the term innovation. (Havas, 2015b) Then neo-classical economics essentially abandoned research questions concerned with dynamics, and instead focused on static allocative efficiency. Optimisation was the key issue for this school, assuming homogenous products, diminishing returns to scale, technologies accessible to all producers at zero cost, perfectly informed economic agents, perfect competition, and thus zero profit. Technological changes were treated as exogenous to the economic system, while other types of innovations were not considered at all. Given the empirical findings and theoretical work on firm behaviour and the operation of markets, neo-classical industrial economics and organisational theory has relaxed the most unrealistic assumptions, especially perfect information, deterministic environments, perfect competition, and constant or diminishing returns. Yet, "this literature has not addressed institutional issues, it has a very narrow concept of uncertainty, it has no adequate theory of the creation of technological knowledge and technological interdependence amongst firms, and it has no real analysis of the role of government." (Smith, 2000: 75)

Evolutionary economics of innovation rests on radically different postulates compared to mainstream economics.[10] The latter assumes rational agents, who can optimise via calculating *risks* and taking appropriate actions, while the former stresses that "innovation involves a fundamental element of uncertainty, which is not simply the lack of all the relevant information about the occurrence of known events, but more fundamentally, entails also (a) the existence of techno-economic problems whose solution procedures are unknown, and (b) the impossibility of precisely tracing consequences to actions". (Dosi, 1988a: 222) Thus, optimisation is impossible on theoretical grounds.

Availability of *information* (symmetry vs. asymmetry among agents in this respect) has been the central issue in mainstream economics until recently. Evolutionary economics, in contrast, has stressed since its beginnings that the success of firms depends on their accumulated *knowledge* – both codified and tacit –, skills, as well as learning capabilities. Information can be purchased (e.g. as a manual, blueprint, or licence), and hence can be accommodated in mainstream economics as a special good relatively easily and comfortably. Yet, knowledge – and a fortiori, the types of knowledge required for innovation, e.g. tacit knowledge, skills, and competence in pulling together and exploiting available pieces of information – cannot be bought and used instantaneously. A learning process cannot be spared if one is to acquire knowledge and skills, and it is not only time-consuming, but the costs of trial and error need to be incurred as well.[11] Thus, the uncertain, cumulative and path-dependent nature of innovation is reinforced.

[10] The endogenous growth theory (Romer, 1990) though an important scientific contribution to the theory of technological change, is not discussed here separately because its major implicit assumptions on knowledge are very similar to those of mainstream economics. When summarising the "evolution of science policy and innovation studies" (SPIS), Martin (2012: 1230) also considers this school as part of mainstream economics: "Endogenous growth theory is perhaps better seen not so much as a contribution to SPIS but rather as a response by mainstream economists to the challenge posed by evolutionary economics."

[11] More recently, learning has become a subject in mainstream economics, too, most notably in game theory. For instance, while "learning" only appeared twice in the title of NBER working papers in 1996, it occurred 5 times in 1999, 6 times in 2002, 13 times in 2008, and 10 times in 2013, among others in the forms of "learning by doing", "learning form experience", and "learning from exporting". Taking the titles and abstracts of articles published in the American Economic Review, "learning" occurred first in 1999, then 2-3 times a year in 2002-2006; 4 times in 2008, 2011, and 2012; 5 times in 2013; 6 times in 2007 and 2010; and 7 times in 2009. A detailed analysis of the substance of these articles is beyond the scope of this paper.

Cumulativeness, path-dependence and learning lead to heterogeneity among firms, as well as other organisations. On top of that, sectors also differ in terms of major properties and patterns of their innovation processes. (Castellacci, 2008b; Malerba, 2002; Pavitt, 1984; Peneder, 2010) Innovators are not lonely champions of new ideas. While talented individuals may develop radically new, brilliant scientific or technological concepts, successful innovations require various types and forms and knowledge, rarely possessed by a single organisation. A close collaboration among firms, universities, public and private research organisations, and specialised service-providers is, therefore, a prerequisite of major innovations, and can take various forms, from informal communications through highly sophisticated R&D contracts to alliances and joint ventures. (Freeman 1991, 1994, 1995; Lundvall and Borrás, 1999; OECD, 2001; Smith, 2000; Tidd et al., 1997) In other words, 'open innovation' is not a new phenomenon at all. (Mowery, 2009)

2.3 Policy rationales derived from economic theories

Different policy conclusions can be drawn from competing schools of economic thought. Mainstream economics is primarily concerned with market failures: unpredictability of knowledge outputs from inputs, inappropriability of full economic benefits of private investment in knowledge creation, and indivisibility in knowledge production lead to a socially 'suboptimal' level of business R&D efforts. Policy interventions, therefore, are justified if they aim at (a) creating incentives to boost private R&D expenditures by ways of subsidies and protection of intellectual property rights, or (b) funding for public R&D activities.

Evolutionary economics of innovation investigates the role of knowledge creation and exploitation in economic processes; that is, it does not focus exclusively on R&D. This school considers various types and forms of knowledge, including practical or experience-based knowledge acquired via learning by doing, using and interacting. As these are *all* relevant to innovation, scientific knowledge is far from being the only type of knowledge required for a successful introduction of new products, processes or services, let alone non-technological innovations. R&D is undoubtedly among the vital sources of knowledge. Besides in-house R&D projects, however, results of other R&D projects are also widely utilised during the innovation process: extramural projects conducted in the same or other sectors, at public or private research establishments, home or abroad. More importantly, there are a number of other sources of knowledge, also essential for innovations, such as design, scaling up, testing, tooling-up, trouble-shooting, and other engineering activities, ideas from suppliers and users, inventors' concepts and practical experiments (Hirsch-Kreinsen et al. (eds), 2005; Klevorick et al., 1995; Lundvall (ed.), 1992; Lundvall and Borrás, 1999; Rosenberg, 1996, 1998; von Hippel, 1988), as well as collaboration among engineers, designers, artists, and other creative "geeks". Further, innovative firms also utilise knowledge embodied in advanced materials and other inputs, equipment, and software.

The Community Innovation Survey (CIS) defines its own set of categories as highly important sources of information for product and process innovation: the enterprise or the enterprise group; suppliers of equipment, materials, components or software; clients or customers; competitors or other enterprises from the same sector; consultants, commercial labs or private R&D institutes; universities or other higher education institutes; government or public research institutes; conferences, trade fairs, exhibitions; scientific journals and trade/technical publications; and professional and industry associations. All rounds of CIS clearly and consistently show that firms regard a wide variety of sources of information as highly important ones for innovation.[12]

[12] See appendix A for sources of innovation in 2010–2012.

The wide variety of knowledge used in innovation processes is a crucial point to bear in mind as the OECD classification of industries only takes into account expenditures on formal R&D activities, carried out within the boundaries of a given sector.[13] In other words, a number of highly successful, innovative firms, exploiting advanced knowledge created externally in distributed knowledge bases (Smith, 2002) and internally by non-R&D processes, are classified as medium-low-tech or low-tech, just because their R&D expenditures are below the threshold set by the OECD.

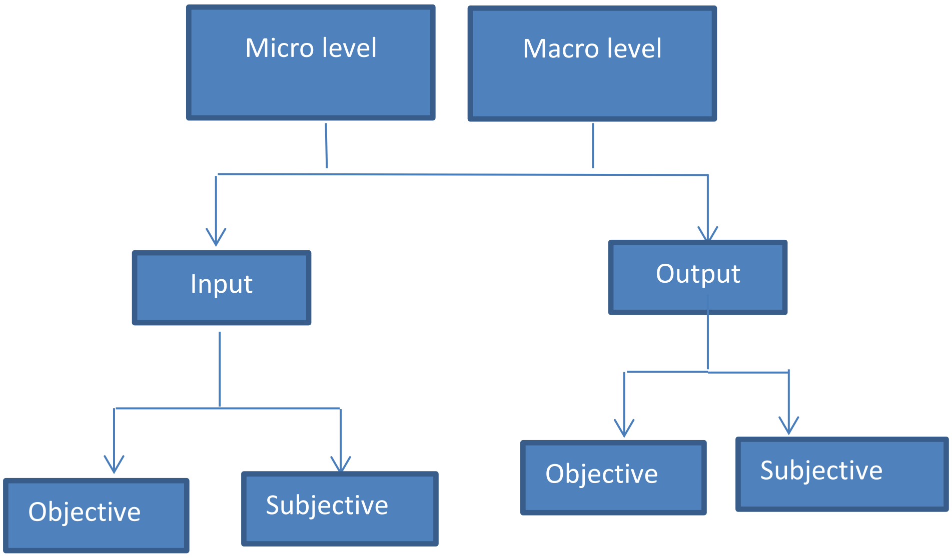
In sum, evolutionary economics of innovation posits that the success of firms is largely determined by their abilities to exploit various types of knowledge, generated by both R&D and non-R&D activities. Knowledge generation and exploitation takes place in, and is fostered by, various forms of internal and external interactions. The quality and frequency of the latter is largely determined by the properties of a given innovation system, in which these interactions take place. STI policies, therefore, should aim at strengthening the respective innovation system and improving its performance by tackling *systemic failures* hampering the generation, diffusion and utilisation of any type of knowledge required for successful innovation.[14] (Edquist, 2011; Foray (ed.), 2009; Freeman, 1994; Lundvall and Borrás, 1999; OECD, 1998; Smith, 2000) From a different angle, conscious, co-ordinated policy efforts are needed to promote knowledge-intensive activities in all sectors.

3. Characteristics and structure of innovation indicators

Before discussing specific innovation indicators, in this section we shortly examine the structure of innovation indicators. A first characteristic is the aggregation level at which the measurement takes place, i.e. the micro vs. macro levels. A second characteristic is what is actually measured and distinguishes between input and output indicators. A third one relates to the kind of data the measurement is based on, i.e. whether these are objective or subjective data. Figure 4 provides an overview. These characteristics lead to single indicators, which can be brought together to compile composite indicators.

[13] The so-called indirect R&D intensity has been also calculated as R&D expenditures embodied in intermediates and capital goods purchased on the domestic market or imported. Yet, it has been concluded that indirect R&D intensities would not influence the classification of sectors. (Hatzichronoglou, 1997: 5)
[14] In an attempt to systematically compare the market and systemic failure policy rationales, Bleda and del Río (2013) introduce the notion of evolutionary market failures, and reinterpret „the neoclassic market failures" as particular cases of evolutionary market failures, relying on the crucial distinction between knowledge and information.

Figure 4: Classification Indicators of Technological Innovation



3.1 Level of aggregation

At the macro level the measurement unit is the country level and consists of two elements: government activities and the aggregate of individual firms' activities. Examples are government expenditures on R&D (GERD) or total business expenditures on R&D (BERD), number of doctorates, etc. Macro level indicators are mainly focused on measuring the environment, in which the private sector conducts innovation activities. Furman et al. (2002) build indicators of innovative capacities of countries. They find that besides the "usual" elements such as investing in R&D through spending on human resources (universities etc.) the kind and effectiveness of governments R&D policies – for example, the extent of IP protection – play an important role in explaining differences in innovative capacities between countries.
Indicators of (technological) innovation at the micro level are measured at the level of the firm, not at the level of the individual inventor. Examples are the R&D expenditures of a firm or the number of patents granted to a firm in a particular year.

A distinction between R&D-based indicators and innovation indicators is crucial. R&D-based indicators generally have more impact on policy-making than innovation indicators. OECD (2009: p. 23) comes up with three reasons:

1. R&D subsidies are an important instrument in science and technology policies of EU-countries and this policy tool requires information on R&D indicators;
2. R&D data are considered more reliable than innovation indicators; and
3. policy-makers are not fully aware of available innovation data and their potential use.[15]

In case of social innovations indicators at the micro level have an extra dimension, namely the individuals that are (more or less) marginalised (see also the MethList[16]).

[15] See also van Beers et al. (2008), Kleinknecht and Mohnen (2002), Kleinknecht et al. (2002).
[16] The MethList is an output of the CRESSI project, outlining elements that should be considered when engaging in social innovation metrics.

3.2 Input- and output-oriented indicators

A distinction between input and output indicators relates to the input necessary to produce innovations and the results of the innovation itself, respectively. Examples of input innovation indicators are:

1. total expenditure on innovation as % of total turnover,
2. expenditure on innovation by type of expenditure (R&D, external knowledge, etc.),
3. share of firms performing R&D, and
4. share of firms performing R&D on a continuous basis.

Output innovation indicators are for example:
1. turnover from product innovations as % of total turnover, and
2. turnover from new-to-market product innovations as % of total turnover (see OECD, 2009).

3.3 Objective versus subjective data

The distinction between R&D indicators and innovation indicators is related to the difference between objective and subjective information. R&D indicators originate from statistical surveys and, for a part, consist of annual amounts of money invested in R&D. Although these pieces of information are provided by firms, external checks are possible and required in order to take decisions on R&D policies. These checks make this kind of information less subjective. In innovation surveys the subjective element is more dominant as answers to the questions have often been structured as yes/no but also lead to perceptions. For example, one question in the Community Innovation Survey (CIS) is: *During the years … did your firm introduce new or significantly improved goods?* Although a definition is provided on what a product innovation is, the words "new" and "improved" will probably not be assessed in the same way by different firms and not even by different employees in the same firm. Information on the "obstacles to innovation" is also somewhat subjective as different firms consider certain phenomena as obstacles while other firms do not.

An example of an objective output measure is patents. These are easily accessible and publicly available. Further, they are classified by technical fields (ICT, nanotechnology etc.). Two drawbacks can be mentioned. First, not all innovations are patented. Patent filing is costly and a time -consuming process and hence not worth the efforts for many (minor) incremental innovations or innovations in technical fields that are very dynamic. Second, not all patents will stimulate the introduction of new products and production processes. Not much is known about so-called "sleeping" patents that are sometimes used to pre-empt competition (Van der Panne, 2004: 51). These are patents that are not used for commercialisation as the new products that coming out of them might be a threat to a very profitable existing product line. In other words, the knowledge gained is patented but only to keep it away from the market and hence the competitors for the coming 20 years.

A disadvantage of CIS data is that very small innovating firms (with less than 10 employees) are not taken into account. A method that also takes into account this "forgotten" group of innovators is the Literature-Based-Innovation-Output (LBIO-) method (see among others Acs and Audretsch, 1988, Coombs et al., 1996). This method scans new product announcements in trade journals and clearly is an output indicator. Van der Panne (1994: 62-63) mentions – besides picking up small innovators and being an output indicator – another advantage: it is able to identify innovations without patent protection.

3.4 Composite indicators

There is a fairly strong pressure to devise so-called composite indicators to compress information into a single figure in order to compile eye-catching, easy-to-digest scoreboards. Composite indicators, constructed by cross-tabulation or multivariate analysis of the link between innovation factors and innovation outcomes, can be useful. They can also be indicators that combine answers to several questions in innovation surveys and can be relevant to identify a number of policy-relevant factors. Examples are (OECD, 2009):

1. Output-based innovation modes: classification by combining information on novelty of the innovation and whether the innovation has been developed and produced in-house
2. Innovation status: classification of formal in-house innovation (innovativeness) and collaboration with external partners (diffusion)
3. Technological and non-technological innovations: combines product/ process innovations (technological) with organisational and marketing innovations (non-technological)
4. Dual innovators: firms that are innovative in both goods and services innovation.

A major source of complication is choosing an appropriate weight to be assigned to each component. By conducting sensitivity analyses of the 2005 European Innovation Scoreboard (EIS), Grupp and Schubert (2010: 72) have shown how unstable the rank configuration is when the weights are changed. Besides assigning weights, three other ranking methods are also widely used, namely: unweighted averages, Benefit of the Doubt (BoD) and principal component analysis. Comparing these three methods, the authors conclude: "(…) even using accepted approaches like BoD or factor analysis may result in drastically changing rankings." (Grupp and Schubert, 2010: 74) Hence, they propose using multidimensional representations, e.g. spider charts to reflect the multidimensional character of innovation processes and performance. That would enable analysts and policy-makers to identify strengths and weaknesses, that is, more precise targets for policy actions. (Grupp and Schubert, 2010: 77)

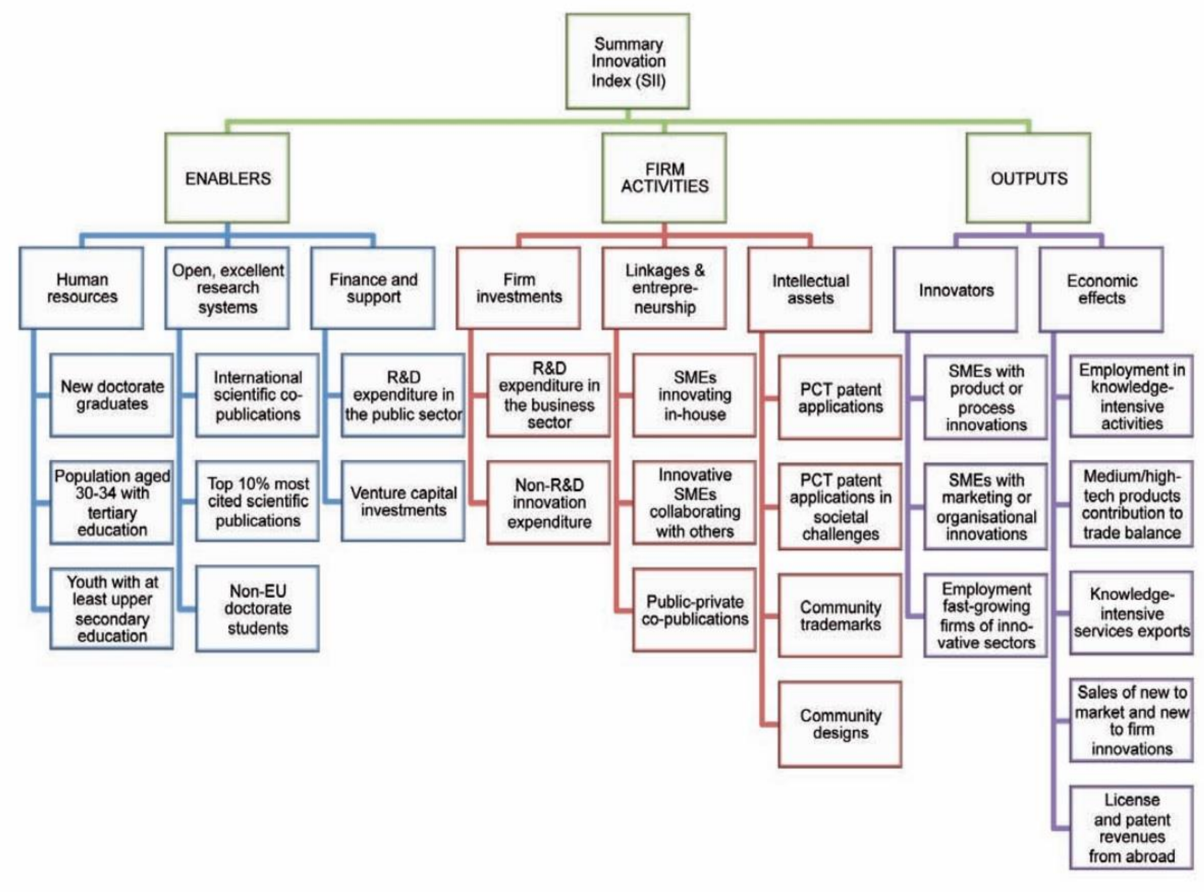
Other researchers also emphasise the need for a sufficiently detailed characterisation of innovation processes. For example, a family of five indicators – R&D, design, technological, skill, and innovation intensities – offers a more diversified picture on innovativeness than the Summary Innovation Index of the European Innovation Scoreboard. (Laestadius *et.al*, 2005) Using Norwegian data they demonstrate that the suggested method can capture variety in knowledge formation and innovativeness both within and between sectors. It thus supports a more accurate understanding of creativity and innovativeness inside and across various sectors, directs policy-makers' attention to this diversity (suppressed by the OECD classification of sectors), and thus can better serve policy needs.

4. Knowledge-, R&D- and technology-oriented measurement indices

4.1 The Innovation Union Scoreboard

An example of a composite indicator is the Summary Innovation Index (SII), constructed by using the 25 indicators of the Innovation Union Scoreboard. Figure 5 provides an overview along three main pillars: enablers, firm activities and outputs:

Figure 5: Measurement framework from the Innovation Union Scoreboard



Source: Innovation Union Scoreboard 2014

The first main pillar, enablers, describes the environment, in which the innovating entities, i.e. the firms, can innovate. “Enablers” are further detailed along three dimensions, 1) human resources, 2) open research systems and 3) finance and support. The first one is measured at the macro level and deals with the education and skill-level of the workforce. The second one, open research systems, refers to the international competitiveness of the science base and constitute of innovation indicators at the micro and meso level. The third dimension, finance and support, measures the availability of public and private funds for financing R&D and innovation activities such as R&D expenditures in the public sector or venture capital investments.

The second main pillar, firm activities, are the innovating efforts of the firms along the following three dimensions, 1) firm investments, 2) linkages and entrepreneurship and 3) intellectual property rights. Firm investments are investments by firms aimed at generating innovations. The second dimension focuses on collaboration between innovating firms and external private and public partners. Different forms of intellectual property rights (IPR) – considered as a throughput in the innovation process – are picked up by the third dimension.

The third main pillar refers to the output of innovations and is categorised along two dimensions, 1) innovators and 2) economic effects. The former one measures the number of firms producing technological and non-technological (e.g. marketing and organisational) innovations, as well as employment in high-growth innovative firms. Economic effects consist of a mixture of indicators on employment (macro and meso level) and commercial output of innovating firms such as the share of sales of new products in the total turnover and revenues from licenses and patents (micro level).

Firms exploit various types of knowledge for their innovation activities. Applying this general observation to the Danish case, and relying on the DISKO survey, Jensen et al. (2007) made an elementary distinction between two modes of innovation: (a) one based on the production and use of codified scientific and technical knowledge (briefly, the ST mode), and (b) another one relying on informal processes of learning and experience-based know-how (called DUI: learning by Doing, Using and Interacting).

Following this distinction, the indicators used in the Innovation Union Scoreboard[17] are characterised below, using a rudimentary classification:

- only R&D-based innovations
- mainly R&D-based innovations
- only non-R&D-based innovations
- mainly non-R&D-based innovations
- both types of innovations.

This rudimentary classification reveals a bias towards R&D-based innovations in the first edition of the EIS: 10 indicators were only relevant for R&D-based innovations; 8 could be relevant for both types of innovations; and none was focusing on non-R&D-based innovations (Table 1).

[17] The Innovation Union Scoreboard originally was called European Innovation Scoreboard (EIS). The EIS and IUS indicators have been revised several times since the first edition of the scoreboard, that is, EIS 2002. The current name of the scoreboard was introduced in 2010.

Table 1: The 2002 European Innovation Scoreboard indicators

	Relevance for R&D-based innovation	Relevance for non-R&D-based innovation
1 Human resources		
New S&E graduates (ISCED 5a and above) per 1000 population aged 20-29	X	
Population with tertiary education (% of 25–64 years age class)	b	b
Participation in life-long learning (% of 25–64 years age class)	b	b
Employment in medium-high and high-tech manufacturing (% of total workforce)	X	
Employment in high-tech services (% of total workforce)	X	
2 Knowledge creation		
Public R&D expenditures (GERD – BERD) (% of GDP)	X	
Business expenditures on R&D (BERD) (% of GDP)	X	
EPO high-tech patent applications (per million population)	X	
USPTO high-tech patent applications (per million population)	X	
3 Transmission and application of knowledge		
SMEs innovating in-house (% of manufacturing SMEs)	b	b
SMEs involved in innovation co-operation (% of manufacturing SMEs)	b	b
Innovation expenditures (% of all turnover in manufacturing)	b	b
4 Innovation finance, output and markets		
High technology venture capital investment (% of GDP)	X	
Capital raised on parallel markets plus by new firms on main markets (% of GDP)[i]	X	
Sales of 'new to market' products (% of all turnover in manufacturing)	b	b
Home internet access (% of all households)	b	b
ICT expenditures (% of GDP)	b	b
Share of manufacturing value-added in high-tech	X	

Legend: X: only relevant; x: mainly relevant; b: relevant for both types
Source: own compilation, drawing on the detailed definition of indicators, EC (2002).

Notes:
-Public R&D expenditures do not equal to GERD – BERD; rather, it should be the sum of government-funded parts of BERD, GOVERD, and HERD
-Three indicators, namely EPO patent applications (per million population), Home internet access (per 100 population), and Inward FDI stock (% of GDP), were only used for candidate countries.
[i] "Parallel stock exchanges focus on high technology sectors." (EC, 2002: 31)

The 2014 edition of the IUS is based on 25 indicators, grouped by 8 innovation dimensions. (EC, 2014) Repeating the same exercise shows that the bias towards R&D-based innovations has been kept: 10 of the IUS 2014 indicators are *only* relevant for, and a further four *mainly* capture, R&D-based innovations; seven could be relevant for both types of innovations; and a mere four are focusing on non-R&D-based innovations.[18] (Table 2).

[18] A fairly detailed, partly technical, partly substantive discussion would be needed to refine this simple classification, especially on the following issues: to what extent upper secondary education, venture capital, employment in knowledge-intensive activities, and knowledge-intensive services exports are relevant indicators to capture non-R&D-

Table 2: The 2014 Innovation Union Scoreboard indicators

	Relevance for R&D- based innovation	Relevance for non-R&D-based innovation
Human resources		
New doctorate graduates (ISCED 6) per 1000 population aged 25-34	X	
Percentage population aged 30-34 having completed tertiary education	b	b
Percentage youth aged 20-24 having attained at least upper secondary level education	b	b
Open, excellent and attractive research systems		
International scientific co-publications per million population	X	
Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	X	
Non-EU doctorate students[i] as a % of all doctorate students	X	
Finance and support		
R&D expenditure in the public sector as % of GDP	X	
Venture capital investment as % of GDP	x	
Firm investments		
R&D expenditure in the business sector as % of GDP	X	
Non-R&D innovation expenditures as % of turnover		X
Linkages & entrepreneurship		
SMEs innovating in-house as % of SMEs	b	b
Innovative SMEs collaborating with others as % of SMEs	b	b
Public-private co-publications per million population	X	
Intellectual assets		
PCT patents applications per billion GDP (in PPS€)	X	
PCT patent applications in societal challenges per billion GDP (in PPS€) (environment-related technologies; health)	X	
Community trademarks per billion GDP (in PPS€)		X
Community designs per billion GDP (in PPS€)		X
Innovators		
SMEs introducing product or process innovations as % of SMEs	b	b
SMEs introducing marketing or organisational innovations as % of SMEs		X
Economic effects		
Employment in fast-growing enterprises in innovative sectors (% of total employment)	b	b
Employment in knowledge-intensive activities (manufacturing and services) as % of total employment	x	
Contribution of medium and high-tech product exports to the trade balance	x	
Knowledge-intensive services exports as % total service exports	x	
Sales of new to market and new to firm innovations as % of turnover	b	b
License and patent revenues from abroad as % of GDP	X	

Legend: X: only relevant; x: mainly relevant; b: relevant for both types
Source: own compilation

based innovations; and to what extent non-R&D-based innovation activities are needed for successful R&D-based innovations?

Note: [i] It is a somewhat strict definition of openness, as it only takes into account non-EU doctorate students.

The indicators used in the previous editions of the EIS and IUS are presented in Appendix B (Tables B1-B7). To give an overview of the evolution of the EIS and IUS indicators, results are summarised in Table 3. In sum, the bias towards R&D-based innovations has been rather persistent, although there has been some fluctuation.

Table 3: The evolution of the EIS and IUS indicators, 2002-2014

	EIS 2002	**EIS 2003**	**EIS 2004**	**EIS 2005, 2006**	**EIS 2007**	**EIS 2008**	**EIS 2009**	**IUS 2010 - 2013**	**IUS 2014**
Indicators reflecting									
only R&D-based innovations	10	9	9	8	7	8	8	10	10
mainly R&D-based innovations	-	3	3	5	5	4	4	4	4
both types	8	9	9	12	12	15	16	6	7
only non-R&D-based innovations	-	-	-	-	-	1	1	4	4
mainly non-R&D-based innovations	-	-	1	1	1	1	1	-	-
Number of indicators	18	21	22	26	25	29	30	24	25

Source: own compilation

Two major conclusions can be drawn from the above analysis for the CRESSI project.

First, while the number and definitions of indicators used to compile the various editions of EIS and IUS have changed to a non-negligible extent since 2002, these indicators consistently focus on measuring R&D activities (inputs and outputs) and R&D-based innovation activities. In other words, they can be relevant in settings characterised predominantly by the so-called ST mode of innovation, but significantly less so in other settings, characterised by other types of innovation activities. In other words, using the EIS or IUS indicators would not help establishing if a certain system is characterised by a low level of innovation activities altogether – or a low level of R&D-based innovation activities. Yet, that is a fairly important distinction both from an analytical and a practical (policy) point of view: these two systems (settings) are fundamentally different.

Several analysts and policy-makers tend to believe that advanced economies can be sufficiently characterised by focussing on the ST mode of innovation, on the one hand, and less advanced economies should also attempt to change the sectoral composition of their economy by increasing the weight of the so-called high-tech (HT) sectors. These views, however, cannot be corroborated by empirical evidence.

Any simple statistical analysis reveals that the so-called high-tech sectors – supposed to be drivers of economic development, due their intense ST mode innovation activities – have a fairly low weight either in output or employment. Innovation studies have shown that technological innovations can hardly be introduced without organisational and managerial innovations. Moreover, the latter ones – together with marketing innovations – are vital for the success of the former ones.[19]

[19] Although it goes without saying that not all technological innovations are based on R&D results, people tend to forget this basic fact. Certain organisational, managerial, marketing and financial innovations, in turn, draw on R&D results (but usually not stemming from R&D activities conducted or financed by firms). For these two reasons it would be a mistake to equate technological innovations with R&D-based innovations.

(Pavitt, 1999; Tidd et al., 1997) Further, those companies are the most successful ones, which consciously combine the ST and DUI modes of innovation. (Jensen et al., 2007)

Yet, the high-tech myth is so powerful that even those researchers who base their work on thorough analysis of facts are taken by surprise when the facts are at odds with the widespread obsession with high-tech. A telling example is Peneder's study on the 'Austrian paradox':

> "On the one hand, macroeconomic indicators on productivity, growth, employment and foreign direct investment indicate that overall performance is stable and highly competitive. On the other hand, an international comparison of industrial structures reveals a severe gap in the most technologically advanced branches of manufacturing, suggesting that Austria is having problems establishing a foothold in the dynamic markets of the future." (Peneder, 1999: 239)

In contrast, evolutionary economics of innovation claims that any firm – belonging to either a low- and medium-technology (LMT) or a HT sector – can become competitive in 'the dynamic markets of the future' if it is successful in combining its own, firm-specific innovative capabilities with 'extra-mural' knowledge available in distributed knowledge bases. In other words, Austrian policy-makers need not be concerned with the observed 'paradox' as long as they help Austrian firms sustain their learning capabilities, and maintain thereby their innovativeness. That would lead to good economic performance – irrespective of the share of LMT industries in the economy. Indeed, good performance has been maintained: Austrian GDP per capita was the fourth highest in the EU in 2013.

From a different angle, while the bulk of innovation activities in the LMT sectors are not based on intramural R&D efforts, these sectors also improve their performance by various types of innovations. These firms are usually engaged in the DUI mode of innovation, but they also draw on advanced S&T results available through the so-called distributed knowledge bases (Robertson and Smith, 2008; Smith, 2002), as well as advanced materials, production equipment, software and various other inputs (e.g. electronics components and sub-systems) supplied by HT industries. (Bender et al. (eds), 2005; Hirsch-Kreinsen et al. (eds), 2005; Hirsch-Kreinsen and Jacobson (eds), 2008; Hirsch-Kreinsen and Schwinge (eds) 2014; Jensen et al., 2007; Kaloudis et al., 2005; Mendonça, 2009; Sandven et al., 2005) Thus, demand by the LMT sectors constitutes major market opportunities for HT firms, and also provide strong incentives – and ideas – for their RTDI activities. (Robertson et al., 2009)

It is worth recalling that the 2003 EIS report also stressed the importance of the LMT sectors, as well as the significance of their innovation activities:

> "The EIS has been designed with a strong focus on innovation in high-tech sectors. Although these sectors are very important engines of technological innovation, they are only a relatively small part of the economy as measured in their contribution to GDP and total employment. The larger share of low and medium-tech sectors in the economy and the fact that these sectors are important users of new technologies merits a closer look at their innovation performance. This could help national policy makers with focusing their innovation strategies on existing strength and overcome areas of weakness." (EC, 2003a: 20)

Since then, however, these ideas have been given less prominence. No doubt, it would be an interesting research question why this is the case, but this paper cannot address this issue.
More recently, another EC document, namely the 2013 EU competitiveness report sends 'mixed' messages on these issues. At certain points it reinforces these adverse effects: „the EU has

comparative advantages in most manufacturing sectors (15 out of 23) accounting for about three quarters of EU manufacturing output. (…) Of the 15 sectors with comparative advantages mentioned above, about two-thirds are in the low-tech and medium-low tech manufacturing groups.

On a positive note though, even in those sectors EU competitiveness is based on high-end innovative products." (EC, 2013d: 3-4, emphasis added). Is it a negative phenomenon, then, that around 10 EU LMT sectors are internationally competitive? A more balanced view is also offered: "… the policy priority attached to key enabling technologies which lead to new materials and products in all manufacturing sectors has a strong potential to upgrade EU competitiveness not only in the high-tech sectors but also in the traditional industries." (EC, 2013d: 5)

To sum up the first conclusion, analysts and policy-makers dealing with innovation should pay attention to both R&D-based and non-R&D-based innovations.

The second conclusion: while social innovations can indeed utilise R&D-based technological innovations, their essence tends to be organisational, managerial and behavioural changes. The EIS and IUS indicators, in turn, do not capture these types of changes.

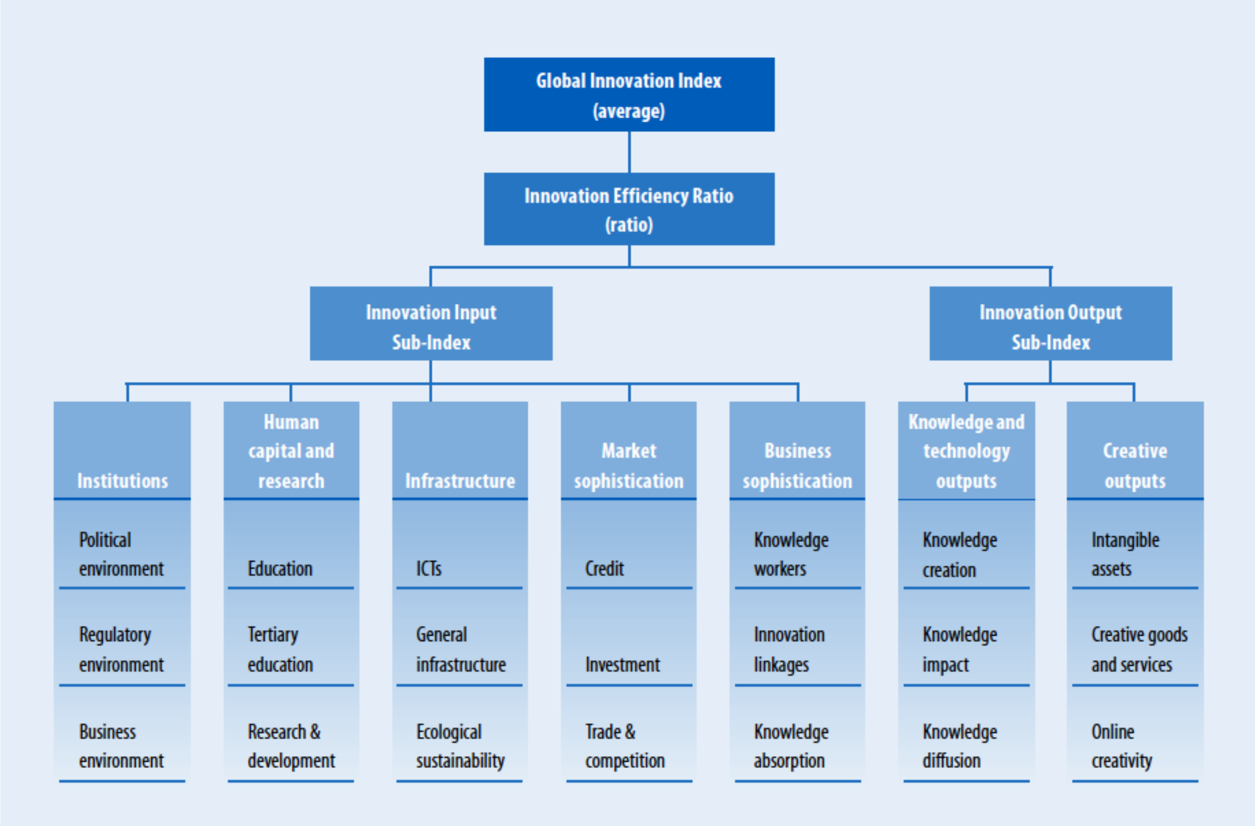
4.2 The Global Innovation Index

The Global Innovation Index (GII) has a significantly broader coverage – compared to the IUS – in two respects: it covers well over 100 countries, and considers 81 indicators, arranged in 7 "pillars". The seven pillars used in the 2014 edition of the GII include:

1. Institutions (9 indicators),
2. Human capital and research (11),
3. Infrastructure (10),
4. Market sophistication (10),
5. Business sophistication (14),
6. Knowledge and technology outputs (14), and
7. Creative outputs (13).

The themes considered by each pillar are summarised in Figure 6.

Figure 6: Framework of the Global Innovation Index 2014



Source: Global Innovation Index 2014

To assess the relevance of these 81 indicators, and especially the 'match' between the themes (or headings) captured by the 7 pillars would require a fairly lengthy paper. In other words, the GII indicators are characterised in a somewhat simplified way here. Most elements are indices themselves, that is, not 'stand-alone' indicators.

Pillar 1: Institutions

> "The political environment sub-pillar includes three indices that reflect perceptions of the likelihood that a government might be destabilised; the quality of public and civil services, policy formulation, and implementation; and perceptions of violations to press freedom.
>
> The regulatory environment sub-pillar draws on two indices aimed at capturing perceptions on the ability of the government to formulate and implement cohesive policies that promote the development of the private sector and at evaluating the extent to which the rule of law prevails (in aspects such as contract enforcement, property rights, the police, and the courts). The third indicator evaluates the cost of redundancy dismissal as the sum, in salary weeks, of the cost of advance notice requirements added to severance payments due when terminating a redundant worker.
>
> The business environment sub-pillar expands on three aspects that directly affect private entrepreneurial endeavours by using the World Bank indices on the ease of starting a business; the ease of resolving insolvency (based on the recovery rate recorded as the cents on the dollar recouped by creditors through reorganisation, liquidation, or debt enforcement/foreclosure proceedings); and the ease of paying taxes." (Cornell University et al., 2014: 45-46)

In a strict sense, not all the above 'ingredients' are institutions, and not all are directly related to innovation processes and performance. It can be argued, though, that the aspects (attempted to be) captured by these indices are relevant to characterise the political, regulatory and business environment for innovation. Among the important missing elements, one should mention legislation on competition,[20] as well as the entrepreneurial culture in a given country.

Pillar 2: Human capital and research

> "The first sub-pillar includes a mix of indicators aimed at capturing achievements at the elementary and secondary education levels. Education expenditure and school life expectancy are good proxies for coverage. Government expenditure per pupil, secondary gives a sense of the level of priority given to secondary education by the state. The quality of education is measured through the results to the OECD Programme for International Student Assessment (PISA), which examines 15-year-old students' performances in reading, mathematics, and science, as well as the pupil-teacher ratio.
>
> (…) The sub-pillar on tertiary education aims at capturing coverage (tertiary enrolment); priority is given to the sectors traditionally associated with innovation (with a series on the percentage of tertiary graduates in science and engineering, manufacturing, and construction); and the inbound mobility of tertiary students, which plays a crucial role in the exchange of ideas and skills necessary for innovation.
>
> The last sub-pillar, on R&D, measures the level and quality of R&D activities, with indicators on researchers (headcounts per million of population), gross expenditure (on R&D, % of GDP), and the quality of scientific and research institutions as measured by the average score of the top three universities in the QS World University Ranking of 2013. By design, this indicator aims at capturing the availability of at least three higher education institutions of quality within each economy (i.e., included in the global top 700), and is not aimed at assessing the average level of all institutions within a particular economy." (Cornell University et al., 2014: 46-47)

Formal education is a crucial factor determining the quality of human capital, no doubt, but life-long learning and other, informal modes of learning are also important. Research is conducted outside universities, too, both in other publicly financed research organisations, as well as inside businesses. Moreover, the quality of research conducted by these latter types of organisations is not necessarily lower than at universities. Moreover, university rankings themselves suffer from several major methodological weaknesses. Thus the name of this pillar is more 'ambitious' than its actual content.

Pillar 3: Infrastructure

> "The third pillar includes three sub-pillars: information and communication technologies (ICTs), general infrastructure, and ecological sustainability. (…)"
>
> The ICTs sub-pillar includes four indices developed by international organisations on ICT access, ICT use, online service by governments, and online participation of citizens.
>
> The sub-pillar on general infrastructure includes the average of electricity output in kWh per capita; a composite indicator on logistics performance; and gross capital formation, which consists of outlays on additions to the fixed assets and net inventories of the economy, including land improvements (fences, ditches, drains); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings.

[20] The intensity of competition is included in Pillar 4.

The sub-pillar on ecological sustainability includes three indicators: GDP per unit of energy use (a measure of efficiency in the use of energy), the Environmental Performance Index of Yale and Columbia Universities, and the number of certificates of conformity with standard ISO 14001 on environmental management systems issued." (Cornell University et al., 2014: 47)

Ecological sustainability is certainly an important issue, but it is difficult to grasp why it is part of the "Infrastructure" pillar, especially when it is measured by the above three components. These are more relevant to reflect those environmental challenges that are to be addressed by innovation efforts – or the outcome of previous eco-innovation efforts. In other words, there is a certain mismatch between the name of this pillar and its actual content.

Pillar 4: Market sophistication

"The Market sophistication pillar has three sub-pillars structured around market conditions and the total level of transactions.

The credit sub-pillar includes a measure on the ease of getting credit aimed at measuring the degree to which collateral and bankruptcy laws facilitate lending by protecting the rights of borrowers and lenders, as well as the rules and practices affecting the coverage, scope, and accessibility of credit information. Transactions are given by the total value of domestic credit (to the private sector, % of GDP) and, in an attempt to make the model more applicable to emerging markets, by the gross loan portfolio of microfinance institutions (% of GDP).

The investment sub-pillar includes the ease of protecting investors index as well as three indicators on the level of transactions. To show whether market size is matched by market dynamism, stock market capitalisation is complemented by the total value of shares traded (% of GDP). The last metric is a hard data metric on venture capital deals, taking into account a total of 18,860 deals in 71 countries in 2013.

The last sub-pillar tackles trade and competition. The market conditions for trade are given by two indicators: the average tariff rate weighted by import shares and a measure capturing non-agricultural market access conditions to foreign markets (five major export markets weighted actual applied tariffs for non-agricultural exports). The third and last indicator is a survey question that reflects on the intensity of competition in local markets. Efforts made at finding hard data on competition have so far proved unsuccessful." (Cornell University et al., 2014: 48)

Pillar 5: Business sophistication

"The last enabler pillar tries to capture the level of business sophistication to assess how conducive firms are to innovation activity. (…)

The first sub-pillar includes four quantitative indicators on knowledge workers: employment in knowledge-intensive services; the availability of formal training at the firm level; R&D performed by business enterprise (BERD) as a percentage of GDP (…); and the percentage of total gross expenditure of R&D that is financed by business enterprise. In addition, the sub-pillar includes an indicator related to the Graduate Management Admission Test (GMAT). The total number of GMAT test takers (scaled by population aged 20 to 34 years old) [was] taken as a proxy for the entrepreneurial mindset of young graduates.

(…) The innovation linkages sub-pillar draws on both qualitative and quantitative data regarding business/ university collaboration on R&D, the prevalence of well-developed and deep clusters, the level of gross R&D expenditure financed by abroad, and the number of deals on joint ventures and strategic

> alliances. The latter covers a total of 2,978 deals announced in 2013, with firms headquartered in 127 participating economies. In addition, the total number of Patent Cooperation Treaty (PCT) and national office published patent family applications filed by residents in at least three offices is included this year to proxy for international linkages.
>
> (…) The rationale behind sub-pillars 5.3 on knowledge absorption (an enabler) and 6.3 on knowledge diffusion (a result)—two sub-pillars designed to be mirror images of each other— is precisely that together they will reveal how good countries are at absorbing and diffusing knowledge. Sub-pillar 5.3 (knowledge absorption) includes four statistics that are linked to sectors with high-tech content or are key to innovation: royalty and license fees payments as a percentage of total trade; high-tech imports (net of re-imports) as a percentage of total imports; imports of communication, computer and information services as a percentage of total trade; and net inflows of foreign direct investment (FDI) as a percentage of GDP." (Cornell University et al., 2014: 48-49; some obvious mistakes, e.g. mentioning BERD instead of BERD, are corrected – A.H.)

The name of this pillar is not explained, although it does not seem to be self-explanatory. It is not clear either why firms should be conducive to innovation activity. Usually analyses have a different logic: market and regulatory conditions, that is, factors external to the firms, can be conducive for – or hamper – innovation activities performed by businesses. Further, it is difficult to accept the ratio of GMAT test takers "as a proxy for the entrepreneurial mindset of young graduates". The name of sub-pillar 5.2 (innovation linkages) only partially matches its components, of which two concern R&D activities, and a third one (on patents) is also more relevant to characterise R&D activities than reflect innovation activities. Data on high-tech imports can only partially reflect knowledge absorption.

Pillar 6: Knowledge and technology outputs

> "This pillar covers all those variables that are traditionally thought to be the fruits of inventions and/ or innovations. (…)
>
> The first sub-pillar refers to the creation of knowledge. It includes five indicators that are the result of inventive and innovative activities: patent applications filed by residents both at the national patent office and at the international level through the PCT; utility model applications filed by residents at the national office; scientific and technical published articles in peer-reviewed journals; and an economy's number of articles (H) that have received at least H citations.
>
> The second sub-pillar, on knowledge impact, includes statistics representing the impact of innovation activities at the micro- and macro-economic level or related proxies: increases in labour productivity, the entry density of new firms, spending on computer software, and the number of certificates of conformity with standard ISO 9001 on quality management systems issued. To strengthen the sub-pillar, the measure of high- and medium-high-tech industrial output over total manufactures output was added this year.
>
> The third sub-pillar, on knowledge diffusion, is the mirror image of the knowledge absorption sub-pillar of pillar 5. It includes four statistics all linked to sectors with high-tech content or that are key to innovation: royalty and license fees receipts as a percentage of total trade; high-tech exports (net of re-exports) as a percentage of total exports (net of re-exports); exports of communication, computer and information services as a percentage of total trade; and net outflows of FDI as a percentage of GDP." (Cornell University et al., 2014: 49-50)

The first sub-pillar is meant to be composed of indicators on "the result of inventive and innovative activities". Yet, most of these indicators are relevant to characterise R&D (and not innovation) activities. As for the knowledge impact sub-pillar, only one of the five components is related to knowledge impacts, and even that one is only partially: reflecting the impact of certain types of knowledge. As for knowledge diffusion, all the four components of that sub-pillar can indicate knowledge diffusion outside a given country (with certain limitations), and thus none of these seems to be relevant to characterise knowledge diffusion inside a given country.

Pillar 7: Creative outputs

> "The first sub-pillar on intangible assets includes statistics on trademark applications by residents at the national office; trademark applications under the Madrid System by country of origin, and two survey questions regarding the use of ICTs in business and organisational models, new areas that are increasingly linked to process innovations in the literature.
>
> The second sub-pillar on creative goods and services includes proxies to get at creativity and the creative outputs of an economy. This year, in an attempt to include broader sectoral coverage, a global entertainment and media output composite was added. In addition, the indicator on audio-visual and related services exports was renamed 'Cultural and creative services exports' and expanded to include information services, advertising, market research and public opinion polling, and other personal, cultural, and recreational services (as a percentage of total trade). These two indicators complement the remainder of the sub-pillar, which measures national feature films produced in a given country (per capita count); printing and publishing output (as a percentage of total manufactures output); and creative goods exports (as a percentage of total trade), all which are aimed at providing an overall sense of the international reach of creative activities in the country.
>
> The third sub-pillar on online creativity includes four indicators, all scaled by population aged 15 through 69 years old: generic (biz, info, org, net, and com) and country-code top level domains, average monthly edits to Wikipedia, and video uploads on YouTube. Attempts made to strengthen this sub-pillar with indicators in areas such as blog posting, online gaming, the development of applications, and have so far proved unsuccessful." (Cornell University et al., 2014: 50-51)

It is not clear why "the use of ICTs in business and organisational models" is an output indicator. Only a small fraction of printing and publishing output is a creative output, with the bulk being the paper and other printing costs. It would be really costly to establish what portion of video uploads on YouTube can be regarded creative output.

In sum, the GII is a remarkable effort both in terms of its geographic and thematic coverage, but it suffers from severe weaknesses concerning business innovation activities. In several cases there is a non-negligible mismatch between the 'headline' notions (pillars and their sub-pillars) and the actual components (indices or indicators) selected. Just as in the case of the EIS and IUS indicators, there is a bias towards R&D-based (ST mode) innovations, and thus the DUI mode is eclipsed. It is even worse, when R&D and innovation are conflated. As for describing and assessing social innovations, it would be difficult to use any of the 81 GII indicators as a relevant one.

5. The Human Development Index[21]

5.1 The relationship between innovation and human development

Human development is typically defined as a process of widening people's choices, enhancing human capabilities – the range of things people can do – and individuals' freedom, enabling them to live a long and healthy life, have access to knowledge and a decent standard of living, and participate in the life of their community (UNDP, 1990).

In such a broad definition the role and relevance of innovation and especially technological innovation for individual and societal well-being can be easily incorporated and new insights for marginalised countries and disadvantaged groups can be gained. Technological innovation is a potentially powerful means for improving living conditions and empowering people in general, but can potentially transform the lives of poor people and open up development opportunities for developing countries (UNDP, 2001). On the one hand, innovations in key sectors such as food, medicine and telecommunications can directly enhance people's nutrition, health conditions and knowledge and increase individuals' ability to participate more actively in social, economic and political life. In addition, the decreasing costs of obtaining information and increasing access to it play a key role in terms of income opportunities, access to credit, network and political participation, knowledge dissemination, education and healthcare progresses, particularly in developing countries. Furthermore, by increasing productivity and boosting economic growth, technical progress can generate new economic activities and job opportunities particularly for the younger generations entering the labour markets. On the other hand, human development may also constitute an important means for technological development. Higher levels of education and human skills are prerequisites for technology creation and diffusion, while access to material resources, information and knowledge can boost people's creativity.

These mutual and fruitful linkages between human development and innovation have been discussed in the 2001 Human Development Report entitled "Making new technologies work for human development". The Report stresses that "technology networks are transforming the traditional map of development, expanding people's horizons and creating the potential to realise in a decade progress that required generations in the past". It also outlines that the potential benefits of technology need to be deeply rooted in a pro-poor development strategy in order to assure that all individuals can benefit from this human development potential.

Since then a growing literature has emerged, with contribution of scholars from different disciplines. Authors emphasise the potential connection between Sen's human capability approach and neo-Schumpeterian approaches in the way in which individuals and their potential are conceived (e.g. Ziegler, 2010; Hartmann, 2014); the importance of innovation in the public sector and for the socio-economic systems; the role of capability innovation in human development (Ziegler, 2010; Ziegler et al., 2013); the relationship between human capabilities and technology (van den Hoven, 2012) and design (Oosterlaken, 2011).[22]

Less attention has been paid to the empirical side for investigating the correlation or the causal relationship between technology and human development or measuring the impact (or, in case, the

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[21] This section is based on a note prepared by Enrica Chiappero-Martinetti, University of Pavia.

[22] For an in-depth analysis between capability approach, technology and design see also the volume edited by Oosterlaken and van den Hoven (2012).

cost) of innovation on individuals' well-being or to develop indicators for measuring innovation from a human development perspective, with the only remarkable attempt done by UNDP in 2001 (see below).

5.2 Measuring technological innovation through the lens of human development

The 2001 Human Development Report introduced a *Technology Achievement Index (TAI)* with the aim "to assess the countries performance in creating and diffusing technology and building a human skills base" and to help policy makers identify appropriate technology strategies in the network age. The attention was focused on society's technological achievements and its diffusion rather than on a country's potential or its inputs.

The suggested composite index measured achievements in four dimensions and two indicators were considered for each of these dimensions.[23] The selected indicators were intended to reflect policy concerns for all countries, irrespective of their level of technological development, and especially helpful for developing countries. Starting from these criteria and bearing in mind the limitations in data coverage, the chosen dimensions and indicators were as follows:

a) *Technology creation*: aimed at capturing the capacity to innovate, it is measured through a.1) the number of patents granted per capita, reflecting the current level of invention activities; and a.2) the per capita amount of receipts of royalty and license fees from abroad, reflecting the stock of successful innovations produced in the past that still have a market value.
b) *Diffusion of recent innovations*: it is measured by b.1) the diffusion of the Internet (hosts per capita); and b.2) percentage of export of high and medium technology products in total goods exports. This latter is intended as testifying the dynamic and capacity to diversify the economy and open new markets.
c) *Diffusion of old innovations*: the basic assumption here is that technological advance is a cumulative process for which the diffusion of older innovations is a necessary step. This dimension is captured by referring to two indicators: c.1) number of telephones (mainline and mobile) per-capita; and c.2) electricity consumption per capita. Both indicators are expressed in logarithms and capped at the average OECD level as they are mostly important at the earlier stages of technological advance and less needed at the most advanced stages.
d) *Human skills*: cognitive skills and skills in science and mathematics are essential in order to assure technological dynamism and adaptability to change. These skills are not easy to define and measure. Even when some cross-country comparisons of such skills have been conducted (e.g. International Adult Literacy Survey [IALS]; Trends in Mathematics and Science Study [TIMSS]), these data mostly refer to industrialised countries. Therefore, the two indicators used for reflecting human skills and their capacity to create and absorb innovations are: d.1) mean years of schooling and d.2) gross enrolment ratio of tertiary students enrolled in science, mathematics and engineering.

The standard HDI-type formula was used for normalising the eight indicator indices to a scale ranging from zero to one:

Indicator index = (actual value – obs. min. value)/(obs. max. value – obs. min. value)

[23] See also Desai et al (2002)

The goalposts were chosen using the minimum and maximum observed values as shown in Table 4 below. The TAI values range from one to zero and as in the case of HDI its interpretation is straightforward as higher values denote high performances in technological achievement.

Table 4: Goalposts for calculating the TAI

Goalposts for calculating the TAI

Indicator	Observed maximum value	Observed minimum value
Patents granted to residents (per million people)	994	0
Royalties and license fees received (US$ per 1,000 people)	272.6	0
Internet hosts (per 1,000 people)	232.4	0
High- and medium-technology exports (as % of total goods exports)	80.8	0
Telephones (mainline and cellular, per 1,000 people)	901[a]	1
Electricity consumption (kilowatt-hours per capita)	6,969[a]	22
Mean years of schooling (age 15 and above)	12.0	0.8
Gross tertiary science enrolment ratio (%)	27.4	0.1

a. OECD average.

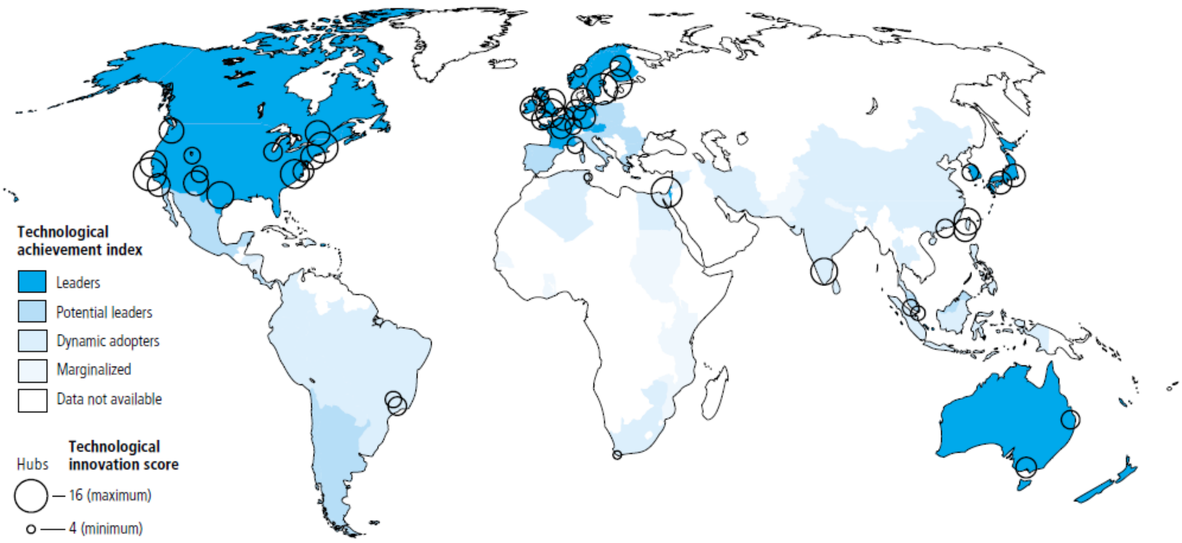
Source: UNDP, 2001: 246

As reported in the table in Appendix D and summarised in Figure 7, innovation and technology are highly concentrated spatially. On the basis of the value of the technology achievement index, calculated for 72 countries for which reliable data were available, countries were possible to be grouped in four main "clubs" labelled as: a) leader countries, with a TAI value above 0.5; b) potential leaders (0.35-0.49); c) dynamic adopters (0.20-0.34) and finally the marginalised countries with a TAI below 0.20.

Figure 7: The geography of technological innovation and achievement

MAP 2.1

THE GEOGRAPHY OF TECHNOLOGICAL INNOVATION AND ACHIEVEMENT



Global hubs of technological innovation In 2000 *Wired* magazine consulted local sources in government, industry and the media to find the locations that matter most in the new digital geography. Each was rated from 1 to 4 in four areas: the ability of area universities and research facilities to train skilled workers or develop new technologies, the presence of established companies and multinational corporations to provide expertise and economic stability, the population's entrepreneurial drive to start new ventures and the availability of venture capital to ensure that the ideas make it to market. Forty-six locations were identified as technology hubs, shown on the map as black circles

Score	
16	Silicon Valley, US
15	Boston, US
15	Stockholm-Kista, Sweden
15	Israel
14	Raleigh-Durham-Chapel Hill, US
14	London, UK
14	Helsinki, Finland
13	Austin, US
13	San Francisco, US
13	Taipei, Taiwan (province of China)
13	Bangalore, India
12	New York City, US
12	Albuquerque, US
12	Montreal, Canada
12	Seattle, US
12	Cambridge, UK
12	Dublin, Ireland
11	Los Angeles, US
11	Malmo, Sweden–Copenhagen, Denmark
11	Bavaria, Germany
11	Flanders, Belgium
11	Tokyo, Japan
11	Kyoto, Japan
11	Hsinchu, Taiwan (province of China)
10	Virginia, US
10	Thames Valley, UK
10	Paris, France
10	Baden-Wurttemberg, Germany
10	Oulu, Finland
10	Melbourne, Australia
9	Chicago, US
9	Hong Kong, China (SAR)
9	Queensland, Australia
9	Sao Paulo, Brazil
8	Salt Lake City, US
8	Santa Fe, US
8	Glasgow-Edinburgh, UK
8	Saxony, Germany
8	Sophia Antipolis, France
8	Inchon, Rep. of Korea
8	Kuala Lumpur, Malaysia
8	Campinas, Brazil
7	Singapore
6	Trondheim, Norway
4	El Ghazala, Tunisia
4	Gauteng, South Africa

Source: Hillner 2000.

Four categories of the technology achievement index (see annex 2.1, p. 46; and annex table A2.1, p. 48)

LEADERS	POTENTIAL LEADERS	DYNAMIC ADOPTERS		MARGINALIZED
Finland (2 hubs)	Spain	Uruguay	Tunisia (1 hub)	Nicaragua
United States (13 hubs)	Italy	South Africa (1 hub)	Paraguay	Pakistan
Sweden (2 hubs)	Czech Republic	Thailand	Ecuador	Senegal
Japan (2 hubs)	Hungary	Trinidad and Tobago	El Salvador	Ghana
Korea, Rep. of (1 hub)	Slovenia	Panama	Dominican Republic	Kenya
Netherlands	Hong Kong, China (SAR)	Brazil (2 hubs)	Syrian Arab Republic	Nepal
United Kingdom (4 hubs)	Slovakia	Philippines	Egypt	Tanzania, U. Rep. of
Canada (1 hub)	Greece	China (3 hubs)	Algeria	Sudan
Australia (2 hubs)	Portugal	Bolivia	Zimbabwe	Mozambique
Singapore (1 hub)	Bulgaria	Colombia	Indonesia	
Germany (3 hubs)	Poland	Peru	Honduras	
Norway (1 hub)	Malaysia (1 hub)	Jamaica	Sri Lanka	
Ireland (1 hub)	Croatia	Iran, Islamic Rep. of	India (1 hub)	
Belgium (1 hub)	Mexico			
New Zealand	Cyprus			
Austria	Argentina			
France (2 hubs)	Romania			
Israel (1 hub)	Costa Rica			
	Chile			

Source: UNDP, 2001: 45

Large disparities among countries still persist, in terms of capacity of creating and diffusing innovation as well as the quantity and quality of human skills needed for actively using and creating innovation. These disparities are associated to an equally remarkable diversity in technological dynamism among developing countries. Finally, as remarked in the Report (UNDP, 2001), the 46 global hubs of technological innovation[24] seemed to have a limited effect on TAI; and this was probably due to the wide inequalities still existing within countries (e.g. despite the importance of the Bangalore hub, India performs quite badly in the ranking based on the TAI, with an index of 0.201).

Overall, the TAI was an interesting and, to the best of our knowledge, the first attempt to measure innovation from a human development perspective. Yet, it is far from being a perfect or uncontroversial measure. As Desai et al (2002) outlined it is not a comprehensive measure. It considers only several technological achievements and not necessarily those that are more relevant for human development. This is largely due to the fact that many aspects of technology creation, diffusion and human skills are hard to quantify on a principal ground. Moreover, available and reliable data are scarce. Finally, by calculating national averages, it does not reflect geographical gaps and individual inequalities within countries.

The TAI has not been reproduced in the subsequent Human Development Reports, but several indicators of technology diffusion and creation have been regularly included in the statistical annex of the Reports since 2001, including data on telephone mainlines, cellular subscribers, internet accessibility and their cost; patents granted; royalties and licences; R&D expenditures; and researchers.

6. The TEPSIE indicators of social innovation

The CRESSI project considers a social innovation as *the development and delivery of new ideas (products, services, models, markets, processes) at different socio-structural levels that intentionally seek to improve human capabilities, social relations, and the processes in which these solutions are carried out* (CRESSI Annex 1 Part B: p. 3). That means that indicators should be composed of inputs (new ideas), throughputs (processes, in which solutions are carried out) and outputs (improvement of human capabilities, social relations)

The TEPSIE project – an FP7-funded project on social innovations – is one of the first attempts to come to (a beginning of) developing a Blueprint of social innovation metrics (TEPSIE, 2013; Krlev et al., 2014). The focus of the TEPSIE Blueprint is the search for an appropriate indicator system. This is a valuable choice as it provides a link with the innovation systems literature and hence the established research line on technological innovation indicators in which the elements input, throughput and outputs are central (for example Acs and Audretsch, 1988; Kleinknecht and Mohnen, 2001). Although the structure of a social innovation indicators system has resemblance with technological innovation indicators systems, the difference is in the contents that build up to the ultimate indicators.

[24] These hubs were defined in 2000 by the *Wired* magazine on the basis of several indicators including universities and research facilities, multinational corporations, and venture capitalists.

6.1 Structure of a social innovations indicator system

As shown in subsection 4.1 of this report, a widely used knowledge-, R&D- and technology-oriented indicator system is the Innovation Union Scoreboard (see Figure 5 above). The structure of the scoreboard is 1) Enablers, 2) Firm activities and 3) Outputs. Not surprisingly the TEPSIE Blueprint displays much resemblance with the measurement framework of the Innovation Union Scoreboard. The three elements are framework conditions (enablers), entrepreneurial activities (firm activities) and organisational output/ societal outcome (outputs).[25]

With regard to output an important difference between technological and social innovations is that the former often leads to actual products and systems, and hence to measurable outputs such as *the turnover from new-to-market product innovations as % of total turnover* or the *number of patented innovations*. TEPSIE (2013) borrows from the public sector innovations literature by emphasising that social innovations output are less tangible and should be related to organisational output and societal outcomes.

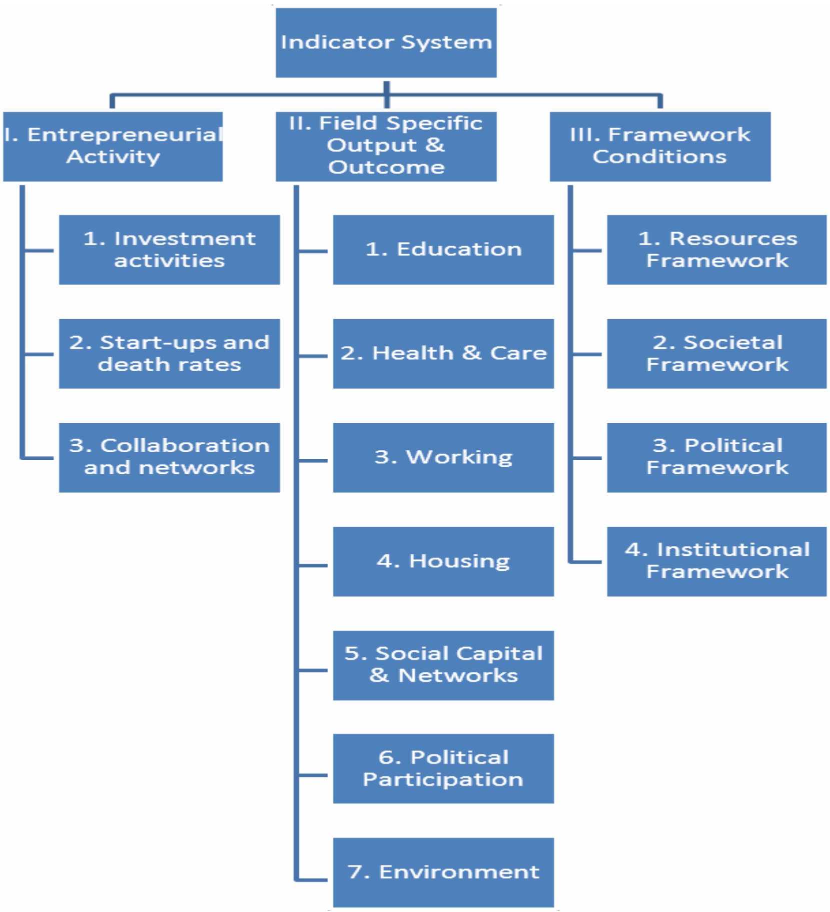
Framework conditions are the resources, incentives, capabilities and opportunities for firms to innovate (TEPSIE, 2013: 29). These are the context conditions. Entrepreneurial activities are pro-active forces of individuals and/or organisations aimed at developing solutions for current challenges. They are able to take risks and mobilising required resources. Societal outcomes are much harder to measure than outputs

Figure 7 below presents the structure of the TEPSIE Blueprint of social innovations indicators in the same kind of structure as the Innovation Union Scoreboard is presented in Figure 5. The Blueprint is also a scoreboard. The sub-indicators of the three dimensions are the building stones for the indicators. Framework conditions consist of the resources, societal, political and institutional framework.

Entrepreneurial activities consist of 1) investment activities, 2) start-up activities and death rates of firms, and 3) collaboration and networks. The social innovations' outputs and social outcomes are very broad and consist of specific fields of social innovation i.e. education, health and care, working, housing, social capital & networks, political participation and environment.

[25] This structure was based on studying 35 studies on innovation measurement (TEPSIE, 2013: 10)

Figure 8: Structure of the TEPSIE Blueprint of social innovation indicator



Source: TEPSIE, 2013: 39

6.2 Contents of a social innovations indicator system

The sub-indicators are further subdivided into singe indicators. For each of the three indicators these are presented in Appendices E, F and G. The single indicators as fundament for the sub-indicators supporting the Framework Conditions consist partly of data that can be found in existing databases such as World Value Survey, corruption indices, World Governance Indicators etc. It becomes a bit difficult when the information needed is much softer such as interests in shared social needs. TEPSIE (2013) suggests addressing this by using for example Google Trends in order to specify how many people are searching for information on specific issues at different points in time (TEPSIE, 2013: 40). This provides information how relevant the issue or theme is considered by people using the internet.

It is worth noting that the use of Big Data can play an important role here. Big Data are large complex datasets that cannot be analysed with standard statistical, econometric or other data processing techniques. Big data analytics is necessary to detect hidden patterns, unknown correlations, etc. in the huge amount of data available through the internet. With data analytics methods the data provided by users of, for example, Facebook, Twitter, internet, Youtube can be analysed and lead to relevant information for single indicators to describe social innovations and their societal impacts empirically (Desouza and Smith, 2014). Big data can provide a key to identifying different categories of human needs and desires as input to social innovation processes.

Krlev et al. (2014) – an outcome of the TEPSIE project on social innovations – interpret entrepreneurs as people with entrepreneurial attitude, which starts with opportunity recognition as well as with a mechanism of resource mobilisation. In the case of "standard" (technological) innovations opportunity recognition focuses on spotting profit and growth opportunities requiring a form of formal organisation (existing or new firm). This focus can also valid in the case of social innovations but often there is more. Social innovations aim for a social goal such as reducing or avoiding marginalisation of (groups of) individuals. Also informal organisations such as civic movements (for example working for environmental preservation) are considered as conducting entrepreneurial activities.

Although data gathering on entrepreneurship has taken off through initiatives such as the *Kauffman index of entrepreneurial activity* and – more oriented towards social innovation – the *Global Entrepreneurship Monitor Report on Social Entrepreneurship*, it is still in its infancy. This is particularly valid for start-ups performing social innovations.

The indicator set building up to the output and outcome of social innovations identify the degree to which a societal social problem has been tackled (Appendix G). The indicators generally reflect the process character of social innovation (TEPSIE, 2013: 48). However, social outcomes measured in this way cannot automatically be considered as the result (or lack) of social innovation. Such an impact can only be shown by a time series analysis. What is measured now is the identification of a field of social change where social innovations might have occurred. Big data analytics referred to above might provide more and better data in addition to existing data as provided by the *European System of Social Indicators* or *the OECD Better Life Index*.

Although TEPSIE (2013) claims that its contribution to social innovation metrics is at the macro-level, still many of the indicators suggested, have micro components. The goals of social innovations, for example reducing marginalisation of individuals or groups of people, are less tangible than the goals of technological innovations, e.g. producing new technologies or products, and hence much harder to grasp with micro-indicators.

Generally, two ways exist to pick up more micro-oriented indicators. First, adding specific questions to existing surveys. For example, in the Community Innovation Survey (CIS) of the EU a question can already be found on whether the innovations reported were provoked by social and environmental goals. This can be used as an example to add similar questions to existing other surveys.

7. Methodological considerations

7.1 Degree of novelty and unit of analysis

A standard question in innovation surveys relates to the degree of novelty. A given innovation can be new to the firm, to the market (in a given country), or to the world. For pragmatic reasons, the Community Innovation Survey (CIS) uses only the first two categories (degrees of novelty): it would be too difficult to judge by the respondents – and subsequently check by experts – if a given innovation is new to the market in a given country or to the world. Of course, in rare cases, e.g. when the first digital camera, mobile phone or tablet is introduced, it is easier to establish that a certain product is new to the world, but even in these exceptional cases there could be some difficulties to establish which product variation (by which company) has been introduced first – and successfully.

This issue is closely related to the classification of innovations. In qualitative analyses the following categories can be used. New goods (that is, products or services) might represent an incremental or a radical change (innovation). If we consider further units (levels) of analysis we can also think of innovations at the level of technology systems, that is, a set of technologically and economically interconnected goods and processes, affecting several companies or an entire sector in the same time, occasionally leading to the emergence of new industries (e.g. canals, gas and electric light systems, plastic goods, electric household devices). Being dissatisfied with the notion of 'long waves' used in analysing business cycles (mainly by Kondratiev and Schumpeter), Freeman and Perez have elaborated on the notion of techno-economic paradigms, that is, "the set of the most successful and profitable practices in terms of choice of inputs, methods and technologies and in terms of organisational structures, business models and strategies. Those mutually compatible principles and criteria develop in the process of using the new technologies, overcoming obstacles and finding more adequate procedures, routines and structures. The emerging heuristic routines and approaches are gradually internalized by engineers and managers, investors and bankers, sales and advertising people, entrepreneurs and consumers. In time, a shared logic is established; a new 'common sense' is accepted for investment decisions as well as for consumer choice. The old ideas are unlearned and the new ones become 'normal'." (Perez, 2009: 14) Just to illustrate, the examples of such paradigmatic changes are the (first) industrial revolution; the age of steam and railways; the age of steel, electricity, and heavy engineering; the age of oil, automobile, and mass production; and more recently the age of info-communications.

Some of these considerations might be useful when analysing social innovations in a qualitative way. Yet, compared to technological innovations, it is likely to be even more difficult to establish the degree of novelty of a given social innovation. But the degree of novelty seems to be of lesser importance in these cases: usually intellectual property rights are not an issue for social innovators. Of course, prestige – being inventive and obtaining acknowledgments for that – might play a role: it could give some impetus to be involved in certain social innovation projects. It is an empirical question to establish the role of prestige in these endeavours.

What seems to be perhaps more relevant – but probably even more difficult than in the case of technological innovations – is to identify whether a given social innovation is an 'isolated' new solution or – using the analogy of technology systems – is it a part of a new 'social system', that is, a set of socially, institutionally, organisationally, and economically interconnected social innovations, affecting several groups of people or an entire community (a neighbourhood, village, town or city) in the same time, occasionally leading to the emergence of new social structures, norms, institutions, behaviour, value systems and practices at a higher level of aggregation (e.g. sub-national regions, nations or even supra-national regions [for example, the European Union]).

Some aspects of the notion of techno-economic paradigms is contested among economists and economic historians dealing with technological innovations on the one hand, and this notion is probably too complex, too demanding – too far-fetched – to be applied to analyse social innovations, on the other. One of its features could be considered, though, namely the interconnectedness of technological, organisational and business model innovations, together with the emergence of a new, widely accepted 'common sense'.

Most of the indicators and indices used to compile the Summary Innovation Index (EIS, IUS), the Global Innovation Index and the Technology Achievement Index reflect the macro level: these components are calculated by aggregating micro level data (e.g. economic indicators at firm level, while education indicators at the level of individuals). In contrast, social innovations can be monitored (observed) at a project level, and it is hardly possible to aggregate these data (observations) in a meaningful way to arrive at a macro level.

7.2 Innovation activities, their framework conditions and impacts

In spite of the relatively long-established tradition in measuring technological innovations – more precisely: business innovations, as we have already stressed in the Introduction – and the significant efforts devoted to advance and standardise methods, there is a considerable lack of clarity whether a certain measurement or monitoring exercise (a set of indicators, data collection, measurement and analytical methods) is aimed at characterising (a) innovation activities (efforts) themselves, (b) the framework conditions (pre-requisites, available inputs, skills, etc.) of being innovative (or successful in innovation efforts), or (c) the economic, societal or environmental impacts of innovations. Given the complexity of innovation processes themselves, as well as that of economic, societal or environmental developments, it is certainly a major difficulty to attribute a certain economic, societal or environmental phenomenon as a direct (or major) effect of a given innovation project (or a set of them at an aggregated level).

These fundamental methodological difficulties certainly apply to social innovations, too, perhaps even *a fortiori*. Again, a noteworthy issue is the lack of conscious efforts to distinguish between measuring (a) social innovation activities (efforts) themselves, (b) the framework conditions (pre-requisites, available inputs, skills, norms, values, behavioural patterns, etc.) of being socially innovative, and (c) the economic, societal or environmental impacts of social innovations.

8. Summary and conclusions

This paper has reviewed and examined business (using a simplifying, and thus somewhat misleading 'shorthand': technological) and social innovation indicators from an economic theoretical perspective and a measurement perspective. In doing so, we have discussed a number of widely used sets of innovation indicators, their context and shortcomings as far as they can be considered as a 'model' for social innovation indicators.

Our findings can be summarised very briefly as follows. Various economics paradigms treat (business) innovation – if not neglect it altogether –in diametrically different ways: consider different notions as crucial ones (e.g. risk vs. uncertainty, information vs. various forms, types and sources of knowledge, skills and learning capabilities and processes); offer diverse justifications (policy rationales) for state interventions; interpret the significance of various types of inputs, efforts, and results differently, and thus – implicitly – identify different 'targets' for measurement, monitoring and analytical purposes (what phenomena, inputs, capacities, processes, outcomes and impacts are to be measured and assessed).

The science-push model of innovation, reinforced by the sophisticated – and thus appealing and compelling models – of mainstream economics emphasises the economic impacts of R&D-based innovation efforts, advances the market failure argument and the concomitant set of policy advice. Hence it focuses the attention of decision-makers and analysts to the so-called ST mode of innovation. Measurement and monitoring systems influenced by this way of thinking – most notably the Innovation Union Scoreboard of the European Commission, but to a significant extent several other attempts, too, e.g. the Global Innovation Index, and the Technology Achievement Index compiled for the 2001 edition of the Human Development Report tend – to pay attention mainly to the ST mode of innovation, at the expense of the so-called DUI mode of innovation, which is equally important from the point of view of enhancing productivity, creating jobs and improving competitiveness.

In contrast, evolutionary economics of innovation – in line with the networked model of innovation – stresses the systemic nature of innovation and thus advocates rectifying any systemic failure that hinders the generation, circulation and exploitation of any type of knowledge required for successful innovation processes. This way of thinking has influenced the measurement and monitoring practices of the European Commission or the OECD to a significantly lesser extent than mainstream economics.

In sum, the IUS indicators in principle could be useful in settings where the dominant mode of innovation is the ST mode. In practice, however, both the ST and DUI modes of innovation are fairly important. (Jensen et al., 2007) Moreover, using the EIS indicators would not help establishing if a certain system is characterised by a low level of innovation activities altogether – or a low level of R&D-based innovation activities. Yet, that is a fairly important distinction both from an analytical and a practical (policy) point of view: these two systems (settings) are fundamentally different. Analysts and policy-makers dealing with innovation, therefore, should pay attention to both R&D-based (ST) and non-R&D-based (DUI) innovations.

Further, while social innovations can certainly rely on R&D-based technological innovations, their essence tends to be organisational, managerial and behavioural changes. The IUS indicators do not capture these types of changes. More generally, analysts and decision-makers should be aware of the diversity of social innovations, too, in terms of their nature, drivers, objectives, actors, and process characteristics.

An assessment of the 81 indicators used to compile the Global Innovation Index has shown that it would not be a fruitful effort to rely on any of those indicators to describe and characterise social innovations.

The Technology Achievement Index does not offer a promising approach, either. It is not a comprehensive measure: considers only certain types of technological achievements and not necessarily those that are the most relevant from the point of view of human development.

Some more general methodological lessons, however, can be distilled from the efforts devoted to measure business innovations. This first one concerns the use of composite indicators. Scoreboards and league tables compiled following the science-push logic, based on a composite indicator to establish rankings, and published by supranational organisations, can easily lead to 'lock-in' situations. National policy-makers – and politicians, in particular – are likely to pay much more attention to their country's position on a scoreboard than to nuanced assessments or policy recommendations in lengthy documents, and hence this inapt logic is 'diffused' and strengthened at the national level, too, preventing policy learning and devising appropriate policies. Despite the likely original intention, that is, to broaden the horizon of decision-makers by offering internationally comparable data, these scoreboards and league tables strengthen a narrow-minded, simplifying approach.

In other words, given the diversity among innovation systems, one should be very careful when trying to draw policy lessons from the 'rank' of a country as 'measured' by a composite indicator. A scoreboard can only be constructed by using the same set of indicators across all countries, and by applying an identical method to calculate the composite index. Yet, analysts and policy-makers need to realise that poor performance signalled by a composite indicator, and leading to a low ranking on a certain scoreboard, does not automatically identify the area(s) necessitating the most urgent policy actions. Analysts and policy-makers, *therefore, need to avoid the trap of paying too much attention to simplifying ranking exercises.* Instead, it is of utmost importance to conduct detailed, thorough comparative analyses, identifying the reasons for a disappointing performance, as well as the sources of – opportunities for – balanced, and sustainable, socio-economic development.

Second, the degree of novelty and the unit of analysis are interrelated issues when business innovations are surveyed. It looks a rather difficult task to establish the degree of novelty of a given social innovation. Actually, this issue seems to be of lesser importance in these cases: intellectual property rights are seldom an issue for social innovators. Prestige – obtained by being acknowledged as a creative social innovator – might, however, play a role: it could be perceived as an incentive to initiate social innovation projects. No doubt, it is an empirical question to establish the role of prestige in these endeavours.

It could be also an interesting – but certainly a demanding – research question to identify whether a given social innovation is a standalone new solution or – using the analogy of technology systems – is it a part of a new 'social system', that is, a set of socially, institutionally, organisationally, and economically interconnected social innovations, affecting several groups of people or an entire community (a neighbourhood, village, town or city) in the same time, occasionally leading to the emergence of new social structures, norms, institutions, behaviour, value systems and practices at a higher level of aggregation (e.g. sub-national regions, nations or even supra-national regions [for example, the European Union]).

Efforts aimed at measuring social innovation cannot rely a similarly long tradition. The TEPSIE project has been a significant effort to this end. It should be noted, however, that its first pillar, called entrepreneurial activity is not specific to social innovation, on the one hand, and somewhat neglects non-entrepreneurial social innovation activities, on the other. Its second pillar, called filed-specific output and outcomes, offers useful hints, but we are faced the attribution problem. The third pillar is concerned with framework conditions. The structure of the TEPSIE indicators prompts a more general caveat: analysts and policy-makers need to be aware of the differences between measuring (a) social innovation activities (efforts) themselves, (b) the framework conditions (pre-requisites, available inputs, skills, norms, values, behavioural patterns, etc.) of being socially innovative, and (c) the economic, societal or environmental impacts of social innovations.

Finally, it worth recalling here, too, that the *Synthetic Grid* presented in deliverable D3.1 of the CRESSI project[26] considers several important issues that should be taken into account when constructing indicators measuring social innovations.

[26] Deliverable D3.1 was submitted to the EC on 27 April 2015. It can be found on the CRESSI website at http://www.sbs.ox.ac.uk/cressi-publications

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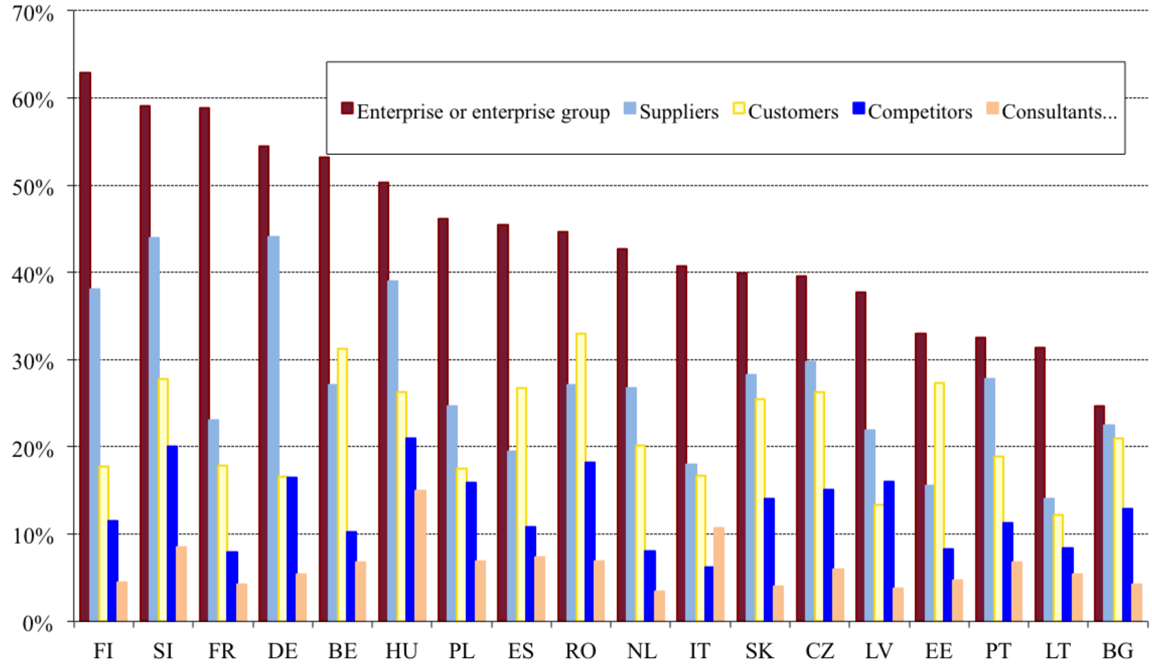
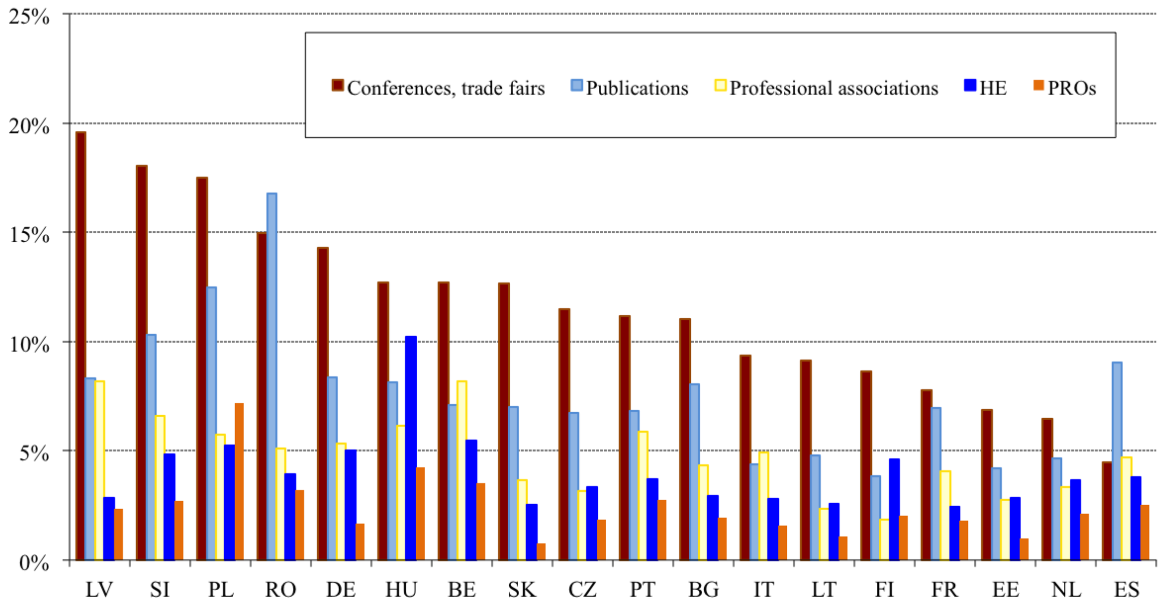
Appendix A: Sources of information for innovation

Figure A.1: Highly important 'business' sources of information for product and process innovation, EU members, 2006-2008



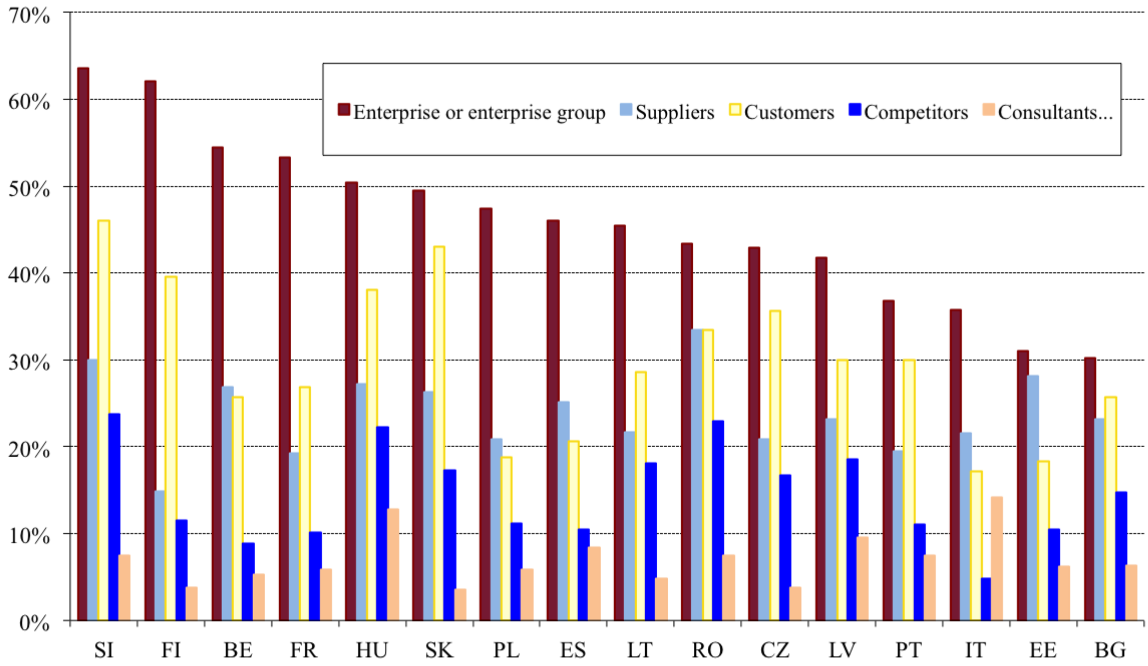
Source: Eurostat, CIS2008
Note: Data for Cyprus, Luxembourg and Malta are not included in this figure.

Figure A.2: Highly important 'scientific' sources of information for product and process innovation, EU members, 2006-2008



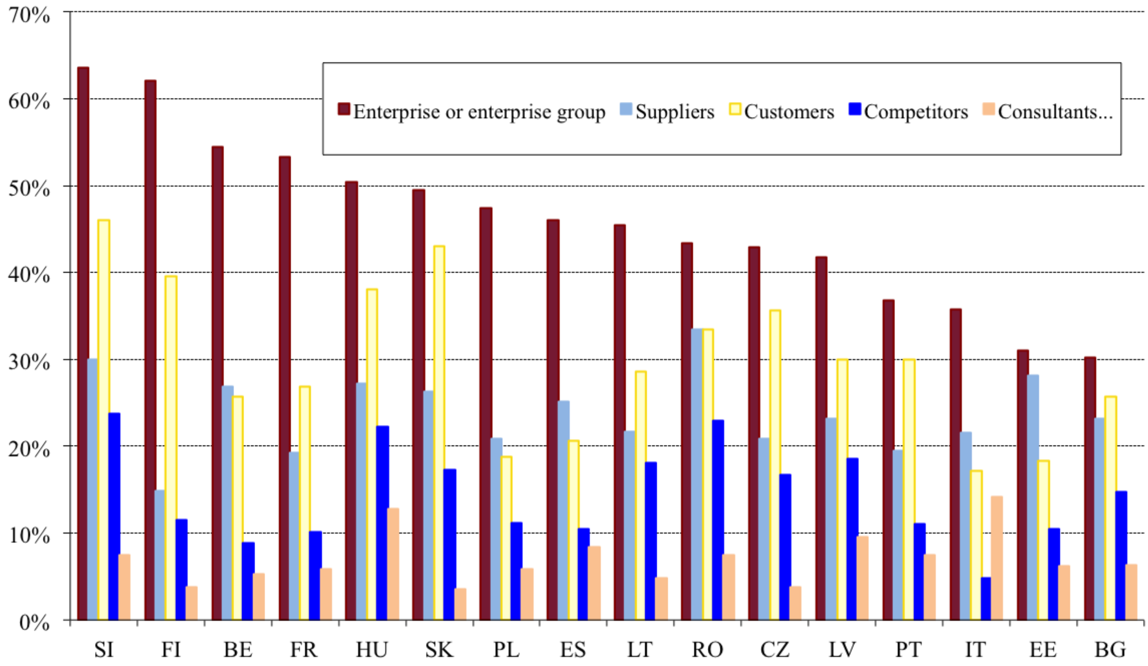
Source: Eurostat, CIS2008
Note: Data for Cyprus, Luxembourg and Malta are not included in this figure.

Figure A.3: Highly important 'business' sources of information for product and process innovation, EU members, 2008-2010



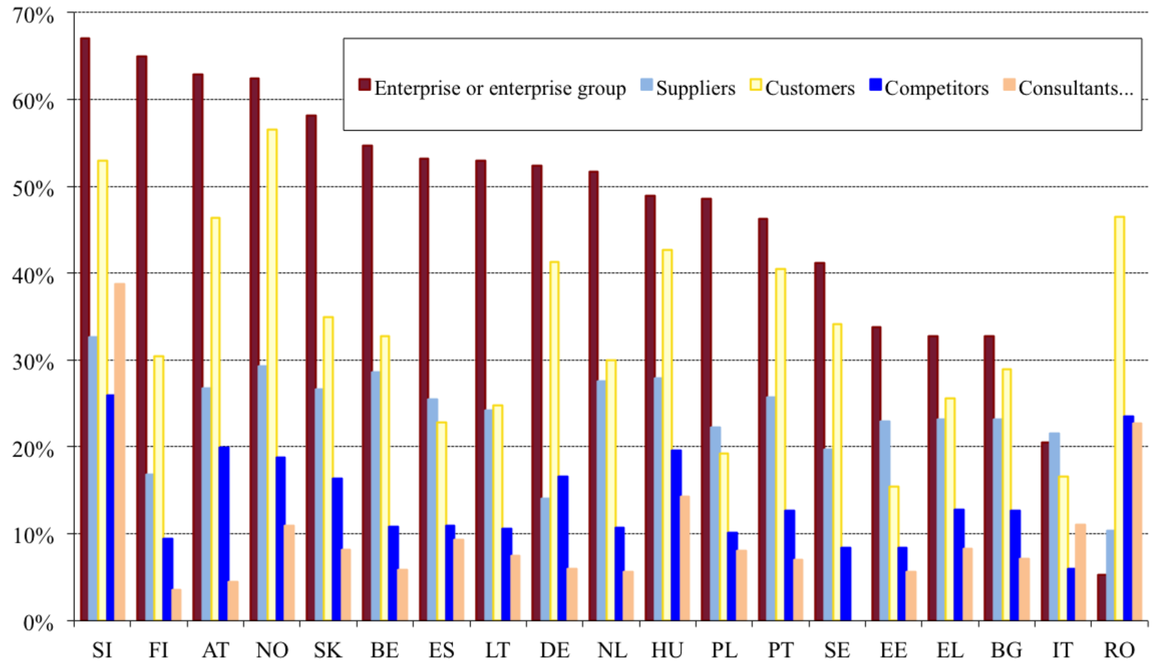
Source: Eurostat, CIS2010
Note: Data for Cyprus, Luxembourg and Malta are not included in this figure.

Figure A.4: Highly important 'scientific' sources of information for product and process innovation, EU members, 2008-2010



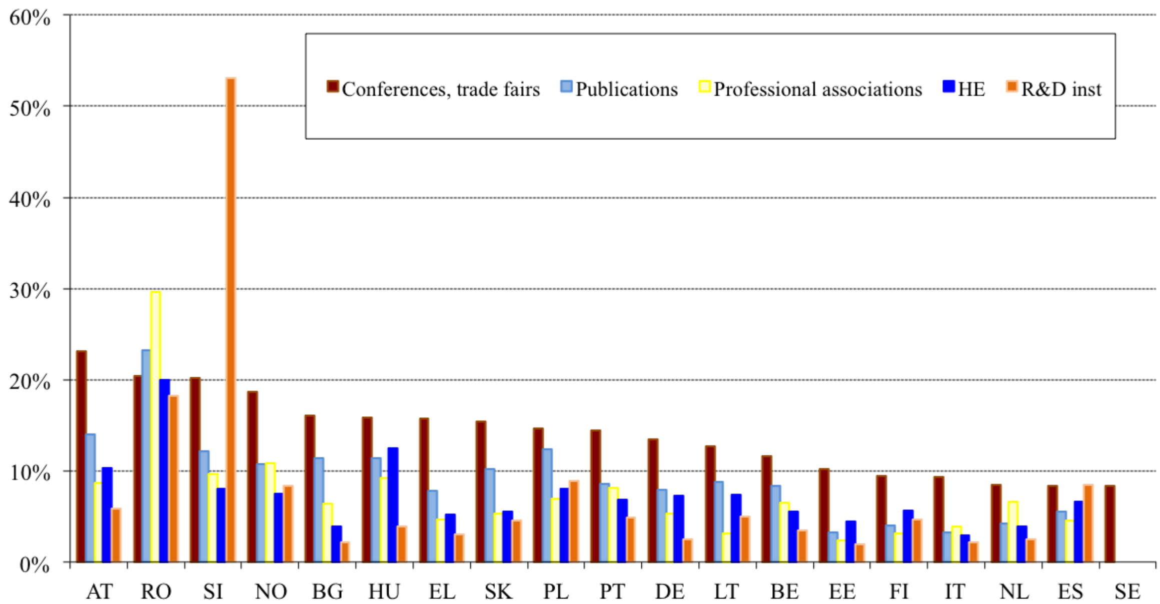
Source: Eurostat, CIS2010
Note: Data for Cyprus, Luxembourg and Malta are not included in this figure.

Figure A.5: Highly important 'business' sources of information for product and process innovation, EU members, 2010-2012



Source: Eurostat, CIS2012
Note: Data for Cyprus, Luxembourg and Malta are not included in this figure.

Figure A.6: Highly important 'scientific' sources of information for product and process innovation, EU members, 2010-2012



Source: Eurostat, CIS2012
Note: Data for Cyprus, Luxembourg and Malta are not included in this figure.

Appendix B: The EIS and IUS indicators

The indicators used in particular editions of the EIS and IUS are presented and assessed in this Appendix, except for the first (2003) and last (2014) editions, which are presented in the main body of this report. The indicators used in 2006 and 2007 were identical, and thus are presented in a single table (Table B.4). Further, the indicators used for the 2010, 2011 and 2013 editions of the Innovation Union Scoreboard were also identical, and thus these are presented in Table B.7.[27]

[27] The numbering convention was changed in 2013: in that year IUS 2013 was published, while continuing the previous convention it would have been called IUS 2012.

Table B.1: The 2003 European Innovation Scoreboard indicators

	Relevance for R&D-based innovation	Relevance for non-R&D-based innovation
1 Human resources		
S&E graduates (ISCED 5a and above) per 1000 population aged 20-29	X	
Population with tertiary education (% of 25–64 years age class)	b	b
Participation in life-long learning (% of 25–64 years age class)	b	b
Employment in medium-high and high-tech manufacturing (% of total workforce)	X	
Employment in high-tech services (% of total workforce)	X	
2 Knowledge creation		
Public R&D expenditures (GERD – BERD) (% of GDP)	X	
Business expenditures on R&D (BERD) (% of GDP)	X	
EPO high-tech patent applications (per million population)	X	
USPTO high-tech patent applications (per million population)	X	
EPO patent applications (per million population)	x	
USPTO patents granted (per million population)	x	
3 Transmission and application of knowledge		
SMEs innovating in-house (% of manufacturing and % of services SMEs)	b	b
SMEs involved in innovation co-operation (% of manufacturing and % of services SMEs)	b	b
Innovation expenditures (% of all turnover in manufacturing and % of all turnover in services)	b	b
4 Innovation finance, output and markets		
Share of high-tech venture capital investment	X	
Share of early stage venture capital in GDP	x	
Sales of 'new to market' products (% of all turnover in manufacturing and % of all turnover in services)	b	b
Sales of 'new to the firm but not new to the market' products (% of all turnover in manufacturing and % of all turnover in services)	b	b
Internet access/ use (composite of home internet access and the share of SMEs with own website)	b	b
ICT expenditures (% of GDP)	b	b
Share of manufacturing value-added in high-tech	X	

Legend: X: only relevant; x: mainly relevant; b: relevant for both types
Source: own compilation, drawing on the detailed definition of indicators, EC (2003b)
Notes: Public R&D expenditures do not equal to GERD – BERD; rather, it should be the sum of government-funded parts of BERD, GOVERD, and HERD

Table B.2: The 2004 European Innovation Scoreboard indicators

	Relevance for R&D- based innovation	Relevance for non-R&D-based innovation
1 Human resources		
S&E graduates (ISCED 5a and above) per 1000 population aged 20-29	X	
Population with tertiary education (% of 25–64 years age class)	b	b
Participation in life-long learning (% of 25–64 years age class)	b	b
Employment in medium-high and high-tech manufacturing (% of total workforce)	X	
Employment in high-tech services (% of total workforce)	X	
2 Knowledge creation		
Public R&D expenditures (GERD – BERD) (% of GDP)	X	
Business expenditures on R&D (BERD) (% of GDP)	X	
EPO high-tech patent applications (per million population)	X	
USPTO high-tech patents granted (per million population)	X	
EPO patent applications (per million population)	x	
USPTO patents granted (per million population)	x	
3 Transmission and application of knowledge		
SMEs innovating in-house (% of all SMEs)	b	b
SMEs involved in innovation co-operation (% of all SMEs)	b	b
Innovation expenditures (% of all turnover)	b	b
Share of SMEs that use non-technical change (% of all SMEs)		x
4 Innovation finance, output and markets		
Share of high-tech venture capital investment	X	
Share of early stage venture capital in GDP	x	
Sales of 'new to market' products (% of all turnover)	b	b
Sales of 'new to the firm but not new to the market' products (% of all turnover)	b	b
Internet access/ use (composite of home and firms' internet access)	b	b
ICT expenditures (% of GDP)	b	b
Share of manufacturing value-added in high-tech	X	

Legend: X: only relevant; x: mainly relevant; b: relevant for both types
Source: own compilation, drawing on the detailed definition of indicators, EC (2004)
Notes: Public R&D expenditures do not equal to GERD – BERD; rather, it should be the sum of government-funded parts of BERD, GOVERD, and HERD

Table B.3: The 2005 European Innovation Scoreboard indicators

	Relevance for R&D-based innovation	Relevance for non-R&D-based innovation
1 Innovation drivers		
New S&E graduates (ISCED 5a and above) per 1000 population aged 20-29	X	
Population with tertiary education (% of 25–64 years age class)	b	b
Broadband penetration rate (number of broadband lines per 100 population)	b	b
Participation in life-long learning (% of 25–64 years age class)	b	b
Youth education attainment level (% of population aged 20-24 having completed at least upper secondary education)	b	b
2 Knowledge creation		
Public R&D expenditures (GERD – BERD) (% of GDP)	X	
Business expenditures on R&D (BERD) (% of GDP)	X	
Share of medium-high-tech and high-tech R&D (% of manufacturing R&D expenditures)	X	
Share of enterprises receiving public funding for innovation	x	
Share of university R&D expenditures financed by business sector	X	
3 Innovation & entrepreneurship		
SMEs innovating in-house (% of all SMEs)	b	b
Innovative SMEs co-operating with others (% of SMEs)	b	b
Innovation expenditures (% of all turnover)	b	b
Early stage venture capital (% of GDP)	x	
ICT expenditures (% of GDP)	b	b
SMEs using non-technical change (% of all SMEs)		x
4 Application		
Employment in high-tech services (% of total workforce)	X	
Exports of high technology products as a share of total exports	X	
Sales of 'new to market' products (% of all turnover)	b	b
Sales of 'new to the firm but not new to the market' products (% of all turnover)	b	b
Employment in medium-high and high-tech manufacturing (% of total workforce)	X	
5 Intellectual property		
EPO patents per million population	x	
USPTO patents per million population	x	
Triadic patent families per million population	x	
New community trademarks per million population	b	b
New community industrial designs per million population	b	b

Legend: X: only relevant; x: mainly relevant; b: relevant for both types
Source: own compilation, drawing on the detailed definition of indicators, EC (2005)
Notes: Public R&D expenditures do not equal to GERD – BERD; rather, it should be the sum of government-funded parts of BERD, GOVERD, and HERD

Table B.4: The 2006 and 2007 European Innovation Scoreboard indicators

	Relevance for R&D-based innovation	Relevance for non-R&D-based innovation
1 Innovation drivers		
New S&E graduates (ISCED 5a and above) per 1000 population aged 20-29	X	
Population with tertiary education (% of 25–64 years age class)	b	b
Broadband penetration rate (number of broadband lines per 100 population)	b	b
Participation in life-long learning (% of 25–64 years age class)	b	b
Youth education attainment level (% of population aged 20-24 having completed at least upper secondary education)	b	b
2 Knowledge creation		
Public R&D expenditures (GERD – BERD) (% of GDP)	X	
Business expenditures on R&D (BERD) (% of GDP)	X	
Share of medium-high-tech and high-tech R&D (% of manufacturing R&D expenditures)	X	
Share of enterprises receiving public funding for innovation	x	
3 Innovation & entrepreneurship		
SMEs innovating in-house (% of all SMEs)	b	b
Innovative SMEs co-operating with others (% of SMEs)	b	b
Innovation expenditures (% of all turnover)	b	b
Early stage venture capital (% of GDP)	x	
ICT expenditures (% of GDP)	b	b
SMEs using non-technical change (% of all SMEs)		x
4 Application		
Employment in high-tech services (% of total workforce)	X	
Exports of high technology products as a share of total exports	X	
Sales of 'new to market' products (% of all turnover)	b	b
Sales of 'new to the firm but not new to the market' products (% of all turnover)	b	b
Employment in medium-high and high-tech manufacturing (% of total workforce)	X	
5 Intellectual property		
EPO patents per million population	x	
USPTO patents per million population	x	
Triadic patent families per million population	x	
New community trademarks per million population	b	b
New community industrial designs per million population	b	b

Legend: X: only relevant; x: mainly relevant; b: relevant for both types
Source: own compilation, drawing on the list of indicators, MERIT and EC JRC (2006)
Notes: Public R&D expenditures do not equal to GERD – BERD; rather, it should be the sum of government-funded parts of BERD, GOVERD, and HERD

Table B.5: The 2008 European Innovation Scoreboard indicators

	Relevance for R&D-based innovation	Relevance for non-R&D-based innovation
1.1 Human resources		
S&E and SSH graduates per 1000 population aged 20-29 (first stage of tertiary education)	x	
S&E and SSH doctorate graduates per 1000 population aged 20-29 (second stage of tertiary education)	x	
Population with tertiary education (% of 25–64 years age class)	b	b
Participation in life-long learning (% of 25–64 years age class)	b	b
Youth education attainment level (% of population aged 20-24 having completed at least upper secondary education)	b	b
1.2 Finance and support		
Public R&D expenditures (GERD – BERD) (% of GDP)	X	
Venture capital (% of GDP)	x	
Private credit (relative to GDP)	b	b
Broadband access by firms (% of firms)	b	b
2.1 Firm investments		
Business expenditures on R&D (BERD) (% of GDP)	X	
IT expenditures (% of GDP)	b	b
Non-R&D innovation expenditures (% of turnover)		x
2.2 Linkages & entrepreneurship		
SMEs innovating in-house (% of all SMEs)	b	b
Innovative SMEs collaborating with others (% of SMEs)	b	b
Firm renewal (SME entries plus exits) (% of SMEs)	b	b
Public-private co-publications per million population	X	
2.3 Throughputs		
EPO patents per million population	x	
Community trademarks per million population	b	b
Community designs per million population	b	b
Technology Balance of Payments flows (% of GDP)	X	
3.1 Innovators		
SMEs introducing product or process innovations (% of SMEs)	b	b
SMEs introducing marketing or organisational innovations (% of SMEs)		X
Resource efficiency innovators [unweighted average of: Share of innovators where innovation has significantly reduced labour costs (% of firms) and Share of innovators where innovation has significantly reduced the use of materials and energy (% of firms)]	b	b
3.2 Economic effects		
Employment in medium-high and high-tech manufacturing (% of total workforce)	X	
Employment in knowledge-intensive services (% of total workforce)	X	
Medium and high-tech manufacturing exports (% of total exports	X	
Knowledge-intensive services exports (% of total services exports)	X	
New-to-market sales (% of turnover)	b	b
New-to-firm sales (% of turnover)	b	b

Legend: X: only relevant; x: mainly relevant; b: relevant for both types
Source: own compilation, drawing on the list of indicators, EC (2009a)
Notes: Public R&D expenditures do not equal to GERD – BERD; rather, it should be the sum of government-funded parts of BERD, GOVERD, and HERD

Table B.6: The 2009 European Innovation Scoreboard indicators

	Relevance for R&D-based innovation	Relevance for non-R&D-based innovation
1.1 Human resources		
S&E and SSH graduates per 1000 population aged 20-29 (first stage of tertiary education)	x	
S&E and SSH doctorate graduates per 1000 population aged 20-29 (second stage of tertiary education)	x	
Population with tertiary education (% of 25–64 years age class)	b	b
Participation in life-long learning (% of 25–64 years age class)	b	b
Youth education attainment level (% of population aged 20-24 having completed at least upper secondary education)	b	b
1.2 Finance and support		
Public R&D expenditures (GERD – BERD) (% of GDP)	X	
Venture capital (% of GDP)	x	
Private credit (relative to GDP)	b	b
Broadband access by firms (% of firms)	b	b
2.1 Firm investments		
Business expenditures on R&D (BERD) (% of GDP)	X	
IT expenditures (% of GDP)	b	b
Non-R&D innovation expenditures (% of turnover)		x
2.2 Linkages & entrepreneurship		
SMEs innovating in-house (% of all SMEs)	b	b
Innovative SMEs collaborating with others (% of SMEs)	b	b
Firm renewal (SME entries plus exits) (% of SMEs)	b	b
Public-private co-publications per million population	X	
2.3 Throughputs		
EPO patents per million population	x	
Community trademarks per million population	b	b
Community designs per million population	b	b
Technology Balance of Payments flows (% of GDP)	X	

3.1 Innovators		
SMEs introducing product or process innovations (% of SMEs)	b	b
SMEs introducing marketing or organisational innovations (% of SMEs)		X
Share of innovators where innovation has significantly reduced labour costs (% of firms)	b	b
Share of innovators where innovation has significantly reduced the use of materials and energy (% of firms)	b	b
3.2 Economic effects		
Employment in medium-high and high-tech manufacturing (% of total workforce)	X	
Employment in knowledge-intensive services (% of total workforce)	X	
Medium and high-tech manufacturing exports (% of total exports	X	
Knowledge-intensive services exports (% of total services exports)	X	
New-to-market sales (% of turnover)	b	b
New-to-firm sales (% of turnover)	b	b

Legend: X: only relevant; x: mainly relevant; b: relevant for both types
Source: own compilation, drawing on the list of indicators, EC (2010a)
Notes: Public R&D expenditures do not equal to GERD – BERD; rather, it should be the sum of government-funded parts of BERD, GOVERD, and HERD

Table B.7: The 2010, 2011, and 2013 Innovation Union Scoreboard indicators

	Relevance for R&D-based innovation	Relevance for non-R&D-based innovation
1.1 Human resources		
New doctorate graduates (ISCED 6) per 1000 population aged 25-34	X	
Percentage population aged 30-34 having completed tertiary education	b	b
Percentage youth aged 20-24 having attained at least upper secondary level education	b	b
1.2 Open, excellent and attractive research systems		
International scientific co-publications per million population	X	
Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	X	
Non-EU doctorate students[i] as a % of all doctorate students	X	
1.3 Finance and support		
R&D expenditure in the public sector as % of GDP	X	
Venture capital investment as % of GDP	x	
2.1 Firm investments		
R&D expenditure in the business sector as % of GDP	X	
Non-R&D innovation expenditures as % of turnover		X
2.2 Linkages & entrepreneurship		
SMEs innovating in-house as % of SMEs	b	b
Innovative SMEs collaborating with others as % of SMEs	b	b
Public-private co-publications per million population	X	
2.3 Intellectual assets		
PCT patents applications per billion GDP (in PPS€)	X	
PCT patent applications in societal challenges per billion GDP (in PPS€) (environment-related technologies; health)	X	
Community trademarks per billion GDP (in PPS€)		X
Community designs per billion GDP (in PPS€)		X
3.1 Innovators		
SMEs introducing product or process innovations as % of SMEs	b	b
SMEs introducing marketing or organisational innovations as % of SMEs		X
3.2 Economic effects		
Employment in knowledge-intensive activities (manufacturing and services) as % of total employment	x	
Contribution of medium and high-tech product exports to the trade balance	x	
Knowledge-intensive services exports as % total service exports	x	
Sales of new to market and new to firm innovations as % of turnover	b	b
License and patent revenues from abroad as % of GDP	X	

Legend: X: only relevant; x: mainly relevant; b: relevant for both types
Source: own compilation, drawing on the detailed definition of indicators, Hollanders and Tarantola (2011)
Note: [i] It is a somewhat strict definition of openness, which only takes into account non-EU doctorate students.

Appendix C: The Global Innovation Index indicators

The first, 2007 edition of the GII has been composed of the following indicators, grouped into eight "pillars", of which 5 meant to represent inputs, while 3 were to reflect on outputs:
At the side of the list, possible critiques can be found in [ ].

INPUTS

Institutions and Policies
Independence of judiciary
Demanding regulatory standards
Prevalence of laws relating to ICT
Quality of IPR
Soundness of banks
Quality of scientific research institutions [The quality of organisations is not an institution ("rule of the game"); A.H.]
Quality of management/business schools [Same as above; A.H.]
Legal obstacles to foreign labour
Time required to start a business
Time required to obtain licenses
Rigidity of employment index
Investor protection index
ICT priority for government
Human Capacity
Brain drain
Quality of human resource approach
Quality of maths and science education
Graduates in engineering
Graduates in science
Population 15-64
Urban population
Schools connected to the internet [At best indirectly – and vaguely – related to human capacity; A.H.]

General and ICT Infrastructure
Quality of general infrastructure
Quality of national transport network
Quality of air transport
Fixed line penetration
Mobile penetration
Internet penetration
International bandwidth
ICT expenditure
Personal computer penetration
Mobile price basket [This is access to infrastructure; A.H.]

Business, Markets and Capital Flows
Access to loans
Sophistication of financial markets

Issuing shares in local share market
Corporate governance
Buyer sophistication
Customer orientation of firms
Domestic credit to private sector
FDI net inflows
Gross private capital flows
Gross capital formation
Extent of clusters
Commercial services imports
Manufactured imports
Private investment in ICT [Why among these indicators? A.H.]
Informal economy estimate

Technology and Process Sophistication
Country's level of technology
E-Participation index
E-Government index
Government procurement of advanced technology
Internet use by businesses
Competition among ISP providers [Why among these indicators? A.H.]
Company technology absorption
Telecom revenue [Why among these indicators? A.H.]
Secure internet servers per 1,000 people
Spending on R&D
Royalty and license fee payments
Business/university R&D collaboration

OUTPUTS

Knowledge
Local specialised research and training [Not output; A.H.]
Nature of competitive advantage [Not output; A.H.]
Quality of production process technology [Not output; A.H.]
High-tech exports
Manufactured exports
ICT exports
Insurance and financial services
Patents registered (domestic and non-domestic) [Not output; A.H.]
Royalty and license fee receipts

Competitiveness
Growth of exports to neighbouring countries
Intensity of local competition
Reach of exporting in international markets
Commercial services export
Merchandise exports
Goods exported
Service exports

Listed domestic companies [Why among these indicators? A.H.]

Wealth
Final consumption expenditure
GDP per capita, PPP
GDP growth rate
Industry, value added
Manufacturer, value added
Services, value added
International migration stock
Value of stocks traded
FDI net outflows

Appendix D: The Technology Achievement Index

A2.1 Technology achievement index

TAI rank	Country	Technology achievement index (TAI) value	Technology creation: Patents granted to residents (per million people) 1998[a]	Technology creation: Receipts of royalties and license fees (US$ per 1,000 people) 1999[b]	Diffusion of recent innovations: Internet hosts (per 1,000 people) 2000	Diffusion of recent innovations: High- and medium-technology exports (as % of total goods exports) 1999	Diffusion of old innovations: Telephones (mainline and cellular, per 1,000 people) 1999	Diffusion of old innovations: Electricity consumption (kilowatt-hours per capita) 1998	Human skills: Mean years of schooling (age 15 and above) 2000	Human skills: Gross tertiary science enrolment ratio (%) 1995–97[c]
Leaders										
1	Finland	0.744	187	125.6	200.2	50.7	1,203[d]	14,129[e]	10.0	27.4
2	United States	0.733	289	130.0	179.1	66.2	993[d]	11,832[e]	12.0	13.9[f]
3	Sweden	0.703	271	156.6	125.8	59.7	1,247[d]	13,955[e]	11.4	15.3
4	Japan	0.698	994	64.6	49.0	80.8	1,007[d]	7,322[e]	9.5	10.0[g]
5	Korea, Rep. of	0.666	779	9.8	4.8	66.7	938[d]	4,497	10.8	23.2
6	Netherlands	0.630	189	151.2	136.0	50.9	1,042[d]	5,908	9.4	9.5
7	United Kingdom	0.606	82	134.0	57.4	61.9	1,037[d]	5,327	9.4	14.9
8	Canada	0.589	31	38.6	108.0	48.7	881	15,071[e]	11.6	14.2[f]
9	Australia	0.587	75	18.2	125.9	16.2	862	8,717[e]	10.9	25.3
10	Singapore	0.585	8	25.5[h, i]	72.3	74.9	901	6,771	7.1	24.2[h]
11	Germany	0.583	235	36.8	41.2	64.2	874	5,681	10.2	14.4
12	Norway	0.579	103	20.2[i]	193.6	19.0	1,329[d]	24,607[e]	11.9	11.2
13	Ireland	0.566	106	110.3	48.6	53.6	924[d]	4,760	9.4	12.3
14	Belgium	0.553	72	73.9	58.9	47.6	817	7,249[e]	9.3	13.6[f]
15	New Zealand	0.548	103	13.0	146.7	15.4	720	8,215[e]	11.7	13.1
16	Austria	0.544	165	14.8	84.2	50.3	987[d]	6,175	8.4	13.6
17	France	0.535	205	33.6	36.4	58.9	943[d]	6,287	7.9	12.6
18	Israel	0.514	74	43.6	43.2	45.0	918[d]	5,475	9.6	11.0[f]
Potential leaders										
19	Spain	0.481	42	8.6	21.0	53.4	730	4,195	7.3	15.6
20	Italy	0.471	13	9.8	30.4	51.0	991[d]	4,431	7.2	13.0
21	Czech Republic	0.465	28	4.2	25.0	51.7	560	4,748	9.5	8.2
22	Hungary	0.464	26	6.2	21.6	63.5	533	2,888	9.1	7.7
23	Slovenia	0.458	105	4.0	20.3	49.5	687	5,096	7.1	10.6
24	Hong Kong, China (SAR)	0.455	6	..	33.6	33.6	1,212[d]	5,244	9.4	9.8[f, g]
25	Slovakia	0.447	24	2.7	10.2	48.7	478	3,899	9.3	9.5
26	Greece	0.437	(.)	0.0[j]	16.4	17.9	839	3,739	8.7	17.2[f]
27	Portugal	0.419	6	2.7	17.7	40.7	892	3,396	5.9	12.0
28	Bulgaria	0.411	23	..	3.7	30.0[i]	397	3,166	9.5	10.3
29	Poland	0.407	30	0.6	11.4	36.2	365	2,458	9.8	6.6[f]
30	Malaysia	0.396	..	0.0	2.4	67.4	340	2,554	6.8	3.3[f]
31	Croatia	0.391	9	..	6.7	41.7	431	2,463	6.3	10.6
32	Mexico	0.389	1	0.4	9.2	66.3	192	1,513	7.2	5.0
33	Cyprus	0.386	..	..	16.9	23.0	735	3,468	9.2	4.0
34	Argentina	0.381	8	0.5	8.7	19.0	322	1,891	8.8	12.0[g]
35	Romania	0.371	71	0.2	2.7	25.3	227	1,626	9.5	7.2
36	Costa Rica	0.358	..	0.3	4.1	52.6	239	1,450	6.1	5.7[g]
37	Chile	0.357	..	6.6	6.2	6.1	358	2,082	7.6	13.2
Dynamic adopters										
38	Uruguay	0.343	2	0.0[j]	19.6	13.3	366	1,788	7.6	7.3
39	South Africa	0.340	..	1.7	8.4	30.2[k]	270	3,832	6.1	3.4
40	Thailand	0.337	1	0.3	1.6	48.9	124	1,345	6.5	4.6
41	Trinidad and Tobago	0.328	..	0.0[i]	7.7	14.2	246	3,478	7.8	3.3
42	Panama	0.321	..	0.0	1.9	5.1	251	1,211	8.6	8.5
43	Brazil	0.311	2	0.8	7.2	32.9	238	1,793	4.9	3.4
44	Philippines	0.300	(.)	0.1	0.4	32.8	77	451	8.2	5.2[f]
45	China	0.299	1	0.1	0.1	39.0	120	746	6.4	3.2
46	Bolivia	0.277	..	0.2	0.3	26.0	113	409	5.6	7.7[f, g]
47	Colombia	0.274	1	0.2	1.9	13.7	236	866	5.3	5.2
48	Peru	0.271	..	0.2	0.7	2.9	107	642	7.6	7.5[f]
49	Jamaica	0.261	..	2.4	0.4	1.5[i]	255	2,252	5.3	1.6
50	Iran, Islamic Rep. of	0.260	1	0.0[i]	(.)	2.0	133	1,343	5.3	6.5

Source: UNDP, 2001: 48-51

Appendix E: TEPSIE Indicator set framework conditions

Indicator dimension	**Proposed indicators**
a) Social Innovation Resources Framework	
Financial resources (dedicated to social purpose)	
-Monetary variables of the social economy	- Share of expenditure of social economy organisations as percentage of GDP(national sources, including expenditures of foundations)
-Public social expenditure	- Total public social expenditure as percentage of GDP (OECD Social Expenditure Statistics database) - Total public social expenditure per head, at current prices and PPPs (OECD Social Expenditure Statistics database)
-Private spending	- Voluntary private social expenditure as percentage of GDP (including households, individuals, NGOs) (OECD Social Expenditure Statistics database)
Human resources	
-Voluntary working	- Number of volunteers (Volunteering in the European Union, GHK)
-Professionalisation/ creative workforce in social fields	- ISCED 5- facilities offering educational programs for staff in social economy organisations (National analysis) - Percentage of 'creative occupations' (Eurostat) (*used in ordinary innovation metrics, i.e. no equivalent for social innovation currently available)* - Workforce who report wanting to act 'socially entrepreneurially' (no data yet)
Infrastructural resources	
-Academic resources deployed on social innovation	- Number of articles with the keyword "social innovation" per country *(not data per country currently available)*
-Social innovation relevant networks	- Number of Ashoka Fellows per country - Number of Schwab Foundation Fellows per country - Number of Social Innovation Exchange (SIX) members - Number and size of other social innovation networks, called 'hubs' or 'labs'
-ICT and overall infrastructure (as basis for social innovation activities)	- Quality of overall infrastructure (World Economic Forum, The Global Competitiveness Report) - Broadband subscribers (OCED Broadband statistics) - E-Readiness Index (Economist Intelligence Unit) - ICT use index (International Telecommunication Union, Measuring the Information Society)
	- Government's online service index (United Nations Public Administration Network, e-Government Survey) - Relation between broadband penetration and citizens uptake of e-government services (OECD, government at a glance)
b) Social Innovation Institutional Framework	
Normative institutions	

-Tolerance	- Proportion of votes of extremist parties (national sources) - Proportion of foreigners in total population (national sources) - Proportion of agreement to xenophobic statements in total population (national sources) - "Acceptance of outsider groups" (World Value Survey) - "Tolerance and respect are important educational objectives" (World Value Survey)
-Gender equality	- "Men have more of a right to get a job in times of job shortages than women – I agree" (World Value Survey) - Women entrepreneurs (Global Entrepreneurship Monitor)
-Solidarity	- Solidarity with elderly, sick, unemployed and immigrants (European Value Study)
-Environmental sustainability	- "Nature protection is more important than economic growth" (World Value Survey) - Interest in environmental pollution (Eurobarometer) - Percentage of households having invested in environmentally friendly products in the last ten years (OCED Environment Policy and Household Behaviour)
Regulative institutions	
-Legislative background for social organisations	- Legislative background for starting a social organisation (national analysis)
-Legislative background for social security benefits	- Committed rights of social security benefits (national analysis)
-Legislative reforms in favour of social innovation	- Number of new laws and regulations enhancing social innovation or social economy (e. g., Social Value Act in the UK, national analysis)
-Commissioning and procurement	- Decommissioning rates to capture the 'creative destruction' of innovation (old services being replaced, national analysis)
Cultural-cognitive institutions	
-Human rights	- Universal human right index (United Nations)
c) Social Innovation Political Framework	
Policy awareness	
-Policy awareness about social innovation	- National innovation strategies / social innovation projects funded by government (national sources and analysis)
-Policy awareness about social needs	- Emphasis of party programs (national sources and analytics)
Political environment	
-Political stability and democracy	- Political stability and absence of violence/terrorism Index (World Bank, World Governance Indicators) - Freedom-House Index – democratic governance (Freedom House)

-Government effectiveness	- Government effectiveness (World Bank, World Governance Indicators)
-Transparency	- Corruption Perception Index (Transparency International)
-Legislation	- Rule of law index (World Bank, World Governance Indicators) - Judicial Independence (World Economic Forum, Global Competitiveness Index)
-Press freedom	- Press freedom index (Reporters Without Borders, Press Freedom Index)
d) Social Innovation societal climate framework	
Needs or demands as reference points for social innovation	
-Interest in shared social needs	- Google Trends tool (Google)
-Request for change	- Questions and requests to the EU Parliament (EU Parliament, national parliaments)
Social engagement and attitudes	
-Political participation	- Depth and breadth of citizens' participation (CSI) - Participation in signature campaigns (World Value Survey) - Participation in boycotts (World Value Survey) - Participation in authorised demonstrations (World Value Survey)
-Memberships in civil society organisations	- Membership in humanitarian or charitable organisations (World Value Survey) - Membership in religious organisations (World Value Survey) - Membership in organisations of arts, music or education (World Value Survey) - Membership in nature protection (World Value Survey) - Membership in associations in sports and recreations (World Value Survey)
-Citizens' attitudes towards entrepreneurship	- Attitudes towards starting a company (moving average over 2 years) (Flash Eurobarometer)
-Citizens' openness for something new, risk taking	Positive attitude towards taking risks (moving average over 2 years) (Flash Eurobarometer) - Interest in inventions and new technologies (Eurobarometer)

Source: TEPSIE, 2013: 42–45

Appendix F: TEPSIE Indicator set entrepreneurial activities

Indicator dimension	Proposed indicators
Entrepreneurial investment activities	
- Investment in innovation by social economy organisations	- Expenditure in innovation by firm size (Community Innovation Survey) (*used in ordinary innovation metrics □ No equivalent for social innovation currently available)*
- Investment in innovation by public	- *No data currently available*
Entrepreneurial start-up activities and death rates	
- Number of start-ups	- Start-up activities (moving average over 4 years),
	share of the participation as owner of start-ups in population aged 18-64 (Global Entrepreneurship Monitor) (*used in ordinary innovation metrics, i.e. no equivalent for social innovation currently available)* - Early-stage social entrepreneurial activity (Global Entrepreneurship Monitor)
- Number of death rates	- Enterprise death rate (OECD Business demography database) (*used in ordinary innovation metrics □ No equivalent for social innovation currently available)*
- Business environment for starting a business	- Barriers to entrepreneurship (OCED Product Market Regulation Database) - Starting a business: procedures (number); time (days); cost (% of income per capita); minimum capital (% of income per capita) (World Bank, Doing Business*)* - Ease of starting a business (World Bank, Ease of Doing Business Index)
Collaboration and networks	
- Citizens' involvement in entrepreneurial activities	- Time spent volunteering (OECD Time Use Surveys database), best to be specified in which kind of organisation
- Clusters	- State of cluster development (World Economic Forum, Executive Opinion Survey) (*used in ordinary innovation metrics, i.e .no equivalent for social innovation currently available)*

Source: TEPSIE, 2013: p45

Appendix G: TEPSIE Indicator set output and outcome of social innovations

Indicators	Proposed indicators
1. Education	
Equality opportunities /	
- Disabilities	- Equal opportunities / inequalities regarding disabled people (EUSI)
- Gender	- Share of women in graduates in ISCED 5 A, 5 B and 6 (OECD) - Equal opportunities/inequalities regarding women / men (EUSI)
- Migration	- Share of foreign students in all students (OECD) - Equal opportunities/inequalities regarding citizenship groups (EUSI)
Skill acquisition	
- Social and personal competence	- Educational attainment (OECD Better Life Index)
- Subject-specific and methodical competence	- PISA results in problem solving (OCED) - PISA results in reading (OECD) - PISA results in math (OECD)
2. Health & Care	
Access and quality of health facilities	
- Satisfaction with system of health care	- Trust in institutions: system of health care (EUSI)
- Access	- Regional disparities of the availability of health care facilities (EUSI)
Health status and research	
- Health status	- Adults reporting good or very good health (OECD Health data, European Union Statistics on Income and Living conditions) - Life-expectancy at birth (OECD Health Data)
- Health-related patent	- Health-related patents (OCED Patent Database)
3. Employment	
Jobs and Earning	
- Employment rate	- Long-term unemployment rate (OECD, Labour Force Statistics database)
- Equality opportunities / inequalities	- Female participation in labour force (International Labour Organization, Key Indicators of the Labour Markets Net) - Equal opportunities/inequalities regarding employment of women / man, disabled people, citizenship, generations (EUSI) - GINI Index (Word Bank)

- Income	- Average annual earnings of full-time employees (OCED estimates based on OECD National Accounts database and Economic outlook)
Work and Life	
- Working hours	- Employees working very long hours (OECD Labour Force Statistics database) - Time devoted to leisure per day (OCED Time Use Survey database)
- Satisfaction with work-life time balance	- European workers satisfied with their work-life time balance (Second European Quality of Life Survey)
- Work and family	- Employment rate of women with children of compulsory school age (OECD Family database, national sources, OECD Labour Force Survey database)
4. Housing	
Housing situation	
- Living space	- Rooms per Persons (European Union Statistics of Income and Living Conditions, national - Living space per Person (EUSI)statistic offices
- Living environment	- Accessibility of shops, public transport, family doctor (EUSI) - Noise / air / environmental pollution (EUSI) - Accessibility of green spaces (EUSI) - Crime in the residential area (EUSI)
Access and quality	
- Homelessness and poor housing	- Homelessness and poor housing (EUSI)
- Satisfaction	- Satisfaction with housing (Gallup World Poll)
5. Social Capital and Networks	
Frequency and quality	
- Frequency	- Frequency of social contact (European Union Statistics on Income and Living Conditions)
- Quality	- Trust in others (Gallup World Poll) - Quality of social relations at the work place (EUSI)
Social cohesion	
- Social cohesion between generations	- Care for old-aged household members (EUSI), has to be controlled for by comparing to levels of poverty, to separate economic necessity from social cohesion
- Social networks	- Social network support (Gallup World Poll)
6. Political Participation	
Voting and being informed	
- Voter turn-out	- Voter turn-out, International Institute for Democracy and Electoral assistance
- Being informed	- Daily newspapers' circulation (World Association of Newspapers and News Publishers, World Press Trends)

Citizens' active involvement	
- Participation in political activities	- Participation in political activities other than voting (European Social Survey)
- Involvement in rule-making	- Consultation on rule-making (OECD Regulatory Management Systems' Indicators Survey)
7. Environment	
Patents and certificates	
- Environment-related patents	- Renewable energy patents (OECD Patent Database) - Patent applications in pollution abatement and waste management technologies (EPO Worldwide Patent Statistical Database) - Patents for climate change mitigation technologies (OCED Patent Database)
- Environment-related certificates	- ISO 14001 Environmental management systems (International Organization for Standardization (ISO), The ISO Survey of Certification)
Preservation of natural capital	
- Protected area	- Share of protected areas (EUSI)
- Renewable energy	- Share of renewable energy sources (EUSI)
- State of environment	- State of environment: Quality of air, water, forests, soil (EUSI) - Environmental Performance Index: Environment health (e. g., air – effects on human health) and ecosystem vitality (e. g., biodiversity) (Yale University and Columbia University) - Benefits of environmental innovations (OECD based on Eurostat CIS 2008 and national sources) - Stock of natural resources (e. g., minerals, oil, wood, flora, fauna) (EUSI) - Ecological Footprint (nations' demands on global regenerative capacity) (National Footprint Accounts)

Source: TEPSIE, 2013: 48–51

Cr | E | S | S | I

Creating Economic Space for Social Innovation

The CRESSI project explores the economic underpinnings of social innovation with a particular focus on how policy and practice can enhance the lives of the most marginalized and disempowered citizens in society.

"Creating Economic Space for Social Innovation" (CRESSI) has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 613261. CRESSI is a collaboration between eight European institutions led by the University of Oxford and will run from 2014-2018.

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