Excellence in the knowledge-based economy: from scientific to research excellence (accepted for publication in *European Journal of Higher Education*)

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Abstract

In 2013, the European Union unveiled its new 'Composite Indicator for Scientific and Technological Research Excellence', marking a turning point in how excellence is understood and used in European policy. This is not an isolated occurrence; policy-based interest in excellence is growing all over the world. The heightened focus on excellence and in particular, attempts to define it through quantitative indicators can have important implications for research policy and for the conduct of research itself. This paper examines how the European Union's understanding of excellence has evolved in recent years, from the presentation of the Lisbon strategy in 2000 to the current Europe 2020 strategy. We find a distinct shift in the understanding of excellence and how success in the knowledge-based economy should be achieved: in the early period, excellence is a fuzzy concept, intrinsically embedded in research and researchers and revealed by peer review. In the later period, excellence is more sharply defined and connected with a particular sort of knowledge, that which produces breakthroughs; the result is that policymakers have turned their focus towards directly steering and controlling what is increasingly considered to be the key element for success in the knowledge-based economy. This change is evidenced by the 'Composite Indicator for Scientific and Technological Research Excellence', its rationale and its components, and also provides an entry point into viewing the implications of what happens to excellence when we start to measure it this way.

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Introduction

Whether from academics, administrators or policymakers, the talk of 'excellence' has become almost ubiquitous in discussions on research and higher education within the European Union (EU). Researchers have identified excellence as a key element in both building the European Research Area (ERA) (Enders and DeBoer 2009) and in the Europeanization of national research policy (Radosevic and Lepori 2009). This emphasis on excellence has bloomed in the past 10-15 years. When Tijssen in 2003 examined the frequency of the use of the term excellence both on the web and in scholarly articles, he found that there were a significant number of occurrences of 'centres of excellence' and 'research excellence', but that references to measures of excellence (including 'indicators', 'metrics' and 'measurements') were extremely rare. We have updated his counts (see Table 1) and the results show a number of things. First, the overall number of occurrences of excellence related to research policy has proliferated dramatically over the past 12 years. Second, 'research excellence', which in 2002 occurred with a frequency of about one in four compared to references to 'centres of excellence', now occurs far more often. Third, references to the measures of excellence now have a significant presence both online and in scholarly discourses. But why is there such a growing interest in excellence and what does this increased interest reflect concerning the nature of research and research policy? In order to answer this, we need first to understand what is actually meant by excellence in the EU today and to understand whether and how that concept has evolved.

Table 1. Frequency of occurrence of 'research excellence' on the Web and in the international scientific literature.

Query search term(s)	World Wide Web[1]		Research literature[2]	
	2002	*2014*	*2002*	*2014*
Centre(s) of excellence	~ 148.000	~3.030.000	38	~15.800
Research excellence	~ 38.400	~1.330.000	32	~55.600
Centre(s) of research excellence	2.225	~568.000	0	~2.500
Indicators of research excellence	10	~24.300	0	~51
Measurement of research excellence	2	~24.100	0	~20
Metrics of research excellence	1	~1.580	0	5
Scoreboard of research excellence	0	1	0	2

Note: [1] Number of occurrences on the Web (Tijssen, 2003 & Google, 27th of June 2014)
[2] Number of occurrences in article title, keywords, or abstracts of publications published in international scientific or technical journals (Tijssen, 2003 & Google Scholar, 27th of June 2014).

Within Europe, this focus on excellence has spawned a range of policy instruments. These include 'centers of excellence' beginning in the 1990s, which later developed into 'networks of excellence' in the Sixth Framework programme. In the UK in the mid-2000s the Research Assessment Exercise (RAE) was revised and renamed as the Research Excellence Framework (REF). In 2006, Germany launched its Excellence Initiative (Exzellenzinitiative) and more recently France followed suit with its own Excellence Initiative (Initiatives d'excellence). While the word chosen is the same, when we dig a bit deeper, we find variations in the way that these policy tools conceptualize excellence. They differ in whether they use ex-ante or ex-post evaluation, whether they promote cooperation, dissemination, defragmentation or competition, and finally whether they strive for inclusivity or selectivity. In other words these tools differ significantly; they are not neutral, but embed particular ideas and agendas.

This focus on excellence also drives efforts to construct quantitative measures of excellence, which at the same time play a key role in reforming our understanding of excellence. This dynamic of mutual shaping also has an important influence on policymaking. The EU's efforts to measure research excellence offer an interesting case in this regard.

In 2013, the EU unveiled its 'Excellence in research' indicator in the biyearly *Innovation Union Competitiveness (IUC) report* (European Commission 2013a) and its companion report *Research and Innovation performance in EU Member States and Associated countries: Innovation Union progress at country level* (European Commission 2013b). The 'Excellence in research' indicator is a composite indicator consisting of four individual indicators that cover four dimensions: highly cited publications, top scientific universities and public research organizations, patent applications, and value of ERC grants. It transforms excellence into something that is measurable; and by combining all four dimensions is used to rank countries by their levels of excellence.

We will argue that the 'excellence in research' indicator marks a change in the definition and understanding of excellence. Excellence within the EU policy discourse has evolved from a fuzzy, intrinsically understood concept rooted in academic virtues and peer review processes to a clear, relational concept which can be quantitatively measured and benchmarked. This change in understanding can be seen as a shift from a conceptualization of 'scientific excellence' towards one of 'research excellence' that is rooted in measures of research outputs and their commercial application. This brings us to our second research question: how should we interpret this change in the understanding of the concept of excellence, and why is it happening now?

Our analytical point of departure is the ongoing discussion of the role and importance of ideas in public policy (Campbell 2002; Beland and Cox 2010; Schmidt 2010). What our journey into the making of this new, interesting policy tool within the EU offers is a chance to examine the interplay between two ideas as they become institutionalized: the knowledge-based economy and excellence. We argue that the indicator reflects a new understanding of the knowledge-based economy that at the same time implies a new understanding of the relationship between science and the economy. In this development, excellence becomes a key concept which must also change to correspond to this new ideational paradigm.

Methodologically the paper approaches the study of this ideational paradigm shift by delineating two distinct five-year periods and constructing a complex profile of the way in which the knowledge-based economy is portrayed in each. These periods correspond to the development of the two major European Union strategies of this century: the Lisbon strategy and the Europe 2020 strategy. In order to construct these two period profiles, the main policy documents dealing with the Lisbon Strategy and Europe 2020 Strategy, the Framework Programmes, and the European Research Area were collected. These included European Commission and European Council communications, green papers, proposals, decisions, regulations, impact assessments and reports. Documents which were not attributed to either the Commission or Council (i.e. external reports) were eliminated from consideration as were documents which were primarily evaluative of past policy and without a future policymaking intent, leaving 13 documents for the Lisbon strategy[1] and 15 for the Europe 2020 strategy.[2] The documents were then coded using a deductive strategy. Based on earlier observations, we started with the hypothesis that the knowledge-based economy is important in order to explain a change in the understanding of excellence and we examined the selected documents with this in mind. Six primary codes were used: Main concerns, Tools for improving the situation, Knowledge-based economy understanding, Research in the Lisbon [Europe 2020] strategy, Excellence, and Breakthroughs. The period profiles were built and compared using this evidence.

The paper begins by examining the concept of the knowledge-based economy from its popularization by the OECD to its early introduction into the European competitiveness strategy, and its role as a central concept in EU policy since the adoption of the Lisbon strategy by the European Council in 2000. Using primary documents, we build a picture of the way the knowledge-based economy was understood in the period of the early Lisbon strategy, from 2000 to 2004. The following section does the same for the early period of the Europe 2020 strategy, from 2010 to 2014. In comparing the results, we find an evolution of the concept of the knowledge-based economy. In the early period, the understanding of the knowledge-based economy was driven by a hands-off, input oriented strategy; that is, increasing the amount of knowledge, number of researchers and knowledge workers, etc. The goal in the early period was to create the best conditions for excellent research, though without targeting excellence directly. In the past decade this has shifted to an output oriented strategy in which the focus is directly placed on producing excellence.

In the next section, we examine the parts of the Composite Indicator for Scientific and Technological Research Excellence in more detail, explaining more precisely what is being measured and how. The composite indicator was chosen as the object of study because it is a new policy instrument that has been given a prominent position in a number of major reports by the Commission. As a composite scoreboard indicator it reflects the Commission's overall stance on research policy, and it subsumes other tools and initiatives such as the European Research Council. Thus in itself, as the most broad-reaching attempt to measure research by the Commission, the indicator is worthy of study; further, we argue that the indicator provides a clear demonstration of the effects of broader ideational trends through its instrumentalization of the ideational shifts which have occurred in the concept of the knowledge-based economy and scientific/research excellence. Thereafter we analyze the evolution of the concept of excellence in the context of the knowledge-based economy. Taking into account other key factors such as the financial crisis and austerity, the desire to use the open method of coordination, the influence of New Public Management reforms, the 'big data' revolution, global university rankings, and the effects of globalization, the paper concludes by looking at the implications of this changing understanding of excellence.

[1] Documents used in the study of the early Lisbon strategy: European Commission 2000a, 2000b, 2002a, 2003a, 2003b, 2004a, 2004b, 2004c; European Council 2000a, 2000b, 2000c, 2000d; European Union 2002.
[2] Documents used in the study of the Europe 2020 strategy: European Commission 2010, 2010a, 2010b, 2010c, 2011a, 2011b, 2011c, 2011d, 2011e, 2012, 2012a, 2013a, 2013b; European Council 2010; European Union 2013.

From the Lisbon Strategy to the Europe 2020 strategy: ways of thinking about the knowledge-based Economy

The knowledge-based economy in the Lisbon Strategy

When the European Council at its summit in Lisbon in 2000 stated that the European Union should become "… the most competitive and dynamic knowledge-based economy in the world …" (European Council 2000, 2) it adopted the idea of the knowledge-based economy that had been developed in the OECD in the mid-1990s (European Council 2000; OECD 1996a; OECD 1996b; Godin 2006).

The basic assumption underlying the idea of the knowledge-based economy is that knowledge – in its different forms: know-what (facts), know-why (scientific knowledge), know-how and know-who – more than ever drives productivity and economic growth (OECD 1996b; OECD 1996a, 12). This implies a transition from an industrial economy focused on natural resources, work division, machine technology and blue collar workers to a new economy where knowledge, human capital, information technology and white collar workers play the main roles. In this new, global knowledge-based economy, countries have to focus more on the production, distribution and use of knowledge in order to stay competitive (OECD 1996a; OECD 1996b).

This also requires a clear focus on research and science (OECD 1996a, 21-27). The science system should not only produce new knowledge but also take part in knowledge transmission and knowledge transfer via education and the development of human resources as well as by spreading knowledge and providing inputs to problem solving.

Right from the beginning, the problem of how to measure competitiveness and performance in a knowledge-based economy came up (OECD 1996a, 29-43). OECD called for improved indicators to measure knowledge input, knowledge stocks and flows, knowledge outputs, knowledge networks and knowledge and learning (OECD 1996a, 31). Indicators such as national spending on R&D, employment of technicians and engineers, number of patents and citations were discussed as important indicators but they were not seen as sufficient.

The idea that we live in a global, knowledge-based economy is adopted by the official EU-reports leading up to and following up on the Lisbon strategy. E.g. the report *Towards a European Research Area* from 2000 states that: "In the final years of the XXth century we entered a knowledge-based society. Economic and social development will depend essentially on knowledge in its different forms, on the production, acquisition and use of knowledge" (European Commission 2000, 5).

The strategy of the knowledge-based economy agreed on at the Lisbon summit thus also includes a much stronger focus on research and development, where R&D is seen as a central source of economic growth and new jobs in the future. The knowledge-based society is thus understood as a society in which knowledge, research, education, human capital, information technology etc. are key components in the creation of economic growth and prosperity. The Wim Kok group, in its report on the Lisbon strategy, calls for three focus points: "information society", "research", and "education and human capital" (Kok et al. 2004, 19).

In 2002 the EU decided on the Barcelona declaration stating that by the year 2010, 3% of GDP should be spent on R&D and that two thirds of the investments should come from private firms. This was argued to be necessary because the USA and Japan already spent much more on R&D relative to GDP than the EU. The United States spent 2.8% and Japan 2.9% on R&D in the year 2000 compared to 1.8% in the EU. So, in order to compete in this new global knowledge-based economy Europe simply had to increase its spending on R&D.

But besides spending too little on R&D, the EU also had to step up in other areas if it wanted to become the world's leading knowledge-based economy. Many problems were thus detected. Using data from the 'Main concerns' coding, these have been consolidated and categorized in Table 2 below. While this is not an exhaustive list, it contains the main problems and challenges identified by the Commission in a select set of policy documents focused on the development of the ERA. These problems and challenges were categorized into three types: Quantitative, Qualitative, and Structural. Quantitative problems are ones that can be characterized in a numerical manner and imply a solution that either increases or decreases a directly measurable input or output. Qualitative problems are measured by quality rather than quantity, and involve some evaluative judgment in their solution. These have to do with things like attractiveness and quality, and when there is a numerical reference it involves relative positioning rather than absolute levels. Structural problems are those for which a solution would require broader systematic change. These have to do with context and the effects that national, European and global pressures are having on the research systems as well as the way in which those systems are structured and fractured on a European and national level. In the early Lisbon strategy period (see Table 2 below), the quantitative problems were predominant (European Commission 2000; 2002; 2003a; 2003b; 2005).

Excellence in the Lisbon Strategy

Excellence in this period is understood as a key component in reaching the objectives of the Lisbon strategy. It is argued that only by maintaining and creating excellence can Europe reach the stated goal of becoming the world's leading knowledge-based economy. Meeting this goal requires creating world class poles of excellence (e.g. European Commission 2003b, 15), the availability of excellent researchers and research personnel (European Commission 2003b), and attaining and developing excellence at European universities (European Commission 2003a).

Excellence is understood primarily as an intrinsic quality embedded in research, researchers and research institutions and as something that takes time to develop (European Commission 2003a, 16). While there are many references to excellence – to 'scientific excellence', 'academic excellence' or most frequently simply to 'excellence' – the concept is not fleshed out or concretized. The idea seems to be that peer review is the only way to judge excellence. Excellence is presented as a kind of black box that can only be opened up and comprehended by peers.

This idea of excellence also underlies the establishment of the European Research Council (ERC) as described by the responsible commissioner, Janez Potocnik, at the time: "The clear aim of the European Research Council is to promote scientific excellence, and the best judge of that are scientists. We want to put high quality, independent scientific advice at the heart of the decision making process and make sure that the brightest and best of European research gets funded (DG Research, European Commission 2005)." He explicitly uses the term 'scientific excellence' and echoes the idea that it can only be identified by scientific experts who will use an international peer review process for making that determination. This strong vision of scientific excellence is shared by Helga Nowotny, then vice-chair of the ERC, who remarked: “Excellence is something you recognise when you encounter it” (Nowotny 2005, 3).

The ERC straddles the shift in understanding of excellence. On the one hand, as described above, it is the embodiment of the traditional idea of scientific excellence, but on the other hand, it embodies the broader shift to research excellence in two important ways. The first concerns the introduction of the concept of frontier research which not only breaks down the barrier between basic and applied research, it challenges disciplinary borders, and most important for our purposes here, introduces the idea of breakthroughs; the 2005 expert group describes frontier research as "… responsible for fundamental discoveries and advances in theoretical and empirical understanding, and even achieving the occasional revolutionary breakthrough that completely changes our knowledge of the world" (Harris 2005, 20).

Secondly, in the transition from the Seventh Framework programme to Horizon 2020, we find that the oversight and control mechanisms for the ERC have changed. In its proposal for establishing Horizon 2020, the Commission sets a target of doubling the share of ERC funded publications in the top 1% of globally most cited papers and sets a goal for the number of policy measures that the ERC inspires (European Commission 2011b). Both of these have been written about since at least the 2003 Expert group report, but were not directly targeted as part of the earlier framework programme tools. It should be noted that the setting of quantitative performance targets is done not only for the ERC, but for all parts of the programme.

The knowledge-based economy in the Europe 2020 strategy

By the year 2010 when the EU sets forth its new overarching strategy for jobs and growth, the *Europe 2020* strategy, it is seeking a way to reinvigorate the Union and bring it out of the financial crisis (European Commission 2010b). As succinctly stated in a later Communication, the knowledge-based economy is central to this solution: "Knowledge is the currency of the new economy. A world-leading research and innovation capacity, built on a strong public science base, is therefore critical to achieving lasting economic recovery and to securing Europe's position in the emerging global order” (European Commission 2012a). This is to be done through the tripartite aims of 'smart,' 'sustainable' and 'inclusive' growth, which broadly follow the three focus points identified by Kok in the Lisbon strategy (European Commission 2010b, 11-17).

On the surface, the general idea that knowledge creates growth has not changed; however, the sort of knowledge that matters in this relationship has. Input-oriented mechanisms supporting the mass production of knowledge are no longer considered the key to growth and competitiveness; instead, the focus has shifted to nurturing the particular sort of knowledge that has the potential to create breakthroughs and major economic impacts (European Commission 2011a; 2012; 2013a; European Union 2013). These breakthroughs are what will allow "... Europe to take a leading role in creating the scientific and technological paradigm shifts which will be the key drivers of productivity growth, competitiveness, wealth, sustainable development and social progress in the future industries and sectors” (European Union 2013). The 2012 Communication from the Commission emphasizes this issue: “Europe is short in the cutting-edge research that can deliver the breakthroughs required to fuel science and technology (S&T)-based business development” (European Commission 2012a, 6). The sort of research that matters is thus the kind that can deliver high financial returns through scientific breakthroughs and their commercialization. The talk of 'breakthroughs' becomes common language in the decision to establish the Horizon 2020 programme, where it is referred to 13 times in reference to all three pillars of the programme

(European Union 2013). While the word is not completely absent in earlier framework programmes, it only appears two times in each of the decisions to establish the sixth and seventh framework programmes (European Union 2002; 2006).

The Barcelona target remains on the agenda as both a serious policy problem and an input oriented solution (European Commission 2010; 2012; European Council 2010, European Union 2013). There is concern over the continuing failure of member states to meet the Barcelona target, and the relative position of the EU to the US (and to a lesser extent Japan and other emerging economies) in R&D investment relative to GDP; however, at the same time there is a shift in the understanding of the value of that investment. It is no longer a freestanding aim, but is explicitly connected with the objectives of efficiency and effectiveness. As stated by the Commission in 2013 in reference to the percentage of GPD spent on research and development, "… the use of these resources will not be effective if they are not invested in a first class research and innovation system that is capable of transforming ideas into innovation and spurring the development and deployment of technologies for industry and society [...] The objectives of efficiency and effectiveness should therefore be actively pursued and must cover the whole research and innovation cycle" (European Commission 2013b, 4). In other words, investment on its own is not the solution.

The set of problems identified in the early part of the Lisbon strategy continue to be relevant in the Europe 2020 period, but in the later period we find a shift in the overall characterization of problems which are more attuned to what the focus on excellence can resolve (see Table 2). There are only a handful of quantitative problems, and while there are more qualitatively defined problems than before, the bulk of the problems in this period are structural (European Commission 2010; 2012; 2013a).

Table 2. Types of problems identified in the discourses of the Lisbon and Europe 2020 strategies

Type of problem	Lisbon strategy[1]	Europe 2020 strategy[2]
Quantitative	• spending too little on R&D (EC, 2002: 3-6; EC,2003b: 4-6, 18; EC, 2005: 3) • too few researchers (EC, 2003a: 6, 21; EC,2003b: 11-12) • too few female researchers (EC,2003b: 11-12; EC, 2005: 11) • too little innovation (EC, 2002: 6; EC,2003b: 5) • low investments in the high tech sector (EC, 2000: 14; EC, 2002: 6-7) • too few researchers who started businesses (EC, 2000: 9, 14; (EC, 2003a: 15-16; EC,2003b: 12-13) • too little funding for universities (EC, 2003a: 6, 12) • insufficient commercialization of research results (EC, 2002: 10-12; EC, 2003a: 7; EC,2003b: 13; EC, 2005: 8)	• continuing low levels of investment (EC, 2010: 2, 6-7; EC, 2012: 6; EC, 2013a: 11-12) • declining global share of publications (EC, 2012: 5) • too few transnational projects (EC, 2010: 20-21, 27; EC, 2012: 10) • not enough world class universities (EC, 2010: 3, 9; EC, 2012: 47)

	• too many students leaving the Union/risk of brain drain (EC, 2000: 19; EC, 2002: 9; EC, 2003a: 10; EC, 2003b: 11-12)	
Qualitative	• not attractive enough research institutions (EC, 2000: 18-19; (EC, 2003a: 21; EC, 2003a: 6-7) • universities not internationally competitive (EC, 2003a: 5-7)	• unattractive conditions for the best researchers (EC, 2010: 6-7, 9; EC, 2012: 11, 41) • inefficient use of funds (EC, 2010: 2, 7, 10; EC, 2012: 19) • not attracting top global talent (EC, 2010: 3, 8-10, 27; EC, 2012: 12)
Structural	• compartmentalization of public research (EC, 2000: 9; EC, 2003a: 8) • too little visibility of European research in the rest of the world (EC,2003b: 4; EC, 2005: 7) • lack of interest in research among Europeans (EC, 2000: 5)	• intensifying global competition (EC, 2010: 2, 27; EC, 2010a: 2EC, 2013a: 4) • no strategic research profile (EC, 2010: 2, 7; EC 2013a: 4, 7) • concentration of research in a small group of countries (EC, 2010: 20; EC, 2012: 6) • insufficient competition in the national research systems (EC, 2012: 2, 8) • low compatibility and interoperability of national programs (EC, 2012: 10) • restricted circulation and uneven access to scientific knowledge (EC, 2012: 14-16, 19) • high costs of patenting (EC, 2010: 7, 15; EC, 2012: 75, EC 2013a: 6) • duplication and fragmentation of research (EC, 2010: 2, 7, 10; EC, 2012: 2, 7, 10) • setbacks from the financial crisis (EC, 2010: 2, 13, 20; EC, 2012: 5; EC 2013a: 16, 25)

[1] Sources: European Commission (EC) 2000; 2002; 2003a; 2003b; 2005
[2] Sources: European Commission (EC) 2010; 2012; 2013a

The post-2010 understanding of the knowledge-based economy has thus shifted its focus from quantity to quality. In terms of research policy this shift is highlighted by a focus on excellence. The Commission in 2011 states this clearly in setting the mission for the expert group tasked with developing an indicator for research excellence: "excellent research is a prerequisite to economic development in the knowledge society” (Barre 2011, 3). The upshot in terms of research policy can be seen clearly in this statement by the Commission: "Notwithstanding differences in interpretation, most accounts of competitiveness attribute an important role to research. However, policymakers are not interested in just any research, but in excellent research in particular” (European Commission 2013a, 108). This relates to the call for a more 'strategic' approach to research policy, and for forecasting which types of research and which researchers can deliver the excellence that policymakers are now seeking.

While the perceived importance of breakthrough producing knowledge is the driving force behind policymakers' interest in controlling its development, there are also a number of governance and economic trends that lie behind this shifted focus.

Globalization sets the stage for much of the Lisbon strategy. The European research strategy and the knowledge-based economy are both dependent on the idea of the globalized nature of the world, and on the critical need to remain as one of the leaders. Policies and problems are set within this positioning game between Europe, the USA and Japan, but increasingly including the BRIC countries as they increase their scientific prowess.

The financial crisis, and the broad political acceptance of austerity as the necessary means of solving it, put new pressures on European governments to streamline and increase efficiencies. This focus on efficiency in public budgets supported a refinement of the objectives of research policy. Rather than simply seeking to promote excellent research, policymakers began seeking to efficiently promote excellent research. Regarding the European Union budget, it became clear that key member states, particularly the UK, would not agree to an increase of the European budget for the 2014-2020 cycle. This again put added pressure on increasing the efficiency of research and innovation.

New Public Management (NPM) reforms can also be seen to play a role in shaping this change. NPM reflects a heterogeneous variety of reforms that can be understood and translated into policy instruments. While it would not be right to argue that a common NPM doctrine has shaped European policy, as it has for a core group of NPM countries including the UK, elements of these reforms have been translated into policy across Europe (Pollitt et al 2007). Most importantly for our purposes, the concept of NPM creates the framework conditions in which the audit society (Power 1997) is conceptualized. The audit society is one in which everything must become auditable; even if not everything will be audited, everything is constructed in such a way that it can be. Auditability requires quantification, but also entails focusing on the structure and process of how internal quality control is conducted as it is often impractical to verify all the actual results. The creation of an audit culture in the area of research policy thus motivates the construction of the concept of research excellence.

Another driving force is the soft law approach to research policy by which the European Research Area is being built. In some cases the EU uses the slightly more formalized approach of the Open Method of Coordination (OMC), while in others it is not named, but still functions according to similar principles. Regardless of what it is called, the mechanism works through agreed benchmarks and peer pressure to compel member states to meet agreed obligations. Without data that can be compared, these soft law approaches have no basis on which to function. Hence it is necessary that excellence be concretized so that it can be compared and used in soft law governance. Without a clear conception of what excellence is, benchmarking becomes a near impossibility.

Finally, the push towards research excellence may be driven by technological feasibility. The sort of processing power which is required to compile the vast quantity of information on which research excellence measures depend, was simply not available in earlier times. This makes research excellence part of the so called 'big data' trend that has opened up possibilities for analyzing data in the business world and which may in some way be self-fulfilling in its desire to find new areas in which to employ its techniques.

The Composite Indicator for Scientific and Technological Research Excellence

Although considered important in achieving the objectives of the Lisbon strategy, it is not until the Europe 2020 strategy that we see a determined effort to measure and benchmark excellence. Marking the first time the EU has attempted to benchmark excellence within one of its scorecards, the Composite Indicator for Scientific and Technological Research Excellence is "… a composite indicator developed in order to measure the research excellence in Europe, meaning the effects of European and National policies on the modernization of research institutions, the vitality of the research environment and the quality of research outputs in both basic and applied research" (European Commission 2013b, 321). The indicator is made public in 2013 in the second edition of the biyearly Innovation Union Competitiveness (IUC) report 2013 published by DG-Research (European Commission 2013a), and is also included in the companion report containing analyses of the individual member states (European Commission 2013b). The composite indicator consists of four individual indicators that cover four dimensions which are then consolidated into one composite ranking of countries. The dimensions are: the share of highly cited publications, the number of top scientific universities and public research organizations in a country, patent applications, and the value of ERC grants.

In 2011, an expert group was formed with the explicit aim of developing indicators for research excellence. The development of the Composite Indicator for Scientific and Technological Research Excellence can be traced in particular through three documents: the report of this expert group (Barré, Hollanders and Salter 2011) and two reports produced the Commission's Joint Research Centre (JRC) that first analyze the indicators proposed by the expert group (Vertesy and Tarantola 2012) and thereafter arrive at the four dimensions that make up the final composite indicator (Hardeman, Van Roy and Vertesy 2013).

The expert group (EG) argues that in understanding and defining the notion of excellence, it is important to recognize that the notion changes in nature depending on the level that is examined. Concerning a project or single piece of research, the EG fully accepts the traditional notion of scientific excellence based on peer-review. However, the nature of excellence changes as we move from research to researchers to research units and finally to regions or countries, which are the focus of the EG. They argue that excellence at a broader level should be seen in terms of the functioning of national research and innovation systems; institutions, infrastructure, resources and capabilities. As the EG argues, "… to address the issue of excellence, the processes are as important as the results" (Barré, Hollanders and Salter 2011, 6).

There is a fairly clear link between the EG's work and the problems and driving factors derived from the Commission documents. The overriding forces that drive the focus are simply what the EG sees as a lack of excellence in itself; a "quality gap" compared to other countries alongside a need for greater efficiency in producing excellence. The EG's view of excellence encompasses many of the problems noted above (see table 2). They note for example three criteria for the excellence of national systems. The first is impact, covering publication and other research performance. The second is openness, which addresses the circulation and access to knowledge, fragmentation of research, and the interoperability of national programmes. The third is attractiveness, which covers the quality of institutions such as universities, conditions to attract and keep top researchers, and patenting costs.

Within this framework, the EG defines six types of activities that together form the excellence of national research and innovation systems. The six categories were constructed in a matrix that looked at the main actors: researcher actors, industrial innovation actors, and societal/political actors and crossed them with impact (knowledge production) and openness-attractiveness (institutional arrangements, interaction schemes). The EG examines and proposes a number of indicators for consideration within each category, though it was acknowledged that the last two categories concerning societal/political actors were particularly difficult to measure at this time.

Vertesy and Tarantola (2012) conducted a feasibility study commissioned by the EU Directorate General for Research and Innovation, that "… built on the theoretical framework proposed by the 2011 report of the Expert Group …" (Vertesy and Tarantola 2012, 3) by testing their proposed indicators. They found that the framework proposed by the EG would function better with a reduced set of indicators for two reasons. First, by removing certain indicators, each dimension or category of indicators would be better able to identify a single distinct aspect of research excellence. Second, some indicators within categories were actually negatively correlated with each other, which creates problems for interpretation of changes in the overall category.

The study thereafter conducts a principle components analysis for the EG's group of indicators (though with a slight modification of a single indicator to improve its statistical robustness). In comparison with the EG's proposal of 4 dimensions (since no indicators were found for the last two of the EG's 6 proposed dimensions), this analysis produced three distinct "pillars" with a set of 13 out of 22 of the EG's proposed indicators. The three pillars are "excellence of public research" (6 indicators), "interactions, collaborations" (4 indicators) and "excellence in industrial research" (3 indicators). Pillar 1, "excellence of public research", includes highly cited publications, excellence in research carried out at top universities and PROs, ability to attract foreign doctoral students, specialization in publications in the fields of grand societal challenges, coordination position in FP projects and public applied research excellence measured through PCT patent applications. Pillar 2, "interactions, collaborations", covers interactions between researchers, both directly, through international co-publications and indirectly, through successfully receiving ERC grants. Pillar 3, "Excellence in industrial research", covers industrial contributions to research excellence in the form of European Patent Office (EPO) patent applications by industry, co-publications between industry and academia and business financing for research carried out at institutes of higher education and public research organizations. The set of indicators is shown in table 3 in the appendix. While much reduced compared to the originally proposed list, the 13 indicators organized in three pillars still maintain to a certain extent the EG's intention that the notion of excellence should be depicted in terms of the functioning of the national research and innovation system as a whole. This is reflected in particular by indicators of collaboration and the attracting of foreign doctoral students.

The final development of the composite indicator was undertaken in yet another project commissioned by DG Research, Composites 4IU (Hardeman, Van Roy and Vertesy 2013). This report provides more detail on why certain indicators were chosen above others, building on both of the previous reports and also the work of Tijssen who they cite extensively in the section on defining research excellence. The study presents the following definition of excellence: "Scientific and technological research excellence is defined as the top-end quality outcome of systematically performed creative work undertaken to increase the stock of knowledge and new applications" (Hardeman, Van Roy and Vertesy 2013, i). Interestingly, this report revisits much of the same ground covered by the EG report, examining theoretical backgrounds for excellence and developing a new framework for the production of excellence. However, this re-examination of the theoretical foundations of excellence does not appear to have much influence of the final proposal of indicators. What instead has a key impact is the selection criteria for indicators of research excellence, first that indicators must represent high-end quality aspects of research and second that they must represent research outputs unless they represent research inputs whose outputs are not covered by main indicators of research excellence.

In other words, indicators are restricted to be output measures, in large contrast to the original EG report. The implicit argument behind this appears to be that output measures already capture variation in the processes or input indicators behind them. This statistical argument aside, it is clear though that each chosen indicator also has a conceptual value, which is important to the interpretation of the measures, to benchmarking and for policy recommendations.

Analyzing the indicator

In this section we analyze the components of the Composite Indicator for Scientific and Technological Research Excellence, try to explain what they mean for our understanding of excellence, and look at the potential implications of these measures and their promotion as policy goals. In a discussion of formal systems for the recognition of excellence of achievement, Merton poses three questions that can help to frame the discussion (Merton 1960): "What unit of achievement is to receive recognition?", "What qualities of a seeming achievement are to be judged?" and finally "who shall judge?". Of particular interest here is the extent to which the achievements recognized and qualities judged correspond to traditional understandings of excellence and the implications of any differences.

As mentioned above, the Composite Indicator for Scientific and Technological Research Excellence consists of four indicators. For highly cited publications the indicator uses the 10% most highly cited publications where at least one author is affiliated to the given country. The calculations are made using Scopus data. The use of 10% most highly cited publications as an indicator of excellence represents a shift from judgments made on the basis of intrinsic quality to judgments made on the basis of relative comparison. Hardeman, Van Roy and Vertesy (2013) argue that publication citation is a relatively direct measure of scientific quality; that it has become institutionalized in many contexts both national and global, is broadly accepted and plays a central role in global rankings. They note the distortions and biases in measuring citations which have been extensively documented, though they believe that as a national measure, it is less likely to lead to undesirable steering effects. We will come back to this point below.

The number of top universities and public research institutions is calculated in relation to a country's population, per million inhabitants. The data used is from the Leiden Ranking and Scimago Institutional Ranking, respectively looking at the top 250 universities and top 50 public research institutions.

A number of university rankings can now be found, and they can be argued to have played a key role in motivating the measurement of excellence in general. Rankings are, however, quite diverse in what they choose to cover. The ranking systems used in the indicator here are entirely based on bibliometric outputs, so the question arises whether it isn't too similar to the above measure of top citations. Hardeman et al (2013) dispute this and argue that what this dimension measures is centers of excellence, which "… attract outstanding researchers (senior and junior) from around the world, offer state-of-the art infrastructure and potentially (due to reputation based on past excellence) attract a large share of public and private research funding, all of which create the virtuous circles or self-reinforcing mechanisms that sustain their excellence" (Hardeman, Van Roy and Vertesy 2013, 35). Scientific institutions in this understanding have distinct autonomy and power as sub-national actors, which should be measured separately from the overall national context.

Patents are measured in terms of population per million on a 3-year moving average with data from OECD and Eurostat. Patents are selected as an indicator because they present a proxy for knowledge transfer and the commercialisation of knowledge. The indicator only counts patents that are registered in multiple countries under the Patent Cooperation Treaty (PCT); the logic behind this is that these are the patents which the patentees themselves believe are the most valuable and likely to bring the highest returns. However, patents can vary greatly in terms of their value and can in some cases reflect strategic concerns rather than an innovation that can be commercialized and marketed. Patents are also very industry specific, with some industries relying heavily on them to document new knowledge while others typically do not patent inventions that can be used to create novel goods and services.

Finally, the ERC grants dimension is calculated according to the value of ERC grants received divided by public R&D performed by the higher education and government sectors. The rationale for choosing this indicator is perhaps less straightforward than for the others, but it is intended as a measure of excellent researchers and potential for excellence:

"Excellent knowledge embedded in researchers and research teams can also be measured through research grants. The most prominent (high value and prestige) research grants, such as that of the European Research Council (ERC) or the National Science Foundation (NSF) of the United States are awarded based on demonstrated outstanding past performance of research teams on the one hand, and on expected outstanding performance on the other hand. Receiving such a grant can therefore be at the same time a proxy for recent excellence and 'excellence in the making'" (Hardeman, Van Roy and Vertesy 2013, 37).

In contrast to the three other indicators, the indicator of ERC grants is only available for EU countries and thus must be excluded in international comparison with non-EU countries. This is a fairly significant limitation, which implies that different comparisons are made between EU countries than with non-EU countries.

The last question Merton asks is 'the who-question': who shall judge? A general answer to this question would be that we, from the Lisbon strategy to the presentation of this new indicator, have moved from a situation in which excellence could only be revealed through peer review – through peers' careful scrutiny of peers work – to a new situation in which policymakers and the general public have direct access to judge whether something is excellent or not. This corresponds with one of the major impetuses for creating the audit society: giving non-experts the tools by which to make judgments. Michael Power (1997) refers to it as the black boxing of expertise. In creating an audit society, he argues that specialist knowledge is co-opted in building "… networks of trust in which the knowledge of others can be more or less 'black boxed' and rendered reliable" (Power 1997, 88).

The smart thing about the composite indicator, as with other audit society tools, is that it in a way still lets the peers do the job. Only papers that peers find worthy of citing (for whatever reason) find their way into the indicator. The ranking of universities is likewise built upon peers' judgments of papers. Peer review – together with the legal system and the market – also decides about patents. And finally the traditional peer review system of academia is drawn into the fourth measurement of the composite indicator – the value of ERC grants. The ERC, which evaluates by peer review, has proven its trustworthiness, and hence, can become a tool of the audit culture.

In all of these measurements, the expert judgment of peer review is 'rendered reliable' in a way that allows for its incorporation into the Composite Indicator for Scientific and Technological Research Excellence. The people behind the indicator have thus tried to combine traditional qualities of academia with transparency in a very simple composite indicator for measuring excellence, but the question is whether something is lost along the way.

In other words, it is important to examine what is not covered by the various dimensions of the composite indicator. This can have relevance for both the measurement and the benchmarking of excellence. One could ask if the relative performance rankings would have been the same, had it been possible to capture a broader or fuller notion of the dimensions, i.e. one corresponding more directly to the detected problems discussed in the previous section above. One could also inquire into the potential implications of policy and research focus moving away from the areas that are neglected by the indicators.

One obvious problem is that citation databases range from near complete coverage of research work within some areas to coverage of only a minority of work within other areas, such as within humanities and social sciences. In particular, excellent research that is published in the form of books, and papers in other languages than English, is not captured by this indicator.

Another problem with the indicator is that even though the chosen rankings of universities are arguably among those that are most based on objective, quantifiable data, the activities of universities are of course much broader than the publication of research in peer reviewed international English language journals and include a number of important activities not captured in this ranking. Besides books in English and papers in national languages, another example is the quality of education activities. It is bad in itself that this does not count – but even according to the idea of the knowledge-based economy, this is problematic. A valuable product of universities in the knowledge-based economy is skillful job candidates who can enter companies and create value.

An additional area that is not covered in the Composite Indicator for Scientific and Technological Research Excellence is the processes themselves that contribute to or generate excellence. As discussed above, the original plans of the Expert Group were to measure key processes in the knowledge-based economy that are important in generating excellence. However, the final chosen indicators focus mainly on excellence as an output and thereby ignore the processes by which excellence is created.

A key question is therefore: what are the potential implications of introducing such an indicator? Will the introduction of this indicator alter the incentive mechanisms and if so, with what consequences? Already Merton warned us against seeing reward systems as neutral tools. Instead of just being a tool for the recognition of 'unsung heroes', a reward system might also bring about imitations of the real thing (Merton, 1960: 432-33). In other words we have to pay attention to the possible side-effects of introducing a tool for measuring excellence.

The individual indicators in the Composite Indicator for Scientific and Technological Research Excellence are country level measures, and the developers of the indicator note that the measurement of excellence at the individual level is still most appropriately assessed through peer-review. However, these indicators, in particular top cited papers and highly ranked universities, are of a nature that makes it possible and relatively simple to apply them at the level of individual units. This creates the risk that the indicators of excellence will be used to benchmark individual researchers, departments or universities. This use would greatly increase the potential for perverse incentives for researchers or research units. Duncan Lindsey, for example, warns us about being too uncritical in equating citations and quality. According to Lindsey (1989: 200): "… an approach that relies on citation counts as a measure of quality may too often be *measuring what is measurable rather than what is valid*." This might also be the case for the other indicators in the composite indicator.

If individual researchers and research institutions start to imitate the indicator by focusing on what counts in the composite indicator – and according to Frey (2007: 209) this is what evaluations normally make people do - they might be able to become more excellent as seen through the lenses of the indicator, but in reality they may perhaps be doing worse than before when it comes to e.g. scientific breakthroughs. When, for example, the number of top papers is rewarded, this might provide an incentive to focus on areas that are the most amenable to generating a large number of citations and may also promote a more short-term focus in research. According to Lindsey "… citation counts favor the scientist doing work in the mainstream or dominant paradigm" (1989, 193), whereas path breaking research can have difficulties getting published in the best journals. In other words, focusing too much on citations may be a disincentive to explore large, unanswered questions that might take a longer time and involve greater risk in terms of chances of success. And, if this is the case, a further question is whether focusing on excellence in terms of highly cited papers can actually steer some research away from attempting to generate large breakthroughs.

These issues are also relevant for universities; i.e. the pursuit of better rankings may in fact imply a change in university's underlying objectives. As Brook has formulated it: "Success in the evaluation process can become a more significant target than success in research itself" (Brook 2002, 176 (here quoted from Frey 2007, 210)). Efforts to boost rankings in the short term can also come at the expense of longer term actions to strengthen core activities and build up the foundations that create the best environment for both research and teaching.

Conclusion: From scientific excellence to research excellence

The change in understanding of excellence in the EU's research policy from the Lisbon strategy to the Composite Indicator for Scientific and Technological Research Excellence can, as we have attempted to show in this paper, be understood as a three stage development: First we found a concept of excellence that was very broad, fuzzy and umbrella-like. Then the concept was defined and fleshed out in the reports leading up to the indicator. Here the understanding of excellence was still a very broad one, but also a much more concrete one than it used to be. Finally the concept of excellence was narrowed down into four concrete measurements in the final version of the composite indicator: the share of highly cited publications, the number of top scientific universities and public research organizations in a country, top patent applications, and ERC grants.

The understanding of excellence in the research policy of the European Union has thus changed significantly within the last 15 years. This change in many ways corresponds to the distinction Tijssen (2003, 94) makes between 'research excellence' and a broader concept of 'scientific excellence'. In the Lisbon strategy the focus was on excellence in a broad sense of the word whereas the new indicator represents a narrower, more focused or – as some critics might say – reductionist view of excellence.

We argue that this shift in the understanding of excellence should be seen in the context of the knowledge-based economy: a new understanding of the knowledge-based economy has called for a new concept of excellence. Increasing pressures of global competition, tightening resource constraints that were further exacerbated by the financial crisis together with a growing emphasis on auditing and performance measurement in the public sector have motivated a shift from the promotion of knowledge creation and transfer in general to targeted efforts to promote excellent research in particular. Measurement efforts have also played a pivotal role in the changing conceptualization of excellence, where the emergence of new measures have been brought about or at least facilitated by the emergence of big data and global statistics.

As Simon Marginson (2011) points out, this development has come about very quickly. Before 2002 there were no global university rankings and no significant global research ranking systems. Today there are many different global ranking systems and they dominate the way we think about education, research and universities. As the OECD has noticed, competition within the research system is not something new, but the emergence of international ratings and rankings has made this competition much more intensive and led to a new view of excellence: “Research has always had an element of competition, e.g. regarding the publication of new findings or access to resources. Recently, other forms of competitive pressures, such as international ratings and rankings of research groups and institutions, have gained in importance and are transforming the perception of research excellence” (OECD 2006, 178). These measures themselves should be considered as a soft policy tool to promote excellence, particularly in the case of the EU.

While our focus in this paper has been on the EU, the EU’s indicator of research excellence reflects to a large extent a global development in the conceptualization of excellence. This is evidenced in particular by the widespread use of indicators of highly cited articles and by university rankings. What is unique in the case of the EU, and which constitutes a further step in this development, is that the Composite Indicator for Scientific and Technological Research Excellence represents the formalization of excellence as a standard measure to monitor and benchmark performance in EU countries.

These changes in the understanding of excellence can have important implications for the conduct of research itself and thereby also research outcomes. If the attention of researchers and research units is focused on performance measures of excellence as opposed to creating excellence itself, researchers may alter their behavior. At this point it is difficult to say what the potential consequences of such a change would be. However, if it leads to a greater short term orientation in basic research, this could in some cases reduce chances for large breakthroughs. Furthermore, the narrower focus of excellence measures can also have implications. Given that indicators only provide incentives to perform in those areas that are measured, there is a risk that important aspects that are not measured, such as teaching, may be given less priority.

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Appendix

Table 3: Revised list of the indicators of research excellence proposed by Expert Group (reduced list as proposed by Vertesy and Tarantola, 2012)

Pillar 1 "excellence of public research"

- % of Highly cited publications / % publications
- % (EU) 250 top scientific universities / % (EU) public RD spending (HERD + GOVERD)
- % Foreigners in doctoral programmes
- Specialisation in publications in the fields of the Grand societal challenges
- % (EU) Coordination position in FP projects/ % (EU) participation in FP projects
- Patent applications by HEIs+PROs (per 1000 researchers)

Pillar 2 "interactions, collaborations"

- International collaborations index
- Collaboration index (with emerging countries)
- % (EU) ERC and/or Marie-Curie grantees / % (EU) public RD spending (HERD + GOVERD)
- % (EU) ERC and/or Marie-Curies grantees / % (EU) of [HE researchers + government RD personnel] in FTE

Pillar 3 "Excellence in industrial research"

- Patent applications by industry (per 1000 researchers and/or relative to BERD)
- Public – private co-publications per million population
- % (national) HERD+GOVERD financed by business / GDP
-

Source: Table 1 and 2 in Vertesy and Tarantola (2012).