



The process of construction of evidence: An analysis of the use of indicators in two decisions of innovation policy

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ABSTRACT

Despite increasing calls for evidence-based policies, knowledge about the practical use of evidences remains limited. This paper studies the process of construction of evidences in decisions of innovation policy to understand how evidences were used. It analysis the use of indicators and other evidences through interviews conducted to inquire about the two decisions: an electric mobility policy and a nanotechnology laboratory. Results show indicators and other evidences were brought to decision processes according to their availability and capacity to support the different interests of the actors and the stakeholders. Their role was influenced by the particular situation of the decision makers. More importantly, the use of persuasive analytical evidences appears to be related with the adversity of the policy context. In addition, research suggests that indicators are one tool among others to foster innovation decisions. In fact, the relatively minor instrumental role of indicators suggests that indicators are mostly a complementary instrument of decision. When used relevantly, indicators can offer support to a decision. But there are other significant influences that need to be taken into account to understand the specific role indicators and other evidences play, such as the social relations of the decision makers and their emotional-intuitive decisions.

KEYWORDS

Evidences; indicators; innovation policy; decisions.

1 THE USE OF EVIDENCE

The use of evidences in policy-making has seen a growing interest in recent years. Several researchers reported an increase in calls for public policies that use evidences.¹ The calls assume that evidence-based policies are an aspiration that improves the quality of the decision, , among other things (C. Porter 2010). However, despite these calls, knowledge about the use of evidence in practice remains rather limited. In fact, we know very little about policy makers' use of information in practice, how information is valued and, in particular, what is the prevalence of formal scientific evidence use in policy decision (Hall and Jennings 2010). Hence, there is the need to study the practices of use of evidence to be able to support claims for evidence-based policies. A way to understand the use of evidences in practice is to centre the study in the use of indicators in cases of policy making. Indicators are conceptual instruments used to measure, evaluate and help with decisions by summarizing characteristics or highlighting what is happening in reality. They are closer to formal scientific evidences and frequently quantified. Furthermore, in a study about sustainable policy at the EU institutions, Sébastien and Bauler (2013) pointed to the need to study the processes of construction of evidence to understand the use of indicators, rather than to focus on their technical quality and their independency from their producers (two factors initially presumed important). Thus, there is the need to study the process of construction of evidences in policy decisions to understand how indicators and other types of evidences are used in practice.

There are several factors that can account for our limitation of knowledge regarding the use of evidences. First, the novelty of the field naturally limits information about the use of evidence in practice. Second, there is an abundance of definitions of evidences that limit our ability to report their use. In one extreme, evidences can be strictly identified with scientific outputs. In this case, evidences comprises all types of science (and social science) knowledge generated by a process of research and analysis, either within or without the policy-making institution (Juntti, Russel, and Turnpenny 2009). On the other end of the spectrum, evidences are interpreted as pieces useful to support policy. In this case, an evidence is not necessarily data or information, but mostly a selection of the available information introduced in an argument to persuade about the truthiness or falsity of a statement (Flitcroft et al. 2011). Third, evidences can assume various forms in different contexts which limit their identification. In fact, evidences can be indicators, historical facts, statistics², and results of experiments, texts, quotes from secondary sources, real experiences or histories, or opinions of individuals in one field. Fourth, these forms can vary with the context: In policy-making, evidences can range from numerical data to ethical/moral interpretations expressing values, attitudes and perceptions of stakeholders and other decision makers. In health contexts, evidences can be research findings, other knowledge that is explicit, systemic and replicable, or simple acceptable waiting times (Lomas et al. 2005). In management contexts, evidences can include costs, technical characteristics of materials, stakeholders' opinions, etc.

The use of evidences in policy-making can be a significant subjective process. In fact, the strength and quality of evidence can be related to the number of controversies that it goes through during its lifetime (Sébastien and Bauler 2013). In these cases, evidence loses strength in the process of decision-making with the increase of controversies it goes through since its creation. Furthermore, the selection of evidence can also depend on the situations in which policy makers find themselves. These situations shape which information is used from the complex set available, and which evidence is rejected or at least downplayed (Perri 6 2002). In fact, policy-making "always makes use of some evidence, but there is a plurality [...] of things that count as evidence, and what counts depends on where policy makers are situated" (Perri 6 2002, 7). In addition, the selection of evidences can be related to epistemological choices of the decision maker, in terms of claims about valid sources of knowledge and how to judge knowledge claims. These choices can be related to the use of quantitative or qualitative information, but also sometimes religious believers might endorse theological claims to knowledge. The choices often reflect ontological assumptions about the objectivity or subjectivity of reality. For example, for some only positivistic techniques of inquiry support claims to knowledge as

¹ See among others Head (2010), Flitcroft et al. (2011); Juntti et al. (2009), Sorrell (2007), and Hall & Jennings (2010).

² For the purpose of this work a statistic is a numerical fact or datum, especially one computed from a sample (Gault 2013).

reliable facts, whereas for others the complexities of the social world demand an interpretation of human behaviour and intentions (Henn et al. 2009). In this context, policy emerges from the interaction of different forms of evidences, filtered and shaped by the processes of decision-making (Flitcroft et al. 2011, 1039).³ These filtering processes are subjective and evidence can be chosen instead of another, leading the argument in different directions. Therefore, what counts as evidence in policy-making is subjective, depends on the controversies associated to them, the particular situation of the decision maker and their epistemological claims.

2 INDICATORS IN INNOVATION POLICY

Policy-making can use many types of evidences, as mentioned earlier. This work will place a particular emphasis on a concrete type of evidence closely related to scientific findings: indicators. There are many indicators that can be used, specifically, for innovation policy purposes. In fact, the last decades have witnessed a significant amount of literature and other efforts directed to developed indicators in this policy field. In this context, indicators can be defined as conceptual instruments used to measure, evaluate and help with decisions by summarizing characteristics or highlighting what is happening in reality. They are commonly understood as variables selected to characterize the efforts undertaken by countries/regions/companies in the field of science and technology and innovation. These indicators cover resources devoted to research and development (R&D), innovation, patenting, technology balance of payments, international trade in R&D-intensive industries, etc. There is a significant amount of innovation indicators freely available for comparisons over time and across countries, regions, sector and companies. For example, the Innovation Union Scoreboard captures the economic success of innovation using five indicators: ‘Employment in knowledge-intensive activities’, the ‘Contribution of medium and high-tech product exports to the trade balance’, ‘Exports of knowledge-intensive services’, ‘Sales due to innovation activities’, and ‘License and patent revenues from selling technologies abroad’ (Hollanders & Es-Sadki 2014). Therefore, this paper places a particular focus on indicators to understand the use of evidences in innovation policy.

The influence of indicators in decision-making is largely unknown. Most literature aims to develop indicators, analyse them or evaluate them. However, only a few authors provided clues regarding the extent to which they are used to make a decision.⁴ The existing studies specific to policy contexts revealed that most indicators were often ignored or that their use was limited in policy decisions (MacRae 1985; Lehtonen 2013; Sébastien & Bauler 2013). In 1985, Duncan MacRae argued that the most frequent problem of indicators was their non-use in policy-making. The reasons for this disregard of indicators could be found in the lack of interest, information overload, lack of communication or even opposition to what is being measured (MacRae 1985). More recently, Sébastien and Bauler (2013) emphasized that policy indicators remain largely enigmatic regarding patterns of embeddedness in institutional decision-making processes. In sum, literature about the extent of the use of indicators is meagre and point to a limited use in policy-making.

The literature in innovation contexts has received recent contributions. In fact, Boavida (2015) found that the use of indicators in technology innovation is significantly high (84%), although slightly differentiated in each innovation group: the vast majority of policy makers use indicators (92%), followed close by business R&D&I leaders (89%), and after by (public) researchers (71%). However, social relations were more important than indicators to these decisions for the majority of all decision makers (59%). These results were emphasized by policy makers (68%) and business R&D&I leaders (59%), although half of the researchers (50%) considered indicators as important as social influences. These gaps between the use and the influence of indicators depict the real influences indicators have in the decisions: researchers are more influenced by indicators than business R&D&I leaders and, to a significant extent, than policy makers. These findings confirmed the idea that the use of indicators is different from their influence, as suggested by Gudmundsson and Sørensen (2012) to policy decisions. Therefore, there is a high use of indicators in technology innovation decisions different from their real

³ To the authors, policy-making is the management of rival value set and notions of evidence.

⁴ A significant part of the existing literature about the influence of indicators in policy-making is recent and resulted from two European projects: POINT - Policy Influence of Indicators and PASTILLE - Promoting Action for Sustainability through Indicators at the Local Level in Europe (Bell & Morse 2013).

influence. Furthermore, Boavida (2015) also found that indicators do not play a very significant role in technology innovation: First, indicators had mostly a symbolic role among policy makers (63%) and a limited instrumental role (29%). These results are in line with findings of Gudmundsson and Sørensen (2012), where policy indicators had a very limited direct instrumental role in two sustainable transport policies. However, Boavida (2015) findings disagree with the widespread non-use of indicators in general policy-making, mentioned by MacRae (1985). In fact, only a significant minority of policy makers (8%) revealed that indicators had no role in their decisions. Second, business R&D&I leaders presented a similar but less emphatic pattern. For them indicators had most of the times a symbolic role in the decisions (53%) and a limited instrumental role (36%). Third, the role of indicators to researchers was different. In fact, researchers revealed that indicators can play, almost heterogeneously, an instrumental (35%) and symbolic (35%) role as well as no role (29%) in their decisions. Therefore, indicators play mostly symbolic roles in decisions of policy makers and business R&D&I leaders, but their role with researchers can be more differentiated. Last but not the least, in a study about the significance of composite indicators⁵ for sustainable policy at the EU institutions, composites were found to be not systematically used directly but having an indirect influence on policy-making that needs to be better understood (Sébastien and Bauler 2013). The conclusion emphasized the need to study the processes of evidence-construction, rather than the technical quality of indicators and their independency from their producers (two factors initially presumed important). This latter work, however, dealt only with policy use of composite indicators at EU institutions.⁶ Therefore, there is the need to develop the understanding of the process of construction of evidences more generally to any type of indicators.

The process of evidence construction can help explain the role of indicators play in the decisions. There are two main reasons for this: First, the selection or the disregard of an indicator can be controversial, particularly in contested policy arenas. In fact, “strategic and political use of indicators, manipulation or even abuse of indicators is not necessarily a problem, but rather an essential part of the production of valid and reliable evidence” (Sébastien and Bauler 2013, 10). For example, a significant increase in the number of patents in a country per year can be introduced as an evidence of governmental efforts to promote innovation patents. The example contains the controversial evidence⁷ that governments can directly claim to promote innovation patents, disregarding the efforts of companies and research institutions. If this controversy is brought to the debate, the policy process will determine the influence an indicator can have in providing rational-analytical support to an innovation policy. Second, in policy contexts indicators are used to reduce ambiguity (Sébastien et al. 2014), and may be introduced to reduce the number of variables observed, to simplify and facilitate communication, and to build clear and unambiguous visions of the desired future (Sébastien and Bauler 2013). In these processes, indicators are expected to communicate evidence in a form suited for policy actors that simplify the description of complex systems (Sébastien and Bauler 2013). Therefore, the role of indicators is dependent on their availability and capacity to play a role in the debate that forms the process of construction of evidences, supporting or undermining a policy.

3 METHODOLOGY

The aim of this paper is to understand the use of indicators and other evidences by analysing two processes of construction of evidences in innovation policies. The in-depth analysis of these processes can provide qualitative insights about policy makers’ use of information in practice, how information is valued and the prevalence of formal scientific evidence use in policy decision. The case studies were part of a larger research project aimed to understand the use, influence and role of indicators in decisions specifically of technology innovation. The first case selected was a policy decision to build an electric mobility infrastructure across Portugal. The case of electric mobility is a frequent example

⁵ The aggregation of indicators creates a composite indicator or an index.

⁶ The use of composite indicators were found to be sometimes controversial (Grupp & Schubert 2010; Nardo et al. 2008). In fact, according to some authors composite indicators are considered more adequate to policy communication, rather than to make decisions (Grupp & Schubert 2010).

⁷ It can be said that it also contains a simplification of reality, because innovation efforts can be measure using other evidences than patents.

of innovation in the S&T literature, and a preliminary examination revealed the use of evidences in the media. The second case study was related to the creation of an Iberian nanotechnology laboratory. A preliminary scrutiny revealed a small number of decision makers, geographically accessible in the north of Portugal. The selection of both cases also considered operational restrictions, such as the possibility to review documents and access to potential data and records, as well as the ability to contact and interview decision makers. In addition, it should be noticed that policy makers were a difficult group to investigate because they were less prone to answer surveys, needed substantial explanatory introduction to the research project and revealed the need for more secrecy.

In this context, in-depth interviews were conducted to answer the same open questions about the context of the decision and the process of construction of evidences. They were conducted to cope with the sensitive nature of the information requested, avoid any suspicion of misuse of information, and provide confidentiality to sources when that was possible. They enabled the collection and triangulation of information until saturation was felt; and provided space for other questions to arise and to reveal insights. Furthermore, the interviews included the same guiding questions to analyse the context in relation to the political, economic and organizational environments, and the process of construction of evidences in relation to the way indicators and other evidences were used. The first case study on electric mobility included 9 in-depth interviews to decision makers: 1 to researchers, 4 to business R&D&I leaders and 4 to policy makers. These interviews lasted from one hour up to four hours, and were conducted between February 2011 and March 2013. In the end, two complementary interviews were made to scholars with expertise on the case in March 2012 and in April 2013. The second case about the nanotechnology laboratory included 4 in-depth interviews with decision makers: 2 with researchers and 2 with policy makers. These interviews were conducted in March 2014 and lasted from one hour up to three hours. In the end, one complementary interview was made with a scholar in March 2014.

4 THE ELECTRIC MOBILITY CASE

In 2005, the Portuguese government elected with majority found favourable conditions to engage in the promotion of technological change. In fact, the government supported sound policies towards renewable energies, and believed that they could give a technological push to promote development of the country. At the same time, Portugal was increasingly dependent on costly oil imports that called for measures to de-carbonize the transport sector. Thus, in early 2008, the government decided to create a working group on electric mobility, to develop infrastructure for street charging of EVs across the country. The national programme, hereafter named Mobi-E, was officially launched in mid-2009⁸. Its pilot phase ended in June 2011, with the full implementation of 1300 slow charging posts and 50 fast charging stations in streets, public parking lots, service stations, airports, hotels and shopping centres⁹. A payment system was also implemented to connect personal communication devices (e.g. tablets, smart phones, etc.). By enabling the user to select the most appropriate operation, the system allows for an analysis of mobility costs in order to optimize energy consumption¹⁰. In the end, Mobi-E fully built the infrastructure for charging electric vehicles, but the project failed to address the expected consumers. In fact, only a few cars could be observed using the charging stations in 2012. The charging stations of Mobi-E were supported by the government, through a public innovation support fund created as a counterpart for the granting of wind power licenses (Godinho, Mamede, and Simões 2013). The power company EDP also made initial investments to supply electricity and continues to support the maintenance of the system (costs of around 600 000€/year¹¹).

The decision makers of Mobi-E constructed a rationale to support their decision.¹² A central argument used to justify the decision was that “the lack of a recharging infrastructure deters the acquisition of electric vehicles” (Pinto et al. 2010, p.15). However, two interviewees described that the

⁸ Resolução do Conselho de Ministros n.º 20/2009. Diário da República, 1.ª série — N.º 36 — 20 de Fevereiro de 2009.

⁹ “Electric Mobility - Portugal Showcase to the World – Institutional presentation”. 2010. GAMEP - Gabinete de Apoio à Mobilidade Eléctrica em Portugal.

¹⁰ “Mobi-E Electric Mobility - Portugal Showcase to the World”. Mobi-E. November 2010.

¹¹ According to 2012 costs.

¹² “Modelo de Mobilidade Eléctrica Para Portugal – Apresentação a Sua Excelência O Ministro da Economia e Inovação – Sumário Executivo”. Presentation. Roland Berger Strategy Consultants. Lisboa. 14/1/2009.

decision was not so much based on the technological effect of the policy, but rather on its political and social impact. Furthermore, technical evidences were sought after the decision¹³ was made. The central piece of evidence supporting the Mobi-E decision was based on an indicator of market penetration for EVs in 2020. This indicator was based on an optimistic scenario for the fleet of EVs. In fact, according to the forecast of the coordinator of the office for electric mobility, in 2020 Portugal would have 750000 electric vehicles (Gomes 2010). But, according to a study of Paulo Santos in 2009, there will be no more than 600000 electric vehicles in 2020 in a “very” optimistic scenario (Santos 2009, 40). Moreover, according to Luís Gomes (2010), the governmental forecast was optimistic because it represented 80% of the sales in 2020 (considering a sales growth rate of 1%). In fact, his study forecasted an optimistic scenario with a penetration rate of 50%, predicting only 322 027 electric vehicles in 2020 (Gomes 2010). Therefore, the programme was decided based on political and social considerations, and the evidences used to support the decision were based on optimistic scenarios.

To better understand the optimistic nature of the evidences brought to support the decision, it is also necessary to take into consideration other forecasts. For example, an expert from the Portuguese Automotive Business Association (ACAP) reportedly stated that in a ‘very’ optimistic scenario 300000 vehicles were expected to be sold in the year 2020 (Santos 2009). This forecast implied an optimistic increase both supported in the ratio population/sales of cars existent in countries like Belgium and the Netherlands, as well as in the assumption that in 2020 Portugal will reach these countries’ economic and social development (Santos 2009). Furthermore, there were three other evidences available, although even these proved distant from reality. First, Gomes (2010) short-term calculations for an pessimistic scenario for 2011 and 2012 were above reality. The author forecasted 394 electric vehicles in 2011, but only 193 electric vehicles were sold in Portugal in 2011 (Beltramello 2012 based on Frost & Sullivan 2012). Gomes also calculated 999 electric vehicles in 2012, but there were only around 300 vehicles on the Portuguese roads¹⁴. Second, the most pessimistic scenario of the two pessimistic considered in Santos (2009) study, predicted a meagre presence of electric vehicles in 2020 with only 80000 units. The author described this latter scenario as “catastrophic”, given the “significance of public and private investments expected” to create the infrastructures and fiscal benefits to acquire electric vehicles (Santos 2009, 44). Santos also added that this was a very unlikely scenario, “justified by the non-acceptance of this kind of technology in the automotive market” (Santos 2009, 44). Third, two other studies provided further evidences in 2010 and 2011. A study contracted by GALP showed that the penetration forecast of the electric vehicle would be significantly slow.¹⁵ Reiner et al. (2010) forecasted also an optimistic technology scenario where BEVs and fuel cell vehicles will have only 5% of market penetration in 2020 in Europe. Therefore, other available evidences existed before the final implementation of the policy that pointed to a moderation in the expectations about the EV market.

Optimist studies forecasting the advent of the EVs were not a Portuguese unique experience. In fact, Midler & Beaume (2010) reported the existence of three scientific studies in the United States predicting the introduction of EVs. The first one in 1973, elaborated by the Wisconsin University, forecasted a penetration rate of 20% of the total sales in 1980 in the USA. In 1979, a Princeton University study forecasted a slower penetration rate (10%) in 2000. Later, in 1994 the World Resources Institute predicted a 25% penetration rate in the US total sales in 2010. Therefore, the literature describes other scientific studies conducted abroad also based on significantly optimistic scenarios.

There are elements to conclude that other evidences played a role in the decision process. In fact, an international consultancy group and a national consultancy company produced evidences to influence policy-making. In fact, the consultancy group was hired by the government to elaborate a technical report on electric mobility¹⁶, and specified technical features for public charging stations. The report also forecasted an optimistic potential market of 180000 EV and Plug-in Hybrid Electric Vehicle for 2020, with 25000 slow charging public posts and 560 fast chargers. This firm also

¹³ “Modelo de Mobilidade Eléctrica Para Portugal, idem.

¹⁴ “Mobi.europe Newsletter”. Mobi.europe. September 2012.

¹⁵ Interview 7, line 211-214 and TIS.PT (2011).

¹⁶ “Modelo de Mobilidade Eléctrica Para Portugal, idem.

calculated that EVs were 11% more competitive than normal ICE to private owners and 12% to companies. Furthermore, another study was solicited by a firm to a national consultancy company and distributed to influence policy outcomes. Some elements of the study benefited the firms' strategy in the short-term, and influenced policy-making in matters of market-share, norms and regulations related to EVs in Portugal. Forecasts were significantly cautious towards the growth of EV market (TIS.PT 2011), creating controversies about the initial governmental claims. Therefore, there are elements to conclude that evidences were introduced in the policy process to influence the final decision in a controversial context.

To conclude, the Mobi-E programme was mainly based on political and social considerations. The evidences used to support the decision were based on optimistic scenarios. Other available evidences existed before the implementation of the decision, and pointed to a moderation in the expectations about the EV market. Some evidences were privately solicited to companies to influence policy-making process. Furthermore, the case study allows five main conclusions in relation to the process of evidence-construction in policy-making. First, the government used their optimistic forecast as an evidence of good policy, focused on an indicator of market penetration of EVs in 2020, and disregarded other independent evidences. Second, time showed that all forecasts were weak evidences to support the policy decision. Third, the subcontracting of a think-tank to support this policy also produced evidences. Fourth, production of technical knowledge by think-tanks can be used to influence policy by policy makers and companies. Fifth, this case revealed the disputed nature of evidences in policy-making, as discussed in the literature. In fact, what constitutes evidence is debatable, loses strength with controversies, can be brought to debate or ignored if useful, and can be influenced by various parties.

5 THE NANOTECHNOLOGY LABORATORY CASE

The idea to create an international Iberian nanotechnology laboratory, hereafter named INL, was initially defined in a governmental policy briefing, during the preparation of the 2005 Summit between Spain and Portugal. The briefing consisted of half a page with political ideas and technical benefits of the proposal. Both the scientific area and the location of the facilities were intentionally left open.¹⁷ In fact, these definitions would be the result of not only negotiations between the two governments, but also the outcome of discussions among government members. At the time, there were several proposals in various scientific fields to be discussed between both countries, such as nanotechnology, grid computing, biotechnology, biomedicine, energy and risk management. There were also several proposals for different regions in Spain and Portugal. Inside the Portuguese government, the stronger candidates to headquarter the facilities were the border regions of Northern Alentejo, where the Évora Summit would be held, and Braga district where nanotechnology research was stronger. In the end of the Summit, the heads of state agreed to locate the facility in Braga, and nominated a Spanish to be its Director-General.¹⁸ Furthermore, the concept of an Iberian joint research laboratory was well received in both Spanish and Portuguese governmental circles for four main reasons: First, the laboratory would cement relations between countries separated by historical events and not prone to cooperate beyond necessary issues. Second, the cooperation would lead to the creation of the first international research institution in Spain or Portugal.¹⁹ Third, the research facility would be dedicated to an advanced scientific area and an emergent technology. Fourth and last, the facility would be opened to participation of other countries, fostering international collaboration.

¹⁷ Cimeira Luso-Espanhola. 2005. "XXIª Cimeira Luso-Espanhola. Évora, 18 e 19 de Novembro de 2005. Conclusões". Évora. Last accessed in 12/12/2014:

http://www.erse.pt/pt/mibel/construcaoedeseenvolvimento/Documents/CONCLUS%C3%95ES%20DA%20XXI%20CIIMEIRA%20LUSO-ESPANHOLA%20DE%20EVORA_2005.pdf

¹⁸ Cimeira Luso-Espanhola. 2006. "Conclusões da XXIIª Cimeira Luso-Espanhola Badajoz, 24 e 25 de Novembro de 2006". Badajoz. Last accessed in 12/12/2014:

http://www.erse.pt/pt/mibel/construcaoedeseenvolvimento/Documents/CONCLUS%C3%95ES%20CIMEIRA_BADAJOZ_2006.pdf

¹⁹ The Institute for Prospective Technological Studies located in Seville was only a European research facility of the Joint Research Centre of the European Commission.

Some evidences were collected during the decision process of the INL. In fact, some elements were found about the international context of investments in nanotechnology, particularly in the USA but also at the EU level (Roco et al. 2000; Roco & Bainbridge 2003; Morrison 2005; Hullmann 2006). Furthermore, Spain conducted a significantly detailed study to determine the activities and necessities in the field and to map and improve technical skills and infrastructures in the period 2005-2010 (Correia et al. 2004). In fact, the study extensively included quantified indicators at regional, national and European level. These indicators included cost of research projects, equipment and their skills; number of researchers and technicians and skills; lists of equipment and projects existent in each laboratory; skills required to operate equipments that already exist, ordered and might be ordered in future; etc. Spain also produced other public reports framing the investments in nanotechnology within the S&T system (Comisión Interministerial de Ciencia y Tecnología 2005a; Comisión Interministerial de Ciencia y Tecnología 2005b). At the time, investments were planned for six Spanish laboratories. To the central government, the INL was part of a larger set of investments that needed to be negotiated with the Spanish regions and their research communities (and later with Portugal). The negotiations required evidences that could be introduced in the assessment of the situation and the distribution of the investments. In addition, Portugal did not produce extensive studies on nanotechnology, despite investments in two new associate laboratories. In fact, only the technical committee preparing the INL creation collected elements to map existing research activities in the country (INL Technical Committee 2006). An interviewee argued that the needs to justify the distribution of investments were lower than in Spain, and mostly directed to the Portuguese nanotechnology community. Moreover, no study was found in both countries that demonstrated an explicit opportunity of investing in nanotechnology and nanoscience versus other scientific areas. In fact, the justifications detected were based on the idea that the USA and other developed countries were investing in this research area.²⁰ However, the same argument is also true for other research areas. Therefore, although both countries introduced evidences in the decision process, the collection of evidences was different in the two Iberian countries: In Spain there were detailed preparatory studies with quantified indicators, and in Portugal there was an ad hoc mapping of research groups.

6 CONCLUSIONS AND DISCUSSION

The results suggest that the process of construction of evidences can help to explain how indicators and other evidences were involved in the decision process. The findings revealed different uses of evidences during the process of construction of evidences. In fact, most evidences were collected to support arguments about the need to implement the policies. In the Mobi-E case, the need for the programme was supported with an indicator of penetration rates of EVs in 2020. Other evidences were also solicited to think-tanks and controversies occurred during the decision process. In the INL case, the evidences were collected with different depth by each country: Portugal mapped existing research activities in the area ad hoc; and Spain had an extensive collection of indicators to negotiate the distribution of investments with regions and the nanotechnology community. Both countries lacked comprehensive evidences to justify the concentration of investment in the field of nanotechnology and nanoscience. Thus, most evidences were collected to provide a rationale to existing policy decisions, although there was an exception in Spain where indicators pre-existed the decision to create the INL. These different uses of evidences are in line with the literature: Flitcroft et al. (2011) signalled an abundance of possibilities for evidence use: in one extreme, evidences can be strictly identified with scientific outputs; in the other end of the spectrum, evidences can be the subjective selection of the available information introduced in an argument to persuade about the truthiness or falsity of a statement. The collection of indicators in Spain reveals a use closer to scientific outputs, whereas the use of the indicator of market penetration in 2020 reveals a use closer to persuasion. Second, the findings are also in accordance to the literature where the strength and quality of an evidence can also be related to the number of controversies that it goes through during its

²⁰ According to Bijker (2014) the history of the Dutch engagement with the identification of nanotechnologies as an important issue for consideration in society, politics and policy makers was done by the Rathenau Institute. A report from this technology assessment institute resulted in getting nanotechnologies on the public agenda, though without any explicit positive or negative undertone. (Bijker 2014)

lifetime (Sébastien and Bauler 2013). In fact, in the Mobi-E case, the indicator of penetration lost much of its strength with the controversies that it went through since its creation. Therefore, these case studies confirmed the literature where a broad type of evidences can be used, and confirm the decrease of strength of indicators due to controversies.

Results also revealed that the role of indicators and other evidences did not particularly increased when business engineers with bachelor degrees and academic scientists with PhDs turned into policy makers. In fact, these policy makers were not particularly engaged in deeper quests for indicators or other evidences then they needed to support their decisions. These findings appear to contradict the Musso and Francioni (2012) idea that the educational level is significantly relevant to the decision-maker response. Alternatively, the results appear to be in line with the literature that described situations as an important factor influencing the role of indicators and evidences: Perri 6 (2002) argued that the situations in which policy makers find themselves shape the information that is selected from the complex set available, and which evidence is rejected or at least downplayed. However, the exception to this was the Spanish collection of indicators found in the INL case, where indicators played a more instrumental role to discuss investments. This suggests that the legitimacy of policy arguments in an adversarial policy context (i.e. regional discussions with the government for investments) depends on the ability of actors to present persuasive analytical evidence, as Sébastien, Bauler, and Lehtonen (2014) recently proposed. In adversarial circumstances, policy makers are more likely to use harder analytical indicators, closer to the concept of scientific evidence, than in a more consensual policy decision.

In sum, the study of the process of construction of evidences helped to explain the way indicators and other evidences are involved in innovation policy. It was possible to conclude that evidences and indicators were brought to decision processes according to their availability and capacity to support the different interests of the actors and the stakeholders. Their role was influenced by the particular situation of the decision makers. More importantly, the use of persuasive analytical evidences appears to be related with the adversity of the policy context. Last, it should be notice that the processes of construction of evidence in policy decisions were significantly different from the scientific process. This is particularly relevant to those that need to deal with both processes. In addition, this angle analysis showed that indicators are one tool among others to support innovation decisions. In fact, the relatively minor instrumental role of indicators suggests that indicators are mostly a complementary instrument of decision. When used relevantly, indicators can offer support to a decision. But there are other significant influences that need to be taken into account to understand the role indicators and other evidences play, such as the social relations of the decision makers and their emotional-intuitive decisions.

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