Technology in Society 38 (2014) 93–102

Contents lists available at ScienceDirect

Technology in Society

journal homepage: www.elsevier.com/locate/techsoc

The outlines of innovation policy in the capability approach

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ARTICLE INFO

Article history:
Received 28 May 2013
Received in revised form 18 February 2014
Accepted 26 February 2014

JEL codes:
B59
I30
O12
O38

Keywords:
Innovation policy
Informational basis
Systems of innovation
Capability approach
The case of food additives

ABSTRACT

Innovation policies are usually expected to contribute to growth in economic performance, in productivity, or in employment. These ultimate objectives are formulated in the political arena; therefore, the examination of their adequacy is beyond the scope of innovation studies. However, these aims are increasingly questioned in other fields of economics. The present paper builds on one of the most influential criticisms of the dominating growth-centred traditions of economics: Amartya Sen's capability approach. We analyze the set of information that would be required for the design, implementation and evaluation of innovation policy if it relied on the capability approach, and how this informational basis would differ from that of the growth centred view. We conclude that switching to the capability approach would result in a sea-change, but the systems of innovation approach, as a framework for analysis, would still be of good use.

1. Introduction

The examination of technological change and innovations is largely multidisciplinary. However, the research community dealing with these issues can be separated into relatively distinct groups [1]. The innovation policy field is dominated by economics, especially evolutionary economics and the systems of innovation approach. As Fagerberg and Sapprasert [2] pointed out, the literature of innovation systems is growing faster than the overall literature of innovation economics; hence its relative weight is presumably increasing.

Systems of innovation, strongly shaped by neo-Schumpeterian evolutionary economics [3,4] and institutional economics [5,6], focuses on a set of interrelated factors that influence the emergence, transfer, modification and diffusion of new technologies [7–9]. The main elements of innovation systems are organizations (actors), institutions and links [10–12].

The function of the system is to "generate, diffuse and utilize technologies that have economic value" [13]. Therefore, amongst the possible connections of actors, the focus is on knowledge and capital flows and interactive learning [14]. These interactions are embedded in a specific, historically developed institutional setting [9,15], which varies in time and space. This results in the uniqueness of the systems [16] and the necessity of differentiated policies [17].

Innovation policies relying on the innovation system theories strive to eliminate "system failures" that hinder the emergence and diffusion of new technologies [18,19] such as the lack or inadequate operation of certain actors, institutions or links [20]. In economic theorizing, the more intense emergence and diffusion of innovations is linked to faster growth in total factor productivity, and hence to economic growth [21,22].

The theories of innovation policy are largely depoliticized [23]. They do not intend to examine the

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http://dx.doi.org/10.1016/j.techsoc.2014.02.004
0160-791X/

adequacy of the objectives formulated at the political arena; rather, they attempt to contribute to their effective realization. According to Edquist [20] the ultimate goals of innovation policy are determined in a political process. "With regard to innovation policy, the most common objectives are formulated in terms of economic growth, productivity growth, or employment" [20].

Thus the normative assumptions lying behind innovation policy theories are characteristically implicit. However, it is apparent that the abovementioned objectives fit well into the dominant utilitarian, growth-centred approach of economic theorizing [24,25]. On the one hand, the objectives formulated in the political process are unlikely to be entirely independent of economic theorizing; on the other hand, the traditions of economics make it difficult to incorporate different political objectives (such as equality, sustainability, etc.). Thus, for innovation policy theories it is quite tempting to accept the abovementioned common aims. However, these objectives are being increasingly questioned in other fields (e.g. the capability approach, ecological economics and critical theories of technology).

The present paper is concerned with the normative assumptions of innovation policy theories. It poses the question whether the capability approach (CA) of Amartya Sen could serve as a basis for innovation policy, what kind of advantages such a "marriage" would provide and how this would shape the outlines of innovation policy theorizing.

The first important steps of finding connections between innovation systems and the capability approach were taken by Johnson et al. [26] and Lundvall [27]. Recently, Capriati [28] systematized the possible links and argued that the "CA can provide a normative framework for the development of the social and institutional context in which innovation systems develop."

While focussing on the connections between the two approaches, little attention has been paid so far to the tensions arising between them. The CA, being a normative framework, imposes questions on the abovementioned understanding of the ultimate goals of innovation policy. The growth-centred view of current innovation policy can also be a subject to severe criticism [29]. While growth may certainly contribute to the expansion of capabilities, the exaggerative attention paid to real-income can be detrimental according to the CA. In Sen's [25] view, the relation of wealth and well-being is neither exclusive (since there are significant influences on our well-being other than wealth), nor uniform (since the impact of wealth depends on many factors).

Although this debate is beyond the scope of traditional innovation policy theories, its consequences may affect its gist. The present paper does not intend to participate in the "utilitarianism versus capability approach" debate. It is rather interested in the question of what the consequences would be if we relied on the capability approach instead of the growth-centred utilitarian view. How would the basis of policy differ in the two approaches? Therefore we focus on the *informational basis* of innovation policy: the set of information that is used and the set of information that is excluded during the design, the implementation and the evaluation of policies [25].

The paper first provides a brief introduction into the capability approach in Section 2. Then Section 3 provides a literature review about the connections of technological change, the systems of innovation theory and the capability approach. The paper outlines the informational basis of an innovation policy that is based on the arguments of the CA in Section 4. In Section 5 we attempt to depict the outlines of innovation policy in the CA. Then in Section 6 we illustrate our arguments through the case of food additives. We draw conclusions in Section 7.

2. The capability approach

The capability approach was developed by the Nobel laureate Amartya Sen, and his works were followed by several capability theorists, researchers and policy designers. Sen's ideas significantly contribute to the contemporary discourses about well-being, development, poverty reduction and many other areas of social science.

Most generally, the approach is applied to assess the well-being of countries or societies. It is a framework, or evaluative space, which shows what set of information should be looked at if we want to assess how well a life is going. Thus, the approach is capable of not just evaluating the aggregate well-being of a community but also of making interpersonal comparisons of well-being [30,31].

In economics – or welfare economics – the capability approach is brought into play to evaluate the level of development or the quality of life, to identify the poor in developing countries, or to assess complex aspects of well-being in advanced economies, inter alia. In political science, it is used to debate policies, or to assess development projects [32].

It is important to emphasize that the capability approach is very much *open-ended*, and is more an evaluative framework than a theory with exact definitions [33]. Hence, to make use of the approach, the theory needs to be extended according to the aim of the actual research topic. This aspect of the approach leaves huge space for different interpretations and extensions [30].

The capability approach arose very much from the dissatisfaction with the classical frameworks and tools of welfare theories [25,34]. It argues that utilitarian welfare theories, subjective well-being measures, and evaluations about primary goods or basic needs have many disadvantages and are built on a too narrow "informational basis" to be able to assess such a multidimensional phenomenon like well-being [25].

Inserting additional information into the previous concepts of well-being was not a new idea when Sen molded the capability approach. An enormous stream of works had already existed on social indicators, on the quality of life and subjective well-being indicators. Sen's important contribution is in conceptualizing, helping to focus, and organizing these efforts [33].

A useful way to explain the capability approach might start with defining two of its fundamental concepts: functioning and capability. "*Functionings* represent parts of the state of a person – in particular the various things that he or she manages to do or be in leading a life" [35]. Certainly, people may deem different "doings and beings" to be

valuable. Functionings can be very simple things like being well-fed, being healthy or literate, but can also mean more complex components of life, such as being graduated, taking part in the life of the community, having self-respect or appearing in public without shame.

Furthermore, the "*capability* of a person reflects the alternative combinations of functionings the person can achieve, and from which he or she can choose one collection" [35]. Thus, capabilities are the full set of attainable alternative lives, they show what people are actually able to do or be. Thus, capability refers to the actual freedom to achieve valuable doings and beings (e.g. the real opportunity to be educated, to take part in the life of the community or to receive medical care). Having different capabilities means that a person can choose from different functionings.

In the capability approach, not just the achievements matter, but also the freedom to achieve. The freedom where a person is free to further his or her own goals (whatever goals they regard as important) is called *agency*. An agent in the CA is "someone who acts and brings about change" [25], who is not just a passive recipient, but takes an active role in shaping his or her own, or his or her community's well-being [36]. Within the CA, humans are not just strict maximizers of narrowly defined self-interest. Individuals have broader values, like sympathy for other persons, or commitment to ethical norms.

In the literature there are two main arguments why we should give significance to agency. First, agency has an intrinsic value. The opportunity to be able to pursue our own goals and make individual or collective choices is usually considered to be valuable. Second, agency has instrumental importance: an agent can facilitate the realization of valuable outcomes. In other words, not just the achievement, but also the way how we achieve matters. That is why we have to make the distinction between functioning and capability. Capabilities are a set of alternative doings and beings one can actually achieve. But it is not equal with the most valued functioning. The opportunity to choose from alternatives is valuable in itself [25].

A key analytical distinction has to be made between means and ends. In our understanding, means can be material resources or immaterial opportunities (like rights, social structures, access to advantage) for achieving valuable goals. At the same time, ends are the valuable objectives for the society specified by social discussion. In the capability approach, it is not satisfactory to focus our attention solely on the means one can utilize to achieve valuable functionings. What a person can achieve with a definite amount of means or resources depends on many circumstances and facts, which are called *conversion factors*. The conversion from means to ends is highly influenced by different factors such as metabolism, physical condition, sex, age, intelligence, public policies, social norms and hierarchies, as well as environmental circumstances, such as the physical and built environment, climate or pollution.

Therefore, in order to be able to assess well-being, besides *means*, *conversion factors* and the opportunity to *act as an agent* have to be considered as well. On the top of this, collective decisions have to be made, since different individuals may deem different "doings and beings" to be important. A community or society first has to determine which functionings are important through some sort of deliberative process. Then the relative importance of the valuable functionings (compared to each other), and the opportunities that are not chosen must be determined. Finally, the weight that is placed on capabilities compared to any other relevant considerations must be decided [25,35]. The complexity of the task may seem to be a drawback of the CA. However, it is probably a smaller problem than reducing the evaluation to the maximization of a single homogenous thing [25].

Some theorists of the capability approach provide a list of valuable capabilities. Nussbaum [37] compiled an exact catalogue of basic capabilities, and argues that everyone would accept that list after deliberation.[1] Sen refuses to offer such a list, and does not judge the relative importance of capabilities, nor of functionings. He argues that communities or societies should decide the most important capabilities through some kind of deliberative processes [38].

3. Technology, innovation systems and the capability approach

The approximation of the technological phenomenon and the capability approach is a relatively new field of inquiry. However, the literature on the issue is rapidly widening, which was signalled by the special issue of the journal *Ethics and Information Technology* (June, 2011), or the volume *The Capability Approach, Technology and Design*, edited by Ilse Oosterlaken and Jeroen van den Hoven [39].

Very important contributions have been made in approximating the CA with science and technology studies (especially actor network theory) [40–42], the critical theories of technology [43], the design of technologies [44], the evaluation of certain technologies or technology-related development programs [45,46], and technology ethics [47,48]. This line of inquiry argues that:

- Technologies play an important role in the expansion of human capabilities (e.g. prefabricated homes facilitate that people quickly get adequate shelter in a disaster area, or telephones contribute to expanding people's capabilities to engage in various forms of social interaction) [41]. Thus, more attention should be paid to the insertion of technology to the CA.
- Technologies, however, do not necessarily contribute to the expansion of capabilities, at least not for everyone (e.g. a bicycle does nor further the ability of disabled people to move around) [44]. This necessitates the evaluation of whether technologies actually contribute to the expansion of capabilities [46,47], and the incorporation this approach in design [44].

[1] The ten central human capabilities according to Nussbaum are the following: life; bodily health; bodily integrity; senses; imagination and thought; emotions; practical reason; affiliation; other species; play; and control over one's environment [37] Nussbaum M. Creating capabilities: the human development approach. Cambridge, Mass.: Belknap Press of Harvard University Press; 2011.

- The expansion of human capabilities takes place in a larger context that may embrace disabling mechanisms as well [49]. For example, a "sleeping policeman", or speed bump, may further the citizens' capability for safety in moving around, but this also hinders the ability to move quickly by cars [41]. This brings us to the question of what kinds of things we wish to be capable of and, of course, what we are happy with others being capable of [41,49].

Recently, the relations of innovation system theory and the CA have also been examined [26–29]. The approximation of these fields has resulted in arguments such as:

- Learning capabilities play an important role in improving the wider set of human capabilities; therefore, CA could benefit from paying attention to innovation systems [27,28].
- On the other hand, innovation system theory should investigate how changes in human capabilities may affect the processes of innovation (e.g. the access to health has a deep impact on learning capabilities and improving agents' ability to actively take part in the process of innovation). The strengthening of democracy, social capital or equality are able to create benevolent ambience for innovation systems [28].

Most of the pertinent works so far have focused on individual capabilities. They have posited research questions such as how new technologies can contribute to the expansion of capabilities considering the personal heterogeneities and the differences in the environment, or how certain fields of inquiry may benefit from a "marriage" with the CA.

What is largely missing, though, is the emphasis on the tensions arising among the examined fields. For example, Capriati [28] demonstrated how innovation systems may benefit from the attention placed on a wider set of human capabilities. However, little attention was paid by him to consequences that may be hard to incorporate by innovation economics, for example, the need to shift away from the growth-centred view, or the necessity to make collective moral judgements on the emerging innovations.

This latter question was posed by Oosterlaken [41], and she drew attention to the importance of the moral judgement of the capabilities brought about by new technologies. But she also adds in connection with the example of the "sleeping policeman", that "scholars working with the CA rather tend to highlight that the sleeping policemen contribute to traffic safety", than how it "disciplines drivers into certain behaviour". This may not seem to be problematic with regard to the abovementioned case, but other cases may be more controversial. For example, the compulsory electronic tax-administration may have substantially different effects on larger enterprises and sole proprietors. For the former group, the everyday use of the internet and different e-applications is obvious and electronic state administration relief. But for a large number of sole proprietors it is burden that requires skills they do not possess. This implies that the collective level should also be analyzed. Works that connect the CA and the technological phenomena have paid very little attention to the problem of collective decisions[2] or collective capabilities.[3] But in order to analyze technological change (the overall operation of the innovation system), instead of single innovations or artefacts, we must attempt to understand judgements from the perspective of the community (society).

4. The informational basis of innovation policy in the capability approach

According to Sen [52], "the informational basis of a judgement identifies the information on which the judgement is directly dependent and – no less importantly – asserts that the truth and falsehood of any other type of information cannot directly influence the correctness of the judgement."

The informational basis of innovation policies based on evolutionary thinking and the innovation systems approach embraces all those elements that influence the emergence and diffusion of innovations, and excludes everything else. However, in the CA this set of information is not necessarily sufficient. In order to be able to depict the set of information required for evaluative judgements in the capability approach, we must have a closer look at the relation between technological change and well-being.

Technologies are usually interpreted as means that may further humans' ability to achieve valuable "doings or beings" [28]. Oosterlaken et al. [42] point out that the reality is actually more complex. Technology may also interact with conversion factors (i.e. whether the design is sensible to individual or environmental factors of conversion), and with the larger social context. Thus it is indirectly connected to human capabilities and agency.

In our understanding, technology is organically and directly linked to the three main components of well-being, which we identified in section 2. Technological change influences the set of available means, the conversion of these means into valuable "doings and beings", and also the possibilities of agency. We attempt here to systematize these relations (Table 1).

From a welfare economics perspective, the informational basis of the dominant growth-centred view has two very important features. One is aggregation, or "sum-ranking" as Sen [4] would call it. By relying on the concept of growth, they interpret welfare gains on the average (per capita), and the allocation of welfare is not examined. The second feature is pecuniary evaluation: they use money

[2] Lawson [49] Lawson C. Technology and the extension of human capabilities. Journal of the Theory of Social Behaviour. 2010; 40:207–23. and Fernadez-Baldor et al. [50] Fernandez-Baldor A, Hueso A, Boni A. From individuality to collectivity: the challenges for technology-oriented development projects. In: Oosterlaken I, Hoven Jvd, editors. The Capability Approach, Technology and Design,. New York, London: Springer; 2012. p. 135–52. can be mentioned as exceptions.

[3] About how collective capabilities can be interpreted in an originally individualist framework, see Ibrahim [51] Ibrahim S. Individual to Collective Capabilities: The Capability Approach as a Conceptual Framework for Self-help. Journal of Human Development and Capabilities. 2006; 7: 397–416.

Table 1
The relation between technological change and well-being in the capability approach.

Means	Converting means into valuable "doings and beings"	Agency
Technological change alters the volume of available means.	Technological change may contribute to the expansion of the capabilities of certain individuals or groups, while leaving the capabilities of others unchanged, or may even result in the degradation of certain capabilities.	Technological systems may further or significantly diminish the possibilities of agency.
Technological change alters the allocation of available means.		Individuals' or groups' ability to adapt to the new reality induced by technological change may differ.
Technological change alters the composition of available means.	A proportion of the available resources must be devoted to defending against the "side effects" of technological change.	The moral judgement of the emerging new capabilities is necessary.

(real income) as a proxy for welfare. This allows them to disregard, or to reduce to a common denominator (per capita GDP) many of the important features of technological change. Within the capability approach, this excluded set of information gains importance. In this respect, the informational basis of innovation policy in the CA is not entirely different, but wider.

It is apparent that technological change is an extremely important factor, or even the main factor, of economic growth today. Since the seminal works of Solow [21,22] this has been widely argued. Therefore, in the course of technological change, the set of means available for the community increases (on the whole and in terms of income). In the utilitarian tradition, income is used as a proxy for preference satisfaction, and the Kaldor–Hicks criteria confirms that growth is beneficial on the whole: the winners would be able to compensate losers, and still would be in a better position than before [53,54]. However this argument seems to be problematic from the perspective of the capability approach [55,56].

Within the capability approach, the *widening of economic opportunities* requires closer scrutiny. First, it is not apparent that more wealth contributes to increased well-being. In case other freedoms were sacrificed for increased growth (e.g. austerities in the fields of education or healthcare), then the evaluation of the shift becomes ambiguous. Second, different groups do not benefit equally from growth, which may change the allocation of wealth. If growth is accompanied by increasing inequalities, then it may result in welfare loss on the whole. The fact that winners could compensate losers does not infer that they actually will. On the top of this, people tend to compare their position to certain reference groups [57,58], and, hence, if someone's position has remained unchanged while new opportunities have emerged for all the others, then in fact their position has become worse instead of remaining unchanged. Third, the same amount of wealth may contribute to different sets of valuable "doings and beings" in case of different individuals or groups, and therefore its allocation is not a by-issue.

Technological change affects the *ability to convert* means into ends. New technologies may be adequate for some, while useless, or dysfunctional for others [44]. For example, a mobile phone will not contribute to the expansion of capabilities where there is no signal, or a loaf of bread will not help to avoid hunger, if someone is allergic to gluten.

Besides, new technologies may also reduce the set of valuable "doings and beings" one can achieve by their resources. New technologies necessarily bring about unforeseen effects (side-effects) [59]. As Feenberg [60] noted, when we use technologies, we act on a system to which we ourselves belong. Within this complex system, our actions return to us in some form. These effects cannot be fully foreseen or eliminated, which is a direct consequence of the nature of complex systems [61,62]. Therefore a proportion of our income must be devoted to defending against the "side-effects" of new technologies (e.g. we must buy sunscreen if we want to go to beach, pay the costs of hazardous waste treatment, etc.). And there are a lot of effects against which we are unable to defend [59], and that decreases well-being (e.g. the blockade of certain areas contaminated by radioactivity apparently decreases the well-being of former residents).

Technological change also affects the *agency*. On the one hand, a series of innovations may contribute to our ability to bring about change. For example social networks, such as Facebook or LinkedIn provide new ways to interact with others, to form groups or to initiate movements. On the other hand, this also brings about new ways to be influenced by advertisements. On the top of this, those who are unable to join the social network, or chose to stay away, partly lose their ability to learn about news and events, or even to find a job.

The whole stream of the substantivist philosophy on technology demonstrated how modern technological societies constrain the opportunities of civil agency [63–65]. Recently, social constructivists have put forth a number of examples showing how new technologies incorporate social relations [66] and sustain hegemonies [60,67]. Feenberg [68] showed that the social content of technologies tends to remain hidden, it is distilled into technical content (becoming "technical code"), which sustains the general view of considering technology to be "neutral". He adds that technologies may also be constructed to overcome the existing hegemonies. Nevertheless, once certain values and social relations become encoded in technological designs, they will shape the possibilities of agency.

Technological change results in the emergence of a new reality to which individuals, groups or societies must adapt. Science and technology studies, and especially the actor-network theory argues, that in this respects "things" become agents [69–71]. And this is what Lawson [49] emphasized when he stated that "the very capabilities that people have depend upon the relations in which people stand both to other people and to things" [49]. For example, the spread of internet has brought about

electronic public administration. Actors must devote time and wealth to learn to cope with the new reality. But individuals' and groups' ability to adapt to changes may differ. The ability to carry out this kind of agency may significantly shape the way technological change affects well-being.

Finally, to be able to make collective decisions in the capability approach, one of the main tasks is to decide which capabilities are thought to be valuable (or more valuable than others). One of the main differences between the capability approach and other approaches to well-being is that CA makes this value judgement explicit and draws attention to its unavoidability.

Therefore, within the CA one must ask whether the capabilities brought about by new technologies are valuable or not. In other words, the ethical evaluation of new technologies is necessary [72]. The same technology may be acceptable for certain societies or groups, while unacceptable for others. The opportunity to carry out such evaluative judgements, and to shape technological change by such acts may significantly affect the relation between new technologies and well-being.

In order to examine how technological change affects well-being, we must pay attention to the tensions between technological change and the normative framework of capability approach. Therefore, the informational basis of innovation policy should embrace the problems of the dominant growth-centred view, the way technologies change the ability to convert means into ends, the unforeseen "side-effects", and how technological change influences agency and constructs a new reality.

5. The outlines of innovation policy in the capability approach

The aforementioned understanding of the informational basis of policy-making has a number of consequences for the outlines of innovation policy. First of all, it shifts the attention from the means to the ends. In the CA, the first question we must address during the process of social choice is what capabilities are deemed to be valuable for the community and how valuable they are [25]. Without this evaluative judgement, the endeavour to provide a wider set of means for people through the operation of the innovation system cannot really be assessed. Second, it draws attention to the fact, that policy-makers are in need of knowledge and information that is scattered amongst a large number of actors. This probably necessitates novel ways of policy learning, and the reshaping of the borderline between expert and lay/citizen, which is also one of the main arguments of the actor-network theory [69,71].

As many of its advocates posit, the borders of innovation systems are not sharp, system boundaries are to a given extent arbitrary [6,9]. Recently, Lundvall et al. [73] called for the broadening of the boundaries of examination in order to become capable of encompassing elements that have gained increased importance in the learning economy, or to incorporate ecological issues.

We also called for the widening of the informational basis in the previous sections in order to be able to reflect the well-being effects of technological change. The systems of innovation approach, as a methodology, is not questioned. System failures could be recognized as rationales for policy making in the capability approach as well; however, the CA sheds light on different types of system failures. We attempt to summarize the outlines of an innovation policy that is based on the CA in Table 2.

We demonstrated that different individuals or groups may be affected by technological change entirely differently, which also implies that they do not judge the well-being effects of technological change in the same way. Within a society there may exist several (sometimes competing or even contrasting) viewpoints about the operation of an innovation system that contributes to well-being (the extension of capabilities).

The *rationale for innovation policy making* in the capability approach is the failure of the innovation system to contribute to the expansion of capabilities. The direct

Table 2
The outlines of innovation policy in the capability approach.

Rationale for policy making	The failure of the innovation system to contribute to the expansion of capabilities: - Technological change creates wealth at the expense of other freedoms, - Technological change creates opportunities that cannot be effectively used to achieve valuable "functionings" for the community.
System failures	Institutions, organizations and links fail to generate and diffuse knowledge: - That contributes to the identification and alteration of ideologies and hegemonies lying behind current innovation processes, - That would be necessary to identify the feedbacks of the system on which we act on when we use technologies (failure to encompass the "side-effects" of technology), - On the ability of the society to adapt to changes, - On the moral judgement of the society and incorporate this information into innovation processes.
Reflecting to the differences of systems	Besides the uniqueness of innovation systems, the differences regard: - The capabilities deemed to be valuable, - The factors of conversion, - The ability to adapt to changes, - The possibilities of agency, - That the moral judgement on new technologies should also be considered.
Forming of innovation policy	Beside unpredictability, uncertainty and bounded rationality policy making should reflect the fact, that: - The required set of knowledge is scattered amongst a large number of local actors (including non-experts), - Innovation policy necessitates value commitment.

corollary of this formulation is that the particular objectives of innovation policy are not fixed once and for all. They will obviously differ in space and time since they are formulated as results of social choices, where the competing or contrasting viewpoints are negotiated.

The failure of the innovation system to contribute to the expansion of capabilities may be interpreted alongside the "building blocks" of well-being. Either technological change creates wealth at the expense of other freedoms, or it creates opportunities that cannot be effectively used to achieve valuable "functionings" for the community. The third major problem may arise in case it reduces the opportunity for agency.

In the contemporary innovation systems literature, the *failures of systems* are originated in the inappropriate operation (or the lack) of certain organizations, institutions and links [20]. Within the CA system failures may also be expressed by referring to these system elements. However, in this case, these elements of the innovation systems are not just required to generate, diffuse and utilize "technologies with economic value". We must also ask *what kind of* information, knowledge or technology is transmitted. If a society expressed its dissatisfaction with the current processes, then it would probably formulate failures such as:

- Institutions, organizations and links fail to generate and diffuse knowledge that contributes to the identification and alteration of ideologies, hegemonies lying behind current innovation processes.
- Institutions, organizations and links fail to generate and diffuse knowledge that would be necessary to identify the feedbacks of the system on which we act on when we use technologies (failure to encompass the "side-effects" of technology).
- Institutions, organization and links fail to generate and diffuse knowledge on the ability of the society to adapt to changes.
- Institutions, organization and links fail to generate and diffuse knowledge on the moral judgement of the society on the capabilities (and thus technologies) deemed to be valuable, and incorporate this information into innovation processes.

Innovation polices based on the arguments of the CA, would be *differentiated policies* indeed. The systems of innovation literature calls for differentiated innovation policies, in order to reflect the (historically developed) unique nature of innovation systems [17,20]. However, it is not just the innovation systems that are different among countries (regions, sectors or technological fields). Communities may differ with regard to the capabilities deemed to be valuable. Due to environmental and personal differences, agents may achieve different valuable functionings through new technologies. The ability to adapt to changes, the possibilities of agency and the moral judgement on new technologies may also be entirely different. Within the world of CA these important peculiarities should all be considered during the design, implementation and evaluation of innovation policies. And this is exactly what could make innovation policies differentiated indeed, since the set of information required for policy making – beside being specific to a given community or society – incorporates knowledge elements that are possessed by local actors.

These arguments imply that in the CA innovation policies should deal with such phenomena that are conventionally considered to be beyond the scope of innovation policy theorizing. It becomes explicit that innovation policy makers are acting in a situation where the "facts" may be uncertain (they are open for different interpretations), values are in dispute, stakes are high (complex structures, interests and hegemonies are in question), and still, decisions are often urgent. Funtowitz and Ravetz [74] call this the terrain of "post-normal science". Latour [69] and Callone et al. [71] argue that in such situations spaces should be created for "hybrid forums", where experts and laypersons, citizens and representatives may equally take part in open public debates. This is very much in line with Sen's arguments about the importance of deliberative participation [25].

Evolutionary economics has a long tradition in dealing with situations of uncertainty, unpredictability and bounded rationality [18,19,75]. The need for policy learning is also widely argued [8,76,77]. What is added here is on the one hand, that the required set of knowledge is scattered amongst a large number of local actors (including non-experts), on the other hand, that innovation policy necessitates value commitment. These differences are not necessarily subtle and have basic consequences on the *forming of innovation policy*.

6. An illustrative example: the case of food additives

The access to food and being well-nourished are capabilities that have been in the forefront of capability theorists' inquiry. They appear in the works of Amartya Sen [25] and Martha Nussbaum [37] as well. In Nussbaum's list of central human capabilities they are evidently linked to "life" and "bodily health". But they can also be connected to a number of other capabilities. For example, eating is also a sensual and cultural experiment ("senses, imagination and thought" in Nussbaum's list), it is sometimes connected to special occasions, such as anniversaries or family reunions ("emotions"), and it is also one of the most basic connections we have with the other species we share our planet with ("other species"). A series of works have applied the capability approach in relation to the "food question" (famines, food production, food security, etc.) [78–80] and the interdependencies of capabilities related to food (e.g. education and food security, food security and social inequality) [81,82].

The rise of industrial food production gave way to numerous technological innovations (process as well as product innovations). One of the most spectacular phenomena is the emergence and extensive spread of food additives. By now they have become an integral part of the daily lives of people in high- and medium-income countries.

Food additives contributed to the avoidance of certain deficiency diseases (e.g. through iodized salt) and microbiological contaminations, or the provision of food for

those with certain special needs (e. g. the production of diabetic, or gluten-free foods). We have a reason to believe that these innovations have contributed to the widening of capabilities for a large number of people. On the other hand, the very same additives are often associated with health risks, such as cancer, hyperactivity or allergies. There is an ongoing debate about these effects and the validity of the investigations pro and contra. What is for sure is that scientific justification (that is based on the demonstration of the effects on one certain chemical, while controlling for all the other possible influential factors) seems to be extremely difficult to provide. First, many of the supposed effects occur on the long run and can be caused by a series of other influential factors as well. Second, people normally consume hundreds of different chemicals, which may even interact with each other. Irrespective of considering additives hazardous or not, a series of regulations have been introduced concerning their authorization, labelling or the allowed average daily ingestion.

Food additives have started to act like agents in the Latourian [69] sense. They have contributed to the organization of groups (e.g. food allergy associations) and movements (organic farming, local food networks, slow-food movements, etc.). They bind together producers, users, authorities, laboratories, regulations, political parties, civil movements, experts and laypersons through complex (hybrid) networks.

What is very important for our purpose is that the emergence of food additives brought into existence a new kind of risk: being allergic to food additives. It is widely accepted that allergic reactions may occur to certain food additives (e.g. sulphites, nitrites and nitrates, benzoates, aspartame, etc.). However, the proportion of affected people and the seriousness of the effects are bones of contention.

Being allergic to an artificial food additive exactly illustrates Feenberg's [60] argument, that "actors become the objects of action". And this is what Beck [59] would call a risk of modernization because an allergy to an artificial food additive cannot occur before people have invented and started to use them (so it is a risk produced by modernization). While industrially produced foods contribute to a set of capabilities for most of the people, they will not do so for others.

Up until here the case does not seem to raise any questions that could not be solved by further innovations. For example, the endeavour of the European Union to further "social innovation" may result in the creation of niches where these special needs are recognized and satisfied by foods that do not contain certain additives. These can also be supplemented by marketing innovations (e.g. new labels and distribution channels). In fact, this process is already taking place. Such an answer is also in line with Oosterlaken's [44] argument to incorporate personal heterogeneities in the design of technologies.

However, we argue that the problem is systemic, and is due to the systemic failure to negotiate the capabilities deemed to be important for the community, and the failure to generate and diffuse knowledge that refers to the ideologies and hegemonies lying behind current innovation processes (e.g. the system is inclined to acknowledge the claims of those who are allergic only until they can be treated as users, but in any other ways these claims are considered to be irrelevant). The systemic nature of the problem derives from the complex interactions of human capabilities.

A series of examinations demonstrate that food allergies affect the well-being of those who are allergic and also their family members in several ways [83–86]. Apart from the direct health effects, a number of other capabilities are also affected. For example, to eat in restaurants or in the canteens of schools or workplaces, to visit foreign countries (where they do not understand food labels), to take part in certain social events. In some cases, more time must be spent for cooking their own foods at home, instead of taking part in leisure or social activities. Especially for less educated people, assistance might be needed to design their diets. These may also influence self-confidence. Therefore, from the aspects of those with allergies to certain food additives, the way we generally produce and distribute our foods is hegemonic.

On the top of this, the arguments in favour of foods free from certain artificial additives may also have other roots than a response to allergies. For example, one may have a reason to oppose certain additives due to environmental concerns. This further complicates the interdependencies of capabilities associated with foods containing artificial additives.

Therefore, the provision of "free-from" foods in order to meet the special requirements of those allergic is not a solution for the problem. It obviously contributes to one very important capability (i.e. being well-nourished), but sustains the hegemonic operation of the innovation system. It enables the system to identify a special group as users, but the negligence of the knowledge, ethical concerns and interests of those who do not directly contribute to the creation and diffusion of innovation is maintained. In order to be able to listen to this set of information, the complex interdependencies of the capabilities must be recognized, and a broader set of actors (including technological artefacts) must be taken into account.

7. Summary and looking ahead

The present paper examined innovation policy making within the framework of the capability approach. Today's innovation policies ultimately aim to contribute to economic growth, productivity growth or employment. These objectives are formulated in the political arena; therefore, the examination of their adequacy is beyond the scope of the innovation policy literature.

However, it seems to be improbable that the formulation of these objectives is fully external. We cannot assume that these aims are moulded in the political arena without any reference to economic theorizing on welfare. Within the dominating utilitarian traditions of economics, growth in economic outputs, productivity or employment almost necessarily lead to increased welfare. But this is not the case in the capability approach, which is the most influential contemporary welfare tradition, hallmarked by Amartya Sen and Martha Nussbaum.

The present paper has argued that, although the "utilitarianism versus capability approach" debate occurs

beyond the scope of economic theorizing on innovation and innovation policies, the consequences might affect the very gist of this stream of literature. We chose the capability approach as a starting point and examined whether this shift in the underlying "axioms" resulted in a change regarding the set of information needed for the design, implementation and evaluation of innovation policies. We concluded that switching to the capability approach would result in a sea-change in the informational basis and also in the main characteristics of innovation policy making. While the systems of innovation approach, as a methodology, would remain useful in the capability approach, the reinterpretation of certain concepts (such as system failures) might be necessary.

Finally we must ask how innovation policy theories could benefit from the capability approach. First, CA provides an incentive and a way to broaden the boundaries of the analysis, which seems to be in line with the intentions of certain salient advocates of the innovation systems approach [73].

Second, within the framework of the CA we may depict a more detailed picture of the effects of technological change. The CA sheds light on the complexity of this phenomenon by decomposing well-being into means (instrumental freedoms), conversion factors and agency. This may provide a deeper understanding of the success of certain countries (regions) and the lagging behind of others. The creation of greater wealth (on the average and in terms of income) through technological change is not sufficient; it must be converted to valuable "doings and beings", which heavily depend on the possibilities for agency.

Third, empirical works could also benefit from this thought. The success of a country (or region) might be better understood if we were able to grasp its ability to convert means into ends, or to provide opportunities for agency. It would also be important in empirical works to operationalize the ability to adapt to the new reality brought about by technological change. The empirical works of Bajmócy et al. [29] demonstrated that the link between territorial innovation performance and certain well-being indicators are rather weak. We suppose, that in case a country (or region) is successful both in innovation performance and well-being, than it is probably successful in the conversion and in leaving space for agency.

Finally, CA could help to make the "post-normal" or "hybrid" situation, in which innovation policy occurs, visible. A large set of knowledge that is required for innovation policy making within the CA is possessed by non-experts. Today, economic theorizing on innovation policy builds on certain (implicit) assumptions about these knowledge elements (e.g. the faster the technological change, the more welcome it is, the effects compensate for side-effects, artefacts can be handled as black boxes, or moral judgements on technology are irrelevant), but these implicit assumptions are either not tested empirically, or seem to contradict other theories. Within the CA it becomes apparent that innovation policy cannot succeed without this set of knowledge. The incorporation of this idea into the forming of innovation policy could be perceived as a way to reduce policy failures.

Acknowledgements

The present paper was supported by the János Bolyai Reasearch Scholarship of the Hungarian Academy of Sciences (Zoltán Bajmócy) and the Apáczai Csere János Scholarship (Judit Gébert), which was realized in the frames of TÁMOP 4.2.4. A/2-11-1-2012-0001 "National Excellence Program – Elaborating and operating an inland student and researcher personal support system convergence program". The project was subsidized by the European Union and co-financed by the European Social Fund. An earlier version of this paper was presented at the 24th Annual Congress of EAEPE (in Krakkow), we are grateful for the useful comments and the encouragement received there. We are especially grateful to Jean-Christophe Graz, Francesco Burchi, Paolo Ramazzotti, Balázs Lengyel, Gábor Király and Don Peckham.

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