

A general model of the innovation - subjective well-being nexus

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Abstract A model of the innovation – subjective well-being (SWB) nexus is needed to advance our understanding of the welfare implications of innovation. Building on an earlier contribution by Swann (G. M. Peter Swann, 2009, *The Economics of Innovation*, Edward Elgar, Cheltenham, UK), I first assemble the major building blocks of such a model and then discuss some of the many potential linkages between them. A central feature is the inclusion of multiple SWB impacts of processes as well as of outcomes. Some general issues that would have to be addressed in any empirical application are also discussed. SWB impacts are to be used as an additional indicator in the assessment of innovation, not as something to be maximised. By taking SWB into account, new insights might emerge that could result in either strengthening or modifying existing innovation policies, or in novel policies.

Keywords Innovation · Subjective well-being · Knowledge-based economies · General model · Policy

JEL Classifications O30 · B52 · D60

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1 Introduction

What is the ultimate aim of innovation-driven economies? The standard answer given by many economists in the neoclassical tradition is ‘to contribute to economic growth and the welfare of society’. Such an answer usually implicitly equates economic growth with increased welfare (in the form of increased output or consumption). Moreover, the success of innovation policies is also usually assessed in terms of these outcomes (Stehnken et al. 2011). Schumpeterian economists, and evolutionary economists in general, seem to have contributed even less to answering the question, despite dismissing orthodox welfare economics as incompatible with evolutionary thinking. According to Schubert (2012a, 2013), they have often endorsed innovation itself as a welfare criterion, i.e. any policy that promotes innovation is seen as a good thing. This is, in some sense, surprising in light of Schumpeterian creative destruction suggesting positive as well as negative impacts of innovation, and a long list of other prominent economists and sociologists, past and present, commenting on this paradox of innovation and prosperity.¹ Some evolutionary economists are beginning to realise that an exploration of the links between innovation and well-being (however defined) is necessary, because without it policy advice has little or no foundation. As Schubert (2012a, p. 586) says in his introduction:²

Innovation is a two-sided phenomenon: While it is generally beneficial in many senses of the word, it also tends to come with harmful side-effects for some of the individuals affected . . . in terms of increased uncertainty, anxiety, devaluation of human capital, dislocation, status loss, etc. . . ., rather than being unconditionally desirable, innovation and innovation-driven change have a complex normative dimension ... We cannot recommend policies to foster learning, change and innovation unless we can make a convincing case that this indeed enhances the actual *well-being* (or welfare) of the agents directly affected. (Italics in the original)

Schubert (2012a) proposes a well-being measure that focuses on ‘effective preference learning’, i.e. on a person’s motivation and ability to learn new preferences in all domains of life. Innovation is worth promoting as long as it contributes to such learning. However, it is not made clear how this approach can be implemented in practice. In contrast, I suggest that much can potentially be learned about the well-being implications of innovation by employing Subjective Well-Being (SWB) measures, and that important opportunities for innovation research might be lost if we ignore them. In short, I suggest that Schumpeterian economics, as well as mainstream policy discourses for Knowledge-Based Economies (KBEs), could greatly benefit from

¹They include John Stuart Mill, Karl Marx, Ernst Friedrich Schumacher (see Swann 2009), as well as Richard Layard (2005), Diane Coyle (2011), among others.

²See Schubert (2012a, p. 586, footnote 2) for references to other evolutionary economists who have written on normative issues. Also see Dolfmsma (2008, chapter 8), who aims to develop a dynamic Schumpeterian welfare perspective which focuses on long-term effects. However, he still equates social welfare with total output.

taking into account insights from ‘happiness research’.^{3,4} While it has been argued by, e.g., Diener et al. (2009, chapter 4) that SWB measures can enhance economic analysis in a wide range of areas, a discussion specifically focussed on innovation seems to be almost entirely missing.⁵ Yet, innovation researchers are beginning to ask questions like “shouldn’t innovation policy-makers consider SWB more than in the past? Shouldn’t policy-makers make SWB a precondition for the public support of innovation. . .?” (Stehnken et al. 2011, p. 1). To begin to answer such questions, I argue we first need a general, and necessarily multi-faceted, model of the innovation-SWB nexus in order to highlight the potential complexities involved.

Some recent contributions seem to point in the same direction and support the view that exploration of the nexus is an idea that is ‘in the air’. For example, this paper is in some important respects similar to Binder (2013), who also argues that SWB measures are well-suited as welfare indicators and benchmarks of societal progress in the context of innovative change, but he does not propose a general model of the nexus. Another example is Martin (2012), who reviews the main contributions of innovation studies since its inception approximately half a century ago and proposes 20 challenges for the coming decades. They are to jolt the reader “from taken-for-granted orthodoxies and cosy assumptions” (ibid., p.1). Arguably, many of the challenges are related to the building blocks (i.e. ‘elements’) and linkages associated with the general model introduced in this paper.⁶ Empirical research on the relationship between innovation and SWB is also beginning to appear (e.g., Dolan and Metcalfe 2012).

There are a number of other, broader, developments that also suggest it might be opportune to link the literatures on innovation, KBEs and SWB: Innovation is increasingly asked to contribute to solving major societal challenges, like climate change, that are in various ways related to, but go beyond, the traditional contribution of innovation to economic growth (Stehnken et al. 2011; Rooney et al. 2012). Also, there is the issue of mental health, which is central to SWB. Mental illness is probably the largest single cause of misery in advanced KBEs (Layard 2005). The prevalence of mental illness in employed people, due to work-related stress and job strain, has reached high levels across the OECD and is now greatly affecting productivity in the workplace (OECD 2012). Moreover, it is likely that many ‘disruptive technologies’ will further transform business models, work, and the way we live in the near future (Manyika et al. 2013).

³The term happiness research is somewhat unfortunate because of its hedonistic connotations. In the economics literature it is synonymous with SWB research. I use it in that broad sense.

⁴Elsewhere I have highlighted the lack of links between the literature on policies for KBEs and that on policy implications of happiness research (see Engelbrecht 2007, 2012).

⁵Some of their examples of policy uses of SWB measures are relevant in the context of the innovation-SWB nexus, e.g. the discussion of unemployment and well-being in the workplace (Diener et al. 2009, chapter 10). The closest they come to commenting on innovation is a brief mention of the lack of knowledge of SWB impacts of technological change (ibid., p. 117).

⁶For example challenge 1 ‘from visible innovation to ‘dark innovation’’, challenge 6 ‘from innovation for economic productivity to innovation for sustainability (‘green innovation’), challenge 7 ‘from risky innovation to socially responsible innovation’ and challenge 8 ‘from innovation for wealth creation to innovation for well-being (or from ‘more is better’ to ‘enough is enough’)’.

Last but not least, in recent years there have been an increasing number of proposals to develop SWB accounts, at many different levels of aggregation and for many different sub-groups of the population (Diener and Seligman 2004; Dolan and White 2007; Diener et al. 2009; Krueger et al. 2009; Stiglitz et al. 2009), and some national and international organisations and agencies have begun to use SWB measures as part of a larger overhaul of official statistics (Commission of the European Communities 2009; New Economics Foundation 2011; OECD 2011; Helliwell et al. 2012). How can we make sure that any official integrated system of SWB accounts will be of any use for knowledge policy making and, more specifically, innovation policy? What particular SWB measures should be adopted, given the large potential number of context-free as well as group, life domain and job facet specific measures that could be collected?

Again, to begin to answer such questions, we first need to develop a general model of the innovation-SWB nexus. This paper tries to contribute to this task by adapting and extending Swann's (2009, chapter 19) 'complex interactive model of innovation and wealth creation'. That model is based on a broad definition of wealth, i.e. Ruskinian wealth, which seems closer to quality of life, both in an objective and subjective sense, and how innovation might be linked to these different aspects of wealth.⁷ I prefer to clearly distinguish between 'objective' and 'subjective' variables, thereby linking the model to the literature on SWB, as well as to a number of concepts of 'objective' wealth. However, Ruskinian aspects of wealth still play a large part in terms of linkages between different parts of the proposed model.

A central feature of the proposed model is the inclusion of multiple SWB impacts of *processes* as well as of *outcomes*. The former are a manifestation of what Frey et al. (2004) call procedural utility, i.e. the "noninstrumental pleasures and displeasures of processes" (ibid., p. 378). Procedural utility is neglected in orthodox economic welfare analysis that focuses on instrumental outcomes. However, it plays a large part in my conceptualisation of the innovation-SWB nexus.

It is important to emphasize that I do not endorse SWB as a social welfare criterion that is to be maximised. The issue is much too complex for that.⁸ I simply argue that better and more comprehensive knowledge of the innovation-SWB nexus should be of interest to innovation researchers in its own right. I advocate measurement of SWB impacts as an *additional indicator* in the assessment of innovation and in innovation policy-making. It is hoped that by doing so, new insights might emerge which could, as the case may be, result either in strengthening or modifying already existing policy prescriptions, or in novel policies so far outside the scope of innovation policy. This view of the role of better SWB information for policy-making is therefore very similar, if not identical, to that of Diener et al. (2009) who advocate it in a much wider policy context. It is also similar, but not quite identical, to Binder's (2013) view, who

⁷Ruskinian wealth is named after John Ruskin, the British philosopher and art historian.

⁸For example, the optimal level of SWB might be less than the highest level possible, it might vary between life domains and individuals, and there might be acceptable trade-offs between SWB and other objectives (Oishi et al. 2007). There is a large literature on the issue of whether policies should, or should not, maximise happiness. Hirata (2011) provides a good overview of the debate.

argues that SWB measures “should . . . be used to assess broadly the societal patterns of outcomes resulting from innovative activities” (ibid., p. 571).⁹

The next section first introduces the elements of the model before presenting the model itself. This is followed by a discussion of some of the many possible linkages between elements, and some further comments on major issues which would have to be addressed when implementing the model empirically. The last section provides a summary and concluding comments.

2 A general model

A convenient starting point for thinking about the innovation-SWB nexus is the question: ‘Does innovation cause SWB or does SWB lead to innovation?’. The first part of the question is immediately recognisable as a normative issue for innovation policy, the second part hints at complex reverse causality and feedback effects.¹⁰ A general model of the nexus should be able to accommodate both directions of causation, as well as a multitude of (direct and indirect) linkages between innovation, SWB and other relevant elements. In this section I first briefly introduce what I regard as the major elements that should be included in such a model. Each can be proxied by a number of alternative and/or complementary variables. The selection of elements and their proxy variables is a question of judgement and, therefore, contestable. I then introduce the general model and also discuss some reactions to this type of model.

2.1 Assembling the pieces

Innovation I use the generic definition of innovation as ‘putting inventions to first commercial use’. In any application of the model, the specific nature of the innovation will be important. In principle, the model should be able to accommodate most types: Product, process, organisational and marketing innovations as defined in the *OSLO Manual* (OECD 2005), as well as other types of innovation, e.g. radical versus incremental innovations, soft innovations etc. (Swann 2009, chapter 3, Stoneman 2010). The focus on commercial use seems to exclude many social innovations. They could be included in a slightly modified model. Moreover, many social innovations will impact on many parts of the model. It is probably fair to say that interdependencies between commercial and social innovations are a so far under-researched topic.

⁹Binder (2013, p. 568) argues that this view can be termed the constitutional or institutional approach to happiness politics, whereas SWB maximisation can be termed the welfare economic approach. Although I broadly agree with the constitutional view, Binder’s view of policy seems to be more hands-off than mine, aiming only at creating institutional frameworks that allow individuals to pursue SWB. I would argue that the model of the innovation-SWB nexus might also be used to identify discretionary policy interventions that aim at supporting SWB without trying to maximise it.

¹⁰It also hints at the issue of how to combine different SWB impacts, i.e. in this case overall SWB versus SWB in the workplace, an issue commented on further in Section 3.2.

Invention This element is meant to capture ‘pre-commercial’ idea generation. It can be proxied by its ‘output’ (i.e. invention) or its various potential ‘inputs’, e.g. research and development (R&D) expenditure, creativity, entrepreneurship, serendipity, luck. In any empirical application of the model, several of these are likely to be relevant and it might be appropriate to split them into separate elements. The inclusion of entrepreneurship is controversial from a Schumpeterian perspective.¹¹ Depending on the context, it could alternatively be included under innovation, or it could be included as a separate element.

Workplace and labour market For many people the work domain is an important, if not central, part of their life and identity. It potentially receives, as well as generates, many of the links associated with innovation in the model. With the development of KBEs over the last half century or so, there has been a shift in employment towards knowledge work, creating its own challenges and problems. For example, Drucker (1999) identified the need to increase knowledge worker productivity as the biggest management challenge of the 21st century. Human brains are the crucial resource in KBEs. They can be fragile and are prone to malfunction, especially when put under too much pressure. One is tempted to ask whether it is a coincidence that the rise of KBEs seems to have been accompanied by a rise in mental disorders and illnesses, like stress, anxiety and depression. However, focussing more specifically on the work domain and in particular on ‘work as a process,’ it is also known that a certain level of stress can help people succeed in challenging tasks, creating ‘flow’ experiences (Csikszentmihalyi 1990). Ng et al. (2009) suggest that research should explore how to maximise the benefits of stress without increasing its negative effects. In short, the workplace is intimately related to SWB in modern economies, and this needs to be acknowledged in innovation research. The major SWB impact of the labour market seems more straightforward, i.e. unemployment is known to usually have a very negative impact on SWB.

Product market Markets for goods and services are an essential part of the model, given the generic definition of innovation used here. It is well-known that relationships between innovations and markets are complex. Different market structures (perfect competition, oligopoly, monopoly) influence innovation in different ways, and innovation also influences market structure, e.g. by leading to higher firm concentration (or less, depending on the type of innovation).¹² Perfect competition is commonly regarded as least conducive to innovation, although Boldrin and Levine (2008) argue that a substantial amount of innovation does take place under this market form.

Material standard of living This element can be proxied by traditional economic performance variables like levels and growth rates of GDP and productivity, as well as alternative and newer variables which try to remedy shortcomings of the older

¹¹Schumpeter firmly associated entrepreneurship with innovation. For a brief introduction to theories of creativity and entrepreneurship see, e.g., Swann (2009, chapters 9, 10).

¹²For a brief introduction to the issues, see Swann (2009, chapter 18).

established measures. In particular, comprehensive or total wealth (TW) has been developed as a stock measure compared to flow measures like GDP. TW is at the centre of the capital approach to development advocated by the World Bank (2011) and others, although measurement is still at a relatively early stage and controversial.¹³

Natural environment Living in the Anthropocene, i.e. in an age where humans impact the planet on a geological scale, but at a much faster than geological speed (The Economist 2011), any general model of the innovation-SWB nexus has to include as one of its elements the natural environment and its sustainability. The model needs to be able to capture not only the (positive and/or negative) environmental impacts of innovation, but also any feedback effects from the environment. Potential variables include pollution indicators, and many of the sustainability indicators put forward in the literature. However, by including SWB and the environment as separate elements, the model would have to be modified to accommodate composite sustainability indices that combine both.¹⁴ Instead, I follow Stiglitz et al.'s (2009) advice that sustainability deserves separate measurement from current (objective and/or subjective) well-being. Another potentially relevant variable is the amenity value derived from natural capital (as noted earlier, natural capital itself is part of total wealth, i.e. it is an objective standard of living variable).

'Objective' well-being This element tries to capture all well-being and social welfare indicators other than SWB indicators and those specifically related to the natural environment and its sustainability. It includes consumption-based utility, i.e. mainstream economic welfare criteria, and also a multitude of 'objective' quality-of-life indicators (e.g., health, education, and social indicators) and well-being indicators collected by many government and non-government organisations (see, e.g., Stiglitz et al. 2009; OECD 2011; New Economics Foundation 2011; Beaumont 2011).

Subjective well-being SWB is diverse, capturing different aspects of people's subjective experiences.¹⁵ I advocate the use of life satisfaction (LSF) or evaluative well-being, in contrast to happiness or emotional (i.e. hedonic) well-being. The latter captures short-lived emotions. LSF captures longer-term considerations of the 'good life'

¹³TW is conceptualised as the present value of (sustainable) consumption over a generation. Major TW subcategories are natural, produced and intangible capital. Measurement of natural capital is improving quickly, but it is still incomplete, excluding important resources like water and fisheries. Numerous assumptions have to be made when calculating natural and produced capital. They can and have been criticized (see, e.g., Perman et al. 2011). By far the largest component of TW is intangible capital. Due to lack of adequate data for many countries it is simply measured as a residual in World Bank (2011). The alternative approach of estimating *all* capital stocks *directly* and adding them up to obtain TW, plus correcting for a number of other issues associated with 'wealth accounting', has been advocated by Dasgupta (2010) and Arrow et al. (2010).

¹⁴Such as the Happy Planet Index (New Economics Foundation 2009) that combines happy life years (life satisfaction \times life expectancy) and an adjusted ecological footprint; or Ng's (2008) environmentally responsible happy nation index.

¹⁵A detailed discussion of different SWB measures is beyond the scope of this paper. For further discussion see, e.g., Diener et al. (2009) and Helliwell et al. (2012).

and its ethical dimensions. Kahneman and Deaton (2010) and Deaton and Stone (2013) find that the two types of SWB have different correlates. They, therefore, emphasize the importance of distinguishing between the two.¹⁶ In the context of trying to assess the SWB impacts of innovation, LSF seems, in general, to be the more appropriate SWB measure when the aim is to use SWB as an additional input into policy-making, and not as something to be maximised. Graham (2011), in her discussion of promises and dangers of using happiness indicators for policy purposes, calls this the choice between Aristotle and Bentham.

SWB can be measured for 'life as a whole', for specific life domains (e.g., work, family life), for particular groups of people in society, or even more specifically for particular job facets (Warr 2007). The different measures arguably convey different but complementary information about LSF of use to policy makers in the private and public sectors. In any particular implementation of the model, due consideration needs to be given to the appropriate choice of SWB measures.¹⁷

2.2 Putting it all together

Having introduced the elements, the general model is presented in Fig. 1. It tries to capture the multitude of potential links between innovation and SWB. Borrowing a phrase from Swann (2009, p. 236), one might call this the 'everything relates to everything else' model of the innovation-SWB nexus. Figure 1 is what in graph theory is called a complete graph. The model will become specific when implemented and adapted for particular innovations (this is beyond the scope of the current paper). In that process, some elements might get modified (e.g., splitting 'innovation' into several elements) and some links will become more important than others (and some might be found unimportant and dropped from the model).

Important features of the proposed model are similar to those mentioned in the literature on National Innovation Systems (NISs), and open to similar criticism. For example, Lundvall (1992, p. 8) argues that innovation is a ubiquitous phenomenon in the modern economy, that invention, innovation and diffusion are not separate stages, and that what to include in a National Innovation System (NIS) is context specific. Edquist (2005), in his assessment of the NISs approach, comments on what he perceives as its major weaknesses, i.e. conceptual diffuseness (no clear definition of NIS boundaries) and the lack of formal theory, suggesting it might be undertheorized. In Edquist's view, remedying the latter does not require that all elements and relations among them must be specified (he regards this as unrealistic, given the complexity of innovation systems). Instead, the NIS should be seen as a device to generate hypothesis about relations between specific variables in the system. An explanation

¹⁶For example, happiness seems to satiate with high income, whereas LSF does not. Earlier, Inglehart et al. (2008) reported that a society's level of LSF is more closely related to economic conditions than is happiness.

¹⁷The multitude of potential SWB measures, even when the same general definition of SWB is used, indicates the need for some standardization, which will hopefully take the form of integrated national systems of SWB accounts.

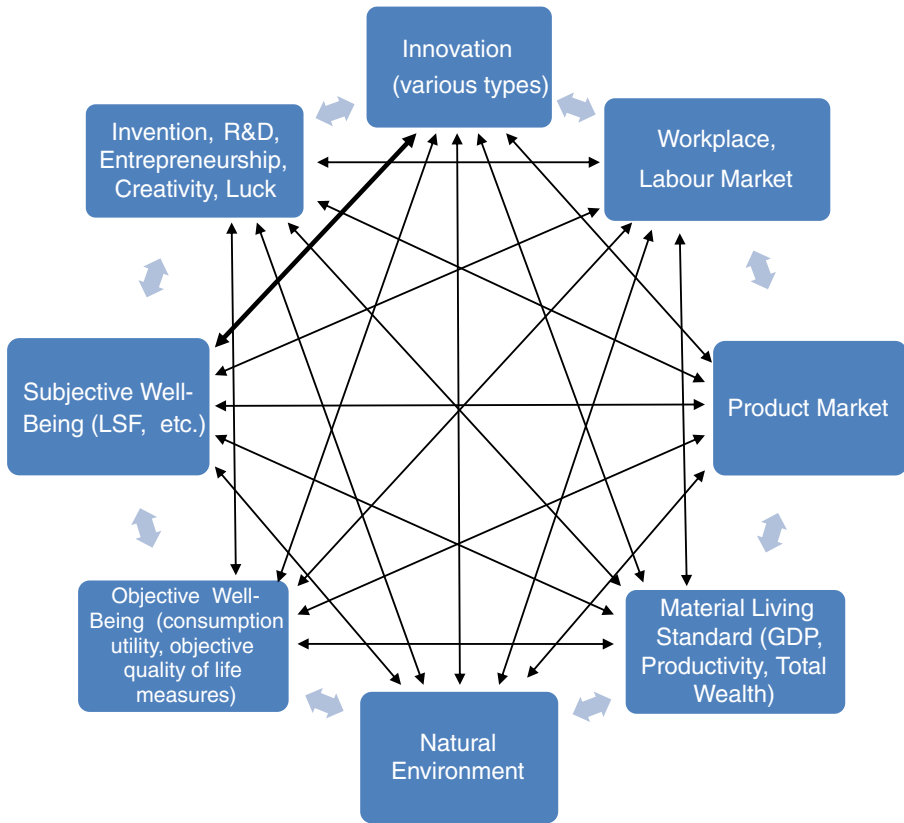


Fig. 1 A general model of the innovation – SWB nexus

of innovation processes will certainly be multicausal. All of these comments can also be made about the model of the innovation-SWB nexus.

Reactions to the type of model shown in Fig. 1 tend to be rather mixed. Swann¹⁸ mentions that policy-makers seem to dislike his model of innovation and wealth creation. This might be due to the still prevalent view that something only counts as innovation if it is producer-driven innovation sold in markets. Many policy-makers also still seem to hold the view that innovation is always and everywhere a good thing. Academics tend to say that it is all rather obvious that everything is connected to everything else, and as such the model it is not very original. This was also the reaction of one of the reviewers of this paper. I think it misses the point. If it is all so obvious, why are SWB impacts rarely taken into account in innovation policy? The proposed model should be regarded as a simple *focussing device* to raise awareness

¹⁸Personal communication, 30 April 2013.

of the many possible linkages and feedbacks. It clearly highlights the potential complexity of the innovation-SWB nexus, and provides a good snapshot impression of why it has been difficult to provide answers about it.¹⁹

Last but not least, Fig. 1 indicates why the relationship between economic growth and average SWB in advanced KBEs, i.e. part of the Easterlin Paradox, is so contested.²⁰ It is not clear a-priori what the net effect of all the links connecting the ‘material standard of living’ and SWB would be even if the direct impact of the former on the latter were known to be positive. By increasing our knowledge about the distribution and intensity of positive and negative links, empirical application of the model should also provide a new avenue for exploring the Paradox. If it turned out that there is one very strong negative link impacting on SWB, focussing policy on changing that link might have a strong effect on overall SWB.

3 Discussion of the proposed model

3.1 Linkages

The following discussion is not meant to be exhaustive. The potential number and complexity of relationships is simply too great. I leave it to the reader to try and think about possible additional linkages and feedbacks in the context of particular innovations of her/his choosing. I first locate the linear model of innovation in the model. Next, I focus on linkages emanating from the various elements, concentrating on those associated with innovation, invention, the workplace and product markets. Some others will be mentioned only briefly.

3.1.1 *The linear model of innovation as a special case (i.e. sub-set) of the model*

As pointed out by Swann (2009), a complex model like that shown in Fig. 1 contains the old linear model of innovation, with causation running from invention, to innovation, to the workplace, resulting in new products or processes, enabling new, improved and/or cheaper products being sold in the market, thereby increasing GDP, consumption and utility/welfare. Swann discusses the severe limitations of such a simple model which neglects other linkages and feedback effects. In particular, it assumes that invention precedes innovation and that innovation only increases welfare/well-being if it increases GDP.

However, even if the linear model did apply and innovation increased conventionally measured welfare, it is easy to contemplate that the net impact of innovation on

¹⁹This resonates with Schumpeter’s view of the complexity of any normative analysis of creative destruction that led him to abandon any attempt at it (Schumpeter 1947, p. 155, footnote 12, reported in Schubert 2013, p. 228).

²⁰For an introduction to the Easterlin Paradox controversy see Clark et al. (2008) and Easterlin et al. (2010). If it is accepted that economic growth in advanced KBEs is mostly due to productivity growth (which itself is mostly due to innovation), the literature on the Easterlin Paradox is highly relevant to the analysis of the innovation-SWB nexus.

SWB might be weak or even negative. Procedural utility impacts might counteract outcome utility, e.g. if there are negative SWB impacts in the workplace or if consumption externalities exist. The latter might reduce any potentially positive SWB impacts of higher consumption due to negative effects on the environment (more garbage, lower amenity values, depleted resources) or due to status effects (keeping up with the Joneses, the hedonic treadmill). In any case, if, as suggested by behavioural economics, people's spending habits are less than perfectly rational and utility maximising, outcome utility becomes weaker and other SWB impacts become relatively stronger.

3.1.2 *Some effects of innovation*

The link between innovation and the workplace is very important for the overall SWB outcome of innovations. The issue of stress in the workplace, and its potentially negative as well as positive impacts on SWB, have already been mentioned. To expand on these themes, there are a number of related process innovations, like organisational and managerial innovations, re-engineering, changes in work practices, e.g. due to Information and Communication Technologies (Cohen 2003; Layard 2005; Bryson et al. 2013), that can create negative impacts. The literature on information overload, cognitive overload etc. also relates to this (Eppler and Mengis 2004). In contrast, policies aimed at increasing SWB of workers might increase productivity (Diener and Seligman 2004; Diener et al. 2009; Helliwell and Huang 2010). An important aspect is how to deal with risk and uncertainty, high levels of which go hand-in-hand with innovation.

A potentially very important direct link between innovation and SWB arises from the process of innovation itself (it similarly can apply to the process of invention). This deserves special mention because it has been argued by Phelps (2009) that the distinctive merit of capitalism is not its power to create (material) wealth, but its ability to create engaging and rewarding work due to its emphasis on innovation, thereby enabling self-actualization and self-discovery. Phelps expressed similar views in his Nobel lecture (Phelps 2007), as well as in some earlier publications, calling such work attributes the essence of the good life. While these are statements about the very core of innovation-driven KBEs, their values and links to SWB, reality in the work domain for most people seems driven by the negative impacts mentioned earlier. However, Phelps views are an improvement over those of mainstream KBE analysts like, e.g., Foray (2006), who seem to have neglected any direct SWB impacts of the innovation process itself. So far there are few empirical studies exploring this issue.²¹

²¹One example is Dolan and Metcalfe (2012). Using a representative survey of the British population and new primary data, they find a strong link between innovation (proxied alternatively by being original and having imagination) and SWB (in the workplace and in life generally). They point out that more research is needed to determine causation. Their explanatory variables mostly capture personal attributes, some of which can be mapped into the model of the innovation-SWB nexus, but many potentially important factors are not included.

Some innovations bypass the workplace and create a direct link to the product market, i.e. those directly affecting the organisation of markets. Swann (2009) gives as examples the invention of the supermarket and e-business replacing smaller shops, increasing the need for travel by car and increasing the carbon footprint (thereby creating further links to environmental sustainability and SWB). There are also direct links from innovation to the natural environment. Positive links mentioned by Swann (ibid.) include the rejuvenation of inner cities, clean technologies and greater fuel efficiency, less noisy technologies. Negative environmental impacts include air and water pollution, and e-waste (due to rapid innovation in computers and software). There are also feedbacks from innovation to creativity and invention, e.g. a link going from innovators to inventors and researchers, in the sense that innovation often raises new research questions (Swann, ibid.).

It should also be acknowledged that not every innovation is acceptable to all consumers. For example, nuclear energy, genetically modified food, cloning, chlorination of drinking water etc. might reduce SWB for some, especially if consumers cannot circumvent adoption. Marketing might be used to make new goods and services acceptable (i.e. changing consumer preferences), as might be strategies that specifically focus on reducing the actual and perceived risks associated with adoption.²² The direction of impact on SWB is less clear if consumers can refuse adoption, i.e. the SWB impact of ‘consumer resistance’ might be positive.

3.1.3 *Some effects of invention*

The link from invention to innovation is that of the old linear model, i.e. some of the many inventions develop into commercially viable innovations, through varying combinations of creativity, R&D, entrepreneurship, serendipity and luck. However, Swann (2009) strongly suspects that much creativity contributes to wealth creation through different channels. He mentions direct links from creativity to the workplace: Companies might allow staff to spend half-a-day a week to pursue their own blue sky projects, which might, or might not, result in invention and/or innovation. If this increases work morale, it is likely to raise worker productivity (as well as SWB).

There are other direct links between creativity and SWB that bypass the workplace (and that are closer related to Ruskinian wealth or quality of life). For example, Swann mentions that hobbies pursued by people in their spare time, e.g. painting, writing, beautifying ones home, gardening etc., usually increase SWB. The latter two examples might also link to environmental sustainability. Swann further mentions the possibility of negative links between creativity and SWB, such as self-destructive lifestyles of highly creative people.

Another set of links connecting creativity, invention, as well as product market and consumption, is Von Hippel’s (1988, 2005) user innovation by intermediate or final

²²For an introduction to the literature on consumer resistance to innovation adoption see Kleijnen et al. (2009).

consumers. Commenting specifically on end user innovation Swann (2009, p. 239) goes so far to state that

... , we could say that the households use their own creativity to produce more from a given bundle of purchased goods and services. While I cannot quantify it, I suspect that this use of creativity may be just as important in wealth creation as that creativity which is channelled through innovation!

Last but not least, open source contributions, crowd sourcing and related voluntary peer production activities often link creativity, invention, innovation and SWB in KBEs, while also increasing productivity and TW. Note that depending on the characteristics of such activities and the degree of commercialisation of their outcomes, they could be classified as inventions or innovations. Benkler (2006) goes so far to argue that such activities are heralding the arrival of a new, although somewhat fragile, mode of production in the internet age which by-passes conventional work arrangements and markets.

3.1.4 *Some effects of the workplace and labour market*

There are many other links emanating from the workplace and labour market in addition to that going to the product market. The conditions one finds in the workplace can impact on creativity, invention and the many forms of employee-driven innovation (Høyrup et al. 2012), providing an important example of reverse causality neglected in the linear model of innovation (Swann 2009). As discussed earlier, conditions in the workplace *directly* impact on SWB. This is a key example of procedural utility (Frey et al. 2004), where procedures and institutions under which people live and work (e.g. hierarchies, labour laws) affect SWB.²³ Frey et al. (ibid.) find that procedural utility is of great importance in employment.

Swann (2009) also discusses workplace impacts on consumption. They can be positive or negative. An employer can promote healthy lifestyles (by providing healthy meals, time for exercises, gym memberships etc.) or unhealthy ones (e.g. work-related stress leading to alcoholism). These, then, again links to SWB. In extreme cases, workplace conditions can be so stressful that they increase the likelihood of employee suicide. The example of France Télécom comes to mind (Jolly and Saltmarsh 2009).

It is also possible that there are negative links between workplace conditions and the environment. Swann (2009) mentions environmental impacts of the early industrial revolution, but one can think of many current examples (e.g., processing of e-waste in Africa and the ship recycling yards near Chittagong in Bangladesh).

3.1.5 *Some effects of product markets (the market place)*

Purchasing final goods and services increases consumption. It is usually assumed that this also increases welfare and SWB. However, product markets might negatively

²³Frey et al. (2004, p. 385/6) argue, e.g., that “hierarchy constitutes a procedural disutility because it interferes with innate needs of self-determination”.

impact on some people's SWB, e.g. when abundance of choice produces anxiety (Schwartz 2004) or when there are status effects. Moreover, Swann (2009) points out that the market place can have SWB impacts other than those associated with consumption. For example, some people derive great pleasure from browsing, be it in expensive high street shops, art auction houses, flea markets, bargain bins, garage sales, open homes, even if purchasing little or nothing. Markets might also provide ideas for innovators, both in terms of providing knowledge about what consumers want and by suggesting organisational changes (ibid.). There might also be SWB impacts because people judge market allocation processes as either fair or unfair. Frey et al. (2004) discuss at some length the literature associated with allocation procedures (of which the market mechanism is one) having procedural utility impacts.

3.1.6 Some other linkages

There are many other direct and indirect linkages that might be of importance when analysing the SWB impacts of a particular innovation. Some of the more obvious ones include: (a) The impacts of innovation-driven economic growth and consumption on environmental sustainability (linking 'standard of living' and 'natural environment'). Swann (2009) mentions that how and what we consume affects the environment in different ways (house insulation, recycling, extent of car use etc.). This can further impact on SWB. There is also some research on the link between consumption of, specifically, digital products and SWB.²⁴ (b) The link from the natural environment, due to its amenity value, to SWB. (c) The direct and positive link from social capital, which is part of TW, to SWB (Helliwell and Putnam 2004; Helliwell and Wang 2009). (d) There might also be a direct link going from social capital to innovation (Akçomak and ter Weel 2009). (e) Swann (2009) mentions a number of links emanating from wealthy individuals: Creativity, invention and innovation might be supported by business angels or through philanthropy (e.g. large donations to universities). (f) There might be a link between entrepreneurship and SWB. However, the literature reports conflicting findings on this issue.²⁵

3.2 Some other issues to consider

There are a number of other general issues that would be encountered in any empirical application of the model.

Subset of variables and links to be analysed The importance of each potential variable and link, as well as feedback effects and chains of causation, will differ by

²⁴For example, Kavetsos and Koutroumpis (2011) find positive correlations for some products and argue this might have implications for public policy, e.g. for recognising internet access as a fundamental human right.

²⁵See, e.g., Uhlaner and Thurik (2007) for findings derived from macro-level cross-country data, and Block and Koellinger (2009) and Carree and Verheul (2012) for findings obtained using micro-level data.

type of innovation, by which industries or sectors of the economy are involved, by who is affected (producers, consumers, other subgroups of the population). Choices and compromises will have to be made depending on the focus of the analysis and data availability. In short, only a subset of variables and links will be relevant and/or measurable.

To give but one example, should only one type of SWB be measured, e.g. LSF, or should impacts also be measured for other types of SWB? It is well established in the literature that for different SWB measures, e.g. hedonic versus eudaimonic, the direction of impact of an event can differ. Moreover, the type of SWB supportive of creativity might be different from the type of SWB impacts we want to measure in the population affected by an innovation. Even if we stick with one type of SWB measure, it is not clear whether, or if so how, different SWB impacts should be aggregated to achieve an overall impact measure. Analysts need to be aware of these issues and should explicitly justify their choices.²⁶

Level of aggregation There are likely to be different SWB impacts of an innovation, depending on whether the analysis is conducted at the micro-, meso- or macro level. Researchers should explore whether it is appropriate and feasible to conduct an analysis at different levels of aggregation, and whether they can be combined.²⁷ Also, the evaluation of SWB gains and losses is made more difficult when considering domain-specific SWB. Overall SWB might not change, despite losses and gains in specific domains. Whether this is acceptable or not is a normative question which should be addressed in any specific innovation study. It is also possible that there are (positive or negative) SWB spillovers from one life domain to another (e.g., there might be work-life balance issues, such as work stress negatively affecting a person's family life). Whether such issues can be explored depends on the available data. The development of consistent SWB accounts by statistical agencies might make this more feasible in future.

Time horizon There are usually trade-offs between short-term and long-term SWB impacts of innovation and, important from a Schumpeterian perspective, preferences evolve over time.²⁸ New products and/or product designs might increase SWB in the short run, but novelty usually wears off after a while. In general, features of human behaviour like cognitive fallacies, unanticipated adaptation, focusing illusion,

²⁶Binder (2013) wants to impose more structure on the SWB analysis of innovations by restricting analysis to "life domains which impact on subjective well-being regardless of context and culture" (ibid., p. 572). He calls this his 'life domain evaluation principle'. However, he is not very specific about what domains to include. There are potentially some similarities to several of the elements included in my general model, but his formulation seems overly restrictive.

²⁷See Dopfer et al. (2004) on the importance of the meso in evolutionary economics. They argue meso change is central for understanding evolutionary dynamics.

²⁸I do not assume preferences are unchanging over time. However, I do not explicitly comment on the issue of endogenous preferences in this paper, an issue which is central to Schubert's (2012a, b, 2013) work. The relationship between preference learning and SWB is a complex one that should be explored further.

memory bias etc.²⁹ add important time dimensions.³⁰ Moreover, it seems to be easier for people to adjust to unpleasant certainties than to uncertainty (Graham 2011). If possible, it should be explored how the degree of uncertainty associated with particular innovations varies over time, and how this affects SWB.³¹ What time horizon(s) to use when implementing the model empirically is an important question that needs to be carefully considered. However, data availability etc. is likely to dictate pragmatic answers.

The issues become even more difficult when trying to take the (subjective and objective) well-being of future generations into account. This is another reason why measured SWB impacts cannot be used as the only criterion to judge the welfare implications of innovation. However, a more complete knowledge of SWB impacts of innovation should be important when addressing difficult normative issues and trade-offs associated with innovation.

Framework conditions So far I have not commented on broader societal factors or framework conditions, such as the nature of the innovation system, or ‘culture’ and ‘values’, that influence innovation, SWB, and the other elements of the model. It should be clear that they potentially affect all of them (one should think of further arrows connecting the elements to a surrounding frame). Determinants of the National and other Systems of Innovation include the Intellectual Property Rights regime, opportunities and incentives for talented individuals, and other institutional factors. Culture and values are contested areas of research that cover a broad literature in modern growth theory and in sociology. In the current context, a good starting point is the World Values Survey and research published by its founder and associates (Inglehart et al. 2004, 2008; Inglehart and Welzel 2005). They argue that high levels of SWB in advanced KBEs are associated with a specific set of values (self-expression or post-materialist values). However, it can be observed that even amongst what are often regarded as very similar advanced economies, people’s beliefs and values about core KBE-elements differ, sometimes greatly so (Engelbrecht 2007). Moreover, Diener and Seligman (2004) report that negative effects of materialism in advanced economies may be one reason for the increase in mental illness. This seems to counterbalance Inglehart et al.’s more positive assessment, at least to a certain degree.

To summarize, a pragmatic approach will be required when implementing the model for specific innovations. Analysts should determine the most important variables and links between them, and also indicate what should but cannot be measured,

²⁹See, e.g., Hirata (2011, pp. 59–63).

³⁰Binder (2013) proposes a second normative evaluation rule, i.e. the ‘welfare dynamics principle’, that is aimed at imposing structure on the SWB analyses of innovation over the medium and long run. It focuses exclusively on hedonic adaptation dynamics. While undoubtedly ambitious and challenging, it leaves out other dynamic relationships of the innovation-SWB nexus.

³¹While Schubert argues there needs to be novelty (and therefore uncertainty) so that people can learn new preferences, he does not highlight the potential impacts of uncertainty on SWB. Not only is it unclear how his approach can be implemented empirically, I would also argue that preference learning is not the same as welfare or well-being. It has its own SWB impacts, which are part of the dynamic relationships of the innovation-SWB nexus.

both in the present and over time. Only the accumulation of such studies is likely to enable us to make progress in understanding the innovation-SWB nexus, and to address normative issues.

4 Summary and concluding comments

Building on Swann's (2009) contribution, I propose a complex, multifaceted general model of the many ways in which innovation and SWB may be connected, and advocate its implementation in empirical innovation studies. This would seem a natural progression of the economics of innovation, given the normative turn in innovation policy associated with today's big societal challenges and developments in SWB research, and increased efforts to collect SWB data on a more frequent, widespread and consistent basis. The model is general in the sense that its specification, i.e. in terms of variables used, their relative importance, the direction and relative importance of linkages, will depend on the innovation analysed, a task not undertaken in this paper. It would likely require a large multi-disciplinary effort.

Over time, accumulation of innovation studies that include a SWB perspective should provide evidence not only on overall SWB impacts of innovations, but also on issues such as the relative importance of procedural utility versus outcome utility, the impacts relative income and status effects have on both, any trade-offs involved, etc. The complexity of the innovation-SWB nexus should also be taken note of when trying to link SWB and innovation databases as suggested by, e.g., Diener et al. (2009). Although we are unlikely to ever be able to account for all of the SWB impacts of innovation, this should not be an excuse for giving up on efforts to take into account as many as possible.

One promising area for further research would seem to be a detailed exploration of the relationship between the general model of the innovation-SWB nexus and the literature on NISs.³² One could envisage an approach best described as 'NIS + SWB'.³³ Whether SWB would be (more or less) an add-on to the NIS, or whether SWB impacts would more profoundly influence our understanding of the NIS, remains an interesting question to be explored. Also, given that learning (in all its forms) is central to NISs, an NIS+SWB approach might go some way toward enabling an empirical assessment of Schubert's evolutionary approach to well-being.

In any case, adoption of a SWB perspective in the economics of innovation should impact on the evaluation of innovations and on innovation policy. I agree with Swann's (2009, p. 271) concluding conjecture that a complex interactive view of innovation is likely to alter future government policy towards innovation. Such policy will take much wider societal considerations into account than the still dominant view that only assesses innovations in terms of their impacts on productivity, profitability, or similar economic performance measures. Increased awareness and knowledge of

³²Lundvall (2011), e.g., acknowledges links between the quality of work, learning opportunities and innovation, and job satisfaction.

³³This would also apply to other types of innovation systems, e.g. regional, sectoral, or technological.

the innovation-SWB nexus should help governments and the public to realise trade-offs between innovation and SWB beyond what has been considered so far. Better knowledge about SWB impacts should provide an additional input into innovation and knowledge policy making, which might be quite subtle. Hirata also captures this sentiment when trying to answer the question what the 'happiness perspective' can contribute to good development:

A society that looks towards happiness for orientation will probably not do everything differently. It will, however, strive to create conditions for a society in which production and consumption are subordinated to a good life rather than the other way around. It will not reduce citizens to consumers, and workers to production factors . . .

. . . It can shake up conventional answers that suggest that the evident goal of development is economic growth and that technological progress will automatically bring well-being. (Hirata 2011, p. 153/4)

In short, while good development and the good life should not be reduced to SWB, the latter is surely an important part of the former. In a similar way, I have argued elsewhere (Engelbrecht 2007, 2012) that SWB research can and should contribute to the development of wisdom-based knowledge policies based on conceptions of the good life.³⁴ In a general sense, the model of the innovation-SWB nexus proposed in this paper is an attempt to contribute to the development of the analytical tools needed to advance the quest for wisdom-based knowledge policies.

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³⁴On wisdom-based knowledge policies see, e.g., Rooney and McKenna (2005) and Rooney et al. (2010). The need to move from an information and KBE to a wisdom economy has also been pointed out by others, e.g. by Daly (1996), one of the founders of ecological economics.

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