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TOWARDS A GENERAL MODEL OF THE INNOVATION - SUBJECTIVE WELL-BEING NEXUS

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Towards a General Model of the Innovation - Subjective Well-Being Nexus*

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ABSTRACT

The paper argues that a model of the innovation – subjective well-being (SWB) nexus is needed to advance our understanding of the welfare implications of innovation. Such a model is currently missing from the literature. Several developments also suggest that it is opportune to link the literatures on innovation and SWB. Innovation is increasingly asked to contribute to solving major societal challenges that go beyond the traditional contribution of innovation to economic growth. There is the issue of mental health. Mental illness is probably the largest single cause of misery in advanced economies. It seems to have gone hand-in-hand with their development. Last but not least, 'happiness economics' has developed greatly over recent decades. There have been an increasing number of proposals to develop SWB accounts and some statistical agencies have begun to collect SWB data.

Building on an earlier contribution by Swann, we propose a conceptual model of the innovation – SWB nexus. We first assemble the major building blocks ('concepts') of our model. For most concepts multiple proxy variables are discussed. Next, some of the many potential links ('connections') between concepts are highlighted. The old linear model of innovation is included as a subset. Some general issues that would have to be addressed in an empirical application of the model are also raised. A central feature of the model is inclusion of multiple SWB impacts of *processes* as well as of *outcomes*. Procedural utility, which is neglected in orthodox economic welfare analysis, plays a large part in our conceptualisation of the innovation-SWB nexus. Finally, we advocate the measurement of SWB impacts as an *additional indicator* in the assessment of innovation and innovation policies.

Keywords: Innovation, Subjective Well-Being, Connections, Knowledge-Based Economies, Conceptual Model, Policy.

JEL: B52, D60, O30

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1. INTRODUCTION

What is the ultimate aim of innovation-driven Knowledge-based Economies (KBEs)? 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 (2010, 2012), 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 (2012, 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 proposes a well-being measure that focuses on a person's ability to learn new preferences in all domains of life, but it is not made clear how this approach can be implemented in practice. Dolfsma (2008, Chapter 8) also aims to develop a dynamic Schumpeterian welfare perspective which focuses on long-term effects. To that end, he includes different types of communication costs in his model. However, social welfare is still measured by total output.

In contrast, we 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, we suggest that Schumpeterian economics, as well as the mainstream policy discourse for KBEs, could

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

[2] See Schubert (2012, p. 586, footnote 2) for references to other evolutionary economists who have written on normative issues.

greatly benefit from taking into account insights from 'happiness research'.[3,4] While it has been argued by, for example, 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, we need a model of the innovation-SWB nexus.

There are a number of other developments that suggest it is 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, 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, 2011a). 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 Economic Foundation, 2011; OECD, 2011b; Helliwell et al., 2012).

An important question that arises from these developments is how can we make sure that any official nation-wide 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 range 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 conceptual, and necessarily multi-faceted, model of the innovation-SWB nexus which is so far missing from the innovation literature. 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'.

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

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

[4] Engelbrecht (2007, 2012) highlights the relative lack of connections between the literature on policies for KBEs and that on policy implications of happiness research.

[5] Some 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).

focuses on instrumental outcomes. However, it plays a large part in our conceptualisation of the innovation-SWB nexus. Schubert (2012, p. 609) also argues that this aspect of the SWB literature might provide a source of inspiration for an evolutionary account of welfare.

It is important to point out that we are not endorsing SWB as a social welfare criterion. We do not argue that it should be maximised. The issue is much too complex for that.[6] We simply argue that better and more comprehensive knowledge of the innovation-SWB nexus should be of interest to innovation researchers in its own right. We 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. Our view on 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.

The next section first introduces the building blocks (or 'concepts') of our model before presenting the model itself. This is followed in Section 3 by a discussion of some of the many possible links connecting the concepts, and some further comments on major issues which would have to be addressed if one were to empirically implement the model. The last section offers a summary and concluding comments.

2. A CONCEPTUAL MODEL

2.1 Assembling the pieces

A starting point for exploring the innovation-SWB nexus is the question: "Does innovation cause SWB or does SWB lead to innovation?" A conceptual model of the nexus has to accommodate both possibilities. However, it also has to incorporate a multitude of other direct and indirect relationships between other *relevant concepts*. In this section we introduce what we regard as the major concepts that should be included in such a model. Each can be proxied by a number of alternative and/or complementary variables.

Innovation: Like Swann (2009), we use the generic definition of innovation of putting inventions to first commercial use. In any application of our model, however, 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, for example radical versus incremental innovations, soft innovations etc. (Swann, 2009, Chapter 3; Stoneman, 2010). The focus on commercial use seems to exclude many social innovations. However, they could be included in a slightly modified model. Moreover, many social innovations will impact on many parts of our model. It is probably fair to say that

[6] For 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.

interdependences between 'commercial' and social innovations are a so far under-researched topic.

Invention etc.: This concept is meant to capture 'pre-commercial' idea generation and its various potential ingredients, i.e. it contains inputs and outputs. It can be proxied by variables like research and development (R&D), invention, 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 categories (e.g. inputs versus outputs). The inclusion of entrepreneurship is somewhat controversial from a Schumpeterian perspective.[7] It is included here because we regard it mostly as an input variable and because it might arguably be an alternative to invention in some cases. Depending on the context, entrepreneurship could alternatively be included under innovation, or it could be included as a separate concept.

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 our 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. However, 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.[8] However, focussing more specially 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 impact on the labour market seems more straightforward, e.g. unemployment is known to have a very negative impact on SWB.

Material standard of living: This concept is 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 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

[7] Schumpeter firmly associated entrepreneurship with innovation. For a brief introduction to theories of creativity and entrepreneurship, see Swann (2009, Chapters 9, 10).

[8] Diener and Seligman (2004) report that the incidence of depression has increased enormously over the past 50 years, at the same time that the material standard of living has increased, calling it a paradox. See Engelbrecht (2012) for further discussion and references on this point.

at a relatively early stage and controversial.[9] It differs from *Ruskinian wealth* advocated by Swann (2009), which seems closer to quality of life, both in an objective and subjective sense.[10]

Product market: Markets for goods and services are an essential part of our model, given the definition of innovation used. 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, for example by leading to higher firm concentration (or less, depending on the type of innovation).[11] 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.

'Objective' well-being: This concept 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 economics welfare criteria, and also a multitude of 'objective' quality-of-life indicators (for example, 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, 2011b; New Economic Foundation, 2011; Beaumont, 2011).

Environment etc.: 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 (Economist, 2011), any conceptual model of the innovation-SWB nexus has to include as one of its building blocks 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 concepts, our model would have to be modified to accommodate composite sustainability indices that combine both.[12] Instead, we have followed Stiglitz et al.'s (2009) advice that sustainability deserves separate measurement from current (objective and/or subjective) well-being. Other relevant variables are the amenity value of natural capital, or natural capital itself. This form of capital plays a central role in the debate about 'weak' versus 'strong' sustainability. The latter implies that a particular form of natural

[9] TW 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 critisized (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. 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).

[10] Ruskinian wealth is named after John Ruskin, the British philosopher and art historian, who advocated a broad view of wealth. We prefer to clearly distinguish between 'objective' and 'subjective' wealth by including them in different concepts in our model.

[11] For a brief introduction to the issues, see Swann (2009, Chapter 18).

[12] Such as the Happy Planet Index (New Economic Foundation, 2009) that combines happy life years (life satisfaction × life expectancy) and an adjusted ecological footprint; Ng's (2008) environmentally responsible happy nation index; or Knight and Rosa's (2011) environmental efficiency of well-being index.

capital is 'critical' and should not be allowed to decline over time, whereas weak sustainability implies that natural capital can be substituted by other forms of capital (Neumayer, 2010).[13]

Subjective well-being: The concept of SWB is diverse, capturing different aspects of people's subjective experiences.[14] We advocate using life satisfaction (LSF) or eudaimonic SWB. It captures longer-term considerations of the 'good life' and its ethical dimensions. In the context of trying to assess the SWB impacts of innovation, this definition seems, in general, to be the more appropriate one amongst the common SWB definitions. It is often distinguished from hedonic SWB or happiness (i.e. short-lived pleasant emotions). Graham (2011), in her discussion of promises and dangers of using happiness indicators for policy purposes, calls this the choice between Aristotle and Bentham. Inglehart et al. (2008) report that a society's level of LSF is more closely related to economic conditions than is happiness.[15] SWB can be measured for 'life as a whole', for specific life domains (for example work and 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 SWB of use to policy-makers in the private and public sectors. In any particular implementation of our model, due consideration needs to be given to the appropriate choice of SWB measures.[16]

2.2 An "everything relates to everything else" model of the innovation-SWB nexus

We are now ready to present our conceptual model that tries to capture the multitude of possible links (or 'connections') between innovation and SWB (Figure 1). Borrowing a phrase from Swann (2009, p. 236), we call this the 'everything relates to everything else' model of the innovation-SWB nexus. It builds on Swann's (ibid., Figure 19.2, p. 237) model, but differs from it in important ways. In particular, we explicitly add the concept of SWB and for most concepts we include multiple potential variables. The latter highlights the high degree of flexibility when implementing the model, and also indicates potentially important 'within-concept' diversity.

Figure 1 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.[17] The model is general in the sense that its specification, i.e. in terms of variables used, their relative importance, as well as direction and relative importance of links, will depend on

[13] The capital approach to development (World Bank, 2011) assumes weak sustainability.

[14] A 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).

[15] However, both LSF and happiness data obtained from surveys are usually 'remembered' or 'life evaluation' measures. Helliwell and Wang (2012) report that such measures for 'life as a whole' currently available from different surveys all tell very similar stories, in contrast to SWB measures that try to capture emotional states at a point in time. Such emotional report measures usually show more variation over time, but differ much less from community to community.

[16] The multitude of potential SWB measures, even when the same general definition of SWB is used, indicates the need for some standardization, hopefully in the form of integrated national systems of SWB accounts.

[17] This 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, 2010, p. 3).

the specific innovation analysed. It can be applied at different levels of aggregation, for different time frames and for different types of data. Hirata (2011) provides a useful, though from an evolutionary perspective limited, starting point for classifying empirical 'happiness research': He suggests studies can be classified in four ways depending on whether cross-section or panel data are used, and whether individual (micro-level) data or group-average data are used. Each category can potentially be further subdivided in many ways, e.g. by extent of geographical coverage, subgroups of people etc. Importantly, Hirata points out that relationships that hold for one type of study need not hold in another type of study.

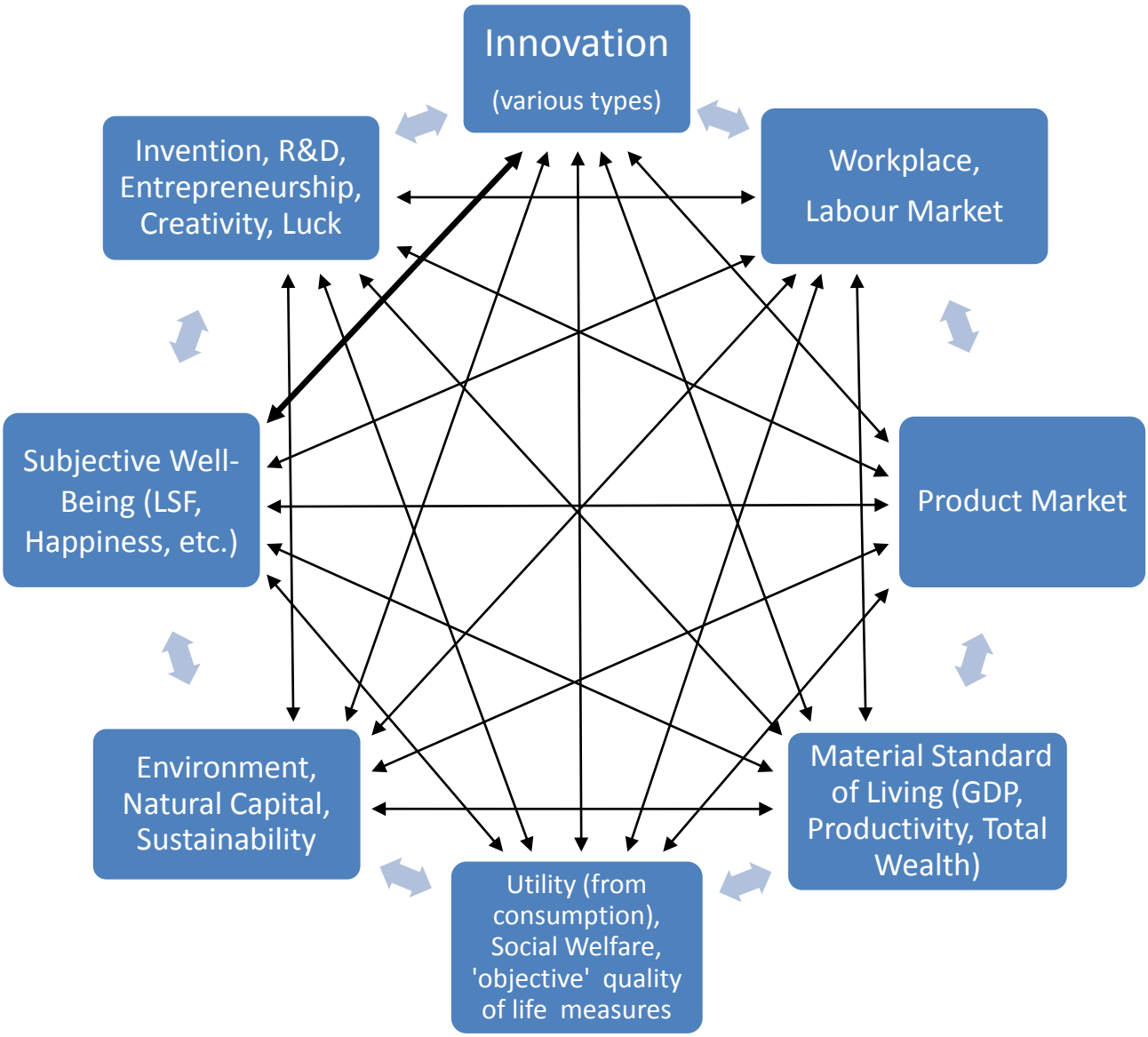

Figure 1: The "everything relates to everything else" model of the innovation – SWB nexus

Although Figure 1 captures many potential links, it still only accounts for a subset of them.[18] One should think of Figure 1 as being embedded within a box or frame that captures broad societal factors that influence innovation, SWB, and the other concepts in the model. We briefly discuss such wider considerations at the end of Section 3.2. In Section 3.1 we neglect them and instead focus on some of the connections between concepts. Figure 1 is what in graph theory is called a complete graph. In any particular application, this will be transformed into another type of graph by dropping some of the connections which are found not to be important. The nature of connections is therefore central. It is tempting to draw parallels to Potts' (2000) characterisation of heterodox economics as giving explicit recognition to the web of connections and changes in connections over time (i.e. evolution). By contrast, orthodox economics can ignore the specificity of connections because it assumes that everything is connected. An empirical exploration of the innovation-SWB nexus using our proposed model requires going from the general (everything is potentially connected) to the specific. It could therefore be said to imply the basic unifying methodology underlying heterodox economics.

3. DISCUSSION OF THE PROPOSED MODEL

3.1 Connections

The following discussion is not meant to be exhaustive. The potential complexity of relationships is simply too great. We leave it to the reader to try and think about possible additional links and feedbacks in the context of particular innovations of her/his choosing. We begin our discussion by first locating the linear model of innovation in our model. Next, we focus on links emanating from our various concepts, starting with innovation.

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

As pointed out by Swann (2009), a complex model like that shown in Figure 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 all the other possible links and feedback effects (many of them will be discussed in the rest of this paper). In particular, it assumes that invention etc. precedes innovation and that innovation only increases welfare/well-being if it increases GDP etc.

It is easy to contemplate that even if the linear model did apply and innovation increased conventionally measured welfare, the net impact of innovation on SWB might be weakened or even become negative. Procedural utility impacts might counteract outcome utility, for example 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 the effects of consumption on the environment (more garbage, lower amenity values, depleted resources) or due to status effects (keeping up with the Joneses, the hedonic

[18] Many correlates of happiness/SWB have been identified in the literature (see Hirata, 2011, Veenhoven, 2012).

treadmill). 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.

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, for example due to ICTs (Cohen, 2003; Layard, 2005; Bryson et al., 2009), 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.

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 from the product market to environmental sustainability and SWB). There are also direct links from innovation to the 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.).

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 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 noted earlier. However, Phelps views are an improvement over those of mainstream KBE analysts like, for example, Foray (2006), who seem to have neglected any direct SWB impacts of the innovation process itself.

Last but not least, it should 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.[19] 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.

Some effects of invention etc.

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. However, if this increases work morale it is likely to raise worker productivity (as well as SWB). There is also some evidence of mutual, if not reverse, causation. For example, Dolan et al. (2008) try to find out whether higher SWB is conducive to creativity and whether working in an innovative environment (proxied by work in the R&D sector) is conducive to higher SWB. They find positive correlation between SWB and creativity, and between SWB and work in the R&D sector.

There are other direct links between creativity and SWB that bypass the workplace. For example, 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, product market and consumption is Von Hippel's (1988, 2005) user innovation by intermediate or final 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.

Some effects of the workplace and labour market

[19] For an introduction to the literature on consumer resistance to innovation adoption see Kleiynen et al. (2009).

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. Frey et al. (ibid.) find that procedural utility is of great importance in employment.[20]

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 (for example 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 examples of France Télécom (Jolly and Saltmarsh, 2009) and Foxconn (Moore, 2010) come to mind.

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 (for example processing of e-waste in Africa, the ship recycling yards near Chittagong in Bangladesh).

Some effects of product markets (the market place)

Purchasing final goods and services increases consumption. It is usually assumed that this also increased welfare and SWB. However, product markets might negatively impact on some people's SWB, i.e. 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 then 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.). Their 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.

Some other links

There are many other links which might be of importance when analysing the innovation-SWB nexus. Some of the more obvious ones are, in brief, as follows. (a) The impact of economic growth on environmental sustainability. (b) The link from the environment, due to its amenity value, to SWB. (c) Swann (2009) mentions that how and what we consume affects the environment in different ways (house insulation, recycling, extent of car use etc.). (d) There is some research on the link between consumption of, specifically, digital products and SWB. See, for example, Dolan et al. (2008) and Kavetsos and Koutroumpis (2011), who

[20] Frey at al. (2004, p. 385/6) argue, e.g., that "hierarchy constitutes a procedural disutility because it interferes with innate needs of self-determination".

find positive correlations for some products. The latter argue this might have implications for public policy, i.e. for recognising internet access as a fundamental human right. (e) Social capital, which is part of TW, is known to directly and positively affect SWB (Helliwell and Putnam, 2004; Helliwell and Wang, 2009). (f) There might also be a direct link going from social capital to innovation (Akcomak & ter Weel, 2009). (g) Swann (2009) mentions a number of links emanating from wealthy individuals: Creativity, invention and innovation might be supported by business angles or through philanthropy (for example large donations to universities). (h) There might be a connection between entrepreneurship and SWB. However, the literature reports conflicting results on this issue.[21]

Last but not least, Figure 1 indicates why the relationship between economic growth and average SWB in advanced KBEs, i.e. part of the Easterlin Paradox, is so contested. [22] 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 our model should provide a new avenue for exploring the Paradox. If it turned out that there is one very strong negative link impacting on SWB, focussing policies on changing that link might have a strong effect on overall SWB.

3.2 Further comments on Figure 1: Some general issues

We briefly highlight a number of general issues that will 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 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, i.e. LSF, or should impacts also be measured for other types of SWB? It is well established in the literature that for different SWB measures, for example 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.

[21] See, 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.

[22] For 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.

Level of analysis and interaction effects: There might 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.[23] 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 (for example, there might be work-life balance issues, such as work stress negatively affecting a person's private 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: So far we have not raised the issue of what time horizon should be used. There are usually trade-offs between short-term and long-term SWB impacts of innovation and, importantly from a Schumpeterian perspective, preferences evolve over time.[24] 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, memory bias etc.[25] might add important time dimensions. Moreover, it seems to be easier for people to adjust to unpleasant certainties than to uncertainty (Graham, 2011). How does the degree of uncertainty associated with particular innovations vary over time? How does this affect SWB? What trade-offs will be acceptable?

The issues become even more difficult when trying to take the (subjective and objective) well-being of future generations into account. In our view, this is another reason why measured SWB impacts cannot be used as the only criterion to judge the welfare implications of innovation. To sum up, what time horizon to use when implementing our model empirically is a difficult question to answer a-priori. However, project funding, resulting data availability etc., will dictate pragmatic answers.

Framework conditions: So far we have not discussed broader societal factors or framework conditions, such as the nature of the innovation system, or 'culture' and 'values'. It should be clear that they potentially affect all variables and links shown in Figure 1 (think of further arrows connecting the variables to a surrounding frame). 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; Inglehart and Welzel, 2005; Inglehart et al., 2008). 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, Engelbrecht (2007) observes 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. Moreover, Diener and Seligman (2004) report that negative effects of materialism in

[23] See Dopfer et al. (2004) on the importance of the meso in evolutionary economics. They argue meso change (or the 'meso trajectory') is central for understanding evolutionary dynamics.
[24] While advocating the measurement of SWB impacts at different points in time, we do not implicitly assume that preferences stay the same.
[25] See, e.g., Hirata (2011, pp. 59-63).

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.

The framework conditions will further include other (or more direct) determinants of the National and other Systems of Innovation, including the Intellectual Property Rights regime, opportunities and incentives for talented individuals, and other institutional factors. In short, additional (national and/or international) determinants affecting Figure 1 might need to be added.

To summarize, we argue that a pragmatic approach will be required when implementing our model for specific innovations. Analysts should determine the most important variables and connections between them, and also indicate what should but cannot be measured. Only the accumulation of such studies is likely to enable us to make progress in understanding the innovation-SWB nexus.

4. SUMMARY AND CONCLUDING COMMENTS

Building on Swann's (2009) contribution, we have proposed a complex, multifaceted conceptual 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 (Stehnken et al., 2011) associated with today's big societal challenges and developments in SWB research, including increased efforts to collect SWB data on a more frequent, widespread and consistent basis.

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, for example, Dolan et al. (2008), Diener et al. (2009).

Adoption of a SWB perspective in the economics of innovation should impact on the evaluation of innovations and on innovation policy. We 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 impact on productivity, profitability, or similar economic performance measures. Increased awareness and knowledge of 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. However, it might also affect behaviour.[26] Any feedback effects would have to be taken into account when formulating policy. [27]

However, we do not argue that SWB should be the only criterion for judging the impacts of innovation, and we do not advocate that it should be maximised at the neglect of all other considerations. Rather, better knowledge about SWB impacts should provide an additional input into innovation and knowledge policy making, which might be quite subtle. Hirata (2011, p. 153/4) captures our sentiment well 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. Where it has to choose, it will opt for quality of life at the expense of economic growth and not for the contrary.
>
> … 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.

In short, while good development and the good life should not be reduced to happiness/SWB, the latter are surely an important part of the former. In a similar way, Engelbrecht (2007, 2012) has argued that SWB research can and should contribute to the development of wisdom-based knowledge policies based on conceptions of the good life.[28] The model of the innovation-SWB nexus proposed in this paper is meant as a contribution to the development of the analytical tools needed to advance the quest for wisdom-based knowledge policy making.

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[26] Diener et al. (2009, p. 66) refer to this as the psychological Heisenberg principle. It is the idea that measuring may affect what is measured.

[27] Potts (2011) suggests there are happiness signalling effects which imply that economic agents learn from each other about what creates happiness, similar to price signalling effects emphasized by Hayek. He uses this as an argument against SWB measurement and against 'happiness policies'. While happiness signalling might be an important evolutionary mechanism, we are sceptical of Potts' dismissal of a SWB perspective on policy. If private agents can learn what promotes SWB, so should government, given its role in the economy. Potts' proposal seems to be a case of throwing the baby out with the bath water.

[28] On 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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