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Information, capital, well-being

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Don Lamberton asked many questions about the nature and role of information, without expecting to be able to provide tidy or neat answers. The issues he raised have not gone away or been resolved. Some have re-appeared in modified or new form. This paper first focuses on the analysis of information at the macro-level, starting with the ill-fated 'information sector' studies and leading on to current attempts to use neoclassical economics to measure macro-level capital stocks in the context of the debate about sustainable development, also known as 'wealth accounting'. Wealth accounting has no place for information-as-capital that goes beyond very primitive proxy measures for intangible capital other than human capital. Often, information-as-capital is neglected completely by denoting such capital stocks as 'enabling assets' that are assumed to be reflected in what turn out to be unmeasurable shadow prices. Next, an issue mostly neglected by Don Lamberton is discussed – the normative assessment of information and innovation. It is argued that neither mainstream economics nor evolutionary economics, information studies, innovation studies and so on currently has an appropriate normative theory of innovation. Increased output, innovation counts, productivity, competitiveness and consumption-related utility (what economists call 'welfare') are poor indicators of what really should be measured, which is the objective and subjective impacts of innovation on people's well-being.

Introduction

Despite information-related topics having penetrated all branches of economics, many of the shortcomings related to the analysis of information and innovation that were highlighted by Don Lamberton remain unresolved or have re-surfaced in new form. The main aim of this paper is to highlight the continuing relevance of Don Lamberton's particular questioning of how mainstream (neoclassical) economics deals with information by relating it to the current literature on 'wealth accounting' that focuses on macro-level capital stocks, and 'intangible capital' in particular.[1] This seems appropriate for two reasons. First, Don Lamberton remained an economist throughout his career, and a non-dogmatic one at that, to the frustration of some of his fellow travellers, who would have preferred him to be less accommodating towards neoclassical economics (see, for instance, Paquet, 1999). Second, the arguably main feature of Don Lamberton's approach to information economics was to regard information and organisation as forms of capital (Lamberton, 1999; Potts, 2003). Capital and its measurement have received increased attention from neoclassical economists in recent years, especially in the contexts of developing metrics that

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go beyond gross domestic product (GDP) to assess economic performance and quality of life, and when trying to analyse economic sustainability (Stiglitz *et al.*, 2009).

To provide context, we briefly go over the old information sector approach, which was an early macro-level approach aimed at highlighting structural changes towards an information economy. We then discuss current wealth accounting approaches, developed to assess economic sustainability by focussing on changes in wealth (changes in macro-level capital stocks). At first sight, the two approaches may seem unrelated. They can be linked by, in particular, how the 'information-as-(macro)-capital' issue is dealt with.

Another aim of this paper is to highlight a vexed issue mostly missing from Don Lamberton's work, but which seems a necessary complement to his efforts. This is the search for an appropriate normative theory of information and innovation. It is argued that such a theory needs to be evolutionary and incorporate the objective as well as subjective assessment of well-being. The less familiar subjective assessment is emphasised, and related to a similar effort by Swann (2014), who focuses on Ruskinian (R-)'wealth'.

Accordingly, the paper is divided into two main parts. The first part has subsections discussing the information sector approach, the literature on intangible capital, macro-level wealth accounting and economic sustainability. The second part is more speculative and focuses on some of the key features on which a normative theory of information and innovation should be built.

Information-as-capital, information sectors, wealth accounting and sustainability

From information as a peculiar form of capital to information sector studies

Don Lamberton's PhD thesis (Lamberton, 1965) critically re-examined the theory of profit and pointed out the need for a new theory that incorporates the peculiar properties of information and organisation. Reviewers at the time correctly perceived his contribution to have been confined mainly to the micro-economic (firm) level (Penrose, 1966). Nevertheless, Don Lamberton (1965, p.6) argued that it would be quite logical to include information and organisation in an expanded definition of capital at both the micro- and macro-economic levels.

In later years, Don Lamberton often pointed out the macro-economic implications of information as a costly resource, especially when it came to broad structural changes in terms of either industries or types of employment, if only because it seemed to strengthen his general arguments about this very peculiar resource, and his particular argument about the importance of complementary information activities taking place in different industries. For example, he argued that because information is not a free good, 'already, an information industry of impressive proportions has developed' (Lamberton, 1974, p.145), and that 'if in our contemporary world information resources are the most important requirement for economic growth, the analysis of income shares ought to mirror that state of affairs' (Lamberton, 1974, p.151).

However, despite supporting a macro approach to information activities, Don Lamberton, quoting Arrow (1974) on the limits of organisation, was also tireless in pointing out that size does not usually imply efficiency, and that aiming to achieve

efficiency might be the wrong objective. Instead, the focus should be on the structural relations within this peculiar form of capital (Lamberton, 1999).

The current author's entry point into Don Lamberton's orbit was a project on the measurement and analysis of information sectors in Pacific countries that built on Machlup's knowledge industry approach (Machlup, 1962) and Porat's approach of measuring so-called primary and secondary information sectors (Porat, 1977). The primary information sector is made up of industries that are based on traded information goods and services. The secondary information sector accounts for the parts of other industries that consist of non-traded organisational information activities measured by information inputs. These 'quasi-firms' capture public and/or private bureaucracies. Information sector studies were an attempt to account for the rising importance of information outputs and inputs at the macro level while sticking (more or less closely) with the national accounting framework. They often applied input–output analysis in order to obtain insights into the structural relationships between the information sectors and the rest of the economy.[2] They were an attempt to analyse structural change from an information-theoretic macro perspective.

Information sector studies were criticised on methodological grounds (for mixing inputs and outputs, and for the many pragmatic decisions required to delineate information outputs and inputs) and for a certain degree of hype about the importance of the information sectors and their relevance for policy (see e.g. Wellenius, 1988; Lamberton, 1996; Engelbrecht, 1997; Braman, 1999). Interestingly, there is great theoretical similarity and empirical overlap between the information sector approach and the measurement of transaction costs in the economy, and the two approaches face similar criticisms (Engelbrecht, 1997). However, in hindsight, the criticisms do not seem any more troubling or severe than problems associated with current approaches to measuring wealth comprehensively at the macro-economic level, as is highlighted below.

From information sectors to intangible capital

Over recent decades, there has been a growing interest in measuring 'intangible capital' at the firm and country-wide levels, using a variety of approaches and methods, and trying to establish its importance for firm performance and economic growth in general. In many ways this can be seen as an exploration of the quasi-firms of the secondary information sector, especially if we amend the latter to include private and public bureaucracies across *all* industries in an economy (including industries in the primary information sector).

Ståhle *et al.* (2015, p.22–27) discern three distinct and fairly separate research traditions with respect to the literature on intangible capital. One focuses on various forms of human capital. Another focuses on the national accounting framework, estimating monetary values for 'intangibles', the latter consisting mainly of computerised information, innovation, research and development (R&D) and 'economic competency', including organisational capital (see Corrado *et al.*, 2005; Lev and Radhakrishnan, 2005). A third stream of research was established in Sweden, based on the work of Sveiby (1997). It focuses on the related concept of 'intellectual capital' and its three major components of human, organisational and relational capital. Drawing on all three research traditions, Ståhle *et al.* (2015) explore the importance of national intangible capital (intangible capital at the national level) for economic growth. It seems to cover a wider range of intangibles than do earlier studies based on firm-level data.

The interest in intangible capital is also reflected in reports published by the Organisation for Economic Co-operation and Development (OECD). Arguably, the information sector approach has survived, at least to a certain extent, in a modified and transmuted form in current OECD efforts to measure the knowledge-based economy (KBE). The focus is on 'knowledge industries', defined in a rather narrow sense,[3] and knowledge-based capital (KBC), also often referred to as intangible assets or intellectual capital. Parallels with the primary and secondary information sectors can be drawn.

KBC is seen as constituting a long-lasting resource for companies and institutions (OECD, 2015, p.38). It is argued that KBC results mostly from investment in human capital. KBC assets consistent with the System of National Accounts definition include software, R&D, entertainment, literary and artistic originals, and mineral exploration (OECD, 2015). It is widely recognised that firms' investment in KBC is usually much larger than that in physical capital, but that this varies among industries. The OECD is also experimenting with a methodology to measure the related concept of 'organisational capital' by identifying firm-specific capital in terms of workers, such as managers, supervisors and professionals, and assuming that they devote a certain proportion of their time at work (one day per week) to organisational tasks. The corresponding proportion of their salaries is then accounted for as investment (OECD, 2015, p.40).

National wealth accounting, sustainability and the curious case of the pragmatically preferable mistreatment of 'enabling assets'

A separate, and mostly macro-economic, research stream not referenced in Ståhle *et al.* (2015) has developed from concerns about sustainable development, defined as sustainability of comprehensively measured wealth. This consists of macro-level estimates of all forms of capital – natural capital, physical capital, human capital (and other forms of intangible capital). It also differs from OECD work on the KBE in that it focuses on measuring actual stocks of capital, not such proxies as expenditure or employment related to KBC, and it puts great emphasis on the inclusion and measurement of natural capital.

There are currently two major related, but alternative, approaches to measuring comprehensive wealth that are pursued by international organisations. One is the estimation of 'total wealth' by the World Bank (2006, 2011). The other is the estimation of 'inclusive wealth' by the United Nations University–International Human Dimensions Programme and the United Nations Environment Programme (UNU–IHDP&UNEP, 2012, 2014). Both are attempts at comprehensive wealth accounting based on neoclassical economics. Numerous theoretical and empirical assumptions are made in the derivation of the estimates, and many shortcomings and unresolved theoretical and empirical issues remain. Both approaches can also be criticised, as can conventional GDP-based growth accounting, for excluding any meaningful role for innovation (Engelbrecht, 2014a). However, this has not prevented the rising popularity of the macro-capital framework amongst public policy makers (Engelbrecht, 2014a), and in discussions about the 'big issue' of sustainability.

Focussing on the estimation of intangible capital, there are major differences between the two approaches. World Bank (2006, 2011) measures total wealth directly as the present value of discounted future consumption. They then subtract sub-categories of capital that can be measured directly – that is, natural capital

(the measurement of which is still expanding relatively quickly) and produced capital (the most established form of measured capital). The difference (the residual) is the intangible capital estimate. By definition, the latter incorporates all forms of capital other than natural and produced capital (and any measurement errors associated with these two) as well as technological progress. The forms of capital not measured directly include human capital, organisational capital, social capital and institutional capital. Estimates of the directly measured capital stocks tend to improve over time with progress in the underlying theories and available data, and they seem much larger than the national intangible capital estimates derived by Ståhle *et al.* (2015).[4]

The World Bank approach of deriving total wealth has been criticised by Arrow *et al.* (2012). The latter advocate using only capital stocks that can be directly measured to derive an estimate of comprehensive wealth. These are confined to natural capital, produced ('reproducible') capital, human capital and health capital (the last is a distinct form of human capital).[5] However, the inclusion of health capital is controversial. Its estimated value is more than twice as large as all other forms of directly measured capital combined.[6] Social capital and other types of intangible capital are not explicitly measured, despite the extensive literature on some of them.

The Arrow *et al.* (2012) approach underlies the bi-annual Inclusive Wealth Reports published by UNU–IHDP and UNEP (2012, 2014). However, health capital is excluded from these reports because it would dominate all else (we are promised a focus on health capital in the 2016 *Inclusive Wealth Report*). Types of capital other than the remaining directly measured ones, such as social and institutional capital, are assumed to be 'enabling assets' (assets that enable the production and allocation of natural, produced and human capital). The effectiveness of such enabling assets is supposedly reflected in the shadow prices of the directly measured capital stocks.

Social capital is understood broadly to include institutions, culture, religion and knowledge (UNU–IHDP and UNEP, 2014). It seems fair to assume that information-as-capital and organisational capital would also fall into the category of enabling assets. In earlier writings, Arrow dismissed outright the notion of social capital (Arrow, 1999). One may wonder whether this view has carried over, albeit in less extreme form, into the methodology used in the *Inclusive Wealth Reports*. For a defence of social capital as a form of capital, see Robison *et al.* (2002).

It might be theoretically defensible, or even preferable, to treat intangible capital (other than human capital) differently from the tangible forms of natural capital and physical capital, but a comparison of empirical estimates reveals that the estimated shadow prices are grossly misleading. Smulders (2012) calls the calculation of shadow prices the Achilles' heel of Arrow *et al.*'s (2012) approach. In fact, it makes the World Bank approach of deriving an estimate of total wealth empirically more attractive.

This is illustrated in Table 1 using data for 30 OECD countries from both the World Bank (2011) and the *Inclusive Wealth Report* 2014 (UNU–IHDP and UNEP, 2014). Focussing on 2005 (the best year to compare wealth estimates from the two sources), the total wealth estimate from World Bank (2011) is much larger than the inclusive wealth estimate from UNU–IHDP and UNEP (2014). This is mostly attributable to the intangible capital estimate being much larger than the human capital estimate (it also includes other forms of intangible capital). Natural capital is measured more extensively in the *Inclusive Wealth Report*, resulting in the larger estimate, but natural capital estimates are small in dollar terms compared with the other capital stocks. Physical capital estimates from the two approaches are fairly

Table 1. Average wealth per capita (in 2005 US$) and wealth (capital) shares, 30 Organisation for Economic Co-operation and Development (OECD) countries, 2005.

World Bank (2011)				***Inclusive Wealth Report* 2014**			
Total wealth	Natural capital	Produced capital	Intangible capital	Inclusive wealth	Natural capital	Produced capital	Human capital
498,953	15,451 (3.1%)	92,517 (18.5%)	390,594 (78.3%)	362,421	27,744 (7.7%)	99,785 (27.5%)	234,892 (64.8%)

Note: Shares are shown in brackets.
Source: Engelbrecht (2015, Table 3, p.15).

similar. If the enabling assets were reflected in the directly measured capital stocks, the dollar value for inclusive wealth should not differ much from that for total wealth.

The differences in per-capita values shown in Table 1 also matter when it comes to wealth shares. The *Inclusive Wealth Report* data suggest a far greater relative importance of physical capital compared with the World Bank data, and by excluding direct estimates of intangible forms of capital other than human capital, the relative importance of intangible capital seems greatly reduced. The higher percentage for natural capital derived from *Inclusive Wealth Report* data is mostly caused by the improved (more comprehensive) measurement of natural capital. Lastly, and not surprisingly given the differences highlighted so far, sustainability indices derived from the two wealth data bases for a large sample of countries are not highly correlated (for details see Engelbrecht, 2015). This raises some doubt as to whether the main objective of the *Inclusive Wealth Reports* of measuring progress toward sustainability (to quote the subtitle of the 2014 *Report*) is even roughly achieved.

In short, the two methodologies and resulting estimates provide different impressions about the relative importance of the different capital stocks and about economic sustainability, even when disregarding the difficult issue of health capital. Moreover, while the total wealth data at least implicitly include empirical estimates of information and organisational capital as part of intangible capital, the inclusive wealth data, despite assumptions to the contrary, do not.

Instead of pretending that the inclusive wealth estimates include intangible forms of capital via the shadow prices of natural, produced and human capital, it would make sense to subtract these more up-to-date direct capital estimates from the World Bank's total wealth estimates to obtain the 'residual of the residual' (intangible capital minus human capital).[7] This would make information-as-capital visible, at least to a certain extent. Because of this partial visibility, it is taken seriously (in the sense of not distorting the big picture of the relative importance of different capital stocks), rather than theoretically assumed to be taken into account as an enabling asset, but practically ignored.

However, it is also abundantly clear that treating information as capital in neoclassical terms leaves out many of its important aspects and consequences. A similar point was made by Braman (1999) about perceiving information as a commodity in neoclassical terms (the information sector approach). She describes its proponents as 'clinging to an old paradigm in the face of mounting evidence of difficulties in the application of this paradigm' (Braman, 1999, p.119). It is sobering to realise that the old paradigm is still currently seen by many economists, and many powerful international agencies, as being at the forefront of analysing sustainability and deriving relevant policy options for dealing with it.

There is some irony here. It is ironic that to make information-as-capital visible in neo-classical models of macro-level wealth accounting, it makes sense to include it as part of a separate form of capital alongside more traditional forms of capital. Proponents of neo-classical economics see it as enabling capital that, as even critics would say is in principle correct, affects and transforms traditional forms of capital. However, the way the impact of the latter is currently taken into account empirically is utterly unsatisfactory, and might always remain so.

The need for an evolutionary theory of wealth and a normative theory of information and innovation

Wealth accounting is just that, accounting. It is not a theory of economic development. Like the more familiar GDP-based growth accounting, it might be compatible with different, even alternative, theories. Put somewhat poetically, the macro-level capital estimates and their changing shares are the relatively calm surface of the economic and social system seen through the spectacles of constant returns to scale, beneath which lurk tempestuous, complex, path-dependent and multifaceted dynamic processes that are little understood and far from 'efficient' or 'optimal'.

A dynamic analysis of all forms of capital needs to be based on evolutionary economics. It needs to incorporate both technological and institutional change, adopt extensive modelling of structural relations within capital stocks, and include analysis of the multitude of externalities associated with the use of any piece of capital (within information capital and other capital stocks, but also between them). The issue of substitution of information and organisational capital for other forms of capital was raised early on by Don Lamberton (1965, p.188). It has also risen to prominence in the discussion of natural capital and the capital approach to development, with the World Bank advocating the use of proceeds (rents) from natural capital to build up other forms of capital, and ecological economists arguing that some forms of natural capital ('critical' natural capital) cannot be substituted. The extent to which the other macro-capital stocks have critical and non-critical components is much less explored. The development of macro-level wealth accounting brings the substitution issues raised by Don Lamberton back into the spotlight.

However, adopting an evolutionary approach to capital formation by itself is not enough if one wants to derive normative implications that can be used as the basis for policy. Arguably, mainstream economics does not currently have an appropriate normative theory of innovation, and nor do evolutionary economics, information studies and innovation studies. Increased output, productivity, information stocks and flows, innovation counts (the 'innovation *per se* is good' view), and consumption-related utility (what mainstream economists call 'welfare') are poor indicators of what really should be measured.

Don Lamberton, although tirelessly pointing out the destructive implications of information economics for neoclassical economic theory, including for Pareto optimality, is largely silent on an alternative to a normative assessment appropriate to an information economics based on the notion of information-as-capital. But there are a few exceptions. For example, he mentions the need to extend the notion of optimality to organisations and their design (Lamberton, 1992), emphasises productive efficiency and international competitiveness (Lamberton, 1998a), and highlights the neglected role of subversives as a low cost, highly productive resource for increasing informational efficiency and productivity, and the need for new institutions to improve the use of knowledge as well as a balanced approach combining socio-economic and technological objectives (Lamberton, 2001). He also emphasises the role of mindsets as a neglected, but often crucial, barrier to information sharing (Lamberton, 2005). Despite the concern for informational efficiency and information-as-capital, Don Lamberton's comments on normative aspects seem to have been mostly confined to standard economic impacts (e.g. competitiveness, innovation, economic growth) and hints at policy needing to go beyond correcting market failures and to encompass the requirement of institutional innovation and evolutionary change.

A normative assessment of information and innovation is, undoubtedly, extremely difficult, but since the publication of Stiglitz *et al.* (2009), the notion that (economic) welfare should be replaced by well-being based on both objective and subjective quality-of-life measures that go beyond income and wealth has gained ground. While objective quality-of-life measures are more familiar, a detailed exploration of the many, and usually neglected, relationships of the innovation-subjective well-being (SWB) nexus is also necessary in order to get a better idea of the overall well-being implications of innovation (Engelbrecht, 2014b). Such knowledge should be used as an additional input in policy-making alongside objective indicators and other considerations.[8]

Similarly, Swann (2014) emphasises the importance of humans as creative beings who derive well-being not only from business innovation (B-innovation), but also from innovation in all other spheres of life. He calls the latter 'common innovation' (C-innovation) and describes it as 'humble innovations made by individuals, households, clubs and local communities' (Swann, 2014, p.ix). C-innovation is 'everywhere; …unexceptional, non-proprietary, inexpensive and modest' (Swann, 2014). Moreover, 'some common innovation activity is *collective*,… But much common innovation is *not* collective' (Swann, 2014, p.4, italics in original). In other words, C-innovation is an inherent attribute of human nature. Potts' (2015) view that C-innovation should be seen as a product only of collective action is unjustifiably restrictive, a consequence of using the lens of an 'innovation commons'. B-innovation is associated with Schumpeterian 'creative destruction', a term immediately highlighting that innovation has positive as well as negative impacts, whereas C-innovation is described as more of a 'gentle and benign breeze' (Swann, 2014).[9]

Swann also distinguishes between material (or M-) wealth and Ruskinian or real (R-) wealth. This is done to emphasise that business does not have a monopoly on wealth creation in society. Both B-innovation and C-innovation contribute to it. However, given the 'wealth equals capital' terminology employed throughout this paper, Swann's distinction between M-wealth and R-wealth is somewhat unfortunate. M-wealth can be thought of as the material means to create R-wealth. The latter is closer to the normative criterion of SWB. R-wealth is not a form of wealth-as-capital, but closer to SWB. Wealth accounting recognises this difference by acknowledging that wealth is a determinant, and not a constituent, of well-being; it focuses on the ingredients necessary for creating well-being (Duraiappah and Jamshed, 2014, p.3). This issue takes us back to early economic writings about what is meant by objective and subjective income and wealth. Fisher (1906) explores this fundamental economic issue and introduces the term 'psychic income' to describe something similar to SWB or R-wealth.

Moreover, Swann's brief discussion of why he does not use the term 'happiness' is somewhat simplistic and misleading (Swann, 2014, p.12). In common with many economists, he uses happiness when referring to SWB research, thereby at least implicitly suggesting it captures only frivolous, momentary emotions. The term 'SWB' would have been preferable, in particular as Swann argues that R-wealth is similar to *eudaimonia*, or psychological flourishing, which is a form of SWB (see OECD, 2013).

Although innovation researchers have not yet settled on an appropriate normative theory, further exploration of synergies among SWB research, R-wealth and Sen's capability approach seems promising (Sen, 1985). This should be seen in the context of trying to develop an evolutionary and systemic normative theory that tries to

avoid both the long-run fallacy of innovation economics (the axiomatic assumption that more information/knowledge/innovation is always desirable *per se*), and the ecological fallacy of confusing societal with micro-level analysis (Engelbrecht, 2014c). How can the long-run fallacy be criticised, given the rise in living standards over the long run in the now-developed countries? The problem is that those who benefit from innovation are often future generations, whereas the current generation is fully exposed to the positive and negative impacts traceable in the innovation-SWB nexus and via objective quality-of-life indicators. It is an intriguing question for future research to explore whether a shift in the balance between C-innovation and B-innovation towards the former, as suggested by Swann (2014), might reduce the severity of the long-run fallacy. The ecological fallacy refers to drawing conclusions from individualistic evolutionary welfare theory and applying them at the aggregate level. The innovation system, SWB and the objective quality of life are systemic and co-evolving, and system-level relationships often differ from relationships at the micro-level (Engelbrecht, 2015b).

Concluding comments

Don Lamberton's search for an appropriate place for information-as-capital in economic theory is of continuing relevance. As illustrated in this paper, this is especially obvious in recent approaches to measure comprehensively macro-level capital stocks in order to analyse the big issue of economic sustainability. Discussion might have morphed from the secondary information sector to organisational capital, to intangible capital and wealth accounting, but there is still no place for the peculiar properties of information-as-capital. When confronted with the implications of imperfect competition because of the peculiar properties of information, Lamberton (1998b) lamented that many economists opt for the 'Hicksian getaway' – they assume that markets are not far from perfect competition. The same still applies to current attempts at macro-economic wealth accounting that assume universal constant returns to scale.

Moreover, comparing the methodologies used in World Bank (2006, 2011) and UNU–IHDP and UNEP (2012, 2014), although the inclusive wealth methodology might seem conceptually preferable because it treats forms of intangible capital other than human capital as enabling assets (differently from the conventional production factors), the estimates provided by the World Bank nevertheless make more sense and suggest quite different contributions of the different capital stocks. The fact that measurement of comprehensive capital at the macro-economic level is still so unsettled, and that it is still confined to a mostly static neoclassical approach that has no room for the crucial dynamic and evolutionary aspects of information-as-capital and innovation, should be an eye-opener and warning to many economists, not only those concerned with sustainability.

Lastly, the development of a normative theory of information-as-capital and innovation is, arguably, a much under-researched and under-developed topic, although it is receiving increasing attention from a number of researchers. Progress in SWB research over recent decades and the acceptance by governments and statistical agencies of a plethora of objective and subjective quality of life indicators provides additional avenues to shed light on the issue. There is some prospect that we might eventually be able to answer the key question: What is all the information for?

Notes

1. The terms 'capital' and 'wealth' are used synonymously in this literature and throughout this paper.
2. The project's outputs were mostly primary information sector studies for various Pacific countries. They were published in Jussawalla *et al.* (1988).
3. OECD (2015, p.25), for example, defines 'information industries' as covering International Standard Industrial Classification Revision 4, Division 26 (manufacturing of computer, electronic and optical products) and Section J (information and communication services), and analyses employment growth in these industries.
4. For example, Ståhle *et al.* (2015) find that intangible capital over the period 2001–2011 accounted for 45% of world GDP, which they argue is much higher than the proportion obtained from previous attempts to measure intangible capital using firm-level studies. In contrast, World Bank (2011) reports that intangible capital accounted for 76% of total wealth (not GDP) in 1995. Not only is the percentage derived from the World Bank data much higher, but total wealth itself is much larger than GDP.
5. They also try to account for some other items, such as oil net capital gains and carbon damages.
6. Also see Hamilton (2012), who comments on the overwhelming importance of health capital when comparing empirical estimates for the US in 2000 provided by Arrow *et al.* (2012) and World Bank (2011).
7. Given the data shown in Table 1, total wealth minus inclusive wealth (the residual of the residual) amounts to US$136,532. Human capital then accounts for 47.1% of total wealth and the 'residual of the residual' for 27.4% of total wealth.
8. Also see Menou (1999), who recognised the importance of exploring the links between information and SWB.
9. A standard neo-classical response would be to continue using constrained optimisation and simply expand the utility function to include utility derived from C-innovation. In a similar vein, Arrow *et al.* (2012, p.322) argue that utility is derived from consumption of not only marketed goods and services, but also 'leisure, various health services, and consumption services supplied by nature'. This is little more than a semantic trick as it does not change the assumptions of constant returns to scale, perfect competition, etc.

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