Life Satisfaction, Comprehensive Wealth and Sustainability in OECD Countries, 1995 – 2005: An exploratory analysis

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Abstract

The World Bank has published comparable 'total wealth' (TW) data for 1995, 2000 and 2005. Building on earlier research, we explore the relationship between average life satisfaction (LSF) and TW, and some related issues (composition of TW, growth rates, convergence, LSF and natural capital), focusing on twenty-six OECD countries. Furthermore, some have argued that 'change in TW per capita' is a more appropriate (economic) sustainability indicator than, for example, Adjusted Net Savings per capita. The paper, therefore, also explores how closely these and other sustainability indices associated with the capital approach to development are correlated with each other, and with some other major sustainability indices. The paper aims to contribute to the attempt to bridge the divides between the 'happiness' literature, the literature on comprehensive wealth, and that on the wide range of sustainability indices. This would seem an important step forward in the debate about how to achieve sustainable development.

Keywords: Life satisfaction, total wealth, natural capital, convergence, sustainability indices, correlation.

1. Introduction

Using the World Bank's (2006) estimates of (sustainable) comprehensive or total wealth (TW) and its major subcategories for 2000, Engelbrecht (2012) explored cross-country 'wealth-happiness' relationships. A major finding was a strong positive bivariate correlation between subjective well-being (SWB) and natural capital (NC) per capita (NCpc) across all countries, as well as amongst the group of high income countries that excluded the most NC intensive ones as outliers. The latter was despite the fact that for this group of countries, NC accounts for only a small proportion of TW. In a multivariate setting, i.e. when NCpc is included as one of the explanatory variables in a SWB equation alongside other established SWB determinants, the correlation between NCpc and SWB survives in larger samples of countries, but due to the small number of high-income countries, results for that group are not statistically significant (Engelbrecht, 2009).

Since the earlier studies were undertaken, World Bank (2011) has published comparable wealth data for 1995, 2000 and 2005, making it possible to add a time dimension to the analysis. We use these data to further explore the relationship between SWB and TW in OECD countries. This is important for a number of reasons. First, if the aim is to increase 'social welfare', we need to shift from output (i.e. GDP) measurement to TW measurement (World Bank, 2006, 2011).[1] It seems, therefore, useful to know how TW and its composition have changed over time, and what it might mean if we use TW instead of GDP in the analysis of various aspects of economic growth. Secondly, SWB and TW per capita (TWpc) can be interpreted as alternative, and very different, types of welfare measures. TWpc is still an 'orthodox' economic welfare measure. By contrast, SWB measures of welfare are based on mental-state accounts (Dolan and White, 2007). With the rise of 'happiness research', the latter have gained importance in recent decades. However, we know little about how TWpc and SWB compare, how they are correlated, and how this might differ from the relationship between SWB and the more conventional GDP per capita (GDPpc). Therefore, in Section 2 of this paper we first analyse growth rates of GDPpc, TWpc and its major subcategories, as well as changes in the composition of TWpc. We then explore the correlation between the SWB variable employed in this paper, i.e. life satisfaction (LSF), and TWpc versus LSF and GDPpc. The time dimension in the data also makes it possible to explore convergence. We report convergence regressions for GDPpc, TWpc and LSF.

Section 3 of the paper focuses more specifically on NC, for two reasons. First, we want to explore whether the earlier findings reported in Engelbrecht (2012) for the correlation between NCpc and SWB also apply in the current data sample. Given that we restrict our sample to OECD countries, our reason for emphasising NC differs somewhat from that advanced in World Bank (2006, 2011).[2] However, they acknowledge (World Bank, 2011, p.

[1] See World Bank (2011), Note 1, p. 24, for references to papers that establish the theoretical link between change in TW and change in social welfare.
[2] They mostly justify their focus on NC because it is especially important for poor countries, i.e. it is at the heart of the 'capital approach to development' where development is seen as a process of using the proceeds (rents) derived from NC to build up other forms of capital (i.e. wealth).

18) that even when the share of TW accounted for by NC is small, like in most OECD countries, "it is essential to focus on management of NC because it differs in key ways from produced and intangible capital." Not only can it provide a wide range of local and global public goods, but many forms of NC are non-renewable and loss of NC can lead to irreversible changes, which is far less common for other forms of capital. Moreover, substitution is often limited.

Secondly, the time dimension in the data enables us to calculate sustainability indices from the wealth data. In particular, World Bank (2006, 2011) argues that 'change in TWpc' (ΔTWpc) is the appropriate measure of economic sustainability derived from the capital approach to development. However, there is controversy about its measurement. It is of interest to explore how different specifications of this measure are related to other economic sustainability measures, such as Adjusted Net Savings. Furthermore, one might argue that 'change in NCpc' (ΔNCpc) is a different, i.e. environmental, sustainability measure, at least for high income countries. We explore the relationship between various sustainability indices derived from the capital approach to development, other major sustainability indices, as well as an 'objective' (GNI per capita) and subjective (LSF) well-being variable. Stiglitz et al. (2009) argue strongly that environmental sustainability, 'objective' well-being and SWB measures all capture important aspects of well-being, and that they must be measured separately, i.e. they should not be combined to create composite indices. World Bank (2011, p. 23) also recognises that economic sustainability is not the same as human well-being. We agree, and argue that it should be of some interest to know how the three types of measures are correlated. In short, this paper aims to contribute to the attempt to bridge the divides between the 'happiness' literature, the literature on comprehensive wealth, and that on the wide range of sustainability indexes. This would seem an important step forward in the debate about how to achieve sustainable development, a point that has also recently been made by Helliwell et al. (2012).

The paper is organised as follows. Section 2 first discusses LSF, wealth and other data used (except for the sustainability indices, which are introduced in Section 3), and then analyses them. Section 3 begins with an exploration of the relationship between LSF and NCpc. Next are some general comments on sustainability indices, a description of the ten indices used, and analysis of how closely they are correlated. We finish with some concluding comments (Section 4).

2. Life Satisfaction, Comprehensive Wealth, GDPpc: Growth Rates, Shares, Correlations, Convergence

2. 1 Data

Country Coverage

Because comparable wealth data are only available for 1995, 2000, and 2005, we exclude countries that joined the OECD after 2005 (Chile, Estonia, Israel and Slovenia) and those for which no wealth data are reported in 1995 (Poland, Turkey, Czech Republic and Slovak Republic). This reduces the sample to the 26 countries shown in Table 1. These countries account for 85.6% (78.8%) of TW in 1995 (2005) of the over 120 countries included in World Bank (2011).

An advantage of restricting the analysis to OECD countries is their relative homogeneity. Institutional and other factors are likely to be much more similar compared to larger samples of countries[3], and so is data availability. For example, there are no or insufficient SWB data for many high-income non-OECD countries, including natural resource intensive countries. Such countries also tend to have very different patterns of development compared to OECD countries and would warrant separate analysis.[4] Furthermore, the relationship between SWB and material standard of living variables is likely to be very different for poor countries compared to high-income OECD countries, again suggesting that separate analysis is warranted.

Life Satisfaction (LSF) Data

There are many different SWB measures.[5] Since we are interested in the nexus between SWB as a ‘welfare measure’, and TW and its subcomponent NC, we use LSF, i.e. a cognitive life evaluation measure. Helliwell and Wang (2012) report that life evaluation measures show much less short-term variation compared to emotional report measures, and much more linkage to life circumstances. This is arguably preferable in our context. We use country averages for LSF that have been calculated *mostly* from responses to the question: *“All things considered, how satisfied are you with your life as-a-whole now?” Answers range from ’10 satisfied’ to ‘1 dissatisfied’*, and have been transformed to a 0-10 scale. Data for the above are taken from the World Database of Happiness (Veenhoven, 2012).

It is still difficult to match SWB data with other data for particular years at the cross-country level. Therefore, there are tradeoffs in this type of study in terms of quality and fit of SWB data. For example, there are comparability issues when responses to similar, but not identical, survey questions are combined in one dataset, and when numerical response scales differ (see, for example, Veenhoven, 2009). On the one hand, we minimize, but cannot completely eliminate, these issues by (almost exclusively) using responses to the same LSF question,

[3] For example, recently Fleche et al. (2012) have analysed the determinants of LSF in 32 OECD countries over the period 1994 - 2008 using pooled regressions at the country level and OECD average. They found that they do not vary a lot between these countries. In line with earlier studies they found income, health status (especially mental health), unemployment and social relationship to be important. They also argue that cultural differences are not major drivers of differences in LSF.

[4] For example, Bahrain, Kuwait, Oman, Saudi Arabia, United Arab Emirates, Brunei Darussalam exhibit declines in TWpc from 1995 to 2005, whereas all OECD countries in our sample exhibit increases.

[5] For a recent summary of different SWB measures and much of the current state of happiness research, see the ‘World Happiness Report’ (Helliwell et al., 2012). The report was commissioned by the United Nations General Assembly for the UN Conference on Happiness which took place on April 2nd, 2012.

which seemed the widest available measure for the time period covered in this study. On the other hand, the disadvantage of trying to avoid pooling responses from different numerical scales that fit our three years is that, where possible, we use simple interpolation to obtain values for 1995, 2000 and 2005 when only data for different years are available. However, in some cases even this was not possible: In the case of Greece, we use the 1999 value for 1995. Moreover, in the following instances data were taken from the World Value Survey databank for a very similar question[6]: Canada (1 data point), Greece (1 data point), Iceland (2000 value is that for 1999, 1 data point taken from 11 step numerical LSF measure); Luxembourg (the 1999 value is used for 1995); New Zealand (only two data points available, for 1998 and 2004). Because not all LSF data are obtained from the same question, we use a 0 to 10 scale for all. However, given the aggregate nature of our data, use of the transformed 0-10 or untransformed 1-10 LSF data does not make much difference. We only report results obtained using the transformed data.[7] Data for the UK were calculated from those reported for Great Britain and Northern Ireland, using population weights.

[Table 1]

LSF data by country for 1995 and 2005 are shown in Table 1. Given the relatively short time period, the fact that most of the OECD countries in our sample are high-income countries, and the nature of the LSF data (i.e. many being interpolated), we do not expect much variation in average LSF over the decade. In fact, we do not analyse change in LSF over time, apart from commenting on the data shown in Table 1 and conducting a simple convergence analysis. It can be seen from the table that the (simple) average of LSF across all countries hardly changed over the ten years (-0.8%), although there are fifteen countries for which average LSF declined and eleven for which it has risen. By far the largest percentage changes are observed for Spain (+11.5%), Mexico (+11%) and Portugal (-15.5%).

Wealth Data

Comprehensive or Total Wealth per capita (TWpc) [8]

Economic theory suggests that TW can be estimated as the present value of (sustainable) future consumption (Hamilton and Hartwick, 2005). World Bank (2006, 2011) adopt this approach and implement it empirically for a large number of countries. By necessity, derivation of the TW estimates relies on many assumptions, data modifications etc. We

[6] The only difference is that the question ends with '…these days?', instead of '…now?'.
[7] Currently the most reliable data on average LSF are probably available from the Gallup World Poll. However, they only start in 2005 and, apart from the latest year (i.e. 2011 or 2012) are only available for a substantial fee.
[8] The reader interested in a more detailed explanation of the methodology used to build the comprehensive wealth estimates is referred to World Bank (2011, Appendix A).

employ these estimates as the best currently available and assume they are meaningful, while recognizing that they are far from perfect.[9]

To obtain estimates of sustainable TW, the calculation of the initial level of consumption, which itself is calculated as the five year average around each of the three years, has to reflect sustainability (which may not be the case). Therefore, in cases where savings adjusted for depletion of natural and physical capital are negative, this amount is subtracted from the consumption level to obtain sustainable consumption (defined as consumption that leaves the total capital stock intact). Then country specific deflators are used to convert consumption to constant 2005 US dollars. Many other assumptions have to be made to derive TW, which involve questions of judgement. For example, estimation of the discount rate requires values for the pure rate of time preference (set to 1.5%) and elasticity of the marginal utility of consumption (set to 1). Also, wealth accounting is done on a generational basis, i.e. a maximum lifetime for all assets is set at 25 years. In short, TW is "calculated as the present value of the current level of consumption (held constant), taken over 25 years and discounted at the pure rate of time preference,…" (World Bank, 2011, p. 95). These choices can be criticized. The World Bank (2011) assesses how reasonable they are by calculating the implicit rate of return on wealth for each country. They find that 80 percent of these rates of return lie between 4 and 6 percent, which is judged acceptable. An alternative, and some would argue preferable, way to derive TW estimates is to estimate all capital stocks separately and then add them up (Dasgupta, 2009). However, this is currently impossible for most countries given measurement problems and data limitations for the largest form of capital, i.e. intangible capital.[10]

The many conceptual and empirical issues associated with measuring TW, be it as the present discounted value of consumption or as the sum of all capital stocks, seem the major reason why the large literature on economic growth theory and empirics which has developed in recent decades is largely focused on GDP and its growth (adjusted for population growth), a concept that can be measured much more easily. However, as pointed out by Dasgupta (2009, 2010), this vast literature seems misdirected, i.e. economists should focus on growth in TW (again adjusted for population growth) instead. In short, Dasgupta argues that TW should be used as the 'left hand side variable' in growth regressions.

[9] The World Bank's wealth accounting has now percolated into textbooks. See, for example, the discussion of pros and cons in Perman et al. (2011). They are rather sceptical of the World Bank's TW estimates, arguing that they add no information beyond that contained in the sustainable current consumption. However, they regard the relative sizes of the major TW sub-categories of some interest. An easy to read summary of wealth accounting and sustainability measurement is provided by Heal (2011).

[10] Arrow et al. (2010) try to improve on the World Bank's (2006) methodology and follow this alternative approach. They introduce many other innovations, for example in how to estimate capital stocks. They also include a different form of capital, i.e. 'health capital'. However, they only do this for five countries, using mostly period-average data from 1995-2000, i.e. for one point in time. They admit that many theoretical and empirical limitations remain. Also see Dasgupta (2010).

Natural Capital per capita (NCpc)

NCpc includes agricultural land, protected areas, forests, minerals, and energy. Only those natural resources are included for which price and quantity data were available for many, if not all, countries. Numerous assumptions and approximations have been used in their derivation (World Bank, 2011).

The energy resources included are oil, gas and coal. Ten metals and minerals are included: Bauxite, copper, gold, iron ore, lead, nickel, phosphate rock, silver, thin, zinc. Note that stock values only include reserves that, at the time of measurement, could be economically extracted or produced, i.e. technological progress which might result in an increase in the stock of subsoil assets is excluded. The value of energy, metals and minerals is calculated at the present discounted value of (estimated) rent over the exhaustion time. The latter is set at 25 years for all countries. Also, a zero growth rate of rents is assumed. Similar assumptions are made in deriving the value of timber resources, but exhaustion time can be shorter than 25 years. The value of non-timber forest resources (hunting, recreation, watershed benefits) are estimated in a variety of ways. For example, it is assumed that only 10% of the forest area in each country is accessible for recreation. Deforestation rates are also taken into account. The value of protected areas is measured at the lower of per hectare returns to pasture and crop land, with returns capitalized over 25 years, using a 4% discount rate. Willingness to pay data for protected areas would have been preferable, but such data were not available. Use of land for tourism is not valued, but a priority for future work.[11] Crop and pasture land values are estimated as net present value of land rents, assuming that products from the land are sold at world market prices. The output from pasture land is based on the value of meat, milk and wool production (at world market prices).

Some other important forms of NC are only partially included. For example, many ecosystems services are indirectly included in the value of land, but many others are still missing from the wealth accounts. The measurement of ecosystem services is a very active area of research. World Bank (2011) points out that one ecosystem service not included but of potentially high economic significance in high-income countries are the aesthetic services provided by natural landscapes, i.e. the share of NC in TW is likely to be underestimated in our sample of countries. Moreover, it is acknowledged (ibid., p. 23) that “public goods, such as carbon storage and biodiversity, pose special challenges and are not well represented in the wealth accounts”.

It should also be noted that some other resources are completely left out. In particular, water, diamond and fishery resources are not included due to lack of data. They are, therefore, implicitly and erroneously included in the ‘residual measure’ of intangible capital. Many of the current omissions are likely to be remedied in future. In the meantime, the reader should keep the current limitations of the NC data in mind throughout the rest of the paper. They provide an important caveat to our results.

[11] For further details, see the annex on missing NC and ecosystem services in World Bank (2011), pp. 21-3.

Produced Capital per capita (PCpc)

The estimates for PCpc include the value of machines, structures, equipment and urban land. Apart from urban land, they are estimated using the perpetual inventory method. The service life of capital is set at 20 years, with a 5% depreciation rate. Urban land is simply measured as 24% of the stock of machines, structures and equipment. World Bank (2011) admits this is most likely an underestimation, but lack of data prevented estimation of country-specific proportions.

Intangible Capital per capita (ICpc)

This is measured as a residual, i.e. by subtracting NC(pc) and PC(pc) from the estimate for TW(pc). In all countries, but especially in high-income countries, IC accounts for the vast majority of TW. One is tempted to borrow a phrase from Abramovitz (1956, p. 11) and call IC(pc) the "measure of our ignorance" of the true sources of wealth in today's knowledge-based economies (KBEs), which indicates "where we need to concentrate our attention".[12]

ICpc is assumed to capture 'raw labour', human capital, social capital, institutional capital ('quality of institutions') and similar forms of capital, for which consistent cross-country data are not yet available, as well as technical progress and items that should have been included in NCpc and PCpc. This multitude of components led the World Bank (2011) to conduct further analysis in order to assess the reasonableness of the IC estimates. They regressed ICpc on human capital adjusted for health differences, institutional quality (proxied by a rule of law index), as well as on a number of dummy variables (time, country, income level) (ibid., chapter 5). It was found that human capital is the main form of IC in rich countries, and the only statistically significant production factor in high-income OECD countries.[13]

It should also be noted that 'net foreign financial assets' are treated in most of World Bank (2011) as part of ICpc. However, in the empirical accounts they are netted out and listed as a separate category. The ICpc data used in this paper exclude them.[14]

GDP per capita (GDPpc) and GNI per capita (GNIpc)

[12] Abramovitz (1956) was commenting on the then lack of knowledge about the causes of productivity increase in the US between 1869 and 1953, which was much higher than growth in measurable inputs.

[13] World Bank (2011, Table 5.3, p. 100) reports estimates for ICpc and HCpc for a select number of countries, including the G7 countries. For Canada and Japan, the reported values for HCpc are larger than those for ICpc (by 18% and 4%, respectively). For all of the poorer countries listed, the value of HCpc is far greater than ICpc (but country fixed effects have large negative values). It is not obvious to us that these findings are reasonable, for example what can explain the estimates for Canada an Japan? Presumably social and institutional capital is not negative in either country. Instead, it might indicate problems with some of the assumptions made in deriving the TW estimates.

[14] Net foreign assets are total assets minus liabilities. The former are the sum of foreign direct investment, portfolio equity assets, debt assets, derivative assets and foreign exchange reserves. The latter are the sum of FDI liabilities, portfolio equity liabilities, debt liabilities and derivates liabilities (World Bank, 2011, p. 150).

Data for GDPpc in 1995, 2000 and 2005 based on purchasing power parity (PPP) in constant 2005 international $ are taken from the World Development Indicators database. GNIpc in 2005 is from World Bank (2011).

2.2 Analysis

Growth Rates of GDPpc and Wealth Variables, Composition of Total Wealth, 1995-2005

We begin our analysis by calculating annual growth rates of GDPpc, TWpc and its major subcomponents (Table 2), as well as their correlation coefficients (Table 3). There is little difference between average annual growth rates of GDPpc and TWpc in our group of OECD countries as a whole (correlation coefficient of 0.88). This is not surprising. GDPpc is, in a sense, the return on TWpc. In 19 countries the growth rate of GDPpc is higher than that of TWpc. The greatest different is in Norway, where the growth rate of GDPpc is almost twice that of TWpc. Only France, Germany, Italy, Japan, Korea, NZ and the UK have TWpc growth rates that are higher than their GDPpc growth rates (and only in Italy, Japan and Korea are they appreciably larger). No country experienced negative growth in either GDPpc or TWpc over the decade. [15]

[Tables 2 and 3]

Trying to interpret the meaning of differences in GDPpc and TWpc growth rates is not straightforward. It might be tempting to argue that countries where TWpc has grown more than GDPpc have been, in some sense, 'less efficient' in producing a return on their wealth. However, if, as suggested in World Bank (2006, 2011), TWpc and not GDPpc is the more appropriate measure of 'social welfare', growth of the former is the important variable to focus on, not growth in GDPpc. Similarly, it has been recognised long ago that any attempt to derive a 'productivity measure' from the relationship between GDPpc and TWpc or their growth rates raises difficult issues, the resolution of which will be influenced by one's view of the nature of the economy. For example, Boulding (1966, p. 9/10), one of the founders of ecological economics, observed that in the context of an economy where resources are limited (his 'spaceman economy')

> "… throughput is by no means a desideratum, and is indeed to be regarded as something to be minimized rather than maximized. The essential measure of success of the economy is not production and consumption at all, but the

[15] The 'raw' data in levels for GDPpc and TWpc (available from the author) show that over the decade, rankings change for some countries but not others. NZ ranks 21st in terms of GDPpc in both 1995 and 2005, and 20th in terms of TWpc (also both years), i.e. focussing on TWpc in ranking exercises would have done little to change NZ's relative position. Other countries that rank very similar in terms of both GDPpc and TWpc are Greece, Korea, Luxembourg, Italy, Mexico, Norway, Portugal, Spain and Switzerland. Australia and Canada rank appreciably higher in terms of GDPpc than TWpc. For France, Iceland, Sweden and the UK it is the other way around.

> nature, extent, quality, and complexity of the total capital stock, including in this the state of the human bodies and minds included in the system. In the spaceman economy, what we are primarily concerned with is stock maintenance, …"

In short, for Boulding it was wealth stocks, not flows (like GDP), that mattered. Therefore, in a spaceman economy it seems desirable to reduce the GDPpc/TWpc ratio, not to maximise it.

Looking at wealth subcategories, it is apparent that the growth rate of TWpc is highly correlated with that of ICpc (correlation coefficients of 0.88; see Table 3). This supports the view of OECD economies being KBEs where intangible capital is more important than physical and natural capital. However, there are exceptions to this cross-country finding. In Denmark, Ireland, Luxembourg and Spain, the growth rate of PCpc is higher than that of TWpc and ICpc. Moreover, Norway's estimate for ICpc is slightly smaller in 2005 compared to 1995. Switzerland is the only country to experience a decline in PCpc.

Turning to NCpc, its growth rates are the most diverse, ranging from +2.53% for Norway to -2.6% for Luxembourg, and they seem different in nature from those for PCpc and ICpc. Even in our group of OECD countries, NCpc has declined on average, and more often then not (17 countries had negative growth rates, 9 had positive growth rates). The correlation coefficients between NCpc and the other variables are all negative, but they are not statistically significant (Table 3).

Differences in growth rates of TWpc and NCpc hint at the issue of 'weak' versus 'strong' sustainability, which is about the degree of substitutability of other forms of capital for NC, although this is usually expressed in terms of absolute, not per capita, values. Perman et al. (2011, p. 86) argue that "roughly speaking, weak sustainabilists say do not let the size of the total stock of capital fall, while strong sustainabilists say do not let the size of the NC stock fall". TWpc has grown in all countries in our sample, in contrast to NCpc, suggesting that disagreements about sustainability between, on the one hand, 'neoclassical wealth accounting sustainabilists' and, on the other hand, those advocating strong sustainability, i.e. most ecological economists and ecologists, will continue.

Shares of NCpc, PCpc and ICpc in TWpc in 1995 and 2005 are shown in Table 4. They do not necessarily sum to 100, because the (positive or negative) share of net foreign assets is not shown explicitly. ICpc has increased slightly over the decade. In contrast, both the shares of NCpc and PCpc have declined, with the decline in the share of NCpc being the larger in relative terms. Looking at country specific shares, it can be seen that NZ's NCpc share was the largest in 1995, followed by Mexico and Norway. By 2005, Mexico's share had more than halved, leaving the top three ranks to the developed natural resource intensive countries Norway, NZ and Australia. For only three countries did the NCpc share increase; they are Norway, Australia and Belgium, with Norway showing the largest increase by far. Japan, Hungary and Switzerland had the highest PCpc share in 1995. Ten years later the top three ranked countries were Japan, Korea and Luxembourg. Countries with the highest shares of ICpc in TWpc in 1995 were the UK, US and Iceland. That was still the same in 2005.

However, Iceland had overtaken the UK and US to be ranked first. The only countries with ICpc accounting for less than 70% of TWpc were Switzerland (both years), as well as Luxembourg and Norway (both in 2005). This seems to have been due to their large positive per capita net foreign assets.

[Table 4]

Correlation between LSF and TWpc versus LSF and GDPpc

Figures 1 and 2 are scatter plots of average LSF against, respectively, GDPpc and TWpc, using data for all three years. It is apparent that there is a somewhat better fit between LSF and TWpc than between LSF and GDPpc. TWpc might 'matter more' for average LSF in OECD countries that does GDPpc. The correlation coefficient between LSF and GDPpc is 0.43, that between LSF and TWpc is 0.60.[16] Scatter plots and bivariate regressions for individual years (not shown) indicate that R^2 for the LSF-GDPpc relationship declines steadily from 0.273 in 1995 to 0.169 in 2005, whereas that for LSF-TWpc declines from 0.435 in 1995 to 0.365 in 2005. By 2005, the R^2 for the bivariate LSF-TWpc regression had risen to more than twice that for the LSF-GDPpc regression. This might suggest that for our sample of countries the first part of the Easterlin Paradox, i.e. that at a point in time, SWB varies directly with income, is stronger if recast in terms of TWpc instead of GDPpc.[17] Exploration of the paradox using wealth data seems an interesting avenue for further research.[18]

Scatter plots and linear regressions for LSF versus the major subcategories of TW (not shown) indicate that the estimates for LSF versus ICpc are close to those for LSF versus TWpc (with an R^2 of 0.346). This is not surprising, given that ICpc is the largest component of TWpc. R^2 from the regression of LSF on PCpc is somewhat lower (0.215). The regression results for the smallest capital category, i.e. NC, are weaker because of the greater importance of outliers. This will be discussed further below.

[16] Our findings might be somewhat misleading in that we impose the linear form on the LSF-GDPpc relationship. Using a logarithmic function produces a slightly better fit (R^2=0.204). However, for TWpc the linear functional form is preferred.

[17] The second part of the Easterlin Paradox concerns changes over time. More precisely, it suggests that despite rising incomes, SWB does not increase. As mentioned earlier, given the nature of our LSF data, we are less confident to comment on changes over time.

[18] We also explored the relationship between LSF in 2005 and, respectively, growth rates of GDPpc and TWpc over the preceding decade. The regressions had no or very low explanatory power (R^2 of 0.01 for the former, 0.1 for the latter), and slope coefficients were negative, possibly indicating a weak form of the 'paradox of unhappy growth' observed in larger samples of countries (see, for example, Graham, 2011).

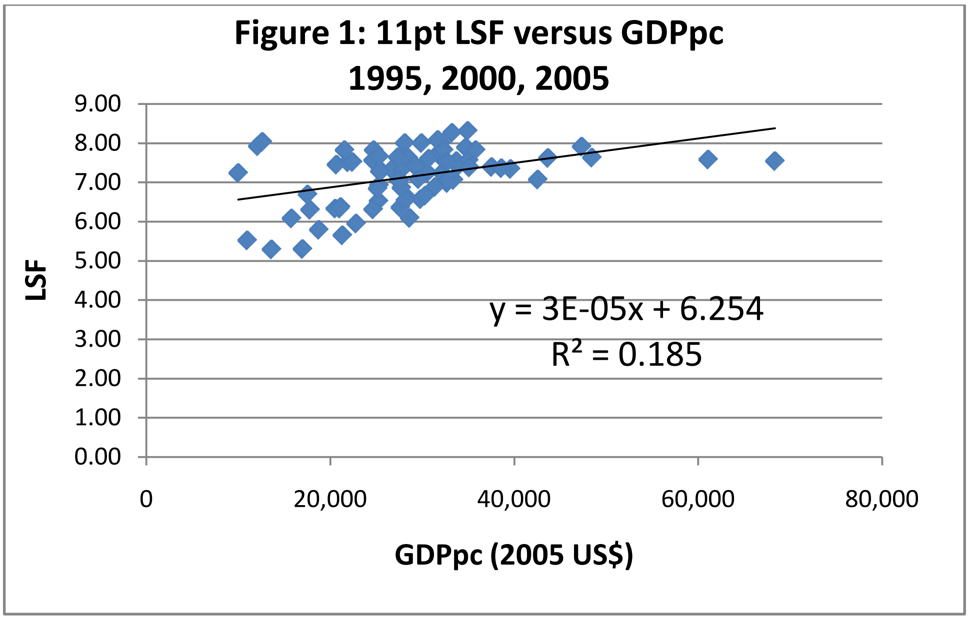


Figure 1: 11pt LSF versus GDPpc 1995, 2000, 2005

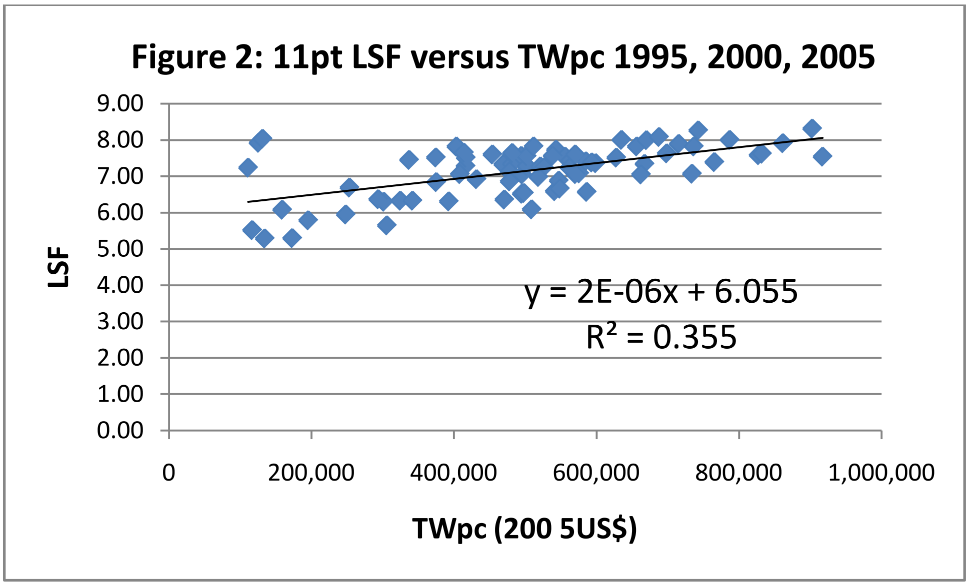


Figure 2: 11pt LSF versus TWpc 1995, 2000, 2005

Convergence Analysis

We explore whether there are any signs of convergence in key variables over the 1995 to 2005 period. To that end, we estimate the 'classic' concept of absolute or unconditional ß-convergence (Sala-i-Martin, 1996) by regressing the annualised growth rate of the variable of interest 'X' over the period t+T on its base year log value and an error term:

$$\frac{\log(X_{i,t+T}/X_{i,t})}{T} = \alpha - \beta \log(X_{i.t}) + \epsilon_{i,t} \qquad (1)$$

X is, respectively, GDPpc, TWpc and LSF; t=1995, T=10, subscript i indexes countries and $\epsilon_{i,t}$ is assumed to be a random error term. When other explanatory variables are added to equation (1), regressions test for conditional ß-convergence. Due to the small number of observations in our sample, we only explore use of a few potential conditioning variables. For GDPpc and TWpc regressions, they are two country dummy variables, i.e. for Mexico and Hungary. These countries are by far the poorest (in terms of GDPpc and TWpc) in 1995 and might therefore distort the estimates.

When exploring convergence in LSF, there are other reasons to include dummy variables for Hungary and Mexico. Mexico is the only Latin American country in our sample. Latin American countries are known to have high levels of SWB compared to their material standard of living. In contrast, Hungary is the only ex-communist country (apart from former East Germany now being part of Germany) in our sample. Ex-Soviet Block countries are usually reported to have low levels of SWB compared to their material standard of living (Bonini, 2008, Inglehart et al., 2008). Moreover, the data suggest that Portugal might be another outlier (it had the largest negative growth rate of LSF). The SWB literature suggests that Trust (a proxy for social capital) and the unemployment rate strongly influence average SWB, the first positively, the second negatively (Frey and Stutzer, 2002, Di Tella et al., 2003). We include these two variables in conditional ß-convergence regressions for LSF and find the former to be highly statistically significant, in contrast to the latter which is always statistically insignificant. We therefore do not report regressions that include the unemployment rate.

Figure 3 and regression 1, Table 5, indicate that there is no evidence of unconditional β-convergence in GDPpc. The estimate for β has the expected negative sign, but the t-ratio is -1.69, i.e. it is not statistically significant at the 10% level. The adjusted R^2 is only 0.07. Adding dummy variables for Hungary and Mexico, and testing for conditional β-convergence, only worsens the estimate.

[Table 5]

The findings for TWpc convergence are quite different (see Figure 4 and regressions 3 and 4, Table 5). Although the R^2 reported in Fig. 4 is only 0.18 (and the adjusted R^2 is 0.15, see regression 3), the estimate for β is negative and statistically significant, i.e. there is unconditional β-convergence. The explanatory power increases further when the two country dummy variables are included (see regression 4, Table 5).

There is no unconditional ß-convergence for LSF (see Figure 5 and regression 5, Table 5). However, somewhat surprisingly, when conditioned on just a few variables, there is convergence. Regressions 6 and 7, Table 5, suggest there is conditional β-convergence in LSF when Trust and the country dummy variables are added. Portugal has by far the lowest level of Trust of all countries in the sample (i.e. 16.2, compared to a mean value of 38.6). Therefore, the Portugal dummy variable is likely to act as a proxy for low Trust that reduces the variation in the Trust variable in regression 7, Table 5.

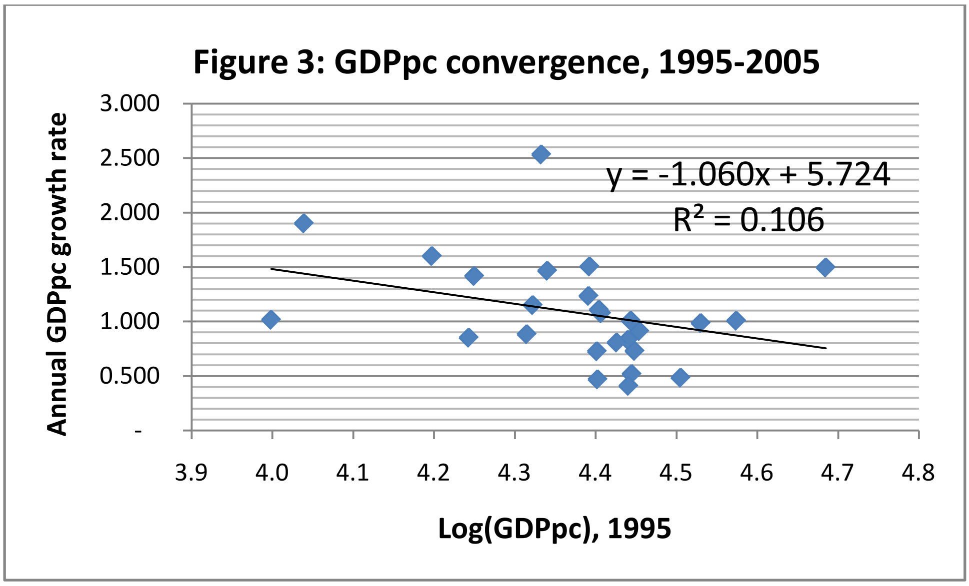


Figure 3: GDPpc convergence, 1995-2005
y = -1.060x + 5.724
R² = 0.106
Annual GDPpc growth rate
Log(GDPpc), 1995
3.000
2.500
2.000
1.500
1.000
0.500
-
3.9
4.0
4.1
4.2
4.3
4.4
4.5
4.6
4.7
4.8

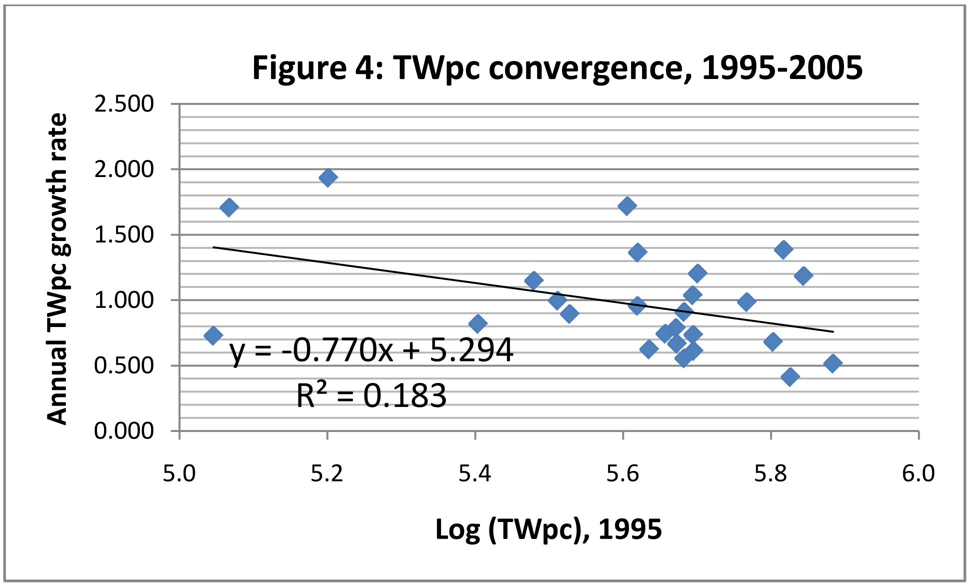


Figure 4: TWpc convergence, 1995-2005
y = -0.770x + 5.294
R² = 0.183
Annual TWpc growth rate
Log (TWpc), 1995
2.500
2.000
1.500
1.000
0.500
0.000
5.0
5.2
5.4
5.6
5.8
6.0

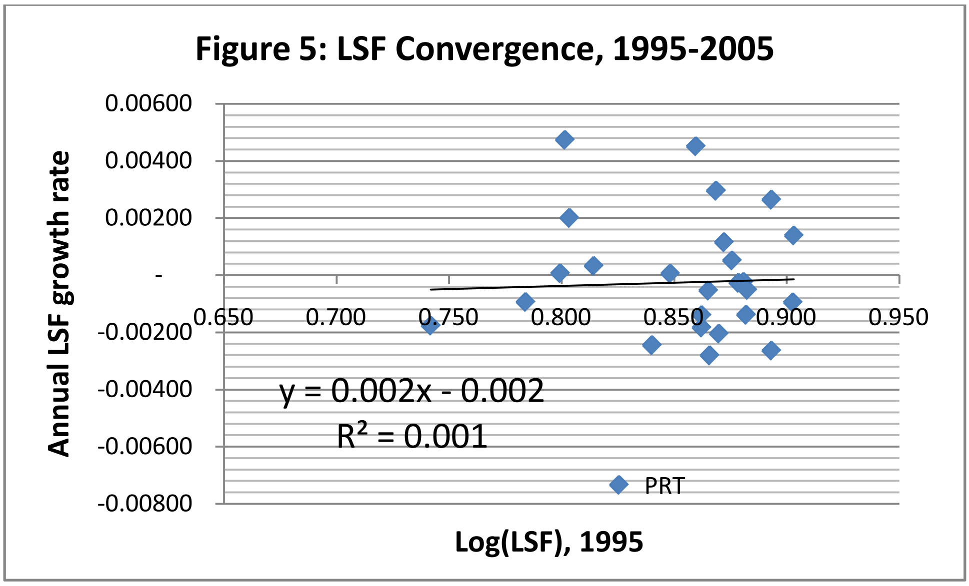


Figure 5: LSF Convergence, 1995-2005
y = 0.002x - 0.002
R² = 0.001
PRT
Annual LSF growth rate
Log(LSF), 1995
0.00600
0.00400
0.00200
-
-0.00200
-0.00400
-0.00600
-0.00800
0.650
0.700
0.750
0.800
0.850
0.900
0.950

The finding of conditional β-convergence in LSF and the importance of Trust are interesting results that are in line with others reported in the literature. For example, Sachs (2012, p. 7), in his introduction to The World Happiness Report, states that "Raising income can raise happiness, especially in poor countries, but fostering co-operation and community can do even more, especially in rich societies that have a low marginal utility of income". However, given the derivation of many of the LSF data, our findings should be taken with a grain of salt, although they at least suggest the possibility of LSF convergence among advanced KBEs.

3. Life Satisfaction, Natural Capital per capita, Sustainability Indices

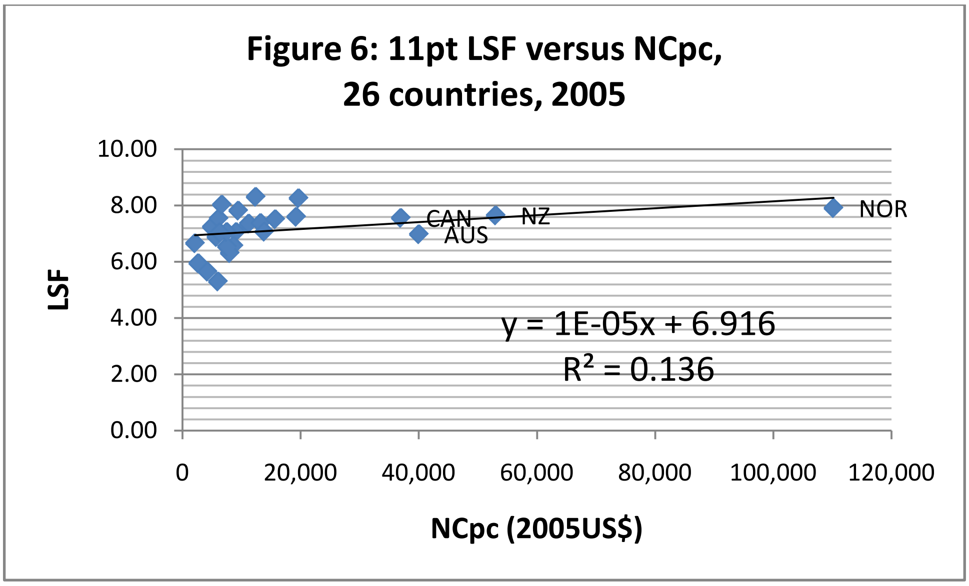
3.1 Correlation between LSF and NCpc

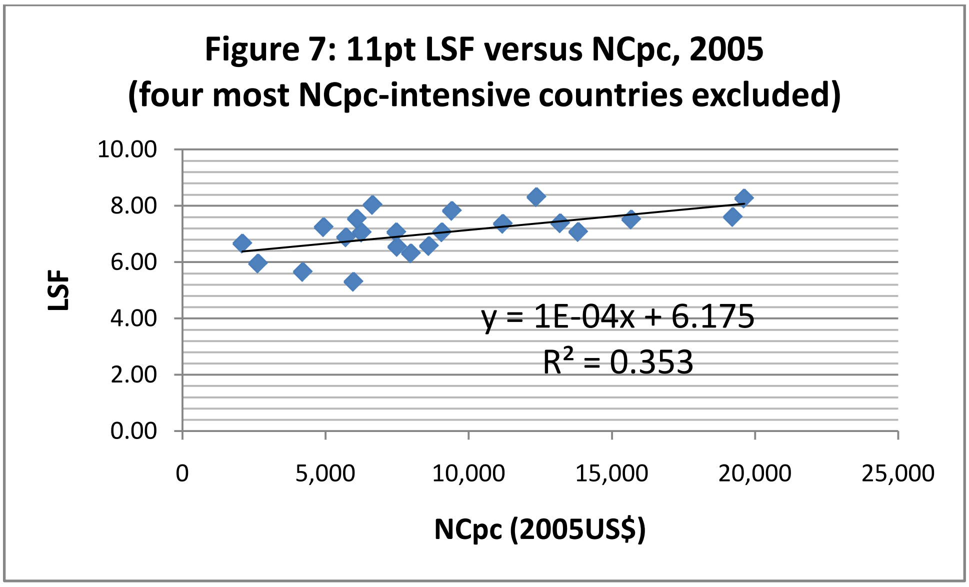
Earlier studies found that across larger samples of countries, all of the major sub-categories of TW are related to SWB measures (Abdallah et al., 2008, Engelbrecht, 2012). By contrast, for the smaller group of higher income countries (i.e. those with GNIpc greater than US$ 10,000 in 2000), this only seems to apply to ICpc and NCpc. Moreover, for the group of highest income countries (GNIpc greater than US$ 20,000 in 2000), NCpc was found to be the only capital variable positively and significantly correlated with SWB when the most NC intensive countries where deleted as outliers (Engelbrecht, 2012). We briefly explore whether we find similar results for our group of countries in 2005.

Amongst the 26 OECD countries in our sample there are a few that have much higher NCpc than the rest. They are 1. Norway, 2. NZ and, either ranked 3rd or 4th in different years, Canada and Australia. When LSF is plotted against NCpc, these countries clearly stand out (see Figure 6). When they are deleted as outliers, the linear relationship between LSF and NCpc becomes stronger (Figure 7). Similar diagrams are obtained for 1995 and 2000 (although for those years, Norway and NZ are more similar), and also when data for all three years are used. Finland seems to be an outlier in terms of NCpc in 2000.

The cross-section findings for the correlation between NCpc and LSF reported in Engelbrecht (2012, Table 6) are broadly confirmed (see Table 6). When Australia, Canada, NZ and Norway are deleted as outliers, the correlation coefficient increases, and more so than for other capital stocks. When the poorer countries are also excluded, i.e. when only countries with GDPpc greater than US$ 20,000 in 1995 are included, NCpc has the highest correlation with LSF, even higher than TW. Also, except for the 26 country sample, the correlation coefficient between NCpc and LSF is higher than that between PCpc and LSF. Constituting the largest proportion of TW by far, ICpc's correlation coefficients with LSF are basically identical to those obtained for TWpc and LSF.

[Table 6]





3.2 Sustainability Indices

Some General Comments

The principal reason for the development of macro-level wealth accounts is a concern for the future. In particular,

> "...measuring changes in wealth permits us to measure the *sustainability* of development ... measuring changes in real, comprehensive wealth provides an indication to governments of whether policy, broadly conceived, is producing increases in both current and future well-being – what economists would term

"social welfare"... It certainly could be argued that the fundamental duty of government is to ensure that its policies lead to increases in social welfare."

(World Bank, 2011, p. 3/4, italics in the original)

In this section we explore how closely a number of prominent measures of sustainability are correlated in our sample of OECD countries.[19] More specifically, our aim is to assess how closely the sustainability measures derived from the wealth data are correlated with some other sustainability indices, as well as with LSF and GNIpc.

The following sustainability indices are included: (1) Adjusted Net Savings per capita (ANSpc) in 2005 (World Bank, 2011); (2) Adjusted net savings as percent of GNI (ANS) in 2005 (as reported by UNDP, 2012); (3) the change in TWpc calculated as the difference between TWpc in 1995 and 2005 (ΔTWpc) (in constant 2005 US$), (4) the change in total wealth as reported in World Bank (2011)[20], which we denote 'change in wealth' (ΔWpc), (5) the change in NCpc between 1995 and 2005 (ΔNCpc); (6) the New Economics Foundation's Happy Planet Index (HPI) for 2005 (Murphy, 2009); (7) Ng's (2008) Environmentally Responsible Happy Nation Index (ERHNI), which is a modification of the HPI; (8) Knight and Rosa's (2011) specification of an Environmental Efficiency of Well-being (EWEB) index for 2005, (9) the Environmental Sustainability Index for 2005 (ESI) (Esty et al., 2005); (10) the Environmental Performance Index (EPI) for 2006 (Esty et al., 2006).

Comparison of different sustainability indices is of interest in its own right, but has become even more important in the context of the current push by policy makers for 'green growth', which aims to combine economic growth and sustainable development. For example, Hallegatte et al. (2012) refer to adjusted measures of net savings as 'key green accounting indicators'. It should be noted that all the sustainability measures included here assume 'weak sustainability', i.e. that other forms of capital can compensate for loss of NCpc. However, not even a constant level of NCpc guarantees (environmental) sustainability if some part of NC is 'critical', i.e. cannot be substituted. Suffice to say the extent to which different measures can be seen to capture sustainability is highly contested, as is the meaning of sustainability itself.

Stiglitz et al. (2009) strongly argue that sustainability needs to be measured separately from current well-being. They are, therefore, very critical of composite indices that combine both. This leads us to first classify the sustainability indices included here into two groups, i.e. those that are associated with the capital approach to development, i.e. measures (1) to (5), and those that incorporate a SWB component, i.e. indices (6) to (10). Another reason for approaching the comparison of indices in this way is that not all the indices with a SWB component are available for all countries. We want to get some idea about how closely

[19] Our selection of indices is not exhaustive. There is an abundance of sustainability measures. For a survey of different classes of indices, see Stiglitz et al. (2009, chapter 3). They classify measures into 'dashboard or sets of indicators', 'composite indices', and 'adjusted GDP' measures.

[20] The change in TWpc explicitly reported in World Bank (2011) is not the actual difference in TWpc between 1995 and 2005. This has also been noted by Perman et al. (2011) and is somewhat confusing.

indices within each group are correlated, before comparing some of the indices from both groups.

Ten Sustainability Indices

The indices are briefly described below. The data are shown in Table 7.

(1, 2) Adjusted Net Savings per capita (ANSpc) and Adjusted Net Savings as percentage of GNI (ANS), both for 2005

Adjusted Net Savings, also called 'genuine savings', are defined in general terms as 'gross savings minus consumption of fixed capital, plus education expenditure, minus depletion of natural resources, minus pollution damages' (Perman et al., 2011, p. 662).[21] Measurement of the component making up ANS can and has been criticized (ibid., chapter 19). It should also be noted that ANS as such focuses on changes in TW, not TWpc. ANS is usually expressed as percentage of GNI. The data for 2005 used here are taken from the UNDP (2012) website. World Bank (2011, Appendix Table E.1), instead, report ANSpc.[22] We use both. World Bank (ibid., p. 39) argues that "the rule for interpreting ANS is simple and clear: if ANS is negative, then we are running down our capital stocks and reducing future social welfare". When ANS is positive, the implication for development is less clear, because population changes are not taken into account. Especially in countries with high population growth, a positive ANS might be misleading as an indicator of sustainable development. That is why ANSpc is preferable, although in high income countries with low population growth this issue is less important. Both ANS and ANSpc can be calculated on an annual basis, in contrast to TW-based measures. They, therefore, have the advantage of providing more frequent feedback on whether the economy is on a sustainable development path or not (ibid., p. 37). The trade-off is that TW-based sustainability indices include more forms of capital, i.e. they are more comprehensive: ANS excludes agricultural land and parts of intangible capital (for further details, see ibid., Box 2.1, p. 38).

(3) Change in TWpc, 1995-2005 (ΔTWpc)

The capital approach to development as implemented in World Bank (2006, 2011) defines sustainability as non-declining per capita consumption over the next 25 years. The particular way of implementing the approach is best described as 'pragmatic', i.e. it seems roughly right, but numerous measurement issues remain. The availability of comparable TW data for more than one point in time allows, at least in principle, the calculation of sustainability aimed at, but not achieved, with ANS, i.e. it allows calculation of the change in total wealth (that is in all capital stocks).[23] Another conceptual difference is that TW, in contrast to ANS, takes into account changes in real prices of assets, i.e. it includes capital gains. ΔTWpc is the

[21] For more detail, see the World Bank website.
[22] World Bank (2011) also report the 'ANS gap'. This shows how much extra savings (as % of GNI) would be needed to keep TWpc constant. For all but five of our 26 countries, they record a 'not applicable'. The five countries are: Greece (0.2), Iceland (5.2), NZ (2.0), Portugal (4.7), US (2.0).
[23] Interestingly, this also seems to accord with Boulding's (1966) vision cited earlier.

'ideal' economic sustainability measure associated with the capital approach to development. It is also advocated by Stiglitz et al. (2009). Of course, by focussing on TW and not NC or its subcomponents, 'weak sustainability' is assumed, i.e. as long as ΔTWpc does not decline, a development path is judged sustainable, even if NCpc declines.

(4) Change in Wealth per capita, 2005 (ΔWpc)

The use of the variable 'change in TWpc' in World Bank (2011) is somewhat confusing. It gives the impression that it is ΔTWpc discussed above. However, it includes only changes in tangible wealth, not in intangible capital. It is therefore much closer to ANSpc. The argument used in World Bank (ibid., p. 157) to defend this approach is that both ANSpc and TWpc should be focussed on stocks and flows that are rival in nature.[24] To distinguish this measure from ΔTWpc, we simply call it 'change in wealth' (ΔWpc).[25]

In our view, because intangible wealth mostly included in people (human capital, social capital) is the largest resource in advanced KBEs, it should be included in a comprehensive measure of economic sustainability. Otherwise we implicitly devalue the role of human beings and divert attention away from issues like the 'depreciation' of human and social capital, stress, mental health in general, which have become increasingly important in OECD economies. It would also sever a potentially important link between wealth accounting and happiness research.

Another reason for including both ΔTWpc and ΔWpc in our comparison of sustainability indices is that we are not aware that the two measures have been compared before. It should be of interest to find out to what extent they are correlated with each other, and with the other indices. It might provide new insights and an additional aspect to the sustainability debate. It should be noted that Arrow et al. (2010) also use a more comprehensive measure of 'change in TW' than does World Bank (2006, 2011). They include changes in human capital as well as in 'health capital'. However, as mentioned earlier, there empirical implementation is limited to only five countries.

(5) Change in NC per capita, 1995-2005 (ΔNCpc)

According to this criterion, development is judged sustainable if NCpc does not decline between two points in time. It is a more appropriate measure of sustainability than those based on TW if most of the concern is about depletion and destruction of the natural environment, i.e. environmental sustainability. However, as mentioned earlier, even a constant NCpc does not imply strong sustainability. The criterion could be refined by dividing NC into a number of components (for example renewable and non-renewable resources) or by focussing more specifically on forms of NC that are deemed 'critical', i.e.

[24] However, although not stated explicitly in World Bank (2011), one is tempted to speculate that ΔWpc is used simply because the authors have less confidence in the reliability of the data currently available to calculate ΔTWpc.

[25] In some sense it would seem more logical to denote the 'change in comprehensive wealth per capita' by ΔWpc, and the 'change in tangible wealth per capita' by ΔTWpc. However, 'total' has become a commonly used substitute term for 'comprehensive' wealth.

that need to be preserved. Heal (2011) explicitly discusses this issue and agrees with others that measures trying to capture changes in wealth should be supplemented with more specific indices of critical NC. However, this is usually done by using physical indicators, not indicators like NC measured in monetary terms.

(6) Happy Planet Index, 2005 (HPI)

The creators of the HPI argue that it measures "what truly matters to us – our well-being in terms of long, happy and meaningful lives – and what matters to the planet – our rate of resource consumption" (Murphy, 2009, p. 1). HPI is calculated as 'happy life years' (life satisfaction × life expectancy) divided by an 'adjusted ecological footprint' (a constant is added to the ecological footprint to dampen its variation). This ratio is then multiplied by another constant to insure that a country achieving maximum LSF and life expectancy (85 years) while living within 'its global fair share of resources' scores 100 on the HPI. It is reported that for OECD countries, HPI has decreased from 1961 to 2005: While happy life years have grown by 15%, ecological footprints increased by 72% (ibid., p. 4).

HPI is an ecological efficiency measure, i.e. it aims to capture the degree to which happy live years are achieved per unit of environmental impact (ibid., p. 13). That is a very different definition of sustainability, one that explicitly includes life outcomes, i.e. happiness and life years, and scales them by a measure of resource use. Like measures (7) to (10) described below, HPI is a composite index that combines objective and subjective variables, and an assessment of current well-being as well as sustainability. Stiglitz et al. (2009) are not in favour of such indices. They argue that composite indices should be regarded as invitations to look closer at their various constituent components, and that the normative implications of the weightings used to aggregate the components are seldom made explicit or justified. Moreover, such indices arguably lack a well-defined notion of what sustainability means (ibid., 237-239) .

(7) The Environmentally Responsible Happy Nation Index, 2003-05 (ERHNI)

Ng (2008, p. 425) argues that the HPI needs to be revised to make it "an internationally acceptable national success indicator that aims positively at long and happy lives but negatively at the external costs of environmental disruption." The revision involves different measurement of the variables as well as a different way of constructing the index. In particular, Ng makes two changes. First, he calculates 'happy life years' differently, which results in giving LSF a greater weight in the calculation of happy life years. Secondly, instead of dividing happy life years by an adjusted ecological footprint, he subtracts from happy life years a measure of per capita external costs imposed by a country on the global community in the present and the future.[26] He only has rough estimates for the per capita external costs, but

[26] The calculation of the per capita global environmental cost is quite involved (for details, see the appendix in Ng, 2008). The starting point for the calculation is an estimate of premature deaths from air pollution, from which total costs are estimated. Only a portion of total costs is taken as external (i.e. as imposed on other nations). Per capita contributions of each nation are calculated as being proportional to its per capita CO_2 emissions etc.

argues that "It is better to be roughly right on important things than to be perfectly accurate on things that are irrelevant" (ibid., p. 433/4).

(8) Environmental Efficiency of Well-being, 2005 (EWEB)

Similar to Ng (2008), Knight and Rosa (2011) argue that the scaling inherent in the design of the HPI is not trivial, and that regression results obtained when using such a ratio measure are difficult to interpret. After surveying a number of environmental efficiency of well-being indices, they devise their own EWEB that takes SWB and the ecological footprint into account without directly combing them or being a ratio measure. They obtain their measure from regressing LSF (*not* happy life years) on per capita ecological footprint and computing the unstandardized residuals. These residuals are their EWEB estimates: A large positive one indicates a country with high well-being relative to their environmental consumption (and vice versa). Knight and Rosa (2011) find that HPI and EWEB are highly correlated in their sample of 105 countries (at 0.89). They also regress their EWEB on a number of potential explanatory variables. Some of their key findings are a negative quadratic effect of economic development (in terms of GDPpc), a negative impact of income inequality, and a positive impact of social capital (Trust). They also employ Latin American and Ex Soviet Union country dummies, with similar results to those reported in Table 5 (i.e. with expected signs, but only with the Latin American dummy being statistically significant).

(9) Environmental Sustainability Index, 2005 (ESI)

Developed by researchers from Yale and Columbia Universities, the ESI is derived by integrating 76 data sets into 21 indicators of environmental sustainability, which are then aggregated further into five major components and finally into the overall ESI (Esty et al., 2005). It covers 146 countries. The authors (ibidl., Box 3, p. 23) argue that "The ISI score quantifies the likelihood that a country will be able to preserve valuable environmental resources effectively over the period of several decades … it evaluates a country's potential to avoid major environmental deterioration". The higher the ESI score, the better. Stiglitz et al. (2009, p. 238) provide some specific criticisms of the index. They argue it is often viewed as presenting the situation of developed countries too optimistically, and that it is also not much use for making comparisons between developed countries.[27] 2005 was the last year for which the ESI has been reported.

(10) Environmental Performance Index, 2006 (EPI)

Last but not least, we include the successor to the ESI, i.e. the EPI, in our analysis (Esty et al., 2006). Developed by the same group of researchers that created the ESI, it has only been reported since 2006. In contrast to the ESI, the EPI is designed to better measure actual policy

[27] Stiglitz et al. (2009, p. 238) argue that "the index essentially informs us upon a mix of current environmental quality, of pressure on resources and of the intensity of environmental policy, but not about whether a country is on a sustainable path or not: no threshold value can be defined on either side of which we would be able to say that a country is or is not on a sustainable path".

performance with respect to (1) reducing environmental stresses on human health and (2) promoting ecosystem vitality and sound natural resource management. This is done by measuring country performance against absolute targets (proximity-to-target methodology). The EPI is based on only 16 indicators (datasets). They are aggregated into six policy categories (sometimes with overlaps). Five of the six are then aggregated into the broad objective of 'ecosystem vitality'; one, environmental health, is directly identified as a broad objective. Finally, the two broad objectives are aggregated (by simply averaging) into the EPI. The 2006 pilot ESI used here is reported for 133 countries. The methodology has been modified in subsequent years.[28] The EPI is a measure of policy achievement in some core environmental areas, but it is not a comprehensive measure of environmental sustainability as such.

Analysis

Table 8 shows correlation coefficients between indices associated with the capital approach to development. The first four are indices of economic sustainability; the fifth is closer associated with environmental sustainability.

The highest positive correlations are between ANSpc, ANS and ΔWpc. While ΔWpc is a more comprehensive measure of changes in capital stocks than is ANSpc, they are almost perfectly correlated. Despite of this, in some cases the different indices give different signals about economic sustainability. Looking at the underlying data reported in Table 7, we see that for Greece, NZ and the US, ΔWpc is negative while ANSpc and ANS are positive. Also, for two countries (Iceland and Portugal), ANSpc and ΔWpc are negative despite positive ANS.

[Table 8]

In marked contrast to correlations between ANSpc, ANS and ΔWpc , ΔTWpc exhibits low, and mostly statistically insignificant, correlation with all three (Table 8). Also, in contrast to ΔWpc, which is negative for five countries (Greece, Iceland, NZ, Portugal, the US), ΔTWpc is positive for all countries in our sample. Using a comprehensive definition of wealth that includes intangible capital, we are much less likely to find instances of unsustainable economic development amongst OECD countries.[29]

Turning to correlations between ΔNCpc and all the other indices shown in Table 8, the disconnect between economic and environmental sustainability becomes obvious. The correlation coefficients are very small, mostly negative and not statistically significant. Table 7 shows that ΔNCpc is negative for 17 countries, with only Australia, Belgium, Canada, Denmark, Finland, Germany, Norway, Spain and the US showing an increase over the

[28] For details, see http://epi.yale.edu/.

[29] However, some caveats may be in order: The statement applies to 'more or less normal times', and to the usual time frames for which data are available. We do not know, and hopefully shall not have the chance to observe, whether a pro-longed economic depression would result in an actual fall in TWpc in OECD countries. Also, in the long run there is, of course, a link between economic and environmental sustainability.

decade. When the four most NCpc intensive countries are excluded, the negative correlations between ΔNCpc and all other indices shown in Table 8 become larger (but, given the small number of observations, only the correlation between ΔNCpc and ANSpc is weakly statistically significant).

To sum up, the correlation coefficients reported in Table 8 point at two issues. Firstly, if we define sustainability as non-declining NCpc, then our group of countries as a whole is probably on a non-sustainable path, whereas in terms of economic sustainability it is on a sustainable path. Secondly, the low correlation coefficients between, on the one hand, ΔTWpc, and, on the other hand, ΔWpc, ANS and ANSpc, raise the question whether the latter three, which are currently the probably most widely used 'mainstream' economic sustainability indices, are misleading. It would be interesting to sequentially add agricultural land and forms of intangible capital to these indices to see which of these currently neglected capital stocks account for most of the difference. For example, it would be interesting to know whether human or social capital is relatively more important.

Next, we explore how closely the remaining sustainability indices are correlated (Table 9). This group includes indices that contain a SWB element, as well as ESI and EPI. Most of them are not available for all 26 countries. Excluding Denmark, Iceland, Luxembourg and Switzerland because of missing observations, we are left with 22 countries. Correlation coefficients between the sustainability indices and LSF are also reported in order to explore how dominant the SWB component is for the composite indices that include it.

[Table 9]

The highest positive correlation is observed between HPI and EWEB (0.94). Although Knight and Rosa (2011) develop their EWEB as an improvement over the HPI, empirically the two indices are quite comparable. Knight and Rosa (2011) report a similar finding for their sample of 105 countries, for which both indices are also highly correlated (0.89). Ng's (2008) ERHNI exhibits a lower correlation with HPI (0.46). Focussing on LSF, we see that both ERHNI and EWEB have a higher positive correlation with LSF than does HPI, i.e. the SWB component of these indices seems more dominant.

ESI and EPI are different types of sustainability indices that do not contain a SWB element. They are positively correlated, but the correlation is far from perfect (0.64). Also, these two indices show relatively low correlations with the other indices included in Table 9. Indices that focus only on environmental aspects seem to provide quite different indications about sustainability than those that combine SWB and environmental elements. This provides support for Stiglitz et al. (2009) view that well-being and environmental indices should not be combined. It is also interesting to note that the signs of the correlation coefficients of ISI and EPI with HPI and ERHNI are different.

Finally, we combine our two groups of indices (Table 10). We exclude EWEB, because it has missing observations for four countries. When all other indices are included, there are only missing observations for Iceland and Luxembourg, leaving 24 countries. We also include

GNIpc to explore how the sustainability indices correlate with a common 'material standard of living' variable.

[Table 10]

The highest correlation coefficient for GNIpc is observed with respect to ANSpc (0.7), followed by correlation with ERHNI, ΔWpc, ESI and LSF (all around 0.6). The correlation coefficient between GNIpc and ΔTWpc is only 0.47. The highest correlation for LSF is with ERHNI, followed by GNIpc. LSF is also positively and statistically significantly correlated with ANSpc, ANS and ΔWpc. It is not statistically significantly correlated with ΔTWpc. Focussing on correlations between the two TW variables, and HPI, ERHNI, as well as ESI and EPI, we can see there are major differences. ΔTWpc has much lower correlation coefficients with respect to HPI, ERHNI and ESI than does ΔWpc, but a higher correlation with EPI. This diversity again highlights the differences between the two indices and the need to clarify which concept of TW is the more appropriate.

Lastly, it is of interest to see how closely the sustainability indices more directly concerned with the state of the natural environment are correlated. ΔNCpc is positively and significantly correlated with the abandoned index ESI (0.42), but not with EPI. This changes somewhat when the four most NCpc intensive countries are excluded. In that case, the correlation coefficient between ΔNCpc and EPI rises to 0.22, which is still modest (and not statistically significant). Also, ΔNCpc is negatively, and significantly, correlated with HPI. This again indicates that the different indices provide diverse messages about sustainability.

4. Concluding Comments

There is a search for social welfare measures that go beyond GDP and that take sustainability into account. Comprehensive macro-economic wealth measurement is part of this quest. Wealth is also closer correlated with subjective measures of well-being, which are now regarded by many governments as at least complementary welfare measures. The aim of this paper has been to contribute to bridging the divides between the 'happiness' literature, the literature on comprehensive wealth, and that on the wide range of sustainability indices.

Our analysis has to be described as 'exploratory' because measurement of key variables is still imperfect in important ways, i.e. validity of the World Bank's (2011) wealth data is conditional on the many assumptions made and shortcuts adopted in their derivation. It is hoped the data will be improved in future. Also, it is still difficult to match SWB data and economic data across countries, even for our sample of OECD countries. It would, therefore, be dangerous to try and draw policy conclusions from our findings, given current data limitations. In their recent survey, Helliwell et al. (2012, p. 94) state that "At this stage the science of happiness is in its infancy and its policy implications are inevitably piecemeal and tentative". Combing happiness, comprehensive wealth, and sustainability indicator research only compounds the difficulties.

Nevertheless, assuming the current wealth data are meaningful, though imperfect, our findings raise a number of issues which should be addressed in the debate about how to achieve sustainable development:

- How should differences in growth rates between GDPpc and TWpc be interpreted, and how should the importance of such differences be judged?
- How should 'change in total wealth' as a measure of economic sustainability be conceptualised and estimated? Should it only include tangible wealth or also intangible capital? While there is much concern about depreciation of NC (after all, this has motivated natural resource accounting), little or no attention seems to have been given to 'depreciation' of human capital and other forms of intangible capital in this context. This is inappropriate in advanced KBEs.
- The above point is directly related to the measurement of economic sustainability: Our preferred measure, i.e. ΔTWpc, does not seem very comparable to the currently most widely used economic sustainability indices (ANS, ANSpc, ΔWpc). However, even the latter, although highly correlated with each other, produce conflicting messages for a few countries.
- NCpc growth rates seem very different from TWpc, PCpc and ICpc growth rates, even in OECD countries, highlighting differences between environmental and economic sustainability.
- NC seems important for LSF in OECD countries. In line with earlier findings (Engelbrecht, 2012), the high positive correlation between LSF and NCpc when the top NCpc intensive countries are deleted as outliers is re-confirmed, as is the finding that for the group of richest countries, NCpc has the highest correlation with LSF of any of the TW subcategories. This suggests that environmental sustainability is associated with a 'happiness bonus', instead of a 'happiness sacrifice'.
- The discussion and correlation analysis of sustainability indices indicated their diversity, i.e. they often measure different, and sometimes not well-defined, aspects of sustainability. This highlights that great care needs to be taken when advocating the use of these indices as guides to policy making.

Also, some of our findings hint at additional arguments (i.e. in addition to wealth being a better measure of social welfare than GDP) supporting the view that it might be appropriate to recast much of 'growth economics' in wealth terms, once more and better wealth data become available:

- The stronger link between LSF and TWpc compared to LSF and GDPpc might indicate that the Easterlin Paradox will be weaker when recast in wealth terms. This seems an interesting extension of the Easterlin Paradox literature worth pursuing.
- The finding of no GDPpc convergence, but TWpc convergence (conditional and unconditional), as well as conditional LSF convergence, suggests that convergence analysis could be usefully extended in these dimensions.

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Tables:

Table 1: Life satisfaction, 1995 and 2005 (11 pt scale)				
Country	**Code**	**1995**	**2005**	**% change**
Australia	AUS	7.28	6.98	-4.1
Austria	AUT	7.05	7.06	0.1
Belgium	BEL	7.33	7.24	-1.2
Canada	CAN	7.60	7.56	-0.5
Denmark	DNK	8.00	8.26	3.3
Finland	FIN	7.51	7.60	1.2
France	FRA	6.52	6.57	0.8
Germany	DEU	7.34	6.88	-6.3
Greece	GRC	6.30	6.31	0.2
Hungary	HUN	5.52	5.30	-4.0
Iceland	ISL	7.82	8.31	6.3
Ireland	IRL	7.82	7.36	-5.9
Italy	ITA	6.92	6.54	-5.5
Japan	JPN	6.36	6.66	4.7
Korea, Rep.	KOR	6.08	5.95	-2.1
Luxembourg	LUX	7.63	7.54	-1.2
Mexico	MEX	7.24	8.03	11.0
Netherlands	NLD	7.62	7.38	-3.1
New Zealand	NZL	7.45	7.65	2.7
Norway	NOR	7.39	7.91	7.0
Portugal	PRT	6.69	5.65	-15.5
Spain	ESP	6.33	7.06	11.5
Sweden	SWE	7.56	7.51	-0.6
Switzerland	CHE	7.99	7.82	-2.2
United Kingdom	GBR	7.28	7.05	-3.2
United States	USA	7.41	7.07	-4.6
Average		**7.16**	**7.13**	**-0.8**

Table 2: Annual growth rates of GDP per capita and wealth per capita variables for 26 OECD countries, 1995-2005					
Country	**GDPpc**	**TWpc**	**NCpc**	**PCpc**	**ICpc**
Australia	1.075	0.955	1.314	0.892	0.940
Austria	0.831	0.610	-0.827	0.692	0.649
Belgium	0.807	0.786	1.442	0.667	0.748
Canada	1.008	0.742	0.555	0.709	0.654
Denmark	0.729	0.680	0.787	0.862	0.536
Finland	1.466	1.363	0.010	0.261	1.608
France	0.726	0.734	-0.211	0.459	0.771
Germany	0.517	0.554	0.139	0.371	0.558
Greece	1.417	1.147	-0.882	0.673	1.519
Hungary	1.901	1.707	-1.477	0.616	2.364
Iceland	1.505	1.383	-1.505	0.906	1.646
Ireland	2.534	1.717	-1.911	2.709	1.636
Italy	0.468	0.623	-0.407	0.385	0.725
Japan	0.408	0.665	-2.354	0.273	0.763
Korea, Rep.	1.600	1.934	-0.309	1.997	2.003
Luxembourg	1.495	1.183	-2.600	1.600	0.506
Mexico	1.015	0.727	-2.434	0.663	1.002
Netherlands	0.911	0.909	-0.125	0.842	0.930
New Zealand	0.883	0.893	-0.120	0.570	1.095
Norway	1.007	0.514	2.533	0.496	-0.055
Portugal	0.851	0.817	-1.473	0.911	1.019
Spain	1.150	0.995	0.013	1.293	1.045
Sweden	1.234	1.036	-0.111	0.341	1.164
Switzerland	0.483	0.411	-2.221	-0.077	0.516
UK	1.107	1.202	-0.344	0.761	1.340
US	0.985	0.984	0.269	0.914	1.040
Average	**1.081**	**0.972**	**-0.471**	**0.799**	**1.028**
Data sources: GDP per capita data are from the World Development Indicators database; wealth data are from World Bank (2011). Net foreign assets are not included in ICpc.					

Table 3: Correlations - Growth rates of GDPpc and wealth variables, 1995-2005				
TWpc	0.88[a]			
NCpc	-0.21	-0.22		
PCpc	0.71[a]	0.65[a]	-0.16	
ICpc	0.70[a]	0.88[a]	-0.31	0.35[c]
	GDPpc	**TWpc**	**NCpc**	**PCpc**
Notes: a = statistically significant at the 1% level (two-sided test) c = statistically significant at the 10% level (two-sided test)				

Table 4: Share of NCpc, PCpc and ICpc in TWpc, 26 OECD countries, 1995 and 2005						
	1995			**2005**		
Country	**NCpc (%)**	**PCpc (%)**	**ICpc (%)**	**NCpc (%)**	**PCpc (%)**	**ICpc (%)**
Australia	7.1	21.8	74.7	7.7	21.5	74.5
Austria	2.2	19.4	79.3	1.6	19.8	80.1
Belgium	0.8	18.1	80.3	0.9	17.6	79.6
Canada	7.2	16.8	78.6	6.9	16.7	77.0
Denmark	2.6	16.9	82.2	2.6	17.6	79.6
Finland	4.6	21.8	76.3	3.4	16.9	80.7
France	1.8	17.0	81.4	1.5	16.0	82.1
Germany	1.1	18.7	79.8	1.0	18.0	79.9
Greece	3.2	21.1	76.3	2.0	18.9	83.1
Hungary	7.2	26.1	70.2	3.5	20.3	81.7
Iceland	2.7	17.0	83.3	1.4	15.2	88.5
Ireland	4.3	14.9	82.6	1.9	18.8	81.1
Italy	1.9	19.0	79.5	1.5	18.0	81.4
Japan	0.8	27.1	71.1	0.4	24.6	72.7
Korea, Rep.	1.8	23.3	75.4	1.1	23.6	76.6
Luxembourg	1.6	21.1	76.3	0.7	23.2	65.2
Mexico	10.5	16.5	76.1	5.1	16.2	81.1
Netherlands	2.8	18.8	79.2	2.2	18.5	79.6
New Zealand	16.2	19.8	70.6	12.8	18.4	73.9
Norway	8.0	21.3	70.4	12.8	21.2	61.7
Portugal	2.3	19.2	79.3	1.4	19.6	83.1
Spain	2.3	18.8	80.1	1.8	20.1	81.0
Sweden	3.3	17.3	81.7	2.5	14.7	84.1
Switzerland	2.3	25.1	67.1	1.3	22.5	68.8
UK	1.3	14.2	84.6	0.9	12.8	87.3
US	2.2	13.9	84.3	1.9	13.6	85.4
Average	**3.9**	**19.4**	**77.7**	**3.1**	**18.6**	**78.8**
Data sources: Wealth data are from World Bank (2011). Net foreign assets are not included in ICpc. Therefore, the capital shares shown do not add up to 100.						

Table 5: Convergence regressions for GDPpc, TWpc, LSF (1995-2005), 26 countries							
	1	2	3	4	5	6	7
	GDPpc growth rate	GDPpc growth rate	TWpc growth rate	TWpc growth rate	LSF growth rate	LSF growth rate	LSF growth rate
Log($GDPpc_{1995}$)	-0.010 (-1.69)	-0.011 (-1.27)					
Log($TWpc_{1995}$)			-0.008** (-2.32)	-0.012** (-2.60)			
Log(LSF_{1995})					0.002 (0.18)	-0.032** (-2.13)	-0.026* (-1.96)
Hungary		0.01 (0.74)		0.001 (0.12)		-0.006 (-1.04)	-0.007 (-1.428)
Mexico		-0.01 (-0.84)		-0.022** (-2.16)		0.014*** (2.82)	0.012** (2.81)
Portugal							-0.013** (-2.53)
Log($Trust_{1995}$)						0.011*** (3.29)	0.007* (1.86)
Constant	0.13** (2.08)	0.14 (1.53))	0.12*** (2.84)	0.18*** (2.96)	-005 (-0.20)	0.20 (0.82)	0.027 (1.24)
R^2	0.11	0.18	0.18	0.36	0.001	0.45	0.58
Adj. R^2	0.07	0.07	0.15	0.27	-0.04	0.34	0.48

Notes: The dependent variables are annual growth rates.
*** = statistically significant at the 1% level; **= statistically significant at the 5% level;
*=statistically significant at the 10% level. Number of observations = 26.

Table 6: Correlations - LSF and wealth variables, for different country samples (data are for all three years)			
	All 26 countries	Without four NCpc intensive countries (22 countries)	Richest group of countries, without NCpc intensive countries (17 countries)
LSF-TWpc	0.60[a]	0.62[a]	0.54[b]
LSF-NCpc	0.36[c]	0.57 [a]	0.59[b]
LSF-PCpc	0.46[b]	0.48[b]	0.32
LSF-ICpc	0.59[a]	0.62[a]	0.54[b]
N	78	66	51

Notes: The four NCpc intensive countries are Australia, Canada, New Zealand and Norway. The richest group of countries includes those with GDPpc > 20,000 in 1995 (in 2005$); it excludes Hungary, Mexico, Greece, Korea and Portugal. N=Number of observations.
a = statistically significant at the 1% level (two-sided test)
b = statistically significant at the 5% level (two-sided test)
c = statistically significant at the 10% level (two-sided test)

Table 7: Sustainability indices, 2005										
Country	**ANSpc**	**ANS**	**ΔTWpc**	**ΔWpc**	**ΔNCpc**	**HPI**	**ERNHI**	**EWEB**	**ESI**	**EPI**
Australia	2,217	2.9	102,411	655	10,438	36.6	8.931	-0.47	61.0	80.1
Austria	3,100	14.5	74,781	2,284	-1,901	47.7	17.536	0.78	62.7	85.2
Belgium	2,917	14.4	93,088	2,283	1,394	45.4	13.762	0.59	44.4	75.9
Canada	2,081	10.7	84,629	881	4,429	39.4	11.300	-0.01	64.4	84.0
Denmark	2,891	14.5	107,664	2,475	3,250	35.5	19.339	**n.a.**	58.2	84.2
Finland	3,586	15.6	153,576	3,207	45	47.2	14.290	1.01	75.1	87.0
France	2,083	10.7	91,172	1,473	-429	43.9	9.409	0.36	55.2	82.5
Germany	2,808	10.9	65,585	2,871	180	48.1	12.133	0.51	56.9	79.4
Greece	217	0.7	91,183	-35	-1,797	37.8	5.562	-0.47	50.1	80.2
Hungary	329	8.4	56,215	392	-2,421	38.9	2.040	-0.45	52.0	77.0
Iceland	-1,091	4.9	246,313	-2,745	-5,119	38.1	**n.a.**	**n.a.**	70.8	82.1
Ireland	6,847	21.9	195,652	4,327	-6,186	42.6	14.716	0.45	59.2	83.3
Italy	1,241	7.9	66,548	552	-737	44.0	11.135	0.27	50.1	79.8
Japan	2,265	9.0	77,954	2,252	-1,507	43.3	4.717	-0.11	57.3	81.9
Korea, Rep.	3,300	21.8	89,195	3,045	-195	44.4	4.312	-0.17	43.0	75.2
Luxembourg	13,885	26.3	218,828	11,484	-4,992	28.5	8.767	**n.a.**	41.8	**n.a.**
Mexico	418	9.4	20,243	164	-4,991	55.6	12.151	1.33	46.2	64.8
Netherlands	3,825	14.1	112,071	3,541	-387	50.6	14.963	1.25	53.7	78.7
NZ	496	8.4	76,975	-501	-1,490	36.2	14.304	-0.42	60.9	88.0
Norway	5,504	15.4	96,193	3,254	48,678	40.4	13.827	0.16	73.4	80.2
Portugal	-577	3.2	52,460	-811	-1,697	37.5	5.547	-0.80	54.2	82.9
Spain	1,869	10.7	83,645	584	22	43.2	12.001	0.33	48.8	79.2
Sweden	4,540	19.4	133,321	4,184	-407	48.0	18.534	0.90	71.7	87.8
Switzerland	8,291	20.1	66,493	6,811	-6,284	48.1	22.789	**n.a.**	63.7	81.4
UK	1,162	6.3	160,229	613	-516	43.3	11.458	0.33	50.2	85.6
US	182	6.1	148,848	-821	831	30.7	8.064	-1.31	52.9	78.5
Mean										
Notes: n.a. = not available. ANSpc, ANS and ΔWpc indicate annual changes (2004 to 2005). ΔTWpc and ΔNCpc indicate 10 year changes (1995 to 2005). HPI, ERNHI, EWEB and ESI are for 2005, EPI is for 2006.										

Table 8: Correlation amongst wealth-based sustainability indices, 2005					
ANSpc	1.0				
ANS	0.85[a]	1.0			
ΔTWpc	0.34[c]	0.26	1.0		
ΔWpc	0.97[a]	0.86[a]	0.24	1.0	
ΔNCpc	0.07 (-0.36[c])	-0.005 (-0.21)	-0.10 (-0.23)	-0.002 (-0.26)	1.0
	ANSpc	**ANS**	**ΔTWpc**	**ΔWpc**	**ΔNCpc**

Notes: All 26 countries included, except for values in brackets, which are for 22 countries, i.e. the sample excluding the NCpc intensive countries Australia, Canada, New Zealand and Norway. ANSpc and ΔWpc are from World Bank (2011). ANS is ANS as percentage of GNI, taken from UNDP (2012). ΔTWpc and ΔNCpc are calculated from World Bank (2011). They are 10 year changes (1995-2005). The other variables are annual changes.
a = statistically significant at the 1% level (two-sided test)
c = statistically significant at the 10% level (two-sided test)

Table 9: Correlation between LSF and non wealth-based sustainability indices, 22 countries, 2005						
LSF	1					
HPI	0.33	1				
ERHNI	0.79[a]	0.46[b]	1			
EWEB	0.53[b]	0.94[a]	0.68[a]	1		
ESI	0.45[b]	-0.05	0.48[b]	0.16	1	
EPI	0.07	-0.30	0.33	-0.11	0.64[a]	1
	LSF	**HPI**	**ERHNI**	**EWEB**	**EIS**	**EPI**

Notes: Denmark, Iceland, Luxembourg and Switzerland are excluded from the sample.
a = statistically significant at the 1% level (two-sided test)
b = statistically significant at the 5% level (two-sided test)

Table 10: Correlations - Sustainability indices, GNIpc and LSF, 24 countries

LSF	1									
GNIpc	0.59[a]	1								
ANSpc	0.47[b]	0.70[a]	1							
ANS	0.38[c]	0.42[b]	0.83[a]	1						
ΔTWpc	0.23	0.47[b]	0.34[c]	0.29	1					
ΔWpc	0.38[c]	0.60[a]	0.95[a]	0.85[a]	0.26	1				
ΔNCpc	0.24 (-0.01)	0.52[a] (0.13)	0.20 (-0.37)	0.03 (-0.18)	0.03 (0.14)	0.06 (-0.03)	1			
HPI	0.23	-0.06	0.37[c]	0.45[b]	-0.21	0.50[b]	-0.22 (-0.36[c])	1		
ERHNI	0.81[a]	0.62[a]	0.66[a]	0.56[a]	0.21	0.62[a]	0.03 (-0.09)	0.36[c]	1	
ESI	0.46[b]	0.60[a]	0.49[b]	0.29	0.29	0.43[b]	0.42[b] (-0.09)	-0.02	0.48[b]	1
EPI	0.12	0.43[b]	0.20	0.09	0.49[b]	0.17	0.01 (0.22)	-0.32	0.32	0.64[a]
	LSF	**GNIpc**	**ANSpc**	**ANS**	**ΔTWpc**	**ΔWpc**	**ΔNCpc**	**HPI**	**ERHNI**	**ESI**

Notes: Data are for 24 countries (Iceland and Luxembourg are excluded from the sample). Numbers in brackets are for 20 countries, i.e. they exclude the four NC intensive countries Australia, Canada, New Zealand and Norway.
ΔTWpc and ΔNCpc are 10 year changes (1995-2005). ANS, ANSpc and ΔWpc are annual changes. GNIpc, HPI, ERHNI and ESI are for 2005. EPI is for 2006.
a = statistically significant at the 1% level (two-sided test)
b = statistically significant at the 5% level (two-sided test)
c = statistically significant at the 10% level (two-sided test)