Average Subjective Well-Being and the Wealth of Nations: Some Insights Derived From the World Bank's Millennium Capital Assessment

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Abstract

The World Bank has provided estimates of total wealth and its major subcategories for a large group of countries in 2000. Total wealth has been interpreted by some to be a measure of social welfare and the object of the sustainable development paradigm. This paper contributes to the debate about the relative merits of subjective versus objective well-being measures in the context of sustainable development. Using scatter diagrams, correlations and regression analysis, it explores bivariate relationships between the wealth estimates and a widely reported measure of average subjective well-being (SWB) or 'happiness'. For comparative purposes, correlations between GNI per capita and the wealth estimates are also reported.

The cross-country wealth-happiness relationship is very similar to the income-happiness relationship. However, differences emerge for wealth subcategories. First, the high correlation between total wealth and GNI per capita is mostly due to produced capital and, to a lesser extent, intangible capital, but not to natural capital. This raises doubts about the appropriateness of total wealth as a well-being measure in the context of sustainable development. Secondly, SWB is more highly correlated with intangible capital than produced capital, and least with natural capital. Thirdly, when the most natural capital intensive countries are excluded as outliers, the relationship between SWB and natural capital becomes much stronger. This is especially noticeable for high income countries. Therefore, putting more emphasis on SWB in the context of sustainable development should shift attention further toward natural capital, but lessen the relative importance of produced capital.

Keywords Average Subjective Well-Being · Total Wealth · Natural Capital · Produced Capital · Intangible Capital · Income · Sustainable Development · Cross-section Data

JEL: E01, O13, Q01.

1. Introduction

The World Bank's (2006) 'Millennium Capital Assessment' (MCA) provides estimates of the per capita levels of total wealth and its major subcategories for 120 countries in the year 2000. It is a major contribution to the literature on comprehensive measurement of national wealth and to the debate about sustainable development, which is one of the millennium development goals (World Bank, 2005, 2006).[1] The wealth estimates have been interpreted to "provide insights about what constitutes a country's base for producing well-being" (Ruta and Hamilton, 2007, p. 60). More specifically, it is assumed that wealth, measured in terms of capital assets, is a measure of social welfare. Ruta and Hamilton argue, therefore, that wealth becomes the object of the sustainable development paradigm.

This study explores the bivariate relationships between a widely reported measure of average subjective well-being (SWB) or 'happiness' and the MCA wealth estimates.[2] For comparative purposes, findings for the relationships between Gross National Income (GNI) per capita and the wealth estimates are also reported. SWB is, by definition, a subjective well-being measure. Wealth is an 'objective' economic well-being measure depending on (sustainable) consumption levels.[3] The subjective and objective macro-level well-being measures used in this study are arguably the best of their type currently available.

The study is motivated by a number of factors. Firstly, with very few exceptions, research that explores the link between happiness and the standard of living has focussed on the income-happiness relationship, not the wealth-happiness relationship. Secondly, some economists, e.g. Ng (1999, 2003), have suggested that current welfare economics is incomplete and that its scope should be extended to include happiness. Thirdly, major international organisations have begun to accept SWB measures as (at least) useful complements to well-being measures based on economic variables.[4] This

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[1] Conventional income measures do not say much about sustainability. Ruta and Hamilton (2007, p. 46) illustrate the problem as follows: "Higher income does not necessarily mean higher sustainability, in the same way as a higher fishery catch does not necessarily mean a bigger fish stock." For a detailed account of the history of efforts to comprehensively measure national wealth and its sustainability, see Hamilton and Atkinson (2006).

[2] In this paper the terms SWB and happiness are used synonymously, although the empirical analysis employs a specific definition of SWB which is derived from a combination of happiness and life satisfaction variables (see section 3).

[3] Also see Hamilton and Atkinson (2006, chapter 2). For an extended discussion of various well-being concepts and their interrelationships, see Gasper (2007a,b). Gasper supports the plurality of concepts, but perceives a great need for conceptual clarification in much of the well-being literature. This issue has obtained increased relevance with the rise of happiness economics. SWB measures have been used as proxy variables for utility in a multitude of studies (Dolan et al., 2008). Clark et al.'s (2008) survey article discusses the issue of whether SWB corresponds to utility, providing many arguments in favour of this view, and some against it.

[4] For example, in the 2006 edition of its publication "Economic Policy Reforms: Going for Growth" the OECD (2006) devotes a chapter to alternative measures of well-being, including subjective well-being indicators. While concluding that GDP per capita remains critical for any assessment of well-being, it acknowledges that GDP can be usefully complemented with other measures like SWB in order to derive a more comprehensive assessment of well-being (ibid., p. 130).

paper contributes to the debate about the relative merits of subjective versus objective well-being measures in the context of sustainable development. It also contributes to the macro empirical literature on correlates of SWB.[5]

Correlation, however, does not imply causation. Frey and Stutzer (2002) point out that income per capita and SWB are likely to be affected by common factors such as the quality of the institutional environment (including stable democracy and more secure human rights), better average health, and many more.[6] Moreover, some authors have found reverse causality between happiness and economic outcomes (Kenny, 1999, Graham et al., 2004). These criticisms also apply in the current context. This study only analyses bivariate macro-level relationships, but it does not develop a theory trying to explain them. It focuses on *proximate* (wealth) causes of the cross-country variation in average SWB, not on *ultimate* causes that might explain the relationships between SWB, total wealth, and its subcategories. Such a theory would have to be a theory of general economic development, wealth, and average SWB. Is it hoped the insights gained will stimulate efforts to develop such a comprehensive theory.[7]

It should be stated at the outset that recognising the differences between average SWB and wealth as well-being measures for sustainable development does not imply that this paper advocates maximisation of average SWB as the primary goal of government policy. This question is beyond its scope. The reported findings are compatible with the view put forward by, for example, Frey and Stutzer (2007) and Ng and Ho (2006), that aggregate happiness indicators should only be used as one type of important macroeconomic input in the political discourse, alongside other indicators. Another major caveat concerns the many shortcomings of the wealth estimates. A premise of this paper is that our currently limited and deficient knowledge of total wealth and its components should not prevent us from working

[5] The paper does not address the role of 'objective' quality of life indices, i.e. that of social indicators. There is some evidence they are mostly robustly correlated with both SWB and GDP per capita, at least in rich countries. However, an important exception might be environmental quality of life indices which do not seem positively related to GDP per capita, indicating a potential conflict between pro-growth and environmental policies (Grasso and Canova, 2008).

[6] Dolan et al. (2008) provide a detailed review of the literature on SWB and its determinants at the micro-level that has appeared in mainstream economics journals since 1990. SWB seems determined by a wide range of personal, social, economic, political and environmental factors. The authors also highlight a range of problems associated with drawing firm conclusions about causal relationships. Arthaud-Day and Near (2005) review the literature on the aggregate income-happiness relationship and conclude that it is positive, but that we do not have a theory that can explain all the facts.

[7] The development theory underlying the MCA is that of development as a process of portfolio management: Managing each of the components of wealth (i.e. types of capital) and efficiently transforming one into the other is crucial for a country's sustainable development. Implicitly, the wealth accounts are based on the idea of a production function in which the different forms of capital are substitutable inputs (see World Bank, 2006, chapter 8). It would be inappropriate to interpret this simply supply side model as a complete model of economic development. However, proponents of the approach argue that it has the advantage of highlighting the responsibilities of economic management to focus on a comprehensive strategy that includes all wealth components, i.e. not just natural resources, but also human, social, institutional capital etc. (Ruta and Hamilton, 2007).

with the best estimates currently available. They can clearly be improved upon in future.

In the data sample used in this study the cross-country wealth-happiness relationship is very similar to the income-happiness relationship. However, differences emerge for wealth subcategories. The high correlation between total wealth and GNI per capita is mostly due to produced capital and intangible capital, but not to natural capital. By contrast, produced capital is relatively weakly correlated with SWB in the group of high income countries. Of the wealth subcategories, intangible capital has the highest correlation with SWB. When the most natural resource intensive countries are excluded as outliers, the positive relationship between SWB and natural capital becomes much stronger, especially amongst high income countries.

Section 2 briefly discusses the macro-level income-happiness relationship, the importance of distinguishing between income and wealth in the context of happiness studies, and some of the literature on sustainable development and SWB. It also introduces the major findings of the MCA. Variable definitions and the data sample are discussed in Section 3. The next two sections present the empirical analysis. Section 4 reports scatter diagram, correlations and some simple regressions. Section 5 contains a more extensive regression analysis. Section 6 concludes. The data are reported in the Appendix.

2. Some Earlier Literature

2.1 SWB, Income, and Wealth

The relationship between income and happiness has been extensively analysed since Easterlin's (1974) seminal contribution. Many studies have provided evidence on the cross-country differences in income per capita and average SWB. A convincing finding is that, on average, people in rich countries are happier than people in poor countries, although there are important exceptions. Another finding is that the relationship seems to be concave. SWB rises with income per capita at low levels of economic development, but once a certain threshold has been reached (e.g. about US$ 10,000 in 1995 $ terms), higher income per capita has less impact on average SWB.[8] However, the impact remains positive, i.e. even in rich countries further increases in income per capita seem to be associated with higher levels of average SWB.

Cross-sectional findings, which by their very nature cannot control for region- and country-specific effects, often differ from time-series evidence. The latter have often been interpreted to show that income per capita has little, if any, impact on happiness (the well-known Happiness or Easterlin Paradox). Unfortunately, given that consistent wealth data for a large number of countries are currently only available for one point in time, it cannot be tested in this paper whether the Easterlin Paradox's applicability extends to total wealth and its major subcategories. For an introduction to the controversy about the Easterlin Paradox, see Easterlin (2005) and Veenhoven and Hagerty (2006). One might be tempted to argue that omitted variables are likely to be responsible for the Easterlin Paradox. However, in a recent paper Di Tella and

[8] See, for example, the survey article by Frey and Stutzer (2002).

MacCulloch (2008) report that adding additional variables only increases the paradox. Studies using micro-level data find a positive income happiness gradient. For a recent survey, and a reconciliation of the macro- and micro-level findings, see Clark et al. (2008). They focus on the incorporation of relative considerations in the utility function. By contrast, Stevenson and Wolfers (2008) conduct an extensive analysis of the income-happiness relationship using multiple rich data sets and find that the Easterlin Paradox does not exist. However, whether it would re-emerge if additional variables were added is not explored by Stevenson and Wolfers. In short, despite an extensive body of research, recent studies suggest that major aspects of the income-happiness relationship are still in dispute.

Many happiness studies use income and wealth synonymously, even though they focus on the relationship between income and happiness. Few studies so far explicitly distinguish between income and wealth. Those that do use micro-level data and find the distinction matters. Mullis (1992) reports that amongst a group of American men a more comprehensive measure of well-being that combines aspects of income and wealth performs better as a predictor of SWB than current income alone. More recently, Headey and Wooden's (2004) study using Australian household wealth survey data and Headey et al.'s (2008) study using similar data for five countries (Australia, Britain, Germany, Hungary and The Netherlands) find that in all cases wealth (net worth, i.e. assets minus debts) affects SWB a lot more than does income. They suggest this is probably due to the fact that wealth provides economic security, which many people value highly. Wealth also allows people to borrow money to cope with bad times and to invest. Moreover, both financial and non-financial assets matter, i.e. both generate real flows of benefits to people.

The major conclusion drawn from these studies is that objective economic circumstances, and therefore economic variables, are more important for SWB than suggested by the Easterlin Paradox and, except for some recent studies, by much of the literature on the income-happiness nexus. Even if income cannot buy (much) happiness, wealth seems to be able to. Of course, measuring wealth is more difficult than measuring income. The definition of wealth in micro-level studies is very different from that used in World Bank (2006). Individual and/or household net wealth only takes (some) financial assets and liabilities into account and, to a certain extent, varies from country to country (see Headey et al., 2008, for details). Intangible capital, so important for total national wealth, is not included in these measures.

2.2 Sustainable Development and SWB

A number of attempts have been made to link SWB and sustainable development across nations. Some authors develop 'environmental impact corrected' happiness measures. For example, the New Economics Foundation's '(Un)Happy Planet Index' (Marks et al., 2006) is constructed as the ratio of average happy life years[9] and the per capita ecological footprint of each country. Ng (2008) modifies this index by remedying some perceived shortcomings in the calculation of happy life years and by

[9] The concept of 'average happy life years' or 'happy life-expectancy' is a proxy measure for well-being that combines measures of SWB/happiness and life expectancy. It was developed by Veenhoven and some of his associates (see Veenhoven, 1996, 2005).

replacing the per capita national ecological footprint by a measure that takes into account a country's global ecological impact. As a national success indicator, his 'environmentally responsible happy nation index' (ERHNI) seems superior because, if adopted as an indicator by governments, it would help focus policy both on increasing happiness and minimising an economy's global environmental impact.

Another approach to linking SWB and sustainable development is not to modify the happiness measure but to investigate the relationship between standard happiness indicators and various measures of sustainable development. Zidanšek (2007), for example, investigates the relationships between, on the one hand, three measures of happiness and, on the other hand, two environmental sustainability indicators (and some of their subcomponents). The latter are the environmental sustainability index (ESI) and the environmental performance index (EPI)[10], the former are average happiness between 1990 and 2000, inequality adjusted happiness, and happy life years.[11]

Zidanšek (2007) expects the causal relationship between sustainability and happiness to go in both directions, i.e. happier people care more about the environment and a better environment creates happier people. He reports scatter plots between various combinations of the two types of indicators and fits linear trend lines which he argues provide evidence of positive correlation. However, the data scatter rather widely and one may wonder whether non-linear relationships might fit them better. In particular, visual inspection of his data would suggest a levelling off of happiness (however measured) for high values of the environmental sustainability indicators. Zidanšek obtains the best linear fit for the (inverse) relationship between happiness and CO_2 emissions, a subcategory of the ESI index. He argues that sustainable development in the interest of future generations does not require a 'happiness sacrifice' from the current generation. Rather, he suggests the possibility of improving happiness and sustainability simultaneously.

This paper addresses the related, but different, question whether sustainable wealth and its major components, which include natural resources, are correlated with SWB in a cross-section of countries.

2.3 The World Bank's Millennium Capital Assessment

The World Bank (2006) has provided a comprehensive snapshot of wealth for a large number of countries at the turn of the millennium. Per capita estimates of total wealth, as well as of its major subcategories (i.e. natural capital, produced capital and intangible capital), are also provided. Some of the estimates are more precise than others (the methodology used to derive the capital estimates is explained in section 3 below). For example, total wealth, as well as natural and produced capital, are estimated directly, whereas intangible capital is measured as a residual by subtracting natural and produced capital from total wealth. Table 1 indicates that the composition of wealth varies greatly by income level. Unsurprisingly, the overall rankings of

[10] For details of these global indexes see the references provided in Zidanšek (2007).

[11] They are taken from Veenhoven's World Database of Happiness at http://worlddatabaseofhappiness.eur.nl/ .

countries by wealth per capita and GDP (or GNI) per capita are quite similar, but the main focus is on the changing composition of wealth across income levels.

Table 1: Average total wealth and its components across 120 countries in 2000 (in 2000 US$ per capita and percentage shares)

Country income group	Natural capital	Produced capital	Intangible capital	Total wealth	Natural capital share	Produced capital share	Intangible capital share
Low-income	1,925	1,174	4,434	7,532	26%	16%	59%
Middle-income	3,496	5,347	18,773	27,616	13%	19%	68%
High-income	9,531	76,193	353,339	439,063	2%	17%	80%
World	4,011	16,850	74,998	95,860	4%	18%	78%

Notes: Countries are classified as low-income (L), lower-middle income (LM), upper-middle income (UM), and high income (H) using the World Bank classification for 2001 (in GNI per capita in US$) available from http://web.world.bank.org/.
L: <= $745; LM: $746-$2,975; UM: $2,976-$9,205; H: > $9,205.
Source: World Bank (2006), Table 1.1, p. 4.

The World Bank (2006, chapter 2) draws the following stylized facts from its analysis: Firstly, *intangible capital is the largest share of total wealth, but it varies widely between income groups and across regions.* Nearly 90% of the cross-country variation in intangible capital can be explained by a simple measure of human capital (years of schooling) and governance as measured by a rule of law index. For some countries, especially oil states, intangible capital might be negative or very low, which is interpreted as an indication of the resource curse. GNI in these countries is too low in the sense that they achieve very low returns on their capital. Secondly, *richer countries have lower shares but higher levels of natural capital*. The World Bank (2006, p. 30) speculates that in rich countries preferences linked to higher income are playing a key role in fostering more careful management of natural capital, and that the value of natural capital might also interact positively with high levels of other types of capital. This might indeed suggest that higher per capita levels of natural capital are correlated with higher levels of average SWB. Thirdly, *poorer countries rely on land resources*. In the poorest countries, land resources make up a large proportion of natural capital. This suggests a possible poverty-land-dependence trap in low-income countries (World Bank, 2005, p. 30).

The sustainability of a country's wealth is assessed by calculating a genuine savings rate (i.e. genuine savings as percentage of GNI) which is then adjusted for the population growth rate to obtain changes in wealth per capita. A test of the theory that genuine savings at some point in time predict changes in future welfare has produced mixed results (Hamilton and Atkinson, 2006, chapter 4; World Bank, 2006, chapter 7). Genuine savings or changes in wealth per capita seem to be poor predictors of future welfare in developed countries, but better predictors of future welfare in developing countries. This could be an indication that the 'objective' wellbeing measure is less suitable for developed countries. However, the test has been far from ideal, requiring many caveats which may have influenced the results.[12] Never-the-less, the relatively poor test results cast doubt on a major policy implication derived from the theory behind the MCA, i.e. that decision-makers do not require direct welfare measurement to guide policy. In (economic) theory, all that is required is that genuine savings (and changes in wealth per capita) are used as a policy guide (Hamilton and Atkinson, 2006, chapter 2). In practise, this might be less than ideal.

3. Variables and Data

3.1 Variables

This section discusses some of the major aspects of the measurement of total wealth and its components[13], and of the SWB variable used. GNI per capita (*GNIpc*) data for 2000 in US$ are taken from World Bank (2006, Appendix 4). All data are listed in Appendix Table 1.

3.1.1 *Total wealth per capita (TotWpc)*

The World Bank (2006) assumes that total wealth per capita can be used as an indicator of (social) well-being. Dasgupta (2001) shows that this requires the assumptions that a) the population growth rate is constant, b) per capita consumption is independent of population size and c) production takes place under constant returns to scale. Arrow et al. (2004) also use such a welfare measure. Following Hamilton and Hartwick (2005), the current value of total wealth W_t is estimated as the net present value of *sustainable consumption*, i.e. the *net present value of the consumption level that leaves the capital stock intact*.[14] Measured in this way, total wealth tries to account for intertemporal equity issues and thus becomes the object of the sustainable development paradigm (Ruta and Hamilton, 2007). The calculation of total wealth requires an estimate of the current level of sustainable consumption (measured as the average of 1998-2000 consumption corrected for any negative adjusted net savings), as well as values for the pure rate of time preference (assumed to be 1.5 percent) and the time horizon considered (assumed to be 25 years, i.e. roughly a generation).

The World Bank (2006) concedes that measuring total wealth as the sum of its components would make intuitive sense, but this is currently infeasible due to data and methodological constraints, leaving plenty of scope for future research to improve estimates. The most severe measurement problems relate to the intangible capital

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[12] Measurement errors, missing variables and exogenous shocks may have distorted the results. Also the test is particularly stringent in that it assumes that genuine saving at a point in time results in changes in future welfare.

[13] For further details, see World Bank (2006), Hamilton and Atkinson (2006, chapter 2), Ruta and Hamilton (2007).

[14] It can be shown that $W_t = \int_t^\infty C(t) e^{-r(s-t)} ds$, where C is current consumption, ρ is the pure rate of time preference, and s is another time index. This requires the further assumptions that the elasticity of utility with respect to consumption equals 1 and that consumption grows at a constant rate (see World Bank, 2006, p. 144).

component, which accounts for a multitude of factors that have greatly increased with the development of knowledge-based economies, e.g. human capital, social capital, institutional capital. How to consistently measure and value these for a particular country, let alone for a large group of countries, remains a formidable challenge.

3.1.2 *Produced capital per capita (ProdCpc)*

Produced capital is made up of machinery, equipment and structures (including infrastructures), and urban land. The first three are measured using the perpetual inventory method to estimate the value of produced capital stocks, whereas urban land is measured indirectly as a percentage of the value of the produced capital stocks. The service life of capital is assumed to be 20 years, with the value of an asset falling to zero after that time. The depreciation rate is 5 percent across countries and over time. Following some estimates reported in the literature, the percentage used to determine the value of urban land from the value of produced capital stocks was set at 24 for all countries.

3.1.3 *Natural capital per capita (NatCpc)*

Natural capital is made up of a large number of non-renewable and renewable resources which, given the available data, are measured and valued at various degrees of accuracy. The non-renewable resources included are oil, gas and coal, the renewable resources are ten metals and minerals (bauxite, copper, gold, iron ore, lead, nickel, phosphate rock, silver, tin, zinc). Their value is calculated as the present discounted value of (estimated) economic profits over the (estimated) life of the resource, which inevitably requires making numerous simplifying assumptions and using guesstimates for many of the important parameter values (see World Bank, 2006, Appendix 1). Renewable resources included in natural capital are cropland, pastureland, forested areas, and protected areas. Some of these (nontimber forest resources and protected areas) can only be measured crudely. For example, protected areas are measured by their opportunity cost in terms of cropland or pastureland, which probably captures the minimum value of protected areas (World Bank, 2006, p. 154). Due to lack of data, other resources which preferably should be included in the total value of natural capital are missing (in particular subsoil water, diamonds, and fisheries). This will have greatly underestimated the value of natural resources of some countries, and overestimated their intangible capital.[15]

3.1.4 *Intangible capital per capita (IntCpc)*

Some of the items included in produced and natural capital are likely to be over-estimated, others underestimated, and other item that should be included are neglected altogether. Moreover, total wealth is also estimated imprecisely. It is therefore difficult to judge whether intangible capital as the difference between the latter and the former is likely to be over- or under-estimated.[16] However, the fact that the share

[15] For example, in the case of Botswana, inclusion of the economic value of diamonds would increase natural capital per capita from just over $3,000 to about $10,500 (World Bank, 2006, p. 25 and Appendix 1). Botswana is not included in the data sample used in this paper.
[16] It would, of course, have been better to use direct estimates of intangible capital. However, such estimates are not available. The conceptual and measurement issues associated with

of intangible capital in total wealth increases with the level of economic development suggests that the World Bank estimates are not completely unreasonable, at least as a first approximation.

The World Bank's (2006, p. 23) interpretation of intangible capital includes human capital (the sum of knowledge, skills, and know-how possessed by the population), a country's institutional infrastructure, and social capital (the latter being interpreted as the level of trust among people and their ability to work together towards common goals), as well as net foreign financial assets through the returns generated by these assets.

A simple regression model that uses just three explanatory variables, i.e. human capital (measured by average years of schooling per capita), remittances from abroad (as a proxy for human capital of emigrants), and quality of institutional environment (measured by a rule of law index), can account for almost all of the variation in intangible capital, with the rule of law index accounting for the largest contribution on average (57 percent), followed by school years per capita (another 36 percent) (see World Bank, 2006, pp. 91-98). However, the relative contributions of the three explanatory variables vary widely between countries, suggesting that a one-size-fits-all policy rule cannot be derived from the findings for the average country (ibid.).

3.1.5 *Subjective well-being (SWB)*

The *SWB* measure used in this paper is taken from Inglehart (2004). It is also available from the website of the World Values Survey (WVS). The measure is constructed from the responses to two questions of the 1999-2002 wave of the WVS: The 'Feeling of Happiness' question and the 'Life Satisfaction' question.[17] For a sample of 82 countries, Inglehart (2005) reconfirms the often observed non-linear relationship between *SWB* and the level of economic development (measured by GNP per capita), i.e. *SWB* levels off for high income countries. It is expected that this also holds for the sample of countries used in this paper.

3.1.6 *Genuine saving and change in wealth per capita (ChWpc)*

The derivation of adjusted net savings or genuine savings is rather complex. First, fixed capital depreciation is subtracted from gross national savings to obtain net savings. Then, education expenditure is added, and the value of depletion of natural resources and pollution damages is subtracted to obtain genuine saving. More precisely, genuine savings are calculated as net national saving plus education expenditure, minus energy depletion, mineral depletion, net forest depletion, carbon dioxide damage, and particulate emissions damage (see World Bank, 2006, Appendix 1). However, due to lack of internationally comparable data some important sources

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intangible capital are difficult and have not yet been resolved (see, for example, Carrado et al., 2005).

[17] Inglehart (2005, p. 11) explains the construction of SWB as follows: "Happiness was rated on a four-point scale, on which high scores indicated low levels of happiness; life satisfaction was rated on a ten point scale on which high scores indicated high levels of satisfaction. To give both variables equal weight, the mean scores on the happiness scale were multiplied by 2.5 and subtracted from the life satisfaction scores."

of environmental degradation such as water depletion, unsustainable fisheries, and soil depletion, are still not taken into account.

Genuine saving not only measure changes in a country's produced assets, but also in its natural resources and environmental quality.[18] However, if population growth is greater than the growth rate of total wealth, genuine savings could be positive, suggesting sustainability, while in per capita terms (tangible) wealth is negative, i.e. declining, and therefore unsustainable. Under the assumption that population growth is exogenous, genuine savings are adjusted for the population growth rate to obtain the change in wealth per capita (see World Bank, 2006, chapter 5). It should be noted that the genuine savings rate and the change in wealth per capita only include tangible wealth. The intuition for this is that much intangible capital is embodied in people (ibid., p. 62). Suffice it to say this is one of many caveats pertaining to the measurement of these variables (ibid., chapter 6).

3.2 The data sample

The data sample used in this study was derived by matching the wealth data with the SWB data. In some cases separate *SWB* values available from Inglehart (2004) had to be combined in order to convert the *SWB* data to the country definitions used for the other variables.[19] Although the World Bank reports wealth estimates for 120 countries, and Inglehart reports *SWB* estimates for 82 countries, there are only 58 country matches between the two databases. Table 2 shows maximum and minimum values of variables (for the whole 58 country sample, and for the 24 high income countries).

Table 2: Minimum and maximum values of variables

	Min	Max
SWB	-2.4 (1.12)	4.32 (4.24)
Total wealth	2,748 (141,282)	648,241
Natural capital	0 (0)	54,828
Produced capital	595 (28,973)	150,258
Intangible capital	-3,418 (107,864)	542,394
Change in wealth	-847 (46)	8,020
GNIpc	297 (10,256)	37,879

Notes: The wealth data are in 2000 US$ per capita. Numbers in brackets are for the high income countries with GNI per capita greater than US$ 10,000. *Source:* See Appendix Table 1.

[18] See World Bank (2006, chapter 3). For a more extended recent discussion of genuine savings as an indicator of sustainability see Hamilton and Bolt (2007).

[19] Separate *SWB* scores for Belgium and Luxembourg were combined, as were the *SWB* scores for East and West Germany, and Great Britain and Northern Ireland. In all cases population fractions were used as weights in the calculation of the aggregate *SWB* values.

Eleven of the 58 countries (i.e. Algeria, Argentina, Colombia, Egypt, Indonesia, Iran, Nigeria, Pakistan, South Africa, Venezuela, Zimbabwe) have a negative *ChWpc*, suggesting that the current level of *TotWpc* is unsustainable and likely to be lower in future. For two countries, i.e. Georgia and the Russian Federation, projected negative population growth rates turn negative genuine savings rates into positive *ChWpc* estimates. At least 6 of the 11 countries with a negative *ChWpc* are classified by the World Bank (2006) as resource-intensive. Venezuela, the country with the largest negative value for *ChWpc*, might have had a stock of produced capital four times larger than its actual stock in 2000 had it followed the Hartwick rule[20] for investing in produced capital since 1970 (ibid., p. 54).

As can be seen from Table 2, variation in the values of variables is generally much smaller for the high income group of countries compared to the complete sample of countries. Among high income countries, Korea has the lowest levels of *SWB, IntCpc* and *TotWpc*, Greece has the lowest *ProdCpc*, and Australia the lowest *ChWpc*. The zero value for *NatCpc* is due to Singapore.

Table 3 reports the top and bottom five countries in the 58 country sample in terms of *SWB*, *GNIpc* and *TotWpc*. Country rankings for the latter two are quite similar, and differ from that for *SWB*. The *SWB* country ranking reflects the well-known finding that most Latin American countries have higher levels of *SWB* than suggested by their level of economic development (Inglehart, 2005), whereas the opposite applies to ex-Soviet Union countries (Inglehart and Klingemann, 2000) and East Asian countries (Ng, 2002).

Table 3: Top and bottom ranked five countries in terms of *SWB*, *GNIpc* and *TotWpc*

	Country	*SWB*	Country	*GNIpc*	Country	*TotWpc*
1	Mexico	4.32	Japan	37.9	Switzerland	648
2	Denmark	4.24	Switzerland	37.1	Denmark	575
3	Ireland	4.16	Norway	36.8	Sweden	513
4	Switzerland	4.00	United States	35.2	United States	513
5	Colombia	3.94	Denmark	29.0	Germany	496
…	…	…	…	…	…	…
54	Romania	-1.30	Pakistan	0.5	Moldova	9
55	Moldova	-1.63	India	0.4	Pakistan	8*
56	Russian Fed	-1.75	Bangladesh	0.4	India	7
57	Zimbabwe	-1.88	Moldova	0.3	Bangladesh	6
58	Indonesia	-2.40	Nigeria	0.3	Nigeria	3*

Notes: An * indicates that the change in wealth per capita is negative, i.e. the current level of *TotWpc* is not sustainable. *GNIpc* and *TotWpc* are in 1000's of US$.

[20] The rule suggests that resource-intensive countries can sustain a constant level of consumption over time if at each point in time the value of investment equals the value of resource rents. This amounts to keeping genuine savings equal to zero at each point in time. A modified version of the Hartwick rule that allows for constant positive genuine savings is used in World Bank (2006, chapter 4).

4. Bivariate Relationships between SWB, GNI and the Wealth Variables

This section reports scatter diagrams, linear correlation coefficients and some simple regressions to highlight the main features of the data. We start by comparing the relationships between *SWB* and *GNIpc* versus *SWB* and *TotWpc*. In the sample of 58 countries, *GNIpc* and *TotWpc* are highly correlated (i.e. linear correlation coefficient of 0.97), indicating that the former is a good proxy for the latter. They also have a very similar correlation with SWB. It is therefore not surprising that the scatter diagrams in Figures 1 and 2 look similar, i.e. both relationships are non-linear (concave). In short, the non-linear cross-country pattern, well-established in the literature on the income-happiness relationship, also seems to apply to the wealth-happiness relationship. Figure 1 and 2, moreover, suggest that for the group of high income countries (*GNIpc* > US$ 10,000) and high wealth countries (*TotWpc* > US$ 140,000), the relationships are approximately linear. Although these two groups contain the same countries, some of the rankings differ. Most noticeable, Switzerland is the undisputed leader in terms of *TotWpc*, in contrast to *GNIpc*.

(Insert Figures 1 and 2)

Table 4 reports the linear correlation coefficients between *SWB* and *GNIpc,* as well as between *SWB* and *TotWpc* (in brackets). They are quite high and very similar for the total country sample, and somewhat lower for the group of high income countries. Moreover, for the high income countries, the correlation between *SWB* and *TotWpc* is greater than that between *SWB* and *GNIpc*. Given the relatively small size of, especially, the high income group of countries, correlations might be quite sensitive to minor changes in the sample. When Portugal, Greece and the Republic of Korea are excluded, i.e. when only countries with *GNIpc* above US$ 12,000 are included, the size of the correlations falls considerably and they become statistically insignificant. Correlations are even smaller for the richest group of countries (*GNIpc* above US$ 20,000). The negative correlation between *SWB* and *GNIpc* for this group is due to the observation for Japan (see Figure 1).

Table 4: Correlations between *SWB* and *GNIpc*, and *SWB* and *TotWpc*

	All countries	*GNIpc*>$10,000	*GNIpc*>$12,000	*GNIpc*>$20,000
SWB	0.62* (0.63*)	0.50* (0.57*)	0.22 (0.31)	-0.10 (0.09)
N	58	24	21	16

Notes: * Statistically significant at 5% level, one-tailed test. Numbers in round brackets are correlations between *SWB* and *TotWpc*. All data are for 2000.

Tables 5 and 6 report linear correlation coefficients between the wealth variables and, respectively, *SWB* and *GNIpc*, for the complete sample and sub-samples of high income countries. Correlations between *GNIpc* and *TotWpc* are high and statistically significant for all country samples. By contrast, those for *SWB* and *TotWpc* are always smaller, and become statistically insignificant for countries with *GNIpc* greater than US$ 12,000.

Figures 1 and 2 also show the OLS regression lines and regression estimates for the semi-logarithmic model $SWB_i = ß \ln X_i + constant + \varepsilon_i$, where *X* is either *GNIpc* or *TotWpc*. The regressions are best interpreted as a rough summary of the data. The model cannot identify causality, i.e. endogeneity issues are not addressed. The R^2's seem to indicate that *GNIpc* 'explains' more of the variation in *SWB* than does *TotWpc*.

Although the statistically significant correlations reported in Table 4 indicate that *SWB* is related to both *GNIpc* and *TotWpc*, the main focus of this paper is on the components of *TotWpc*. How are they correlated with *SWB* and, for comparative purposes, with *GNIpc*? It is the latter part of the question that is addressed first (see Table 5). In order to save space, scatter diagrams between *GNIpc* and the wealth variables are not reported. Correlations are reported for the complete data sample, the three sub-samples of high income countries, and samples that exclude the most natural capital rich countries in per capita terms (inclusion of the latter was found to have a great influence on correlations, in particular those between *SWB* and *NatCpc* reported in Table 6).

Table 5: Correlations between *GNIpc* and the wealth variables for different country samples

Countries:	All	*with GNIpc*		
		>$10,000	>$12,000	>$20,000
Wealth:				
Total wealth (*TotWpc*)	0.97* [0.97*]	0.84* [0.85*]	0.76* [0.75*]	0.60* [0.62*]
Natural capital (*NatCpc*)	0.35* [0.32*]	0.18 [0.37]	0.06 [0.23]	0.29 [0.09]
Produced capital & urban land (*ProdCpc*)	0.97* [0.97*]	0.90* [0.88*]	0.88* [0.84*]	0.85* [0.80*]
Intangible capital (*IntCpc*)	0.94* [0.95*]	0.71* [0.76*]	0.58* [0.61*]	0.33 [0.44]
N	58 [52]	24 [20]	21 [17]	16 [14]

Notes: * = Statistically significant at 5% level, one-tailed test.
Numbers in square brackets are for the data samples that exclude the most natural capital rich countries (Norway, New Zealand, Canada, Venezuela, Australia, Russia).

In the full sample, *GNIpc* is, as noted earlier, almost perfectly correlated with *TotWpc*. This seems mostly due to *ProdCpc*. Correlations between *GNIpc* and *ProdCpc* are statistically significant in all data samples, although they are somewhat smaller in the high income country samples. However, in the three high income country samples, the correlation between *GNIpc* and *ProdCpc* is even higher than that between *GNIpc* and *TotWpc*! *IntCpc* and, especially, *NatCpc* are less strongly correlated with *GNIpc*. The lower correlations between *IntCpc* and *GNIpc* observed for the groups of high income countries is somewhat surprising, given that intangible capital accounts for 80% or more of their total wealth. Correlations between *NatCpc* and *GNIpc* are not statistically significant for the groups of high income countries. This finding is similar to that by Grasso and Canavo (2008), who report a small negative (and statistically insignificant) correlation between their environmental quality of life indicators and GDP per capita in European Union countries. Excluding the most natural capital rich countries from the data samples does not change the statistically significant correlations very much, and it does not make the correlations between *NatCpc* and *GNIpc* in the high income country samples statistically significant.

Turning to *SWB*, Figures 3, 4 and 5 show scatter diagrams of *SWB* versus the three wealth components. They indicate quite different and distinct cross-country relationships. In Figure 3 there is a group of mostly rich (in terms of *GNIpc*) and very natural capital intensive countries for which *SWB* seems to vary little with the level of *NatCpc* (i.e. Norway, New Zealand, Canada, Venezuela, Australia). This makes it difficult to fit a curve to the data.[21] Russia is an outlier in that it has a relatively high *NatCpc,* but very low *SWB*. For the rest of the countries, there appears to be a stronger positive relationship between *NatCpc* and *SWB*.

(Insert Figures 3, 4, 5)

The scatter diagram of *SWB* versus *ProCpc* (Figure 4) displays a similar curve-linear relationship as that of *SWB* versus *TotWpc,* i.e. it levels off for richer countries. By contrast, the relationship between *SWB* and *IntCpc* seems mostly linear (see Figure 5). It should be remembered that the intangible capital estimates for many poor countries are probably quite unreliable, as they are just the residual in the wealth accounts. This is best illustrated by the fact that for two countries in the sample, i.e. Algeria and Nigeria, the estimates for *IntCpc* are *negative* (see Appendix Table 1).[22]

Correlations between *SWB* and the wealth variables are, again, reported for the complete data sample, the three groups of high income countries, and the country samples excluding the most natural capital rich countries (Table 6). It should be noted that the groups of high income countries are defined as before, i.e. in the conventional way in terms of *GNIpc*, not in terms of *TotWpc*. This ensures that the sub-samples in Tables 4, 5 and 6 include the same countries. Moreover, the relationships observed for the groups of high income countries seem more representative as they exclude the 'unusually happy' Latin American countries and the 'unusually unhappy' ex-Soviet Union countries. These strong region-specific effects seem to be mostly responsible for the semi-logarithmic pattern observed in Figure 2, and they can only be properly accounted for when comparable wealth data for more countries and other years become available. Separate correlations for the poorer country groups are therefore currently not very meaningful and are not reported.

[21] Neither a straight line, nor a semi-logarithmic or polynomial function seems appropriate.

[22] Negative or very low levels of intangible capital require additional explanation. The World Bank (2006, p. 29) argues that:

> "… total wealth is the present value of *sustainable* consumption. What the low and negative values of intangible capital are really saying is that the level of GNI is *too low* in these countries. If it were higher, then higher levels of consumption per capita could be sustained and both total wealth and intangible capital would be higher. GNI is too low …in the sense that they are achieving extremely low rates of return on their produced, human, and institutional capital. This is a classic symptom of the *resource curse*…".

Table 6: Correlations between *SWB* and the wealth variables for different country samples				
Countries:	All	with *GNIpc*		
		>$10,000	>$12,000	>$20,000
Wealth:				
Total wealth (*TotWpc*)	0.63* [0.63*]	0.57* [0.68*]	0.31 [0.45*]	0.09 [0.17]
Natural capital (*NatCpc*)	0.34* [0.40*]	0.37* [0.63*]	0.31 [0.59*]	0.21 [0.56*]
Produced capital & urban land (*ProdCpc*)	0.54* [0.55*]	0.26 [0.31]	-0.04 [-0.003]	-0.39 [-0.39]
Intangible capital (*IntCpc*)	0.62* [0.63*]	0.54* [0.69*]	0.30 [0.49*]	0.17 [0.27]
N	58 [52]	24 [20]	21 [17]	16 [14]

Notes: * = Statistically significant at 5% level, one-tailed test.
Numbers in square brackets are for the data samples that exclude the top natural capital rich countries (Norway, New Zealand, Canada, Venezuela, Australia, Russia).

For the complete country sample and the sample of countries with *GNIpc* above US$ 10,000, the highest correlation for wealth sub-categories is that between *SWB* and *IntCpc*. *ProdCpc* is not statistically significantly correlated with *SWB* in any of the high income country samples. In these samples *IntCpc* as well as *NatCpc* have the highest correlations with *SWB*, whereas *ProdCpc* is (at best) uncorrelated if not negatively correlated with *SWB*. This is a reversal of what is reported in Table 5. It seems that, in high income countries, physical capital accumulation is highly correlated with social well-being as traditionally measured by economists, but not with *SWB*. However, all correlations reported for the two groups of richest countries are statistically insignificant.

This changes greatly when the most natural capital rich countries are excluded. In that case, all correlations, except those between *SWB* and *ProdCpc*, increase greatly, and often become statistically significant. In particular, for the two richest samples of countries, *NatCpc* has by far the highest (and statistically significant) correlation with *SWB*, greater even than *TotWpc*. In the group of countries with *GNIpc* greater than US$ 20,000, *NatCpc* is the only wealth variable that is correlated with *SWB* at a statistically significant level. Although natural capital accounts for only a tiny proportion of total wealth in high income countries, it seems to have a disproportionately high correlation with *SWB* in these countries. This is quite remarkable. By contrast, correlations between *ProdCpc* and *SWB* are little affected when the most natural capital rich countries are excluded, and they remain statistically insignificant.

Lastly, the relationship between *SWB* and the degree of sustainable development as measured by *ChWpc* is explored. The scatter diagram (Figure 6) shows a wide variation in levels of *SWB* for countries with negative and low levels of sustainability. However, for countries that have attained a certain positive minimum level of *ChWpc*, there seems to be a positive relationship (which is also indicated by the quadratic regression line[23]). Correlations between the two variables support this hypothesis. For the complete sample of 58 countries, the correlation is 0.47 and statistically

[23] A quadratic regression has a higher R^2 than a linear or curve-linear regression.

significant. However, this might be misleading given the curve-linear relationship. If a threshold level of \$500 for *ChWpc* is used to split the sample, a different picture emerges. For the group of 33 countries for which *ChWpc* is below \$500, the correlation is negative (-0.19) and statistically insignificant, whereas for the 25 countries for which *ChWpc* exceeds \$500, it is 0.54 and statistically significant.[24]

(Insert Figure 6)

5. Further Regression Analysis

In order to further explore the relationships between the wealth variables, *SWB* and *GNIpc*, more detailed regression analyses than those reported in Figures 1, 2, 4 and 5 are conducted. In particular, it is checked which functional form (e.g. linear, lin-log or double-log) is most appropriate, and whether the adopted functional form is a good approximation to the actual data.[25] In order to assess the latter, Box-Cox regressions that let the data determine the general functional form are conducted. For economic interpretation, elasticities at the mean derived from both the preferred functional forms and from the general Box-Cox regressions are calculated and compared.[26] Differences between these elasticities would indicate that the results are, at least partly, dependent on the chosen functional form. It is worth repeating that the regressions only explore the bivariate relationships between variables. They do not imply causality as we do not postulate and test a model of the relationships, i.e. no other potentially relevant variables are included.

First, however, sequential Chow tests are conducted to test for parameter stability across the complete data sample. They indicate a major break in the sample, i.e. when countries are ranked by *GNIpc*, only parameter estimates for the richest 39 countries are stable. These are countries with *GNIpc* above US\$ 1900 in 2000. This group only includes one country with negative *SWB* (Latvia). Also, all regressions for the richest two country groups (countries with *GNIpc* above, respectively, US\$ 12,000 and US\$ 20,000), produce statistically insignificant estimates and are not reported. In the following, therefore, the focus is on regressions for the 39 country sample and the 24 country sample of high income countries (*GNIpc* above US\$ 10,000). For comparative purposes, regressions for the full data sample are also reported.[27]

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[24] The group of countries with *ChWpc* less than US\$ 500 is dominated by region-specific *SWB* effects, i.e. it includes all the Latin American countries and most of the ex-Soviet Union countries. The group of countries with *ChWpc* greater than US\$ 500 is much more homogenous. It includes all high income countries (except Australia), plus the upper middle income countries Latvia, Estonia and Hungary. Australia has an exceptionally low level of sustainability among high income countries (see Appendix Table 1).

[25] The issue of functional form has also recently been emphasised by Stevenson and Wolfers (2008) in their re-assessment of the income-happiness relationship.

[26] In Box-Cox regressions, variables for which all observations have positive values are transformed according to $x = \left(x^{\lambda} - 1\right)/\lambda$, where x is a variable and λ is the transformation parameter. If λ = 1, x is linear, if λ = 0, x is logarithmic. If not all observations of a particular variable are positive (like SWB in the 58 country sample), it is not transformed, although the other variables in the regression are.

[27] In all regressions, the value of zero for *NatCpc* in Singapore is replaced by 0.01. Similarly, in regressions for the complete 58 country sample, the negative values for *IntCpc* in Nigeria

Only the broad results obtained for *GNIpc* regressions are mentioned (the detailed results are shown in Appendix Table 2). All *GNIpc* regressions, except those involving *NatCpc*, have high 'explanatory power' and produce statistically significant parameter estimates. All estimated elasticities, again except those for *NatCpc*, are high (and mostly very high, i.e. above 0.85). For all three country samples, the elasticities obtained for *ProdCpc* are as high, or higher, than those obtained for *TotWpc*. This confirms the dominant association between *GNIpc* and *ProdCpc*. The estimates for *NatCpc* are only statistically significant in the 58 country sample, and even in that case the elasticity is the lowest of all wealth categories. In short, *TotWpc* seems to 'explain' almost all of the variation in *GNIpc*, and this seems overwhelmingly due to *ProdCpc*. In contrast, except for the 58 country sample, *NatCpc* is not directly related to *GNIpc*.

Durban Watson (DW) and Jarque-Bera (JB) test statistics are also reported. DW can be interpreted as a test for serial correlation, non-normal residuals, heteroscedasticity and general model misspecification. JB is a popular alternative test for non-normality of residuals (Kennedy, 2003). In Appendix Table 2, only regressions involving *TotWpc* (for all three data samples), and *ProdCpc* and *IntCpc* (for the group of high income countries), pass both criteria. However, in most cases elasticities derived from specific functional forms do not differ much from those obtained from Box-Cox regressions.

Regression results obtained for *SWB* are quite different from those obtained for *GNIpc* (see Table 7). *GNIpc* and *TotWpc* 'explain' between 22% and 48% of the variation in *SWB* (see the R^2). Interestingly, the explanatory power of regressions is higher in the 24 country sample compared to the 39 country sample, and highest in the 58 country sample. The elasticities of *SWB* with respect to *GNIpc* and *TotWpc* are similar, but the latter is largest (and larger than that for *GNIpc*) for high income countries. *A 1% increase in TotWpc in the average high income country is associated with an increase in SWB of just over 0.5%.* Higher material living standards (measured in terms of *GNIpc* or *TotWpc) are* associated with higher average *SWB*, and there is no evidence that this is less important for the group of high income countries compared to the data samples that also include poorer countries.

(Insert Table 7)

Of the three wealth subcategories, *IntCpc* has the highest 'explanatory power' and the largest elasticities. They are again larger in the sample of high income countries compared to the sample of 39 countries, and largest in the 58 country sample. The high income country regression involving *IntCpc* also has better statistical properties than regressions involving *NatCpc* and *ProdCpc*. *ProdCpc* seems to be more important in the 58 country sample compared to the smaller samples, although the estimates remain statistically significant in all three samples. By contrast, estimates for *NatCp* are not statistically significant in the high income country sample (p value of 0.07). *NatCpc* explains little of the variation in *SWB* in any of the three country samples. Also note that the elasticity estimates for *NatCpc* and *ProdCpc* are affected

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and Algeria are replaced by 0.01. This not only enables log and Box-Cox transformation of the natural and intangible capital variables, but it also seems to make economic sense.

by the functional form, i.e. elasticities derived from the regressions that adopt specific functional forms differ somewhat from the Box-Cox elasticity estimates.

For *NatCpc* this highlights the issue already apparent from Figure 3. The most natural capital rich countries seem to be in a group of their own and should probably be excluded if we want to derive insights into the relationship between *SWB* and *NatCpc* for the 'average' country. This issue is explored by dropping the six countries with the highest levels of *NatCpc* from both the *GNIpc* and *SWB* regressions. The regression estimates are reported in Table 8.

None of the Box-Cox regressions for *GNIpc* are statistically significant, in contrast to the *SWB* regressions. In the 52 country sample, *NatCpc* 'explains' more of the variation in *SWB* than in *GNIpc*, and has a higher elasticity. The elasticity of *SWB* with respect to *NatCpc* reported in regression 2, Table 8, has increased greatly (to 0.62) from that reported in regression 3, Table 7, to become the largest elasticity of any of the wealth variables, including *TotWpc*. The second largest elasticity in that country sample is that of *SWB* with respect to *IntCpc*, which is 0.60.[28] However, *NatCpc* still 'explains' only 16% of the variation in *SWB* (see the R^2). A similar picture emerges in the 34 country sample, although in that sample all elasticities are smaller (regression 4, Table 8).

(Insert Table 8)

The greatest change, however, occurs in the sample of countries with *GNIpc* above US$ 10,000. Instead of being statistically insignificant (compare regression 13, Table 7), the parameter estimate for *NatCpc* is now statistically significant (regression 6, Table 8). Moreover, the 'explanatory power' of the regression as measured by the R^2 increases greatly to 40%, and the elasticity of *SWB* with respect to *NatCpc* remains at 0.33, i.e. it is very similar to that in the 34 country sample. Amongst the three wealth sub-categories, the regression for *IntCpc* (not shown in Table 8) has higher explanatory power, that for *ProdCpc* has lower explanatory power. To sum up, although accounting for only a very small proportion of total wealth in high income countries, *NatCpc* does seem to be highly related to *SWB* in these countries.

Finally, it should be noted that regressions of *GNIpc* and *SWB* on *ChWpc* are not reported. Although *ChWpc* is meant to indicate the degree of sustainability of a country's development path, it would make more sense to use changes in *GNIpc* and changes in *SWB*, instead of their levels. When *GNIpc* and *SWB* are regressed on *ChWpc*, strongly positive relationships emerge between *GNIpc* and *ChWpc*, and less strong relationships between *SWB* and *ChWpc*.[29]

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[28] The *SWB* and *GNIpc* regressions for *TotWpc*, *ProdCpc* and *IntCpc* are not shown in Table 8. They are available from the author.

[29] This applies to both the complete sample of 58 countries as well as the 25 countries with values of *ChWpc* above US$ 500. For the 33 countries with lower values for *ChWpc*, no statistically significant estimates are obtained. The detailed results are available from the author.

6. Conclusions

The cross-country analysis of bivariate macro-level relationships between *SWB* and the MCA's wealth estimates presented in this paper has produced a number of findings. First, among the group of high income countries (*GNIpc* > US$ 10,000) the correlation between *SWB* and *TotWpc* is greater than that between *SWB* and income (i.e. *GNIpc*). This is similar to Headey et al.'s (2008) micro-level findings, despite the differences in types of data, data coverage, and variable definitions. Wealth does seem somewhat more important for *SWB* than income. In short, objective economic circumstances are likely to matter more for *SWB* than suggested by studies that use income instead of wealth. Secondly, the differences in the correlations between the components of wealth per capita and *GNIpc* versus *SWB* highlight an important difference between average *SWB* and the social well-being measure *TotWpc*, which is derived from discounted future consumption. The latter is closely correlated with physical capital accumulation, a traditional economic growth variable, whereas the former is correlated with intangible capital. Thirdly, when countries with highest *NatCpc* are deleted as outliers, *NatCpc* 'explains' a large part of the variation in *SWB* amongst high income countries, despite accounting for only about 2% of total wealth in these countries. One might argue that preservation of natural capital in rich countries provides a 'happiness bonus', rather than requiring a 'happiness sacrifice'.[30]

It seems appropriate to re-state the obvious: *SWB* differs from *TotWpc.* However, the findings reported in this paper raise some doubts about whether *TotWpc* really is a suitable proxy for the kind of well-being one may want to associate with sustainable development. At a minimum, it seems reasonable to take *SWB* into account as an additional well-being measure. Putting more emphasis on *SWB* in the context of sustainable development would not reduce the importance of natural capital, quite the opposite. However, it would likely lessen the importance of produced capital.

Major caveats concerning the findings reported in this paper are issues of causality, data quality and the cross-section nature of the data. They also indicate directions for further research. Given the nature of the data used, issues of causality could not be explored. However, it seems sensible to assume there is mutual causality between *SWB* and sustainable wealth, although factors other than wealth might be more important for increasing *SWB*.[31] To properly address the issue requires nothing less than a general and comprehensive theory of sustainable development that includes insights from happiness research. Turning to the issue of data quality, advances in the direct and consistent measurement of intangible capital across countries seem difficult to achieve but might bring the highest pay-off in terms of accuracy of the wealth estimates. Also, the many heroic assumptions underlying the estimates of natural and

[30] The link between natural capital and human welfare has also been identified by Heal (2008) as an area of research that has been given too little attention in the context of assessing the negative impacts of climate change. The current paper contributes to filling this gap in our knowledge.

[31] For example, Zidanšek (2007) argues that people are happy more because of the degree of freedom and education they enjoy rather than environmental sustainability. He draws the conclusion that sustainable development strategies are needed which also increase freedom.

produced capital need to be re-assessed when better data become available.[32] This would have to be weighed against the feasibility of providing comparable wealth estimates for different years. There is also an obvious need to account for region- and country-specific effects by extending the analysis in the time dimension, and to test the relationships between *SWB* and the wealth variables for particular countries or groups of similar countries other than the high income countries. Another desirable extension would be the incorporation of intra-country features, e.g. the distribution of wealth.[33]

Last but not least, it is not immediately obvious how total wealth and its major subcategories should be included in micro-level studies. Should they be included as macro-variables alongside micro-variables?[34] If not, what are the micro-level counterparts of the macro-level wealth aggregates? How should public good consumption be included? How should private consumption be measured?[35] Despite the great efforts involved in deriving the macro-level MCA data, defining and deriving empirical estimates of their micro-level counterparts might be even more difficult.

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[32] Note, for example, that asset prices are assumed to reflect the social worth of capital, which reflects its social scarcity (Ruta and Hamilton, 2007). Asset price bubbles, presumably, lead to distorted wealth estimates.

[33] See Davies et al. (2007) attempt to estimate the world distribution of household wealth. Their definition of wealth is considerably narrower than that used in World Bank (2006), but it seems the first time researchers have estimated household wealth and its distribution, composition and concentration for such a large sample of countries (i.e. 150).

[34] Schyns (2002) adopts such a multilevel modelling approach and finds that aggregate 'wealth' (measured as a country's real GDP per capita) is positively correlated with individuals' life satisfaction. Helliwell (2003) also adopts a multilevel modelling approach in a cross-country analysis of SWB but includes a much wider range of macro level variables. While not focussing directly on wealth, some of his variables capture certain wealth aspects, for example social capital (which is part of intangible wealth).

[35] Some of these issues are also raised by Clark et al. (2008).

Figure 1:

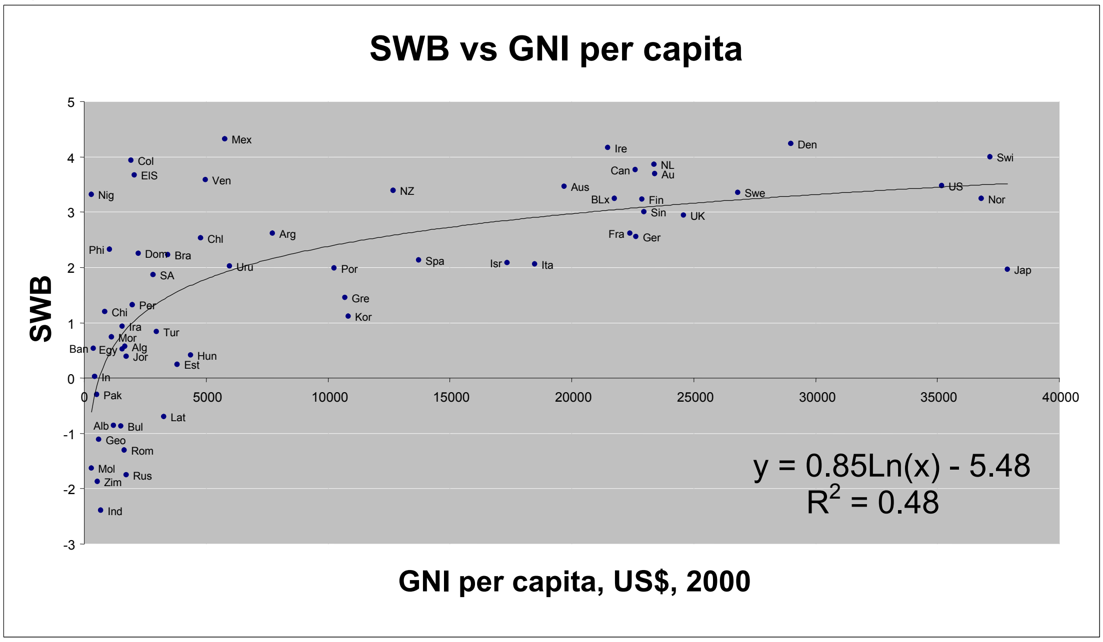

Figure 2:

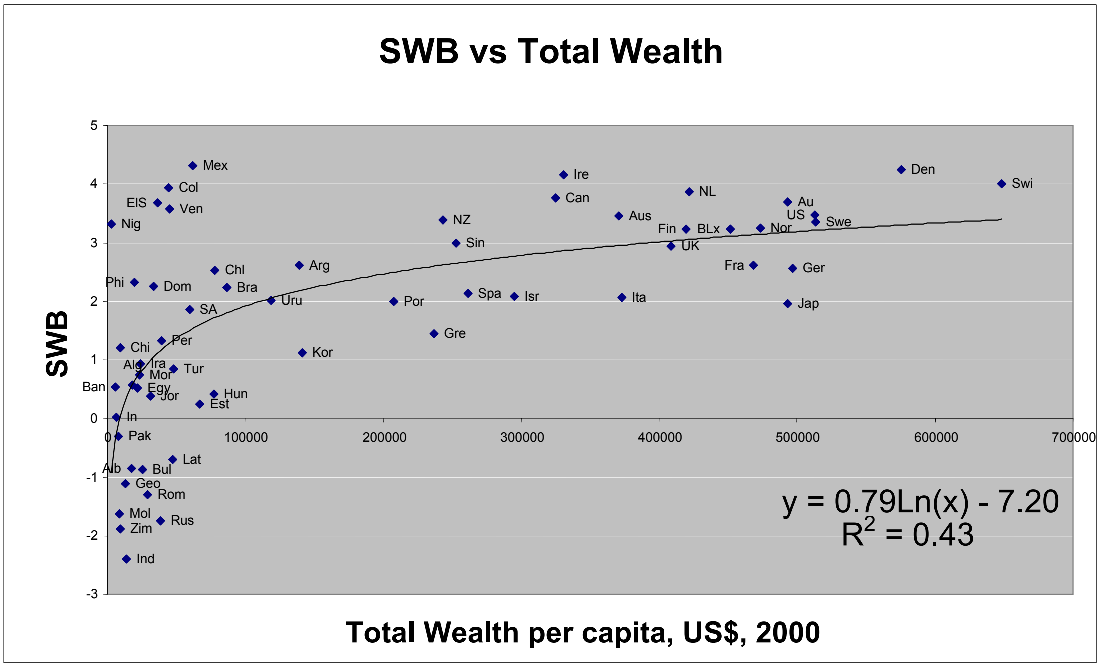

Figure 3:

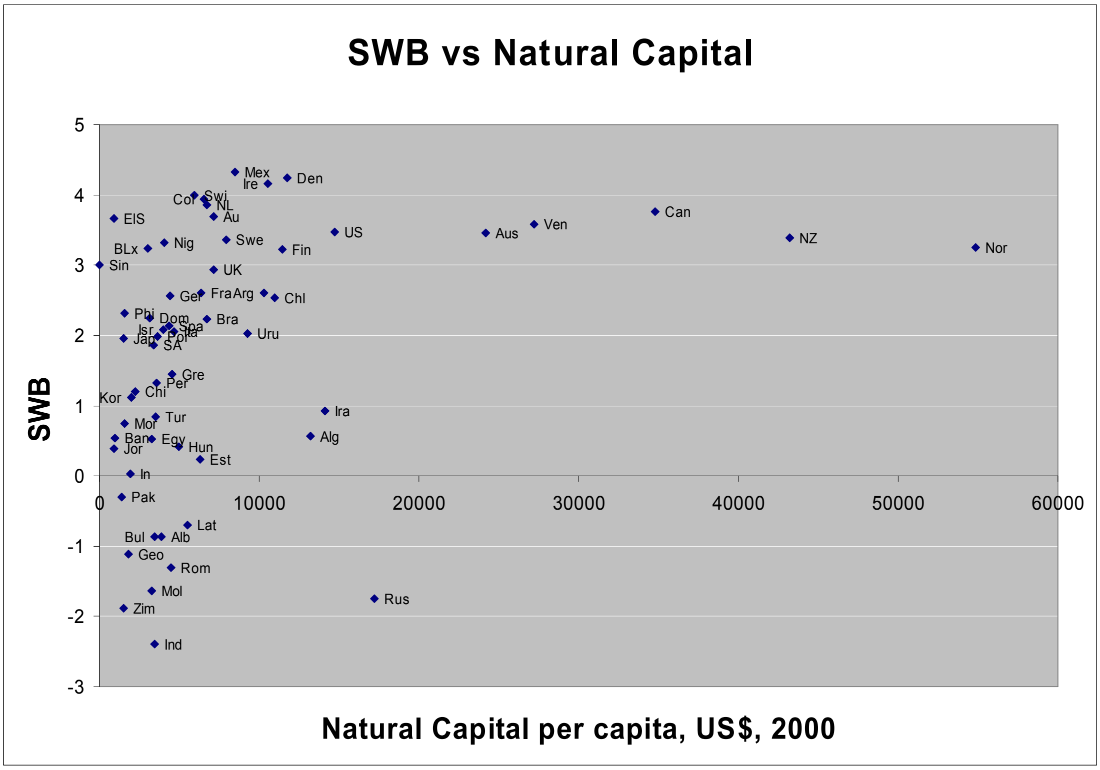

Figure 4:

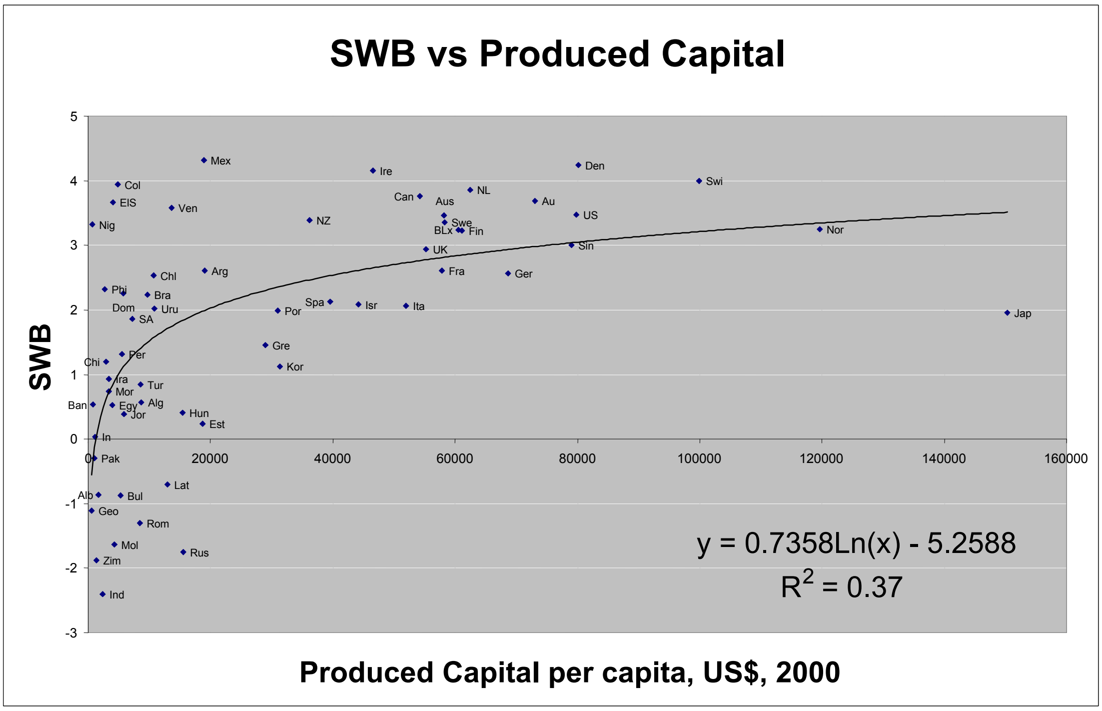

Figure 5:

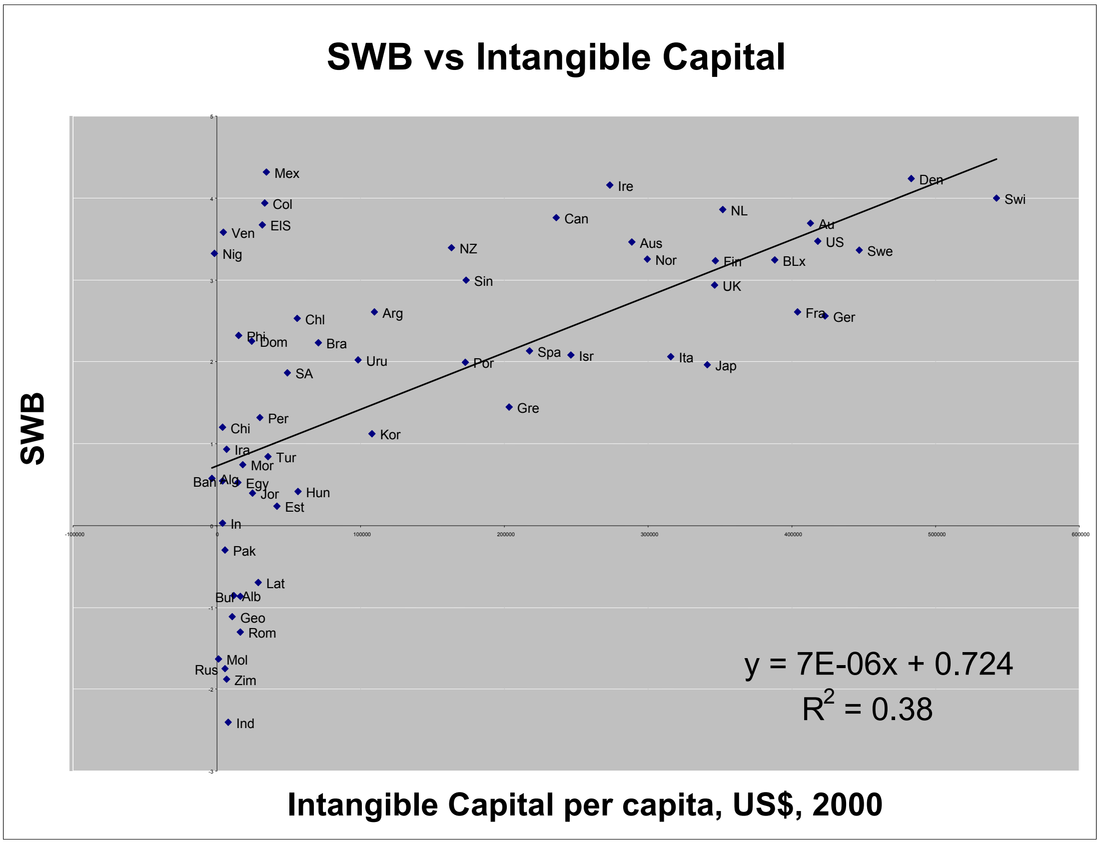

Figure 6:

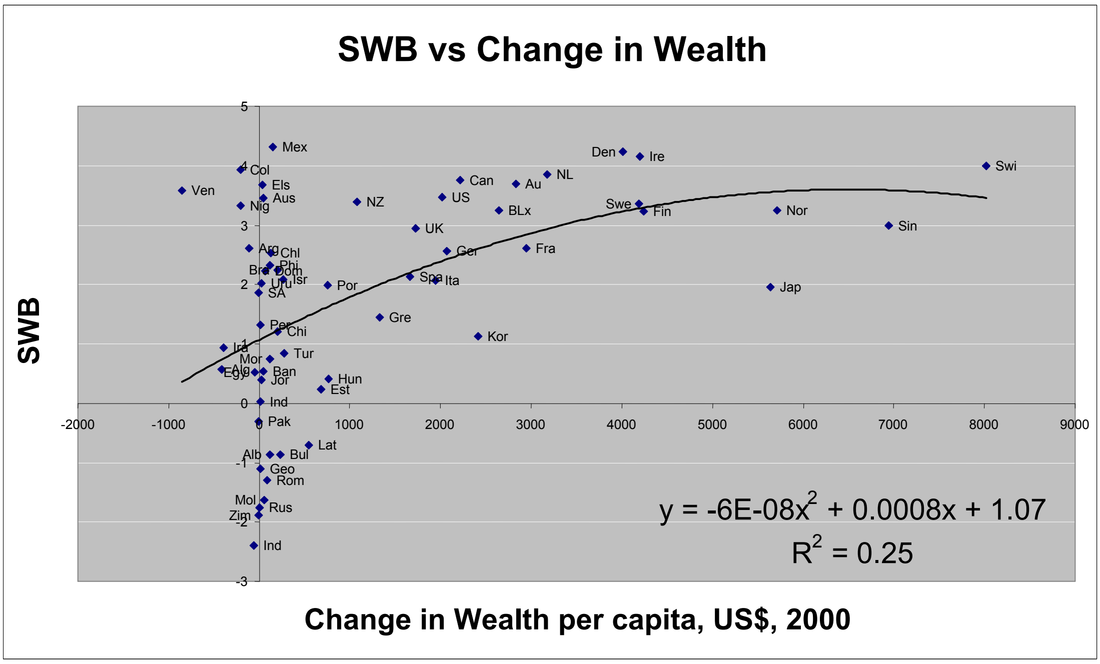

Table 7: *SWB* regressions															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
GNIpc	0.85* (7.17)					0.05* (3.22)					1.33* (3.39)				
TotWpc		0.79* (6.47)					0.003* (3.30)					0.004* (3.29)			
NatCpc			0.06* (2.73)					0.035* (2.21)					0.023 (1.882)		
ProdCpc				0.74* (5.68)					0.013* (2.35)					0.91** (2.24)	
IntCpc					0.007* (5.91)					0.0035* (3.19)					0.004* (3.03)
Constant	-0.42 (-1.65)	-1.73* (-3.06)	1.24* (4.27)	-0.18 (-0.45)	0.72* (2.84)	1.85* (6.31)	1.82* (6.13)	2.27* (9.36)	2.07* (7.01)	1.88* (6.50)	-1.09 (-0.91)	1.43* (2.92)	2.69* (12.12)	-0.75 (-0.45)	1.62* (3.48)
Fct. form	lin-log	lin-log	linear	lin-log	linear	linear	linear	linear	linear	Linear	lin-log	linear	linear	lin-log	Linear
R^2	0.48	0.43	0.12	0.37	0.38	0.22	0.23	0.12	0.13	0.22	0.34	0.33	0.14	0.19	0.29
DW	1.68**	1.68**	1.14	1.85**	1.50	1.52#	1.52#	1.27	1.48#	1.53#	1.87**	1.85**	1.15	1.75**	1.93**
JB	3.06**	3.19**	3.20**	0.40**	0.37**	0.33**	0.005	2.50**	1.69**	0.03	0.39**	0.42**	0.74**	0.62**	1.09**
N	58	58	58	58	58	39	39	39	39	39	24	24	24	24	24
Elasticity at mean	**0.49**	**0.46**	**0.29**	**0.42**	**0.58**	**0.29**	**0.31**	**0.13**	**0.21**	**0.28**	**0.45**	**0.52**	**[0.09]** **[p=0.07]**	**0.31**	**0.45**
Box-Cox regressions:															
Elasticity at mean	**0.53**	**0.58**	**0.41**	**0.53**	**0.57**	**0.29**	**0.31**	**0.18**	**0.22**	**0.28**	**0.46**	**0.52**	**0.13**	**[0.20]** **[p=0.17]**	**0.44**
Lambda	0.09	0.27	0.52	0.24	0.48	0.71	1.39	0.58	0.55	1.46	0.63	0.96	0.65	0.86	1.27
R^2	0.48	0.44	0.14	0.38	0.42	0.22	0.23	0.14	0.14	0.22	0.30	0.33	0.19	0.08	0.28

Notes: The dependent variable is *SWB*. Variables are measured in thousands of US$ in 2000. t-statistics are given in round brackets. * Statistically significant at 1% level, ** statistically significant at 5% level. # inconclusive. With the exception of elasticities given in brackets, all Box-Cox elasticities are derived from parameter estimates that are statistically significant at the 2.5% level of significance. Elasticities in brackets are derived from parameter estimates that are not statistically significant at conventional levels. The numbers in brackets below the insignificant estimates indicate their p value. In the 58 and 39 country samples, *SWB* is not transformed in the Box-Cox regressions because some of the *SWB* values are negative. The JB (Jarque-Bera) test statistic is distributed Chi-Square with 2 degrees of freedom. The small sample critical values for the upper limits of the JB test are taken from Deb and Sefton (1996).

Table 8:	Regressions excluding the six countries with highest natural capital per capita[1]					
	1	2	3	4	5	6
Dependent variable	*GNIpc*	*SWB*	*GNIpc*	*SWB*	*GNIpc*	*SWB*
NatCpc	0.99** (2.41)	0.19* (3.10)	0.75 (1.31)	0.14** (2.34)	0.79 (1.68)	0.15* (3.45)
Constant	4.89 (1.87)	0.62 (1.56)	10.38** (2.63)	1.65* (4.05)	17.83* (5.33)	1.91* (6.00)
Functional form	linear	linear	linear	linear	linear	linear
R^2	0.10	0.16	0.05	0.15	0.14	0.40
DW	0.19	1.02	0.10	1.33	0.30	1.46**
JB	7.91	2.58**	1.97**	2.17**	2.81**	1.10**
N	52	52	34	34	20	20
Elasticity at mean	**0.52**	**0.62**	**[0.30] [p=0.20]**	**0.34**	**[0.21] [p=0.11]**	**0.33**
Box-Cox regressions:						
Elasticity at mean	**[0.29] [p=0.12]**	**0.62**	**[0.12] [p=0.58]**	**0.32**	**[0.21] [p=0.12]**	**0.33**
Lambda	0.17	0.95	0.34	1.79	0.87	1.13
R^2	0.05	0.16	0.01	0.17	0.13	0.40

Notes: [1] Norway, New Zealand, Canada, Venzuela, Australia and Russia.
Variables are measured in thousands of US$ in 2000. t-statistics are given in round brackets. * Statistically significant at 1% level, ** statistically significant at 5% level. # inconclusive. With the exception of elasticities given in brackets, Box-Cox elasticities are derived from parameter estimates that are statistically significant at the 2.5% level of significance. Elasticities in brackets are derived from parameter estimates that are not statistically insignificant at conventional levels. The numbers in brackets below the insignificant estimates indicate their p value. In the 52 and 34 country samples, *SWB* is not transformed in the Box-Cox regressions because some of the *SWB* values are negative. The JB (Jarque-Bera) test statistic is distributed Chi-Square with 2 degrees of freedom. The small sample critical values for the upper limits of the JB test are taken from Deb and Sefton (1996).

Appendix

Appendix Table 1: Data									
Country	Abb.		*GNIpc*	*SWB*	*NatCpc*	*ProdCpc*	*IntCpc*	*TotWpc*	*ChWpc*
Nigeria	Nig	L	297	3.32	4040	667	-1959	2748	-210
Moldova	Mol	L	316	-1.63	3260	4338	1173	8771	56
Bangladesh	Ban	L	373	0.54	961	817	4221	6000	41
India	In	L	446	0.03	1928	1154	3738	6820	16
Pakistan	Pak	L	517	-0.3	1368	975	5529	7871	-2
Zimbabwe	Zim	L	550	-1.88	1531	1377	6704	9612	-4
Georgia	Geo	L	601	-1.11	1799	595	10642	13036	16
Indonesia	Ind	L	675	-2.4	3472	2382	8015	13869	-56
China	Chi	LM	844	1.2	2223	2956	4208	9387	200
Philippines	Phi	LM	1033	2.32	1549	2673	15129	19351	114
Morocco	Mor	LM	1131	0.74	1604	3435	17926	22965	117
Albania	Alb	LM	1220	-0.86	3892	1745	11675	17312	122
Bulgaria	Bul	LM	1504	-0.87	3448	5303	16505	25256	238
Egypt	Egy	LM	1569	0.52	3249	3897	14734	21879	-45
Iran	Ira	LM	1580	0.93	14105	3336	6581	24023	-398
Romania	Rom	LM	1639	-1.3	4508	8495	16110	29113	89
Algeria	Alg	LM	1670	0.57	13200	8709	-3418	18491	-409
Jordan	Jor	LM	1727	0.39	931	5875	24740	31546	28
Russian Fed.	Rus	LM	1738	-1.75	17217	15593	5900	38709	4
Colombia	Col	LM	1926	3.94	6547	4872	33241	44660	-205
Peru	Per	LM	1991	1.32	3575	5562	29908	39046	15
El Salvador	ElS	LM	2075	3.67	912	4109	31455	36476	37
Dominican Republic	Dom	LM	2234	2.25	3176	5723	24511	33410	198
South Africa	SA	LM	2837	1.86	3400	7270	48959	59629	-2
Turkey	Tur	UM	2980	0.84	3504	8580	35774	47859	273
Latvia	Lat	UM	3271	-0.7	5485	12979	28734	47198	551
Brazil	Bra	UM	3432	2.23	6752	9643	70528	86922	64
Estonia	Est	UM	3836	0.24	6283	18685	41802	66769	681
Hungary	Hun	UM	4370	0.41	4947	15480	56645	77072	765
Chile	Chl	UM	4779	2.53	10944	10688	56094	77726	129
Venezuela	Ven	UM	4970	3.58	27227	13627	4342	45196	-847
Mexico	Mex	UM	5783	4.32	8493	18959	34420	61872	155
Uruguay	Uru	UM	5962	2.02	9279	10787	98397	118463	20
Argentina	Arg	UM	7718	2.61	10312	19111	109809	139232	-109
Portugal	Por	H	10256	1.99	3629	31011	172837	207477	750
Greece	Gre	H	10706	1.45	4554	28973	203445	236972	1327
Korea, Rep of	Kor	H	10843	1.12	2020	31399	107864	141282	2415
New Zealand	NZ	H	12679	3.39	43226	36227	163481	242934	1082
Spain	Spa	H	13723	2.13	4374	39531	217300	261205	1663
Israel	Isr	H	17354	2.08	3999	44153	246570	294723	268
Italy	Ita	H	18478	2.06	4678	51943	316045	372666	1947
Australia	Aus	H	19703	3.46	24167	58179	288686	371031	46
Ireland	Ire	H	21495	4.16	10534	46542	273414	330490	4199
Belgium-Luxembourg	BLx	H	21756	3.24	3030	60561	388123	451714	2649
France	Fra	H	22399	2.61	6335	57814	403874	468024	2951
Canada	Can	H	22612	3.76	34771	54226	235982	324979	2221

Appendix Table 1 ctd.									
Country	Abb.		*GNIpc*	*SWB*	*NatCpc*	*ProdCpc*	*IntCpc*	*TotWpc*	*ChWpc*
Germany	Ger	H	22641	2.56	4445	68678	423323	496447	2071
Finland	Fin	H	22893	3.23	11445	61064	346838	419346	4236
Singapore	Sin	H	22968	3	0	79011	173595	252607	6949
Netherlands	NL	H	23382	3.86	6739	62428	352222	421389	3176
Austria	Au	H	23403	3.69	7174	73118	412789	493080	2831
United Kingdom	UK	H	24606	2.94	7167	55239	346347	408753	1725
Sweden	Swe	H	26809	3.36	7950	58331	447143	513424	4191
Denmark	Den	H	29009	4.24	11746	80181	483212	575138	4014
United States	US	H	35188	3.47	14752	79851	418009	512612	2020
Norway	Nor	H	36800	3.25	54828	119650	299230	473708	5708
Switzerland	Swi	H	37165	4	5943	99904	542394	648241	8020
Japan	Jap	H	37879	1.96	1513	150258	341470	493241	5643

Notes: All data, except those for *SWB*, are in 2000 US$. They are from World Bank (2006). Countries are classified as low income (L), lower middle income (LM), upper middle income (UM), and high income (H), using the World Bank classification for 2001 (in GNI per capita in US$) available from http://web.world.bank.org/. L: <= $745; LM: $746-$2,975; UM: $2,976-$9,205; H: >$9,205.
SWB data are from Inglehart (2004).

Appendix Table 2: *GNIpc* regressions

	1	2	3	4	5	6	7	8	9	10	11	12
TotWpc	0.97* (46.85)				0.97* (26.08)				0.90* (8.21)			
NatCpc		0.39* (2.788)				0.25 (1.62)				0.11 (0.86)		
ProdCpc			0.96* (28.61)				0.96* (30.69)				0.88* (12.47)	
IntCpc				0.07* (20.41)				0.06* (13.00)				0.74* (5.66)
Constant	-2.69* (-28.19)	7.52* (4.11)	-0.93* (-9.37)	1.02 (1.45)	-2.66* (-13.58)	12.96* (5.52)	-0.90* (-8.10)	1.83 (1.41)	-2.27* (-3.49)	21.47* (9.73)	-0.51 (-1.77)	-1.15 (-1.54)
Functional form	Double log	Linear	Double log	linear	Double log	Linear	Double log	linear	Double Log	Linear	Double log	Double log
R^2	0.98	0.12	0.94	0.88	0.95	0.07	0.96	0.82	0.75	0.03	0.88	0.59
DW	1.94**	0.27	1.97**	1.68**	1.71**	0.16	1.78**	1.59**	1.82**	0.11	1.80**	1.34[#]
JB	2.49**	9.25	123.8	137.2	3.96**	2.49**	5.65	38.43	2.09**	0.48**	0.89**	2.33**
N	58	58	58	58	39	39	39	39	24	24	24	24
Elasticity at mean	**0.97**	**0.30**	**0.96**	**0.90**	**0.97**	**[0.16] [p=0.11]**	**0.96**	**0.88**	**0.90**	**[0.05] [p=0.40]**	**0.88**	**0.74**
Box-Cox regressions:												
Elasticity at mean	**0.97**	**0.40**	**0.99**	**0.88**	**0.97**	**[0.19] [p=0.18]**	**0.97**	**0.87**	**0.90**	**[0.06] [p=0.42]**	**0.98**	**0.74**
Lambda	0.11	0.22	0.34	0.42	0.16	0.41	0.14	0.43	0.08	0.53	-1.03	-0.02
R^2	0.98	0.12	0.96	0.92	0.95	0.05	0.96	0.87	0.75	0.03	0.93	0.59

Notes: The dependent variable is *GNIpc*. Variables are measured in thousands of US$ in 2000. T-statistics are given in round brackets. * Statistically significant at 1% level, ** statistically significant at 5% level. [#] inconclusive. With the exception of elasticities given in brackets, all Box-Cox elasticities are derived from parameter estimates that are statistically significant at the 2.5% level of significance. Elasticities in brackets are derived from parameter estimates that are not statistically significant at conventional levels. Numbers in brackets below the insignificant estimates indicate their p values. The JB (Jarque-Bera) test statistic is distributed Chi-Square with 2 degrees of freedom. Small sample critical values for the upper limits of the JB test are taken from Deb and Sefton (1996).

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