Review

The case for the hybrid capital approach for the measurement of the welfare and sustainability ☆

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A B S T R A C T

This paper provides an overview of the plethora of approaches that are available to measure welfare and sustainable development. Many methods exist but there is no consensus on the 'correct' approach. Furthermore, we also show that the wide variety of sustainable development indictor (SDI) sets which have been adopted also show significant differences. We argue that this is mostly because many of these studies do not use a theoretical approach. We argue that the 'capital approach', which is used in the sustainability debate, is the most promising method to enhance international harmonization. Support is mounting in the scientific, policy and statistical communities for this approach in which economic capital, human capital, natural capital and social capital are distinguished. Many applications of this method express these capital stocks in monetary units (the 'monetary capital approach'). This paper argues that the 'hybrid capital approach', in which the capital stocks can also be measured in non-monetary units, is probably more likely to achieve consensus over a large number of countries and institutes. Also a number of challenges remain for the capital approach. We argue that ideally the indicators should be based on satellite accounts of the national accounting framework. Also the capital approach could be further expanded to current welfare, progress of societies, inequality, and the international dimension of sustainability. We conclude that if the hybrid capital approach is adopted it may become easier to make consistent, theoretically sound and policy relevant comparisons between countries.

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1. Introduction

In the post-war period social scientists and statisticians have taken great strides to better understand the welfare and well-being of societies. Many statistical systems and databases have been constructed to help societies keep track of these developments in societies. One of the most successful statistical innovations has been the System of National Accounts (SNA) (United Nations, 1993). Since its inception in the 1950–1960s the SNA has been adopted by just about every nation to measure their economic transactions. The aggregates from the SNA, such as Gross Domestic Product (GDP), are very influential in policy debates and are used widely in applied economic analysis.

However, debate over the theoretical basis and the interpretation of the aggregates is as old as the SNA itself. One of the most enduring issues has been the question whether GDP is a measure of welfare. Despite the fact that the SNA itself explicit states that "Neither gross nor net domestic product is a measure of welfare" (United Nations, 1993, section 2.178) many economists and policy makers still use it as such (perhaps for lack of an alternative). For a recent overview of the problems related to the use of GDP see van den Bergh (2009).[1]

Since the early 1970s the question of sustainability, i.e. the ability to *maintain* welfare levels in the future, has added an extra dimension to the discussion of the progress of societies. Influential reports such as Club of Rome (Meadows et al., 1972) and the Brundtland report (WCED, 1987) have emphasized the idea that we should not only be mindful of our own welfare but also that of future generations. Just about all large international organisations have considered this issue and some have created valuable indicator databases (Eurostat (European Communities, 2007), OECD, 2008, World Bank, 2006 and United Nations, 2007).

During the last few decades a plethora of approaches have emerged to measure welfare or sustainability. Scientists, national institutes and international organisations have developed many composite indicators (one aggregate number) or sets of indicators to measure these phenomena. The composite indicators usually have a clear theoretical foundation, which are based on adjustment of GDP or other macro-economic aggregates from the SNA. The indicator sets are mostly based on national sustainable policy strategies which were often based on three dimensions (economic, environmental and social) of sustainable development as defined by the Brundtland Commission (WCED, 1987). More recently the 'capital approach' has been proposed as a theoretical basis for sustainable development indicators (SDI) (Atkinson and Pearce, 1993; Atkinson and Hamilton, 2003; World Bank, 2006 and UNECE, 2009).

Nevertheless, not a single one of these approaches has been adopted outright. Individual scientists, institutes and international organisations adopt very different approaches. The lack of agreement on the right way to measure these phenomena also means that the authoritative comparison between countries is difficult. Although many of the approaches do include results for a variety of countries these will not be influential unless the method is widely accepted.

One way of gaining influence is by reaching agreement with a large group of countries, scientists of institutes. A notable project is the SDI database for the European Union which was produced by the Statistical Agency of the EU (Eurostat). It is a policy-based approach in which indictors are picked based on the European Strategy for Sustainable Development Policy. The fact that this is a common strategy for 27 countries, with consultations between many stakeholders, as well as the large database makes it very influential. Nevertheless, in this paper we will argue that in the long run welfare and sustainability require firm theoretical foundations, as well as institutional support, to attract a large enough constituency of support.

The main objective of this paper is to recommend an approach which is the most promising to make better, theoretically sound and policy relevant comparisons between countries' welfare and sustainability. We argue that the 'capital approach' is the most promising way forward. This conceptual method has gained support in the academic, statistical and institutional field. We believe that the 'hybrid capital approach', in which monetary as well as non-monetary measurement is used, might be capable of achieving consensus amongst a large group of countries and institutes.

The paper is structured as follows. Section 2 starts with an overview of the main definitions such as welfare and sustainable development. In the second part of the section an overview of the most important indicator approaches is discussed. Section 3 provides a comparison of the SDI-indicators used by countries and international organisations. Section 4 argues the case for the hybrid capital approach. Finally, a research agenda for the capital approach is discussed in Section 5. Section 6 concludes.

2. Definitions and indicator approaches

2.1. Definitions of some core terms[2]
2.1.1. Welfare and capital

In this paper we adopt the utilitarian notion of (social) welfare as a subjective measure of the sum of all individual's utilities generated from the consumption of goods and services (Perman et al., 2003). Goods and services are produced from capital, which are the resources of a society. In traditional economic literature, the term capital is reserved for durable goods which are treated as needing replacement only discontinuously or periodically (Hayek, 1941). The notion of 'capital' was subsequently broadened to include natural (SEEA, 2003) and human capital (Becker, 1964). Recently, the final pillar, social capital, has become of more importance (Bourdieu, 1986; Coleman, 1988, 1990; Fukuyama, 1995 and Putnam, 1993, 1995).

Economic theory uses production functions, which relate the capital to the produced goods and services. In theory the only restriction is that all the goods, services and capital forms are scarce. The goods and services are consumed, and thereby provide

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[1] Other references include Lintott (1996), England (1998), Dowrick et al. (2003), Lawn (2003) and Matthews (2006).

[2] It is beyond the scope of this paper to make a complete summary of the abundant literature on these topics.

Table 1
Overview of approaches.

Composite indicators	Corrections of National Accounts Aggregates	National Wealth/Genuine Savings (GS)	SD
		Measure of Economic Welfare (MEW)	W
		Index of Sustainable Economic Welfare (ISEW)	W
		Genuine Progress Indicator (GPI)	W
		Sustainable Net Benefit Index (SNBI)	W
		Sustainable National Income (SNI)	SD
	Other approaches	Human Development Index (HDI)	W
		Sen's Capability Approach	W
Set of indicators	Policy-based approach		SD
	Model-based approach	Dimensions (Pillars)	SD
		Economic dimension	
		Social dimension	
		Environmental dimension	
		DPSIR	SD
		Driving force	
		Pressures	
		State	
		Impact	
		Response	
		(Hybrid) Capital Approach	SD
		Economic capital	
		Natural capital	
		Human capital	
		Social capital	

utility/welfare to the citizens of a country. Utility is a value that individuals attach to the satisfaction of their preferences through consumption. The contribution of the goods and services to utility are formalized in a utility function. Note that in this paper we adopt the broad concept of welfare in which consumption is far broader than the commodities that are provided by the market (Hennipman, 1945, 1977).

2.1.2. Well-being

Well-being is a subjective measure of the satisfaction or happiness of individuals. Well-being is not as clearly defined in economics as the term welfare. Sometimes the two terms are used synonymously (for example in "Where is the Wealth of Nations" of the World Bank, 2006) while on other occasions well-being is interpreted as something broader than welfare (Sen, 1987 and Dasgupta, 2001).

Sen (1987) regards well-being as a multi-dimensional quantity, depending not only on what individuals have achieved or attained in the way of goods and services, but also on various attributes they enjoy as citizens (e.g. freedom, tolerance).

In essence, it all depends on what one includes in the utility function. However, it seems fair to say that well-being is a subjective measure which is broader than "utility derived from the consumption of goods and services".

2.1.3. Sustainable development and sustainability

The well-known 'Brundtland-Commission' defines sustainable development (SD) as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). Usually an economic, an environmental and a social pillar (dimension) are distinguished. Environmental economists elaborated this definition and defined sustainability as the capacity to provide non-declining future welfare (Neumayer, 1999). It is often operationalized by defining different forms of capital such as man-made capital, human capital, natural capital and social capital (World Bank, 2006; UNECE, 2009; Figge and Hahn, 2004) because future welfare is dependent on the availability of capital.

Two types of sustainability are usually distinguished: weak and strong sustainability see, e.g. Pearce and Atkinson (1993), Rennings

and Wiggering (1997), Dasgupta (2001), Ronchi et al. (2002), Ekins et al. (2003) and Ayres (2006).

Weak sustainability is achieved when the total capital stock – physical, human and natural – is non-declining through time. In this variant, development is sustainable even if some component (such as natural capital) is declining, provided the total capital stock does not decrease. In other words, capital stocks are substitutable (Hartwick, 1977).

For strong sustainability the substitution of capital forms is limited. Sustainable development is attained, in a strong sense, if the nation's stock of environmental capital is non-decreasing (Pearce and Atkinson, 1993). The same holds for other forms of capital for which critical levels can be defined.

2.2. Overview of indicator approaches

Table 1 provides an overview of the approaches which have been applied to the measurement of welfare or sustainable development. The table shows that the most important distinction is the division between composite indicators[3] and indicator sets.

In the former approach a single indicator is produced. Six of these approaches can be considered as methods that provide adjustments of national accounts (NA) aggregates while two other approaches are not monetary. The 'sets of indicators' approaches are based on the idea that one number is not capable of capturing the full complexity of these multidimensional phenomena. Many countries and institutes have adopted indicator sets to monitor sustainable development. A number of countries based the indicator sets on their policy statements (policy-based approach). Other countries combined policy-based approach with a conceptual model (the model-based approach) which can be divided

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[3] There are other composite indicators. We have included only the most important approaches in our overview. Our list also omits indicators which focus on a single domain of sustainability such as the environment (e.g. Ecological Footprint, Wackernagel and Rees, 1996) or are only adopted in one country (e.g. IEWB for Canada, Osberg and Sharpe, 2002). We also do not include subjective measures such as happiness (Veenhoven, 2009, Marks et al., 2006) as well as indicator sets that specifically concern the development of the third world countries (United Nations Millennium Development Goals).

in three frequently used models: based on classical pillars (economic, environmental and social) of sustainability, the DPSIR-method (driving force, pressure, state, impact and response) and the capital approach. In the last column of the table we have indicated which approaches are used to measure welfare (W) or sustainable development (SD).

2.2.1. Composite indicators

One approach to measure welfare or sustainable developments is the composite indicator approach (also referred to as the one-number approach). These indicators aggregate information in order to provide a single (usually monetary) measure of progress. Due to the rising criticism of the use of GDP as a welfare indicator, many of these indicators were developed in order to adjust GDP or other macro-economic aggregates in some way. A short description of the composite indicators, mentioned in Table 1, is provided below. The composite indicators are presented in chronological order of their introduction.

1. The 'Measure of Economic Welfare' (MEW) constitutes the first versions of modified national income and it was constructed by Nordhaus and Tobin (1973) in order to reflect economic welfare more accurately. Three kinds of modifications were introduced. First of all, expenditures with regard to health care and education were treated as investment in human capital whereas expenditures on police and on defence were treated as 'intermediate' thus not in themselves generating welfare. Secondly, services of capital goods such as durable consumer goods and leisure time were added. Finally, costs of urbanisation were subtracted. The MEW is also known as net economic welfare (NEW). For more literature on this area see Moon (1977), Samuelson and Nordhaus (1992).

2. 'Sustainable National Income' (SNI) was developed by Hueting (1974). SNI in the year of calculation is defined as the maximum attainable level of production whereby, with available technology in the year of calculation, vital environmental functions remain available for years to come. Environmental functions are defined as the possible uses of our non-human made physical surroundings, on which humanity is dependent, whether they be producing, consuming, breathing or recreating. To evaluate the development of a country the distance between 'formal' national income and SNI is calculated. Due to the fact that the SNI is by definition lower than the 'formal' national income, a decreasing distance implies more sustainability. For more details, see Gerlagh et al. (2002).

3. Amartya Sen developed a conceptual framework that deals with human capability and freedom (Sen, 1985). He considers the development of a country as the expansion of people's capabilities. Sen argues that neither opulence (income, consumption) nor utility (happiness, desire fulfillment) constitute or adequately represent human well-being and deprivation. 'Sen's Capability Approach' (Sen, 1985) evaluates social status in terms of human well-being in which the emphasis is on so-called functional capabilities. This approach contrasts with a common view that sees development purely in terms of GDP growth, and poverty purely as income-deprivation. For more details regarding the capability approach, see Nussbaum (2000) and Clark (2005).

4. Cobb (1989) developed the 'Index of Sustainable Economic Welfare' (ISEW) in order to provide a more reliable monetary indicator of economic welfare and sustainability. The ISEW takes household consumption from the national accounts as a starting point. Household consumption assumes that the more individuals consume, the better their economic welfare is. The ISEW is calculated by adjusting household consumption for items such as the distribution of income, activities not included in GDP (e.g.

housework), damage caused by economic activities and the consideration of net capital endowment of foreign investors. It also takes into account the depletion of natural capital and pollution (which requires valuing non-renewable capital). For more details on ISEW, see Max-Neef (1995), Stockhammer et al. (1997), Castañeda (1999), Neumayer (1999), Neumayer (2000a), Clarke and Islam (2005) and Pulselli et al. (2006).

5. The 'Human Development Index' (HDI) was developed in 1990 by the United Nations Development Programme (UNDP, 1990). The HDI consists of three dimensions which capture relevant aspects of human well-being: longevity (measured by life expectancy at birth as a proxy for health achievement); knowledge (measured by adult literacy rate combined with gross educational enrolment ratio); standard of living (measured by GDP per capita). These three dimensions of HDI are averaged after a normalisation process. According to Sen (2000) the HDI is the most important application of his capabilities approach, which measures individual well-being on the basis of what a person is capable of doing with his goods. Additional literature on the HDI: Desai (1995) and Neumayer (2001).

6. The 'Genuine Savings' (GS)/'National Wealth' (NW) is based on the Hicksian income concept and it was introduced by Atkinson and Pearce (1993). Together they can be described in the 'monetary capital approach' where NW describes the stocks while GS describes the changes in stocks. GS is the indicator of sustainability used by the World Bank (World Bank, 2006). The GS starts with gross national saving after which the consumption of fixed capital is subtracted to give the net national saving. In order to adjust for investments in human capital, current expenditures on education are added. In addition both the value of natural resource depletion and the value of damages from pollutants are subtracted. The GS indicator is based on the concept of weak sustainability as it allows for substitution of natural resources by produced and human capital (Hartwick, 1977). For more details, see Neumayer (2000b), Arrow et al. (2003), Atkinson and Hamilton (2003), del Mar Rubio (2004), Pezzey et al. (2006) and Pillarisetti (2005).

7. The 'Genuine Progress Indicator' (GPI) deviates slightly from the ISEW in terms of the specific categories of adjustments included (Cobb et al., 1995). To calculate the GPI, consumption expenditure is weighted with an index of income inequality. Secondly, the following monetary benefits are added: volunteer work and the value of time spent on household work; parenting; the value of services of consumer durables (e.g. cars) and the services of highways and streets. Finally, three categories of expenses are deducted from the GPI: defensive expenditures[4]; social costs (such as the cost of divorce, crime or loss of leisure time); and depreciation of environmental assets and natural resources. More details regarding GPI can be found in Anielski and Rowe (1999), Hamilton (1999), Neumayer (2000a) and Costanza et al. (2004).

8. The 'Sustainable Net Benefit Index' (SNBI) was introduced by Lawn and Sanders (1999). They argue that when using GDP as a welfare indicator poor bookkeeping is exhibited, because no distinction is made between costs and benefits. Therefore they developed the SNBI which is defined by the difference between two accounts: 'uncancelled' benefits of economic activity (e.g. services from volunteer work) and the 'uncancelled' costs of economic activity (e.g. noise pollution).

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[4] Some of the expenditure in the economy relates to the avoidance of using the sink function of the environment. This includes environmental protection expenditures and may include other expenditure of a type which might be described generally (albeit not very precisely) as defensive expenditure (SEEA, 2003, section 1.57).

Table 2
Components of composite indicators.

Aspects/composite indicators	MEW	SNI	ISEW	HDI	GS	GPI	SNBI
Economical aspects							
GDP/national income/consumption	X	X	X	X		X	X
Net savings/foreign borrowings/net official transfers					X		
Capital consumption		X			X		
Income distribution			X			X	X
Non-market goods (for example housework)			X			X	X
Defensive expenditures							
Costs of efforts to obtain the present level of welfare (police, defence, intensity of work)	X		X			X	X
Defensive costs (urbanisation, road accidents)	X		X			X	X
Social costs			X			X	X
Environmental costs							
Environmental damage (pollution)		X	X		X	X	X
Depletion of natural resources		X	X		X	X	X
Durable consumer goods	X					X	X
Social aspects							
Leisure time	X						X
Health (expenditure as an investment or life expectancy)	X		X	X		X	X
Education (expenditure as an investment or enrolment)	X		X	X	X	X	X

In Table 2 table several aspects have been listed in the first column in order to show which aspects are covered by the composite indicators. Sen's Capability Approach has not been included because it focuses on capabilities of people and therefore does not suit in the mentioned classification.

2.2.2. Sets of indicators

Many countries and institutes have adopted sets of sustainable development indicator rather than composite indicators because of the multidimensional character SD. Underlying this approach is the belief that these different dimensions cannot be aggregated in a meaningful way, at least not with the present state of knowledge. Many also argue that these weights should be provided in a political process. We distinguish the policy-based approach and the model-based approach.

1. Policy-based approaches.

    In the policy-based approach indicators are selected on the basis of government policy on sustainability. The basis of this method is that policy makers decide what is important to SD, identify different policy topics and themes and select relevant indicators in alignment with the policy documents. The strength of this approach is that the indicators are by definition policy relevant. Weaknesses of the policy-based approach are that problems could exist with interpretation of policy documents, and that there is a possibility that the political statements will not provide a comprehensive or theoretically robust definition of SD. Finally, a weakness could be that political goals and policies can, and most likely will change over time which can lead to a change in the indicators or SD definition. A well-known set of sustainable development indicators is that of Eurostat which is based on the EU Sustainable Development Strategy (European Communities, 2007).

2. Model-based approach.

    2a. Sustainable development pillars.

    The simplest model-based approach is based on the three dimensions (pillars) defined by the Brundtland report, i.e. economic, environmental and social. In practice SD pillars are often also used for an allocation of the indicators in the policy-based approach, so the distinction between the model-based approach and the policy-based approach is often difficult. Note also that some indicators can be classified in more than one pillar.

2b. DPSIR model.

    Another model-based approach is the DPSIR-approach. The roots of this framework can be traced back to the State-Response framework developed by Statistics Canada in the late 1970s (Rapport and Friend, 1979). It captures the key relationships between factors in society and the environment. Therefore it is particularly useful for policy-makers because this framework monitors aspects of sustainability policy. The disadvantage of this approach is that it focuses primarily on the environment. The driving force could, for example, be the production of an enterprise, which causes a pressure on the environment (pollution), in which case the state of the soil deteriorates. This change in the state of the soil has an impact because of the economic damage that is caused by the fact the soil cannot be used for the construction of houses. As a response the soil could be cleaned. For more details on the evaluation of the DPSIR-framework see EEA (1995), Gabrielson and Bosch (2003) and Holten-Andersen et al. (1995).

2c. Capital approach.

    The capital approach is based on the concept of maintaining economic, environmental, human and social capital over time for future generations. The reasoning behind this is that this is the only way to ensure that welfare is maintained by future generations (WCED, 1987). This approach is firmly based in macro-economic theory (Hicks, 1939) although the range of phenomena which are considered to be 'capital' has expanded significantly beyond mainstream economics. For the purpose of sustainability four types are usually distinguished: economic, natural, human and social capital (UNECE, 2009). Although there are measurement issues, the capital approach generally provides a solid and theoretically sound conceptual framework for sustainable development indicators. It leads to indicators which measure SD in a consistent way. In Section 2.2.1, we have already discussed the GS/NW approach which is based on capital theory. Here a single indicator is calculated by producing monetary values for all subcomponents. Contrary to this 'monetary approach' the capital stocks can also be measured partly in other units. For example, in the case of natural and social capital most indicators will have to be measured in non-monetary units because of the difficulty in producing appropriate valuation methods. Because of the

use of multiple units we propose the term 'hybrid capital approach'. In Section 4 we will argue why we believe that this approach is the most fruitful way forward.

3. Sustainable development indicator (SDI) sets in practice

In this section the sustainable development indicators based on national strategies of 19 countries and 3 international organisations will be discussed. The main goal of this section was to compare and contrast the existing indicator sets as they are currently published. Although we have been able to gather a large amount of SDI sets we do not claim that the provided overview is complete.

Selecting countries and international organisations, the following criteria were used:

Only those countries have been selected that presented their indicators (implicit or explicit) using three pillars: economic, social and environmental.
Only the sets of indicators coming from official government agencies such as statistical offices or ministries have been selected.

To compare the indicators of the countries and organisations we need a common classification scheme for the indicators. The adopted division by themes is based on the Eurostat Monitoring Report because it is one of the most visible SDI sets available (European Communities, 2007). It includes 10 themes. A variety of sources were used for information about the SDI sets.[5] The average amount of SD indicators is 45, and ranges from 12 to 119.

For the sake of clarity we have grouped indicators that describe similar phenomena. For example indicators such as GDP per capita (regional) GDP in Purchasing Power Standards or GDP growth have been put together under one indicator "GDP per capita". Moreover the indicators that describe the same phenomenon but were subdivided into categories (gender, age, educational level, etc.) have been placed under one name where the breakdown is no longer visible. In some cases we could not avoid subjective assessment because a lack of documentation forced us to divide the indicators into themes and sub-themes only on basis of their names.

In Table 3 the indicators that are used by four or more countries/organisations are presented.

It can be seen that the number of indicators per theme differs tremendously. For example theme 'Public health' has 13 indicators and theme 'Global partnership' and 'Good governance' only one. Possible explanations for the differences are that some countries lack data on some of these indicators or that some countries have not included these specific themes because they do not consider them to be relevant for sustainable development.

What is very striking is that there is no single indicator that was employed by all countries. Thus, even some common indicators such as 'GDP', 'Biodiversity' or 'Emissions of greenhouse gasses' were not included by all countries in their sets of indicators. One possible explanation of this could be that some countries focused more on environmental indicators whereas other focus on economic or social indicators.

In Fig. 1 the distribution of the amount of indicators per theme is given. More than 20% of the indicators belongs to 'Management

of natural resources'. Less than 5% of the indicators has been classified to 'Transport', 'Global partnership' or 'Good governance'.

In Table 4 the percentage of indicators per country is given. The distribution of indicators per theme differs strongly per country. For example, the number of indicators for 'Management of natural resources' in Denmark and Portugal is nearly half of the total number of indicators in those countries. Furthermore the distribution of indicators in this theme is very large; it ranges between 2 and 44. The 'Good governance' theme is characterized by a very small amount of indicators in most of the countries. Some of them have no indicators in this theme at all. In 'Public health' the difference in the number of indicators per country is not very large. Only eight countries have indicators in all themes.

4. The hybrid capital approach

What have we learned from the overviews of Sections 2 and 3? There are a two very clear conclusions which can be drawn.

Firstly, it is quite clear that there is a huge variation in the methods and approaches that are used to measure welfare or sustainable development. Nevertheless, none of these approaches can claim any real dominance.

Secondly, there is a clear distinction between composite indicators and sets of indicators. Composite indicators are easier to communicate to the public, but there are often questions about the aggregation techniques. In essence this often boils down to trust which the researchers have in the monetization techniques (Lawn, 2003) available or the view that a set of indicators is the only viable way of presenting a multi-dimensional phenomenon such as sustainability (Stockhammer et al. (1997).

The overall picture is of a very diverse line of research. This is not necessarily a bad thing. Each indicator (set) has its own focus and will therefore bring different insights to the fore. Nevertheless, the diversity does raise an important issue. Apparently there is a huge difference of opinion about what welfare and sustainability is. To an extent one can argue that these differences may be the results of legitimate differences in the preferences of countries. Nevertheless, our overview of SDI's in Section 3 showed that even similar countries have adopted very different indicators sets for sustainability. This implies that there are other reasons for the differences.

In our view the differences in SDI sets are largely caused by the fact that most are not based on a theoretical framework. The indicator sets are mostly "policy-based", which means that they have been adopted after (extensive) consultations with policy makers. However, the outcome of such a process is very unpredictable and it is hardly surprising that there are large differences between countries. A theoretical framework would ensure that these consultation processes would be more focussed and would lead to more similar, yet not necessarily identical, indicator sets.

We suggest that the capital approach could provide the required theoretical framework. Support for this approach is mounting in the scientific (Atkinson and Pearce, 1993; Atkinson and Hamilton, 2003), policy (World Bank, 2006) and statistical communities (UNECE, 2009). The method is based on economic theory and distinguishes a coherent list of assets (Economic, Natural, Human and Social). In essence it is not much more than the application of the age-old production function $Y = f(E,N,H,S)$. Yet as economist will note the list of assets is broader than in mainstream economics and thereby includes insights and theory from other social sciences and environmental-economic theory. An additional advantage is that the link to economic theory means that the approach can also take advantage of measurement frameworks that have been created for economics and the data which has been collected (particularly the System of National

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[5] We have relied heavily on Hass and Moe (2006), but we have also used reports of Austria (Federal Ministry of Agriculture, Forestry, Environment and Water Management, 2006), Germany (Federal Statistical Office of Germany, 2007) and Switzerland (Swiss Federal Statistical Office, 2004; Swiss Federal Statistical Office Switzerland, 2005). For three countries (Denmark, Finland and Switzerland) only the headline indicators were used, because the more detailed indicators were more country-oriented.

Table 3
Summary of the most frequently used indicators per theme.

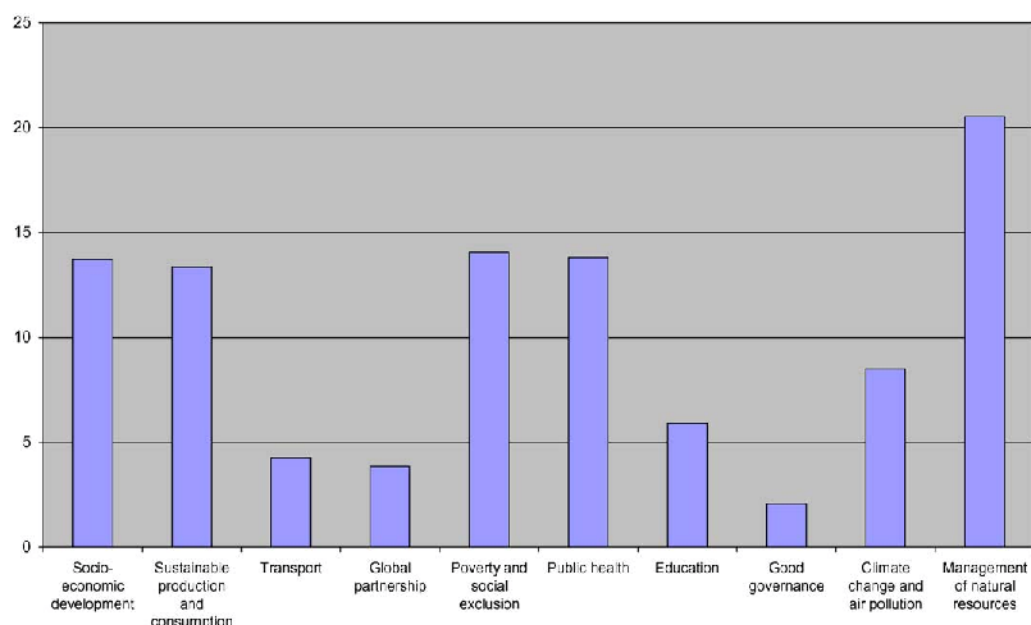| Theme	Indicator	Number
Socio-economic development	GDP per capita	19
	General government gross net debt	12
	Research and development expenditure (and/or patents)	9
	Employment, by age group	8
	Investment share of GDP	6
	Value added by main sectors of economy	6
	Foreign direct investment	5
	Inflation rate	5
	Labour productivity by main sectors of economy	5
	National income per capita	5
	Net current account	5
Sustainable production and consumption	Energy consumption by sectors	13
	Municipal waste collected and its disposal	12
	Energy use and intensity	10
	Share of energy from renewable sources in total energy consumption	10
	Domestic material consumption	8
	Generation of (industrial) waste (by sectors) and its disposal	8
	Recycling of waste (paper and glass, construction)	8
	Generation and disposal of hazardous waste	7
	Generation and disposal of radioactive waste	6
	Consumption by chemical type	4
	Energy production	4
Transport	Pattern of passenger transport	6
	Volume of transport (passenger and freight)	5
	Freight transport by mode	4
Global partnership	Official development assistance	13
Poverty and social exclusion	Unemployment rate by age, gender, education level	16
	Risk of poverty	13
	Female to male wage ratio (gender pay gap)	10
	Reported crimes	10
	Inequality of income distribution	9
	Household composition	5
	Dwelling density	4
Public health	Life expectancy (at birth)	14
	Population growth rate (sometimes regional)	10
	Mortality (below the age of 65 and/or due to selected illnesses)	8
	Health care expenditure relative to GDP	6
	Old-age dependency ratio	6
	Working accidents (work related injuries)	5
	Child welfare (young adults)	4
	Fertility rate	4
	Net migration rate	4
	Noise pollution (% of population exposed to traffic, railway and air traffic noise)	4
	Nutrition status of population	4
	Obesity	4
	Population connected to sanitation system	4
Education	The highest level of education attainment (by age group)	7
	Access to the internet	6
	Early school-leavers	5
	Level of tertiary education	4
Good governance	Voting activity (electoral participation)	5
Climate change and air pollution	Emissions of greenhouse gases	18
	Emissions of acidifying substances (SO_2, NO_x, NH_3, NMVOC)	11
	Emissions of air pollutants (sulphur dioxide, carbon monoxide, benzene, lead, heavy metals, lead and nitrogen oxides)	7
	CO_2 emissions per capita and/or GDP	6
	Emission of ozon precursors (CO, NMVOC, NO_x, CH_4)	6
	Consumption of ozone depleting substances	5
	Average (surface) air temperatures	4
Management of natural resources	Biodiversity and number of protected species	17
	Agricultural area and organic farming	10
	Quality of bathing and surface waters/ coastal eco-systems	9
	Area of protected land (to maintain biological density)	8
	Forest area and its utilisation	6
	Development in areas as of nature, wood, farm land, housing and roads	5
	Fish catches (outside safe biological limits)	5
	Use of fertilisers and pesticides	5
	Land use	4
	Proportion of surface water management (sewerage)	4

Fig. 1. Percentage distribution of indicators per theme.

Table 4
Percentage distribution of indicators for each country.

Countries	Themes									
	Socio-economic development	Sustainable production and consumption	Transport	Global partnership	Poverty and social exclusion	Public health	Education	Good governance	Climate change and air pollution	Management of natural resources
Australia	20	4	0	0	4	12	12	0	12	36
Austria	2	5	5	5	27	12	4	7	11	21
Czech Republic	19	16	10	3	16	10	3	3	3	16
Denmark	8	14	0	0	2	12	0	0	20	44
Estonia	13	17	6	2	15	17	6	0	6	20
Finland	20	7	3	3	13	20	3	10	10	10
France	8	25	0	8	17	17	0	0	8	17
Germany	18	11	11	7	7	11	11	0	7	18
Hungary	14	22	6	0	14	18	4	0	6	14
Ireland	26	4	5	2	23	18	14	2	5	2
Latvia	12	13	3	0	11	13	9	0	15	22
Lithuania	22	6	0	0	28	11	6	0	6	22
Luxembourg	22	11	4	4	11	15	4	0	7	22
Malta	22	26	4	0	9	4	4	0	9	22
Norway	13	19	0	13	6	6	6	0	13	25
Portugal	3	21	0	0	7	7	0	3	17	41
Sweden	13	15	3	7	14	19	6	3	7	14
Switzerland	18	12	12	6	29	6	6	0	0	12
United Kingdom	8	11	11	2	22	16	2	3	9	17
Eurostat SD-indicators	11	16	9	5	7	18	3	9	6	15
United Nations Indicators of SD	9	14	2	4	12	12	7	2	7	32
United Nations Millennium Development Goals	0	6	0	15	15	29	21	3	3	9
Average	14	13	4	4	14	14	6	2	8	21
Minimum	0	4	0	0	2	4	0	0	0	2
Maximum	26	26	12	15	29	29	21	10	20	44

Accounts and the System of Environmental and Economic Accounts (SEEA)).

Despite the fact that support for the capital approach is mounting, there is still also some reluctance to adopt this approach. On of the reasons is the issue of *how* to apply the capital approach. So far the monetary capital approach dominates the scientific literature. Studies such as the World Bank (2006) calculate monetary values for all capital stocks. As one might imagine this is quite a large leap from the more (European) approach in which indicators sets are dominant (probably driven by the greater scepticism of monetization techniques as well as the idea that sustainability is a multidimensional issue which warrants measurement in different units).

An interesting and valuable exchange of these views took place in the Working Group for Statistics of Sustainable Development (WGSSD) (UNECE, 2009). The capital approach was confronted

Table 5
An example of a small SDI set based on the hybrid and monetary capital approach.

	Hybrid capital approach	Monetary capital approach
Economic capital (e.g. machines and buildings)	Euros	Euros
Natural capital (e.g. fossil fuels reserves)	Gigajoules	Euros
Human capital (e.g. knowledge and skills of workers)	Percentage of population with higher education	Euros
Social capital (e.g. trust)	Generalized trust score	Euros

with Eurostat's set of SDI indicators which lead to the conclusion that many of the indicators could actually be used in the capital framework. In the end the final report advised a mix of monetary and non-monetary indicators. Non-monetary units are used for those stocks that "cannot or should not be valued" (p. 59).

This is an interesting approach, but we would like to sell it in a subtly different way. Let's define the "hybrid capital approach" as an approach in which each capital stock is measured in his/her own distinct unit. To illustrate the difference between the monetary and hybrid approaches, Table 5 shows what the units would be for a SDI set of 4 indicators.

Basically the differentiation between the two methods is inspired by notion that countries can "agree to disagree" about how far to go in the monetization process/monetary capital approach. This seems a logical compromise because of the disparate views that exist. There will hardly be any countries that object to economic capital being measured in currency units, but the situation and methods for natural capital will lead to far more discussion. For social capital there is, with the current state of knowledge, very little debate to have. The WGSSD report does not identify any valuation methods and the World Bank (2006) uses a residual approach.

It therefore seems reasonable to assume that the hybrid capital approach is currently the only viable option. Allowing for non-monetary indicators will mean that agreement over indicators will probably be easier.

Does that mean that the hybrid capital approach excludes monetary units? No, quite the contrary, monetary values can easily be adopted if countries agree that the capital stock is best measured in currency units (e.g. economic capital). Conceivably this might also mean that the hybrid capital approach may actually evolve into the monetary capital approach if the scientific methods improve and are accepted within statistical communities. The distinction between the two approaches is therefore also a means of structuring the sustainability debate while still producing a global SDI set based on the hybrid capital approach.

5. A research agenda for the hybrid capital approach

Although the hybrid capital approach seems promising there are a number of areas which need to be developed further.

5.1. Current welfare and the progress of societies

Our discussion on the hybrid capital approach has focussed on its use for sustainable development. However, as we have shown in Section 2, capital and welfare are both part of the same theoretical framework. Basically capital approach distinguishes current welfare and future welfare (measured through capital).[6] We could therefore also introduce a number of indicators for current welfare to the indicator set. This would make quite a good basis for comparisons of the "progress of societies" (when also combined with the international dimension and inequality, see discussion later on).

5.2. Monetization and theoretical challenges for human and social capital

Some forms of capital such as economic or natural capital are very well developed and described in the SNA and SEEA respectively. Nevertheless, there are still a lot of theoretical challenges (Smits and Hoekstra, 2008). In the case of human capital the dominant theoretical basis is provided by Jorgenson and Fraumeni (1995) but this has not been internalized by the statistical community. The OECD has recently initiated a task force for human capital accounts. Social capital is probably the most challenging in terms of its theoretical development. There is quite a bit of support that this is an important capital form but the most important question is what exactly we want to measure. The most promising route seems to be to regard the networks and the trust which they generate as the social capital stocks of society (Smits, 2007).

5.3. Choosing indicators

When choosing indicators for the capital approach, we recommend taking into account indicators from the current policy-based approaches. These indicator sets (such as Eurostat's SDI list and the Lisbon targets) reflect the outcomes of international discussion and have the advantage that a lot of internationally comparable data has been gathered. A confrontation of the SDI database and the capital approach already took place in the WGSSD (UNECE, 2009).

5.4. National accounts and satellites

Ideally the indicators of the hybrid capital should be produced using a common statistical framework so that the indicators are consistent. The national accounts, and the various satellites, provide such a system. This framework is theoretically consistent (although not identical) to the capital approach. Some countries have already implemented SDI sets based on the SNA/SEEA (Federal Statistical Office of Germany, 2007; Statistics Sweden, 2008). These initiatives also have the advantage that the data is consistent to input–output tables which enables modelling (Hoekstra et al., 2008).

Although the capital approach and the SNA are similar, there are important differences which need to be explored further. Human capital, for example, is not included in the SNA. Interesting recommendations have been made by Dale Jorgensen on introducing human (and other types of) capital in a "new architecture" for national accounts (Jorgenson and Landefeld, 2006, 2009; Boskin, 2009).

5.5. Industry breakdown and inequality

National totals for indicators provide interesting information on the general development. However, it is also important to breakdown the indicators into industry types or demographic characteristics (age, gender, and ethnicity) to gain insight into distribution of the capital and welfare.

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[6] This distinction is also made by the Stiglitz-Sen-Fittoussi Commission for measuring the progress in France (Stiglitz et al., forthcoming).

5.6. International aspects

Because the capital approach focuses only on national indicators aspects it is necessary to develop additional indicators which cover international aspects of sustainability. For example, some countries may exhibit "carbon leakages" whereby domestic emissions are lowered by increasing certain imports. It is therefore also important to produce indictors that register the "embodied" greenhouse gasses in the imports (for an overview of this literature see Wiedmann et al., 2007).

6. Summary and conclusions

The paper provides an overview of over 40 years of work on the measurement of welfare and sustainable development. Many different methods and approaches have been proposed. Nevertheless none of the approaches has been accepted as the 'correct' approach.

We suggest that the lack of uniformity in indicator sets is due to the fact that they do not use a theoretical basis. We propose the capital approach, in which all capital stocks are measured in their own units.

We conclude that if the "hybrid" capital approach is adopted it may become easier to make consistent, theoretically sound and policy relevant comparisons between countries.

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