The Cost of Sustainability Capital and the Creation of Sustainable Value by Companies

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Keywords

British Petroleum (BP)
eco-efficiency
industrial ecology
natural capital
opportunity cost
sustainability indicators

Summary

We develop and apply a valuation methodology to calculate the cost of sustainability capital, and, eventually, sustainable value creation of companies. Sustainable development posits that decisions must take into account all forms of capital rather than just economic capital. We develop a methodology that allows calculation of the costs that are associated with the use of different forms of capital. Our methodology borrows the idea from financial economics that the return on capital has to cover the cost of capital. Capital costs are determined as opportunity costs, that is, the forgone returns that would have been created by alternative investments. We apply and extend the logic of opportunity costs to the valuation not only of economic capital but also of other forms of capital. This allows (a) integrated analysis of use of different forms of capital based on a value-based aggregation of different forms of capital, (b) determination of the opportunity cost of a bundle of different forms of capital used in a company, called cost of sustainability capital, (c) calculation of sustainability efficiency of companies, and (d) calculation of sustainable value creation, that is, the value above the cost of sustainability capital. By expanding the well-established logic of the valuation of economic capital in financial markets to cover other forms of capital, we provide a methodology that allows determination of the most efficient allocation of sustainability capital for sustainable value creation in companies. We demonstrate the practicability of the methodology by the valuation of the sustainability performance of British Petroleum (BP).

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Introduction

Sustainable development is a normative concept that calls for "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987); that is, it calls for some kind of intergenerational equity (e.g., Goodland and Daly 1996). This aspect of intergenerational equity is often modeled using a capital approach (Harte 1995; Stern 1997). According to the constant capital rule, a development must leave the capital stock per capita at least unchanged to meet the normative demand of sustainable development (e.g., Harte 1995; Stern 1997). Although it is a commonplace notion that a society needs several different forms of capital, there is a debate about how many groups of capital should be distinguished and taken into account (e.g., Dyer and Poggie 2000; Ekins 1992). Next to economic (here used synonymously for human-made or manufactured) capital, there are, for example, natural and social capital. For the purpose of this article, a subdivision of the different forms of capital is not necessary.

Companies, Sustainable Development, and Efficiency of Capital Use

The concept of sustainable development and the capital approach to sustainability have also been applied to companies (e.g., Atkinson 2000; Huizing and Dekker 1992). On one hand, companies use capital, which is undesirable because capital is valuable and limited. On the other hand, companies' output, that is, the products and services they produce, is desirable.[1] Companies thus need to optimize the way in which they use capital. Put differently, companies need to enhance their efficiency.

In this article, efficiency refers to the ratio of value created to capital used (Freeman et al. 1973; Schaltegger and Sturm 1990) and we interpret value created as a form of economic value.[2] Efficiency will be enhanced whenever more value is created for a given amount of capital or less capital is used for a given amount of value created.

The conservation of capital stock as required by the constant capital rule will be more easily achieved the more efficiently capital is used. Thus, companies must aim at high efficiency of capital use if they are to contribute to sustainable development. More efficient use of resources is of course no guarantee of less capital being used (e.g., Berkhout et al. 2000; Herring and Roy 2002; Mayumi et al. 1998). Improvements in efficiency can be overcompensated if companies' economic growth exceeds the improvement of their efficiency (rebound effect).[3] On the other hand, if the use of capital is to be reduced for a given amount of value created, efficiency must be enhanced. It follows that, ceteris paribus, increase in efficiency is a necessary but not sufficient condition for reduction of capital use, if the amount of value created is not to be reduced. Furthermore, an increase in efficiency does not give any information about how value is created and how the different forms of capital are distributed. A change of the distribution of value created and/or capital can have a negative impact on sustainability performance. It is for these two reasons that the ceteris paribus assumption is of crucial importance when the relationship between efficiency and sustainable development is analyzed. The same assumption is also made by the approach presented in this article.[4]

If we interpret corporate sustainability performance under the ceteris paribus assumption, the efficiency of corporate capital use must be determined. A company contributes to sustainable development whenever it uses every single form of capital more efficiently than another company. But this is rare. Companies will usually use some forms of capital more efficiently and other forms of capital less efficiently than other companies. To evaluate the use of capital in these cases, it must be determined if the higher efficiency of the use of one form of capital can compensate for the lower efficiency of the use of another form of capital. This aggregation problem appears whenever we have different forms of capital that are measured in different units and therefore cannot be aggregated easily.

In the field of natural capital, this aggregation problem has been dealt with by environmental impact assessment approaches (e.g., Fava et al. 1991; Heijungs et al. 1992a; 1992b; Odum 1996;

Wackernagel and Rees 1996). Impact assessment, though, has exclusively approached this aggregation problem by aggregating different environmental impacts[5] according to their relative burden. In general, for this purpose burden-based approaches convert all environmental impacts into equivalents of one of the impacts.

Put generally, this is expressed as follows:

$$\mathrm{EI}_1 - \text{equivalents} = \mathrm{EI}_1 + \frac{w_2}{w_1} \cdot \mathrm{EI}_2 + \ldots + \frac{w_n}{w_1} \cdot \mathrm{EI}_n \quad (1)$$

with EI = environmental impact and w = relative burden of an impact (weight).

This aggregation is based on the relative burdens of different environmental impacts. To derive these relative weights, different logics are applied. One frequently used approach is to classify environmental interventions according to their contribution to a group of environmental problems that serve as impact categories (e.g., Heijungs et al. 1992a; 1992b). Other examples are, for example, energy- (e.g., Odum 1996) or space-oriented (e.g. Wackernagel and Rees 1996) methods.

All these approaches have in common that they allow (1) determination of the burden of one environmental impact relative to another environmental impact and (2) optimization of these burdens based on this information. It is for this reason that we refer to these approaches as burden-based approaches.

Most environmental impact assessment approaches, though, do not allow the aggregation of all environmental impacts into a single figure. Furthermore, they do not allow consideration of other forms of capital such as, for example, social or economic capital. To integrate different forms of capital based on a burden-based approach, the relative burdens of the different forms of capital that are generally accepted would have to be established. In our view, no existing impact assessment approach meets this criterion.[6]

In this article we fundamentally shift the perspective of the analysis to concentrate on value creation (i.e., on the numerator of efficiency ratios) instead of damage caused (i.e., the denominator), as in burden-based approaches. To determine the value created, we fall back on the concept of opportunity costs. The suggestion to consider the opportunity costs of the use of economic and natural capital can be traced back to the end of the nineteenth century.

> Not only time and strength, but commodities, capital, and many of the free gifts of nature, such as mineral deposits and the use of fruitful land, must be economized if we are to act reasonably. Before devoting any one of these resources to a particular use, we must consider the other uses from which it will be withheld by our action; and the most advantageous opportunity which we deliberately forego constitutes a sacrifice for which we must expect at least an equivalent return. (Green 1894, p. 224)

Unfortunately to date very few scholars (Figge 2001; Figge and Hahn 2004a; 2004b) have taken up this suggestion to assess the value of capital beyond economic capital.[7] Opportunity costs are, up to this point, only applied in the valuation and allocation of economic capital. In an earlier article, we introduced the value-based logic for the measurement of corporate sustainability performance for the first time (Figge and Hahn 2004a). Although sharing the fundamental value-based logic and the notion of opportunity cost, the methodology described in the present article represents a significant further development. The three fundamental innovations of this article are that it (1) considers the total amount of capital used rather than just the change of capital use, (2) integrates all different forms of capital rather than just addressing the use of natural capital, and (3) provides a methodology to evaluate the use of all different forms of capital similar to the way economic capital is valued on financial markets today.

Thus, in this article we take up Green's suggestion to consider the opportunity costs of *all* forms of capital. We call the entirety of all different forms of capital a company uses its sustainability capital.[8] Our approach allows determination of a company's cost of sustainability capital. Following the example of the financial markets, we use the cost of a company's capital to determine how much value a company has created after deduction of its cost of sustainability capital. We call the value that exceeds a company's sustainability capital its sustainable value.

The next section shows how the cost of capital is determined in the financial markets. This logic is then extended to sustainability capital and applied to the real world example of British Petroleum.

Economic Cost of Capital

In the financial markets it is commonly assumed that capital should be allocated where it creates most value. For this purpose the expected risk-adjusted return for alternative uses is calculated and capital is allocated where maximum return is expected (e.g., Brealey and Myers 1996, 12). In financial economics it has been proposed for quite some time (e.g., Green 1894; Haney 1912) that economic capital is invested in a company whenever the expected return of the investment lies above the opportunity cost of capital. Opportunity costs indicate the value that would have been created by an alternative use of capital. In the financial markets opportunity cost of capital corresponds to the yield of an investment with a similar risk.

In practice the opportunity cost and thus the cost of capital is determined by the equation

$$CC = \frac{VC^M}{CE^M} \tag{2}$$

with CC being the cost of capital, VC^M the value created by the market, and CE^M the amount of capital employed by the market.

In the financial markets a profit (e.g., Stewart 1991) or free cash flow (e.g., Rappaport 1986) figure is usually used as an indicator for value created. But the same relationship can be used with a broader definition for value created (e.g., value added).

A company creates value when it uses capital more efficiently than the market. To determine if and how much value has been created, the yield of the capital employed by the company is compared to its cost of capital. For this purpose the cost of capital can be subtracted from the yield of a company's capital. The result is called a value spread,

$$VS = \frac{VC^C}{CE^C} - \frac{VC^M}{CE^M} \tag{3}$$

with VS being the value spread, VC^C the value created by the company, and CE^C the amount of capital employed by the company.

The value spread shows how much value is created per unit of capital employed. The value spread can be used to calculate the excess value created by the company by multiplying the value spread by the amount of capital employed by the company,

$$EVC = VS * CE^C \tag{4}$$

with EVC being the economic value created.

In other words, a company creates a positive economic value if the value created by the company is higher than the opportunity cost of the capital employed, that is, higher than the value that would have been obtained by investing the same amount of capital in the market. In the following, we use this logic to determine the opportunity cost of sustainability capital use and sustainable value creation.

Cost of Sustainability Capital and Sustainable Value Creation

The preceding section has shown how the (opportunity) cost of economic capital is calculated in the financial market. This logic can be applied fruitfully to a whole set of different forms of capital and to a broader definition of value created, as required by the normative concept of sustainable development. Similarly to the interpretation of opportunity cost in the financial markets, we now interpret the average value created by a form of capital in the market as its opportunity cost. The opportunity cost of different forms of capital thus corresponds to the efficiency of the use of these different forms of capital on the level of a benchmark. We assume in the following, first, that this benchmark is the economy of a country. In this case, opportunity cost is determined by the ratio of the value created on the level of the entire economy per capital used. We assume, second, that the economic value created corresponds to the value of all products and services produced within a country. If we subtract depreciation, this value corresponds to the net domestic product (NDP).[9] In general, the opportunity cost

of capital can thus be defined using the equation

$$OCC_i = \frac{NDP}{C_i^E} \quad (5)$$

with OCC_i = opportunity cost of capital i, NDP = net domestic product, and C_i^E = amount of capital i used in the economy.

The opportunity cost of capital indicates the value that is created per unit of capital in an economy on the average. We can now turn to value creation on the corporate level. For this purpose we calculate the return on each form of capital. The complement to net domestic product on a corporate level is net value added. Net value added corresponds to the value created within a company after depreciation. It excludes any value that has been created by suppliers or that will be created by customers. The net domestic product of an economy is made up of all net value added for all economic entities. The return on capital thus corresponds to

$$RC_i = \frac{NVA}{C_i^C} \quad (6)$$

with RC_i = return on capital i, NVA = net value added, and C_i^C = amount of capital i used in the company.

As described above, value is only created if the return on capital exceeds the opportunity cost of capital. Therefore, and similarly to the way value creation is calculated in the financial markets, we now calculate value spreads,

$$VS_i = \frac{NVA}{C_i^C} - \frac{NDP}{C_i^E} \quad (7)$$

with VS_i = value spread of capital i. The value spread reflects the hyper-efficiency of the use of a form of capital, that is, how much more efficiently a form of capital is being used in comparison to a bench-mark. To establish how much value has been created by the use of capital by a company, following the example of the financial markets, we now multiply the value spread of each form of capital by the amount of capital used by the company,

$$VC_i = VS_i \times C_i^C \quad (8)$$

with VC_i = value created through the use of capital i.

By calculating VS_i and VC_i for every form of capital i, one can determine whether a company uses the different forms of capital in a value-creating way. It is important to note that at this stage we are relating the entire value, that is, NDP and NVA, several times to different forms of capital. Although this is current practice in the calculation of return on economic capital, it is misleading. The companies of an economy use a bundle of different forms of capital and it is the entire bundle that creates value. It is necessary to come up with an *integrated* appraisal of the value that has been created by a company by using a *bundle* of different forms of capital. Assuming that we consider n forms of capital, simply summing up the value created for every form of capital $i \in [1; n]$ overestimates the value created by a factor n. To correct for this we must divide by factor n. As a result we obtain sustainable value, that is, the value created by a hyper-efficient use of all forms of capital: A positive (negative) sustainable value indicates that a company uses its capital base more (less) efficiently than the benchmark. In other words, sustainable value expresses whether the value created by a company exceeds the opportunity cost of its capital use. Sustainable value can therefore be calculated as

$$SV = \frac{1}{n} \sum_{i=1}^{n} VC_i \quad (9)$$

with SV = sustainable value created by the company.

One could now be led to believe that dividing by n attributes the same weight to all forms of capital. We show that this is not the case but that the weight of each form of capital depends on its importance for value generation. Recall that in calculating VC_i for each form of capital i, we multiply the amount of each form of capital by the corresponding VS_i. The weight with which each form of capital i enters the calculation of sustainable value is thus determined by how much more or less efficiently each form of capital i is used compared to the benchmark. Thus, dividing by n does *not* serve to weight the different forms of capital but only to avoid double counting of value creation. The different forms of capital are weighted by their over- or underefficiency compared to the benchmark or—in other words—by

the degree to which they succeed in or fall short of covering their opportunity cost.

In a next step we can now also determine the sustainability efficiency[10] of capital use. Capital efficiency can be expressed by relating value created to the cost of capital. We know that the more sustainable value is created, the more the NVA of a company exceeds the opportunity cost of its capital base. The total opportunity cost of a company's capital base, or, in other words, its cost of sustainability capital, is thus given by the difference between NVA and the sustainable value of a company. Sustainability efficiency can thus be defined as the ratio of NVA to the cost of sustainability capital,

$$SE^C = \frac{NVA}{CSC} \tag{10}$$

with SE^C = sustainability efficiency of the company and CSC = cost of sustainability capital.

A company is the more efficient the more its net value added exceeds its cost of sustainability capital. Sustainability efficiency is unity when net value added corresponds to the cost of sustainability capital and below one when the company is overall less efficient than its benchmark. In contrast to single capital efficiencies, the sustainability efficiency considers all forms of capital simultaneously and relates them to the value created. It relates the total value created to the opportunity cost of the *bundle* of the different forms of capital used.

In the following, we apply the valuation of the cost of sustainability capital to the real world example of the capital use of British Petroleum in 2001.

Practical Application

The preceding section explained the theoretical concept of cost of sustainability capital and Sustainable Value creation. This section now demonstrates the application of the methodology using the example of British Petroleum (BP).

Prior to calculation of the sustainable value created by BP, some methodological issues concerning the application of the approach have to be considered. Three questions need to be addressed for the application of the sustainable value methodology. These questions are explained using the case of BP as an example.

First of all the scope of the analysis has to be determined. This includes (1) the choice of the economic activity or entity to be analyzed and (2) the choice of the forms of capital to be taken into account. Conceptually, the methodology is suitable for the analysis of the sustainability performance of any form of economic activity or entity such as companies, regions, national economies, processes, or products. In this article, we focus on companies and have chosen BP and its performance in 2001 as an example. Furthermore, the analytical scope of the analysis has to be determined; that is, the forms of capital to be included in the analysis have to be chosen. Conceptually, the choice of the different forms of capital should include those forms of capital that are most critical to the sustainability performance of a company. From the viewpoint of sustainable development, the criticality of the capital forms used by a company can be judged by the scarcity or degree of depletion of the capital form. In practice this choice is often limited by the availability of the relevant performance data. For the case of BP we have taken into account the forms of capital listed in table 1.

Table 1 shows the economic, environmental, and social performance data for BP in 2001. For the construction of efficiency indicators, it is important that the value figures and the figures on capital use have the same scope (UNCTAD 2003). Therefore, we only consider the impacts caused directly by BP, because they cover the same scope as the value term used for the analysis. If we considered impacts caused by suppliers or customers of BP, the value term would have to be adjusted accordingly. We use environmental and social impacts as proxies for the use of environmental and social capital. The use of natural and social capital translates into a flow of resources. These flows of resources can be measured in terms of environmental and social impacts.[11] In this practical application we consider the following eight different forms of capital: Nonfinancial assets, CO_2, CH_4, SO_2, NO_x, CO, work accidents and PM_{10}. Net value added represents BP's contribution to the United Kingdom's net domestic product.[12] To analyze the amount of economic capital that is tied up by BP's

Table 1 Performance data of BP in 2001

BP (2001)	*Amount*	*Sources*
Net value added [£]	15,563	BP 2002, authors' calculations
Nonfinancial assets [million £]	69,885	BP 2002, authors' calculations
CO_2 [t]	73,420,000	BP 2004a
CH_4 [t]	367,201	BP 2004b
SO_2 [t]	224,541	BP 2004b
NO_X [t]	266,133	BP 2004b
CO [t]	124,584	BP 2004b
Work accidents [number]	83	BP 2004c
PM_{10} [t]	16,666	BP 2004b

Note: t = metric tonne = megagram (Mg) = 10^3 kilograms (kg, SI) ≈ 1.102 short tons.

operations we have estimated BP's nonfinancial assets. The financial assets (e.g. shares) must not be included because they represent assets that are accounted for in the balance sheets of other companies (OECD 2001, 116). BP's nonfinancial assets were estimated by subtracting all financial assets (e.g., securities) from BP's total assets.

The second question to be addressed is the choice of the benchmark level. The choice of the benchmark reflects a (normative) judgment because it determines the cost of sustainability capital of a company, that is, the efficiency that a company has to exceed. Consequently, the benchmark level chosen determines the explanatory power of the results of the sustainable value analysis of a company. It should therefore be chosen with great deliberation. Conceptually, different efficiency figures could be considered as benchmarks. On one hand, the efficiencies of other economic entities, such as national economies, regions, industry sectors, or companies other than the one under examination, could be used as benchmarks. On the other hand, one could also use performance targets such as emission reduction targets to form the benchmark efficiencies. This option is particularly useful if the analysis is to take into account the normative goal that companies should reduce the amount of capital they use over time. For the case of BP, we use the efficiency of the British economy in the year 2001 as benchmark. It follows that BP covers its cost of sustainability capital if and only if it uses its different forms of capital more efficiently than the British economy.

Table 2 shows the corresponding economic, environmental, and social performance data of the United Kingdom in 2001. Total net wealth as reported by the national accounting system has been chosen as an approximation for the economic capital base of the United Kingdom.

The indicators shown in tables 1 and 2 do not reflect all forms of capital that BP uses. Other

Table 2 Performance data of the United Kingdom in 2001

UK economy (2001)	*Amount*	*Sources*
Net domestic product [million £]	884,718	National Statistics 2003
Total net wealth [million £]	4,375,200	National Statistics 2003
CO_2 [t]	572,500,000	Baggott and colleagues 2003
CH_4 [t]	2,195,238	Baggott and colleagues 2003, authors' calculations
SO_2 [t]	1,125,000	DEFRA 2003
NO_X [t]	1,680,000	DEFRA 2003
CO [t]	3,966,500	National Statistics 2003
Work accidents [number]	132,696	Office for National Statistics 2003, authors' calculations
PM_{10} [t]	178,000	DEFRA 2003

important forms of natural and social capital are missing. This is due to the fact that BP has not reported them up to this point and/or that they are not available on the benchmark level. Information on additional forms of capital can be included analogously, though, as it becomes available.[13]

Finally, and in order to achieve valid results, it is important that the performance data on the corporate level and on the benchmark level correspond. This refers to the time period as well as to data quality and scope.

Based on the performance data at the corporate and the benchmark level, sustainable value can now be calculated in the five steps described in the preceding section:

1. Calculate the opportunity cost of each form of capital by relating the United Kingdom's net domestic product to all eight forms of capital as introduced earlier on page 52.
2. Calculate BP's return on capital by relating BP's net value added to all eight forms of capital, respectively.
3. Calculate the value spreads by subtracting for each form of capital the results of step 1 from the results of step 2.
4. Calculate the value created by each form of capital by multiplying the total amount of each capital used by BP by its corresponding value spread.
5. Calculate the sustainable value by summing up the results of step 4 and dividing them by the number of different forms of capital considered, that is, by eight.

Figure 1 shows the results of the calculations for all five steps. Overall BP creates a sustainable value of $-£72{,}373{,}000{,}000$.[14] As can be read from figure 1, the use of only two resources (economic capital and work accidents) contributes positively to sustainable value. The use of all other resources has a negative impact on sustainable value creation.

These results can also be used to calculate the sustainability efficiency of BP in 2001. The opportunity cost of the bundle of BP's sustainability capital, that is, BP's cost of sustainability capital, sums up to 87,936 million £. We can now relate BP's value added to the opportunity cost of BP's sustainability capital to come up with BP's sustainability efficiency—it is calculated to be $\frac{15{,}563\,\text{million}£}{87{,}936\,\text{million}£} = 0.177$. This number shows that BP earns only 17.7 pence (p) per pound (£) of opportunity cost of sustainability capital. Consequently its sustainability efficiency is below unity. BP thus falls short of covering its cost of sustainability capital. A total of 72,373 million £ sustainable value is lost. Put differently, we may expect that had the resources been allocated to the British economy on average rather than to BP, an additional 72,373 million £ more value would have been created.

	Step 2 Return on capital [Mio £/unit]		Step 1 Opportunity cost of capital [Mio £/unit]		Step 3 Value spread [Mio £/unit]		Step 4 Amount	Value created [Mio £]
Economic capital	(0.2227	-	0.2022	) ⇨	0.0205	*	69,885 Mio £ =	1,431
CO_2	(0.0002	-	0.0015	) ⇨	-0.0013	*	73,420,000 t =	-97,897
CH_4	(0.0424	-	0.4030	) ⇨	-0.3606	*	367,201 t =	-132,425
SO_2	(0.0693	-	0.7864	) ⇨	-0.7171	*	224,541 t =	-161,020
NO_X	(0.0585	-	0.5266	) ⇨	-0.4681	*	266,133 t =	-124,587
CO	(0.1249	-	0.2230	) ⇨	-0.0981	*	124,584 t =	-12,225
Work accidents	(187.5060	-	6.6673	) ⇨	180.8388	*	83 =	15,010
PM_{10}	(0.9338	-	4.9703	) ⇨	-4.0365	*	16,666 t =	-67,272
	Step 5				Sustainable value			-72,373 Mio £

Figure 1 Calculation of BP's sustainable value for the year 2001. *Note:* Mio = million (10^6).

Conclusions

Companies must earn their cost of capital to create value. In the financial markets this statement is widely accepted. Unfortunately, the financial markets take into account only one form of capital when calculating the cost of capital. Companies, however, need many different forms of capital. Considering only economic capital might be acceptable when only the stakeholder group investors need to be considered. If a broader view is taken, such as in the context of sustainable development, more forms of capital must be considered.

This article shows how the cost of sustainability capital can be determined analogously to the way the cost of economic capital is determined in the financial markets. By taking up a value-based perspective as opposed to the burden-based logic applied in the literature so far, we provide a methodology that allows integrated aggregation and evaluation of the use of all different kinds of capital used for value creation in companies. For this purpose we fall back on the trusted notion of opportunity costs. In the financial markets, an investment is only regarded as successful if it covers its cost of capital, that is, its opportunity cost. We expand this logic to the use of all forms of capital and argue that sustainable value is only created by companies that cover the opportunity costs of all forms of capital used. We develop a methodology to determine the cost of sustainability capital and sustainability efficiency of capital and, ultimately, the level of sustainable value creation.

Clearly the usability of such a methodology is limited by the data that are available on corporate capital use, on one hand, and on the opportunity cost of the different forms of capital, on the other. To test the applicability of our approach under real world conditions, we have applied the methodology to the example of British Petroleum. The analysis is done on the basis of information that is freely available in the market today. The methodology yields illuminating and revealing results. This underpins the practicability of the approach.

The choice of benchmark is central to the cost of sustainability capital. It determines the explanatory power of the analysis. The methodology introduced in this article shows how much more value is created when a set of capital is used in a company rather than in the benchmark. The benchmark should be chosen to match the desired analysis. It might be useful, for example, to use an international benchmark when analyzing a multinational company such as BP or to use a sector benchmark for a best-in-class analysis. Another possibility is to use a desired efficiency as benchmark instead of an observed efficiency. This could, for example, be derived from international treaties (e.g., the Kyoto protocol) and desired economic growth to construct a desired target efficiency.

The concept developed in this article evaluates the use of different forms of capital relative to a benchmark. A weakness of this value-based approach in comparison to burden-based approaches is that it does not indicate whether the overall capital use is sustainable. It shows how much a company contributes to making the use of capital more sustainable. If current capital use is unsustainable, reallocating capital from less efficient to more efficient users based on the sustainable value approach can help to make capital use more sustainable. But sustainable value does not indicate if and when a sustainable use of capital has been attained. To overcome this weakness, a further conceptual development to integrate value- with burden-based approaches is necessary.

As mentioned in the Introduction, the constant capital rule is the key to the capital approach to sustainability. It is thus necessary to discuss the approach presented in this article in the light of the constant capital rule. Our approach relates the efficiency of capital use by companies (micro level) to the efficiency of a benchmark (macro level). Companies earn their cost of sustainability capital whenever they use their set of different forms of capital more efficiently than the benchmark. Two major implications result from this. Concerning the micro level, the approach shows whether the different forms of capital have been allocated to the most value-creating uses and the value created accordingly. With respect to the macro level, the approach leaves the total amount of each form of capital unchanged and constant. Sustainable value thus expresses the excess value created by a company while preserving a constant level of capital use on the macro level. Because

it leaves the amount of capital unchanged on the macro level, the approach presented in this article is based on the notion of strong sustainability (analogously to Figge and Hahn 2004a). Moreover, as shown above, the approach can integrate reduction targets if there is a need to reduce the amount of capital used.

Because this article represents a paradigmatic shift from burden-based to value-based assessment of corporate sustainability performance (see also Figge and Hahn 2004a; 2004b), there is a need to apply and test the approach on a wider empirical basis. This should be of interest not only to academic researchers but also to practitioners. Environmental and sustainability managers are increasingly assessed as to whether they have contributed to more efficient use of economic capital. Sustainable value allows integration of other forms of capital. Environmental and sustainability managers can now demonstrate their contribution to enhanced use of overall capital. External stakeholders such as financial and sustainability analysts can use this concept to conduct an integrative analysis of the sustainable performance of companies. Financial analysts can continue to use their trusted approaches and will only need to broaden the capital base of their analyses.

Furthermore, the new perspective taken up in this article offers an array of promising research avenues, one of which would be a comparative assessment of the implications for sustainability capital use and allocation drawn from a value-based perspective versus the established burden-based logic. Most importantly, however, the methodology developed in this article represents an important contribution to applying good and well-established economic thinking to sustainability assessment and to furthering the idea of sustainable and reasonable use of the capital stock with which we are endowed.

Notes

1. In this article we are only concerned with the use of capital and not with its formation. The products and services produced could either be consumed or invested, that is, be used to create capital in turn. However, because capital is scarce, companies must use capital as efficiently as possible irrespective of how the value created is used later on.
2. The methodology presented in this article is not restricted to a specific notion of value. Other forms of value could be integrated into our analysis. However, because we introduce the methodology in a corporate and thus economic context, we continue to use an economic notion of value created.
3. For a discussion of the role of the rebound effect in industrial ecology, see the recent article in this journal by Hertwich (2005).
4. At first sight the ceteris paribus assumption seems to be quite drastic. It is important to point out, however, that we distinguish between a macro and a micro level in this article. Sustainable development refers to the macro level, whereas individual companies act on a micro level. The ceteris paribus assumption can therefore still be given when a company (micro level) uses more capital as long as the overall use of capital on the macro level (e.g., the national economy) is not affected. This can, for example, be the case when a more efficient company replaces a less efficient company. For an in-depth discussion see the article by Figge and Hahn (2004a).
5. In this article we use the term "environmental impacts" analogously to "natural capital." When a company causes environmental impacts, it makes use of natural capital.
6. We gratefully acknowledge the diverging opinion of one of the reviewers of this article. We agree that burden-based approaches to impact assessment are conceptually sound and burden-based aggregation of different forms of capital is possible in theory. However, we disagree that in practice it can be done in such a way that it meets general approval. Value-based impact assessments are based on the current (or projected) value of the use of different forms of capital and thus reflect the outcome of market or other social processes. In our view it is therefore fair to assume a considerably higher degree of general social approval for value-based aggregations.
7. Integrating opportunity costs of protected areas into valuation and priority setting in biodiversity conservation are subjects of ongoing debate (Balmford et al. 2000; Lovett 2001). However, these approaches only value one form of natural capital, that is, land, by opportunity cost and do not conduct an integrated assessment of different forms of capital.
8. The term sustainability capital does not express any normative statement on the characteristics of

the different forms of capital. Rather it addresses the entirety of different forms of capital that are subject to the (normative) constant capital rule, that is, the entirety of the capital that should be managed in a sustainable way.

9. We consider depreciation to be the pro rata cost of capital that has been used up. It is for this reason that we propose to subtract depreciation from the economic value created.
10. The term sustainability efficiency reflects the integrated efficiency of the use of all different forms of capital under the condition that the total amount of capital used on the benchmark level remains constant.
11. Physically speaking, the resources listed are (undesired) outputs rather than inputs. Companies need to be able to emit pollutants to be able to produce. It is for this reason that they can be considered to be inputs from an economic point of view.
12. Strictly speaking, the net value added represents BP's contribution to the United Kingdom's net national product, because BP is active not only in the United Kingdom but in other countries of the world. Unfortunately, it is not possible to separate BP's international operations from its domestic operations or to estimate the different forms of capital for all countries in which BP operates.
13. Conventional economic assessments of corporate efficiency are based on economic capital as the only form of capital. They (implicitly) assume either that only economic capital constitutes a relevant scarcity or that the other forms of capital are used as (in)efficiently as economic capital. For the sustainable value methodology the second assumption applies.
14. 1 pound (£) was equal to approximately 1.61 Euros and about US $1.44 in 2001.

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