REVIEW:

A CRITICAL EVALUATION OF THE CAPITAL THEORY APPROACH TO SUSTAINABLE DEVELOPMENT

M.P. de Wit and J.N. Blignaut[1]

It is argued that the capital-theory approach (CTA) does not adequately account for all the different elements of sustainable development. To overcome this problem, this paper attempts to point out what a more integrated and dynamic approach to sustainable development entails and what the consequences regarding policy-making of such an approach are. Neither the CTA nor an integrative, dynamic approach to sustainable development in itself provides an exclusive framework for approaching policy for sustainable development. The CTA provides useful, but static information for macroeconomic policy-makers on an aggregate scale of analysis. Integrative and dynamic approaches recognise the complexities of sustainable development at more disaggregated scales and take account of the importance of historical information. This approach is useful for prioritising political actions on more complex sources of unsustainability at lower scales of analysis.

1. INTRODUCTION

It has long been a standard approach in economics to analyse economic systems in terms of different types of capital. The relatively new concepts of natural and social capital have been preceded by theories on measuRing, the stock, flows and depreciation of man-made and human capital. In the neoclassical economic theories on the environment, the natural environment is viewed as natural capital, comparable to other types of capital such as man-made capital. Based on this so-called capital theory approach (CTA), the standard practice is to aggregate the monetary value of natural capital to influence macroeconomic policy-making decisions. Although there is a disagreement on a universal methodology, the overall procedure has been captured in the 1993 System of National Accounts (United Nations 1993) and related activities on environmental accounting.

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[1] *The authors are employed at the Council for Scientific Industrial Research and the Department of Economics, University of Pretoria respectively.* *The financial assistance of the Council for Scientific and Industrial Research (CSIR) and the comments by a few anonymous referees and the editor of Agrekon are hereby gratefully acknowledged. Views expressed in this paper are, however, those of the authors and do not necessarily reflect the views of any of the institutions that they may be involved with.*

It has been argued that this capital theory approach (CTA) does not adequately account for the different elements of sustainable development, namely economic efficiency, ecological sustainability and socio-cultural equity (Stern, 1997, Hediger 1997). The CTA to sustainable development can play a role in defining relatively simple indicators for sustainable development and can be useful in a setting where policy-makers demand information on the operationalisation of sustainable development. However, the conclusion is that the CTA to sustainable development is a static approach that must be used with great caution to avoid a feeling of misplaced concreteness.

Based on the available literature it is not entirely clear what this critique on the CTA means for economic policy-making. This paper attempts to add to the debate by pointing out what an integrated, dynamic approach to sustainable development entails and by providing some suggestions on the consequences regarding policy of such an approach.

The objective of this paper is to evaluate the CTA as a basis for influencing policy decisions on sustainable development. In section 2 a short overview on the theory of CTA to sustainable development is presented and in section 3 the policy tools based on the CTA are discussed. Section 4 argues that there is a need for a more dynamic, integrated approach to sustainable development and section 5 makes some practical suggestions to realise such an approach. In section 6 a few conclusions are made.

2. THE THEORY OF CTA AND SUSTAINABLE DEVELOPMENT

The CTA is based on the idea that the maintenance of a stock of capital over time is a prerequisite for sustainable development. Both the environmental economic and ecological economic approaches support this approach, but differ in terms of the degree to which different capital stocks can be substituted for each other (Stern, 1997; Toman, 1994; Daly, 1996 and Costanza, 1991).

The environmental economic approach suggests substitutability between man-made and natural capital, thereby emphasising the maintenance of the overall capital stock over time. This approach is also known as the weak sustainability rule. The ecological economic approach emphasises the complementarity of man-made and natural capital, proposing to maintain specific capital stocks intact, i.e. the strong sustainability rule[1] (see Blignaut & De Wit (1999) for a discussion on economic theories on the environment and sustainability rules).

The attractiveness of this approach is that it suggests relatively simple rules to ensure sustainability and relatively simple indicators of sustainability. This situation has seemingly cleared away the vagueness that has previously attended discussions of sustainability (Stern, 1997:148). In practice most applications of the CTA have favoured the principle of green accounting based on the weak sustainability rule (see Repetto *et al.*, 1989 and Blignaut, 1995).

Apart from man-made capital where the practice of asset depreciation is well established, recent work has concentrated on natural capital asset depreciation (Repetto *et al.*, 1989 and El Serafy, 1989). This depreciation is governed by a set of capital depreciation rules rigorously embedded in, amongst others, neo-classical growth theory[2]. To hedge against the depreciation of natural capital, a portion has to be saved for future consumption. The same principle is reverberated in the Hotelling rule which states that it is probable that if a country leaves its natural resources alone (in other words saves it) it would appreciate at the market discount rate because of its increasing scarcity (El Serafy, 1989:16). In so doing the country will contribute to savings and hence its own future welfare. The opposite of this is that if a country lives beyond its income, it will be worse off in future. When the reverse of the Hotelling rule is implemented, namely that when natural capital is utilised today, the country forsakes firstly, future appreciation, secondly, possible future income and thirdly, the future use of the resource.

When dealing with goods and services that are clearly marketed, the above-mentioned principle can be applied relatively easily as all the necessary information is in monetary terms. With regard to the natural environment, the required data are not readily available in monetary terms. This is because the physical entities (e.g. air pollution and the value of iron ore 100 years from today) generally have no market value. The physical data must therefore be transformed into monetary values by means of a number of valuation techniques[3].

The purpose of valuing the use of the environment is to provide the necessary empirical and monetary information to support the notion that the natural environment must be included in the definition of capital. Redefining capital and the valuation of the use of the environment has become known as the capital theory approach (CTA) to sustainability (Stern, 1997:156), the reason being that, should the capital base stay intact, sustainable development becomes possible. Should the capital base of a country be eroded, however, a country is living beyond its means. How the CTA can be placed in a policy

framework in support of either weak or strong sustainable development will be explored next.

3. THE POLICY TOOLS BASED ON CTA AND SUSTAINABLE DEVELOPMENT

In the CTA several tools are available to measure progress towards sustainable development. These tools reflect the underlying environmental and ecological economic theories on sustainable development. The most popular approach, driven by powerful institutions such as the International Monetary Fund (IMF) and the World Bank, is natural resource accounting (NRA) (or environmental accounting or green accounting) (United Nations 1993). The purpose of NRA is to ascribe a monetary value to the use and the change in stock of natural resources in a systematic way that corresponds to the Systems of National Accounts (SNA) used to compile, among others, the Gross Domestic Product (GDP). The data intensity of environmental accounting, *inter alia*, suggests other more recent economic approaches to sustainable development, namely the concepts of genuine savings and national wealth. Genuine savings is perceived to be the true rate of saving of a country after the degradation and depletion of natural resources are taken into consideration (Pearce & Atkinson, 1993). Genuine savings are a flow measure, building on the income rules of neo-classical growth theories. Should a negative rate of savings persist, a decline in national well-being is inevitable (World Bank 1997:8). Not only the flow of income, but also stock estimates yield valuable insights where various forms of capital are factored in the analysis (World Bank, 1997:2). This measure of wealth is a response to the interpretation that sustainable development concentrates and enhances the opportunities for future generations (World Bank, 1997:19 and Serageldin & Steer, 1995:30). It is a shift away from flow measures in the economy, such as GDP, to a measurement of the stocks of capital. The World Bank (1997:19) states: *Stocks of wealth underpin the opportunities people face, and the process of sustainable development is fundamentally the process of creating, maintaining, and managing wealth.* These approaches can all be included in the weak interpretation of sustainable development (Stern, 1997).

The ecological economic approach, or strong approach to sustainable development, is another interpretation of the CTA. Ecologists have argued for separate biophysical indicators, thereby electing not to subject ecological changes to the mainstream economists' interpretation of sustainable development. These indicators are meant to serve as early warning signals for a change in the critical levels of natural capital, such as ecosystem services necessary for life support (Costanza & Daly, 1992). This so-called strong

sustainable development approach suggests that specific aggregates of capital stocks should be maintained, i.e. every class of capital needs its own set of indicators. The proponents of strong sustainable development argue for the precautionary principle, a safe-minimum standard (SMS), or even absolute standards approach to natural capital, a concept not unknown in earlier economic literature[4].

4. AN INTEGRATED AND DYNAMIC APPROACH TO SUSTAINABLE DEVELOPMENT

An evaluation of the CTA is discussed according to two themes, first, its partial approach to sustainable development as opposed to the integrated nature of the concept sustainable development and secondly, sustainable development and CTA within a complex and dynamic system.

4.1 An integrated approach to sustainable development

Economic, ecological and socio-cultural sustainability on its own would not guarantee sustainable development. The definitions of sustainable development in ecology and economy can provide insights for an integrative framework, but are not sufficient on its own. Ecological concepts of sustainability focus on the implicit capacity to adapt to the stresses imposed on an ecosystem by its interdependence with other systems. This physical concept of ecological sustainability (or Holling-sustainability) admits the functioning of ecosystems within the boundaries of the organisational parameters of the systems (Common & Perrings, 1992). This sustainability rule comes closest to the ecological economic interpretation of strong sustainability. Every category of capital should be sustainable in its own right. There are no trade-offs allowed with natural capital protected by safe-minimum or absolute standards. However, neither Holling-sustainability nor the ecological economists' version of strong sustainability provides a comprehensive account of sustainable development. Holling sustainability abstracts from human needs and preferences, equity requirements and economic efficiency conditions. Ecological economics, *sic* strong sustainability, neglects the complexity and dynamics the system of sustainable development and the requirements of economic efficiency (after Hediger, 1997:104-105).

The economic approach to sustainable development has been described as Solow-sustainability, based on the Golden Rule of neo-classical growth theory (Solow, 1992). This environmental economic sustainability or weak sustainability is blind to the physical properties of dynamic ecological-economic interactions (Common & Perrings, 1992). It also requires an

equitable intra-generational initial stock of capital big enough to support a decent standard of living. It is assumed that the economy receives free gifts from the environment (as a source of natural resources and receptor of pollution and waste). While Holling-sustainability takes a macroscopic, system-based view, Solow-sustainability considers only one component of the system for sustainable development, namely the economic system (Common & Perrings, 1992).

Socio-cultural sustainability often narrowly focuses on population growth as the key force disrupting sustainable development (Ehrlich & Ehrlich, 1991). However, various institutional factors governing access to the resources can play a major role in moving towards or away from sustainable development (see Leach, Mearns & Scoones, 1997 and North, 1990). This dynamic approach, based on the relative costs of (environmental) entitlements and institutions, provides answers to previously neglected areas in the Holling and Solow approaches to sustainability. However, this approach alone does not directly take account of biophysical limits and economic efficiency considerations.

Sustainable development is bigger than the sum of its ecological, economic and socio-cultural sustainability parts. Sustainable development is not the same as sustainability. Even in the case where economic, ecological and social sustainability is achieved, it does not follow per definition that sustainable development is achieved. An integrated approach, incorporating all the key principles of sustainable development is needed (Hediger, 1997). It is apparent that none of the basic sustainability principles is sufficient to achieve sustainable development.

How do the dimensions of sustainable development relate to each other? Various sub-disciplines such as economics, ecology, social and developmental studies and philosophy contribute to the sustainable development debate. However, this frequently leads to a largely unproductive debate, where actors tend to support the positions of their particular disciplines (Van Jaarsveld, 1996:37)[5]. It is clear that the various components of sustainable development are closely linked to each other. This requires an integrated approach to defining a system of sustainable development. Hediger (1997:106) concluded that an analysis of sustainable development should be extended from an economic and ecological approach to the social context provided by institutional and (co)-evolutionary economic approaches[6].

Besides an effective integration of economic, ecological and social factors, an integrated approach must also take account of the dynamics of a sustainable development system. As implied by the word development, sustainable

development is in a process of continuous change. The passage of time includes novelty and unknown goals, as emphasised by the evolutionary approaches.

4.2 The dynamics of sustainable development

Sustainable development can best be described as a complex, dynamic system. A sustainable development system is complex in the sense of the number and intensity of interrelationships between components and dynamic in the sense of real-world changing realities and transformation. Departing from more static approaches to sustainable development, the nature of a sustainable development system (SDS) can be described as follows:

- The SDS is an *open system* as matter and energy flow between the economic and ecological subsystems, and information and knowledge between the socio-cultural and economic and ecological subsystems[7].

- The SDS is a *living system* as the interaction between human beings and ecosystems are studied. Some sub-components are non-living, such as natural resources (minerals, fossil fuels) and ecosystem services (clean air, mountain scenery). However, human beings are ultimately responsible for the organisation and use of these non-living components.

- The SDS is a *soft system* as sustainable development cannot be defined *ex ante* with an appeal to a scientific truth. The criteria for sustainable development are understood differently in various (economic) theories on sustainable development. In some cases, sustainable development could be defined as a harder system when the problem is relatively simple and well-defined and where objectives are well-structured. Such an approach could only be helpful on the analysis of sustainable development on smaller spatial and shorter temporal scales, such as the sustainable development of a particular firm in the short term.

- The SDS reveals the *tension* between *spatiotemporal scales* for economic and ecological subsystems. All economic and ecological changes have dimensions in both space and time (Lunney *et al.*, 1997:135), although very different (Ring, 1997:237). These changes are, however, based on different organisational principles in terms of, amongst others, space and time. The material and value-orientated facets of production and consumption lead to the homogenisation of time and space in a capitalistic economy (Altvater, 1994). Economic activity can be described in two ways: as (i) the transformation of matter and energy and (ii) the creation of a surplus

which is measured in money units (Altvater, 1994:80). The latter description is arguably perceived to be the most important in current capitalist societies, but in many instances the co-ordinates of production are still defined in terms of physical time and physical space. The emphasis on the production of a surplus has led to a shortening of economic activities (time is money) and the removal of quantitative and qualitative impediments in space, or in other words: globalisation. The environment, in contrast, has irreducible dimensions in time and space, mainly due to relative slow time rates of ecological production and differentiated spatial structures, especially for terrestrial ecosystems (Ring, 1997). The relative slow rate of ecological change relative to economic activity and geographical characteristics are not included in standard economic analysis (Lange 1999:30). The question is to what extent these different systems can be integrated. Altvater, (1994:82) even argues that ecological crises can, in many regards, be understood in terms of the collision between spatiotemporal interpretations. A discussion on the linkages between economics, environment and human activity therefore need to take account of this spatiotemporal collision between economic and environmental systems.

- The *classification* of the SDS is a *function of the problem at hand*. The resolution (space, time and number of components) needs to be defined *ex ante*, before a systems analysis could be performed. If a problem is defined on a national level a detailed economic resolution (detailed microeconomic behavioural models) would be at the expense of model predictability or description, while the omission of ecological and socio-cultural concerns would be at the expense of the system definition itself. If the focus is on national policy-making, a layered approach can be used to model the SDS on a national level, before subsystems can be defined and modelled at another resolution to aid the actual implementation of recommendations.

- The SDS in itself is in a *process of change*. The important question is whether this change can be modelled as risk or should be treated as novelty. On the component-level the chances are greater that some processes do have known probabilities, but on the level of a change in SDS itself (change at the organisational level) the dynamic, novel character of change is applicable. Any optimisation procedure that neglects the sustainability of the overall system will fail to take account of the dynamic and evolutionary effects of sustainable development (see Turner *et al.* 1996).

- This change is a continuous interplay between the stability and the resilience of the SDS. The *degree and type of connectedness* becomes an

important variable for understanding the dynamics of the SDS. This Holling-type of continuous structural change is not entirely new to the study of economic systems. The accounts of Kuznets (1959) and Schumpeter (1934, 1939) have become standard references in explaining long-term economic growth patterns. These economic approaches present the notion of equilibrium in a more sophisticated way, but without accounting for dynamic systems far from equilibrium (see Clark & Juma, 1987).

The complex, dynamic character of the SDS has important implications for economic theory on and the design of policy for sustainable development.

5. POLICY-MAKING FOR SUSTAINABLE DEVELOPMENT: SOME FURTHER SUGGESTIONS

Several economic theories align more closely to an integrated, dynamic approach to sustainable development than the neo-classical CTA. For instance, the contributions from institutional economists focus on deeper level changes in structures and institutions, value systems, rules of the game and power systems (Bergstrom, 1993:7-9). Evolutionary economists accept the dynamic reality of historical time (Faber & Proops, 1990) and co-evolutionary economists suggest that economic, socio-cultural and environmental dimensions of sustainable development evolve in co-existence (Norgaard, 1985 and Gowdy, 1994)[8]. This section attempts to outline the policy relevance of such an integrative and dynamic approach to sustainable development.

An attempt is made to list the main differences between the CTA and integrative, dynamic approaches to sustainable development in Table 1. On a theoretical level, the differences are mainly between a focus on equilibrium and the process of development, on optimisation or simulation, on aggregation or disaggregation and on the current situation as opposed to historical relevance (see Stern, 1997:161). First, the capital theory approaches lead to the development off highly aggregated indices (such as genuine savings and stocks of national wealth) that have significant political advantages in communicating with the public, but do not provide an ideal or adequate framework within which political action should be prioritised (Van Jaarsveld, 1996:17). An in-depth analysis of disaggregated data is needed to capture the *complexity* on a lower level of analysis. These indicators do not indicate whether a system is sustainable in an absolute sense, but they might help in describing whether the system is moving from or toward sustainable development. Second, simulation models of the complex economy-environment-socio-cultural interactions are more transparent than calculating

the supposed level of sustainable income or net capital accumulation (Stern, 1997:162). Forecasts are always subjected to sensitivity analysis or the construction of confidence intervals. Third, a historical approach would assess what effects past activities had on sustainable development until the present. Stern, (1995) conducted a study on the impact of changes in mining income in some developing countries with large mining sectors on GNP per capita over a twenty-five year horizon. The sample mean showed no improvement in long term GNP despite the fact that most economies have met the Hartwick-rule of reinvestment of resource rents in alternative forms of capital as evaluated at market prices. The next step in such an analysis would be to answer the question why some other economies were more sustainable and apply the conclusions to the lagging performance of the other economies.

The CTA aims for an absolute measurement of a level of sustainable development, through indicators on the stock of natural capital in a country. The integrative, dynamic approach to sustainable development aims to improve the relative levels of sustainable development by focusing on the sources of unsustainability at lower levels of analysis (Ayres, 1998).

The difference between the CTA and other more integrative and dynamic approaches to sustainable development lies primarily in the perception of the term sustainable development. The different approaches are useful in different cases, depending on the purpose of sustainable development policy analysis.

Table 1: Comparing, the CTA and the integrative, dynamic approach to sustainable development

	CTA	Integrative, dynamic approach
Theory focus	Equilibrium Optimisation Aggregation Current situation	Development Simulation Disaggregation Historical relevance
Policy focus	Measure absolute sustainable development	Relative sustainability of activities

The CTA approach provides useful, but static information for macroeconomic policy-makers on an aggregate scale of analysis. Integrative and dynamic approaches recognise the complexities of sustainable development at more disaggregated scales and takes account of the importance of historical

information. This approach is useful for prioritising political actions on more complex sources of unsustainability at lower scales of analysis.

6. CONCLUSION

Neither the CTA nor an integrative, dynamic approach to sustainable development in itself provides an exclusive framework for approaching policy for sustainable development. While CTA is useful on a macro-economic scale of decision-making, integrative and dynamic approaches recognise complexities at lower scales of analysis. Different approaches are useful in different cases, depending on the purpose of an analysis on policy for sustainable development. The challenge remains to find an organisational framework that does not exclude any particular approach *a priori*.

NOTES

1. *It has been recognised that social capital constitutes another class that necessitates further economic research (World Bank 1997).*

2. *For a background discussion on the so-called "Golden Rule" of neo-classical growth theory, that configuration of the economy that yields the highest consumption per capita and which can be maintained indefinitely, see Hicks (1946) and Phelps (1961).*

3. *Valuation techniques are extensively discussed in the environmental economic literature. For example see Pearce & Turner (1990), Munasinghe & Lutz (1991) and Blignaut (1995).*

4. *For earlier discussions on the SMS see Ciriacy-Wantrup (1968) and Bishop (1978).*

5. *Serageldin & Steer (1995) illustrated the differences in the approach of an economist, ecologist and sociologist to sustainable development.*

6. *An integrated approach to sustainable development would therefore require a synthesis between weak and strong sustainability. Trade-offs between different concerns of sustainability should be possible. This means that an integrated framework is formulated on the basis of a value principle, which is extended to include some physical principles in order to comply with the carrying capacity and integrity of global ecosystems (see Hediger, 1997 for a discussion).*

7. *Information and knowledge can serve as inputs in economic processes, but also in non-economic processes, such as the appreciation of nature's beauty.*

8. *It is beyond the scope of the paper to discuss these theories in detail. For a critical discussion of the CTA approach see Stern, (1997).*

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