Toward a Calculational Theory and Policy of Intergenerational Sustainability

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The economic theory of intergenerational sustainability is essentially neoclassical in nature and purports to provide a prescriptive framework for deciding how current generations can use "available resources" to assure and enhance the well being of both current and future generations. Intergenerational sustainability is premised on the notion that this generation is failing to meet its societal or public responsibility to "maintain" a "broadly defined capital stock" for the purpose of sustaining a broadly defined income for the benefit of future generations. The interventionist and prescriptive nature of this view is captured in the following quote:

> Fundamentally, "sustainable development" is a notion of . . . disciplining our current consumption. This sense of "intergenerational responsibility" is a new political principle, a virtue that must now guide economic growth. The industrial world has already used so much of the planet's ecological capital that the sustainability of the future is in doubt. That can't continue. (Burndtland 1989 as quoted in Anderson and Leal 2001, p. 163)[1]

As intergenerational sustainability is presented, the issues and the theory are viewed globally and are cast in largely macroeconomic terms. For example,

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[1]Contrary to what the quotation suggests, this political prescription is not *new*. The economist A.C. Pigou outlined the scope of what he viewed as the government's role: "It is the clear duty of Government, which is the trustee for unborn generations as well as for its present citizens, to watch over, and if need be, by legislative enactment, to defend, the exhaustible natural resources of the country from rash and reckless despoliation" (Pigou 1932, pp. 29-30).

the approach to defining and maintaining this "broadly-defined capital-stock" is unusually macroeconomic in nature. The concept of "capital" refers to virtually all features of the physical environment that are thought to sustain man's well being and is inclusive of ecosystems, the atmosphere, oceans, exhaustible resources, and other assorted "environmental assets." In this latter sense, the theory of capital found in the economics of sustainability is inaptly metaphorical.

This inapt metaphor is extended to the concept of income. The "broadly defined income" to be sustained for future generations includes an imputation of the aggregated "benefits" yielded by this "broadly defined capital stock." To sustain this imputed "income," Robert Solow proposes a vast undertaking of "public investment" on a scale the he presumes to know:

> The appropriate policy is to generate an economically equivalent amount of net investment, enough to maintain society's *broadly defined capital stock* intact. The point is that only a commitment to sustainability is translated into a commitment to a specifiable amount of productive investment. *We know the rough magnitude of this requirement.* (Solow 1992, p. 20; emphasis added)

But why would Solow say: "*we know the rough magnitude of this requirement?*" Again, as in the case of imputed income, Solow and others see the task of determining intactness of the capital stock as being made possible by the hopelessly misguided presumption that valuation is objective and that planners are able to make welfare inferences for future generations.

Calculational foundations are virtually never broached in the economics of intergenerational sustainability.[2] This paper redresses this oversight by critically examining the calculational foundations of the neoclassical models of intergenerational sustainability. Not surprisingly, this examination shows that the assumed objectivity of valuation (utility) and imputability of a "broadly defined income," have led sustainability economists to several analytical

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[2]On issues related to sustainability and calculation, Gary North (1992) calls attention to Robert Heilbroner's oddly contradictory acknowledgement that Mises was correct on the subject of socialism.

> Robert Heilbroner admitted in 1990 that Ludwig von Mises's critique of socialism in 1920 had been correct: socialist economic planning is inherently irrational. Oskar Lange's critique of Mises on this point was incorrect. Robert Heilbroner, "Reflections: After Communism," *New Yorker* (September 10, 1990), p. 92. He also admitted that socialism as an economic ideal went down with communism's ship (pp. 98-99). But then he added this note of hope for all former socialists. "*There is, however, another way of looking at socialism. It is to conceive of it not in terms of the specific improvements we would like it to embody but as the society that must emerge if humanity is to cope with the one transcendent challenge that faces it within a thinkable timespan. This challenge is the ecological burden that economic growth is placing on the environment.*" (North 1992, p. xiv; emphasis added)

errors. For example, what is labeled a "broadly defined capital stock" totally ignores private rights of property and monetary exchange. By default, sustainability is treated as a public good requiring public provision.[3] *But without private property and monetary exchange, there can be no capital calculation and no rational means of maintaining either capital or income for current or future generations.* To some Austrian economists, the importance of calculational foundations may seem too obvious to warrant mention. However, neoclassical economists such as Robert Solow and Geoffrey Heal appear oblivious of economic calculation and its importance in the reckonings necessary to conserve resources. These economists recognize no linkage between intergenerational sustainability and the calculational foundations of private property and monetary exchange. The paper explores an alternative theory of sustainability based on private property, monetary exchange, and capital accounting. Without these calculational institutions there can be no rational maintenance of capital or income.

These conclusions prompt a reassessment of the government's presumed role in issues bearing on sustainability. Part of this reassessment is the acknowledgement that what is preserved for future generations through governmental intervention may not be critical to the welfare of those as yet unborn (Taylor 2002, p. 4). Yet even in light of skepticism voiced by some regarding government's "legitimate function," an expanded role for private property is largely rejected as a solution to presumably public-good issues involving exhaustible resources, environmental degradation, ocean fisheries, and depletion of timber resources.[4] Nonetheless, elimination of the government's role in resource management would be important in fostering more secure property rights, lowering private time preferences and inducing greater private propensities to save and provide for the future. Additionally, a greater reliance on the institutions of economic calculation would mean a more robust evolution of the resource base as entrepreneurs deal with emerging economic scarcities.

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[3]Public goods are defined as being (1) nonrivalrous in consumption and (2) nonexcludable in that providers cannot exclude others benefiting from the goods. These properties seem to necessitate governmental provision.

[4]For example, in analyzing the philosophical foundations of private property, Professor Lawrence Becker asserts:

> Ownership of vital depletable resources (fossil fuels, fresh water, mineral deposits) may have to be restricted to the rights of income, transfer and limited transmissibility, with management use, and actual possession effectively under public control. Again, this is a requirement . . . not of "justice in the abstract," but of the conditions imposed by . . . a densely populated, industrial world in serious danger of exhausting its resources both by consumption and abuse. If the necessary conservation cannot be guaranteed . . . under a system of full liberal ownership by individuals, then something along the outlines mentioned above seem the only rational course. (Becker 1977, p. 117)

A Neoclassical Theory of Intergenerational Sustainability Based on Metaphors of Value, Capital, and Income

The concept of capital in sustainability economics is critically dependent upon assumptions regarding the measurability of valuation and the imputability of a "broadly defined income." In this sense, the theory is fundamentally neoclassical. An entire generation, supposedly functioning as a single "acting entity," is presumed to make decisions with respect to the uses of the aggregate stock of capital and its maintenance. But the dangers of this type of presumption have been noted. "To speak of society's autonomous and independent existence . . . and its actions is a *metaphor* that can easily lead to crass errors" (Mises 1998, p. 143). The paper explores these inapt metaphors as they arise in the theoretical treatments accorded valuation, capital, and income.

Wieserian Value and Neoclassical Welfare Functions

The economics profession has never been able to finally abandon the notion that valuation is objective and that "utility" is a measurable, quantifiable magnitude.[5] To the extent that value is treated in this way, it becomes a grossly misleading economic metaphor. Many of these abortive notions of valuation seem to have their origins in the economics of Friedrich von Wieser. The same modern-day neoclassical misconceptions embedded in sustainability theory (i.e., cost-benefit valuation and shadow prices) can be traced back to Wieserian imputation theory of the late nineteenth century. "If a socialist community were to give up exchange—the payment of buyer to seller—it would not on that account require one to give up this measuring scale for the valuation of goods" (Wieser 1971, p. 20 as quoted in Bostaph 2003, p. 10). The upshot of this quote is that valuation itself is seen as a computational tool. In commenting on Wieser's surprisingly modern perspective on valuation, Jörg Guido Hülsmann observes

> Starting from the premise that value is a quantity, Wieser developed a value theory that foreshadowed the way economic analysis would be practiced during the rest of the twentieth century. . . . His value theory was based on the fiction that one could meaningfully speak of value without respect to wealth or income of the acting person. The value that is independent of income or wealth is "natural value." Of course the natural value of capital goods is derived from the natural value of consumers' goods. . . . Moreover, Wieser held that natural value was objective in that it is the same for all persons. . . . According to Wieser, only if all members of society are perfectly equal in their wealth and income position do the values of a monetary economy coincide with natural values. And since natural value is the economic ideal for all possible real economies, it follows that economic policy should make sure that all factors of production

[5]For example, see, Heal (1998) and Chichilnisky, Heal, and Vercelli (1998). The extent to which utility is measurable is addressed below.

> should be treated according to their natural values. This might be achieved in the perfect communist state. But it might also be achieved through government intervention in the market economy. (Hülsmann 2003, pp. xxxii-xxxiii)[6]

This same unquestioning faith in imputation is reflected in the twentieth century notion of shadow prices as applied in the theory of sustainability: "an imputation of value of a commodity or service which has no market price . . . may be calculated reflecting the marginal opportunity cost or the marginal value of their use as inputs" (Pearce 1992, p. 391). Also, note Robert Solow's comment on the failure of market prices to be sufficiently forward-looking:

> everyday market prices can make no claim to embody that kind of foreknowledge. Least of all the prices of natural resource products, which are famous for their volatility, have this property; but one could entertain legitimate doubts about other prices, too. The hope has to be that a careful attempt to average out speculative movements and to correct for other imperfections . . . would yield adjusted prices that might serve as rough approximations to the theoretically correct ones. (Solow 1992, p. 16)

This statement is nearly a paraphrase of Wieser's made a century earlier.

Wieser's distrust of market prices, reliance on imputation of value, and his strongly egalitarian bent are also readily apparent in the observations of Geoffrey Heal, now of Columbia University. Heal offers a definition of sustainability premised on the following requisite features: (a) a treatment of the present and the future that places a positive value on the very long run, (b) recognition of all the ways in which environmental assets contribute to economic well-being, and (c) recognition of the constraints implied by the dynamics of environmental assets (Heal 1998, p. 14). The egalitarian nature of Heal's view of sustainability has an intertemporal twist; it is reflected in his view that individual time preference should not interfere with society's efforts to preserve the use of "capital assets" for the benefit of future generations. In Heal's view, the ways in which environmental assets contribute to human well-being are to be somehow gleaned or reckoned by a central regulating authority. Heal seems to envision a higher social standard of welfare that transcends individual valuation; "welfare" must be reckoned by a superior authority capable of inferring "true values." This perspective is consistent with the view that sustainability is a public good to be provided to future generations outside of the institutions of private property and market exchange. Most economists addressing sustainability seem to concur with Heal's viewpoint.[7] Interestingly,

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[6]In offering these remarks, Hülsmann references the above quoted article by Bostaph (2003).

[7]Notable exceptions include Jerry Taylor (2002) of the CATO Institute and Wilfred Beckerman (1994 as reprinted in Pezzey and Toman 2002). Beckerman has addressed sustainability in two books (1996 and 2002).

the "public-good designation" is not supported or buttressed by any legitimate link to the valuations of individuals as the discussion below will argue.

Once an economist is able to assume that valuation is objective and measurable, the next logical step is to posit the existence of objective, measurable utility functions. But if one were able to accept this notion, then the imputation of a utility function for an entire generation of people does not seem to be an impossible leap. The economic theory of sustainability has actually gone to these extremes in its use of aggregate utility functions for entire generations of people. Of course, these techniques are not new to the economic theory of sustainability. Rather, the aggregate utility function came into prominent use during the 1960s and 1970s as academic economists expended effort in trying to link the Frank Ramsey model of savings with the one-sector aggregate growth models as developed by Robert Solow (Ramsey 1928; Solow 1956). Hence, in the work of Geoffrey Heal and Graciela Chichilnisky, one finds models that examine "intertemporal welfare functions" that purport to encompass not only the welfare of the current generation but that of future generations as well (Heal 1998; Chichilnisky 1996, pp. 219–48).

Public "Investment" to Maintain the "Broadly-Defined Capital Stock"

Geoffrey Heal's approach to assuring intergenerational sustainability accords with Robert Solow's concept of maintaining a heterogeneous "capital stock." The relevant "capital stock" includes all environmental assets mentioned by Geoffrey Heal above. In similar manner, sustainability theorists, David Pearce and Jeremy Warford, express the need to maintain the "capital stock" of society; "sustainable development is about conserving the *overall capital stock* since this is consistent with economic efficiency and intergenerational fairness" (Pearce and Warford 1993, p. 53; emphasis added). Robert Solow notes "it goes without saying that this concrete translation of sustainability into policy leaves a lot of questions unanswered. *The split between private and public investment has to be made in essentially political ways*, like the split between private and public saving" (Solow 1992, p. 20; emphasis added).

Notions of intergenerational fairness and political decision-making dovetail with the view that the rate of discount should be zero for the "required public investment." This idea has been around for some time; A.C. Pigou advanced a similar perspective on discounting long ago. "[T]here is wide agreement that the State should protect the interests of the future in some degree against the effects of our irrational discounting and of our preference for ourselves over our descendants" (Pigou 1932, p. 29). Robert Solow has echoed Pigou: "You may wonder why I allow discounting at all. I wonder too: no generation should be favored over any other. . . . We can think of intergenerational discounting as a concession to human weakness" (Solow 1992, p. 10). Solow's comment suggests a view that private action, private property, and private time preference are, at best, ancillary to the attainment of sustainability. There is no acknowledgement that the discount rate is an expression of scarcity. The savings necessary to maintain the "broadly-defined capital stock" become a

public function involving coerced confiscation of property through taxation. Solow expands upon his view of the analytical framework for sustainability and the "investments" that must be made by current generations:

> It is absolutely vital that "capital" be interpreted in the broadest possible sense to include everything, tangible or intangible, in which the economy can invest or disinvest, including knowledge. . . . Investment and depletion decisions determine the real wealth of the economy and each instant's NNP appears as the return to society on the wealth it has accumulated in all forms. . . . Each generation inherits a capital stock in the very broad and inclusive sense that matters. In turn each generation makes consumption, investment and depletion decisions. . . . A concern for sustainability implies a bias toward investment...enough investment to keep the broad stock of capital intact. . . . What should each generation give back in exchange for depleted resources if it wishes to abide by the ethic of sustainability? We now have an answer in principle. It should replace used-up resources with other assets of equal value or equal shadow value. (Solow 1992, pp. 16–19)

The "broadly-defined capital stock" to which Robert Solow makes reference is an agglomeration of heterogeneous physical things that defy coherent aggregation. This agglomeration includes the atmosphere, oceans, and ecosystems. But Solow is not deterred:

> Once again, I should mention that the same approach can be applied to environmental assets. . . . The environmental case is more complex, because even a stylized model of environmental degradation and rehabilitation is more complex than a model of resource depletion. The principle is the same, but the execution is even more difficult. (Solow 1992, p. 19)

Solow's latter statement rests implicitly on the assumption that valuation is sufficiently objective to accommodate imputation. Hence, he contrives a metaphorical view of "capital" that, without the implicit assumption of objective valuation, is essentially nothing more than a disparate bundle of incommensurable of things.

The "Income Concept" Applied to Neoclassical Sustainability Theory

By assuming that valuation is objective, Solow and others presume to be able to make welfare inferences for future generations and to make judgements about what type of "broadly defined capital stock" will assure future generations a sustained "broadly defined income." They posit the ability to value the flow of benefits yielded by this "capital stock." This aggregated timestream of benefits is the "broadly defined income" to which these theorists refer in their application of capital theory to sustainability. The "aggregate imputed income" of society is intended to be an analogue to the income of an individual businessman. As applied to a businessman, income can quite legitimately be treated as the return on a capitalized asset. This return is the income yielded through his *ownership* of the "asset." In other words, this definition of income for the businessman would be sustainable indefinitely and

represents that which can be "consumed" without diminishing the value of capital. Sustainable income for the individual businessman will be net of the expenditure of resources required for the maintenance of those assets yielding the income. To the extent that the actor avoids these expenditures, capital is consumed; to the degree that additional maintenance expenditures are made that assure an increase in sustainable income, the individual has been engaged in acts of "saving" (Mises 1998, p. 261).

One could extend this inapt metaphor of the income annuity to represent the income of a nation or perhaps even the world economy. In fact, such a metaphorical extension is precisely what sustainability theorists have made. The metaphor rests on the assumption that the actor is a generation of human beings making decisions about an all-inclusive "resource base" or "broadly defined capital stock." The generation metaphorically is seen to function as a single being acting to sustain a flow of imputed benefits analogous to the income of the individual businessman described above. The "income imputation" would be the presumably measurable benefits accruing to society from the existence and proper maintenance of Solow's "broadly defined capital stock" inclusive of the atmosphere, the oceans, various ecosystems, etc. Robert Solow offers the following observation on how this "income concept" should be viewed:

> At each instant, net national product indicates the largest consumption level that can be allowed this year if future consumption is never to be allowed to decrease . . . net national product measures the maximum current level of consumer satisfaction [i.e., income] that can be sustained forever. . . . Properly defined and properly calculated, this year's net national product can always be regarded as this year's interest on society's total stock of capital. (Solow 1992, pp. 16–19)

Geoffrey Heal concurs: "our concept of income would have to be a sophisticated one indeed, encompassing income of all types, psychic as well as monetary, from environmental assets, and adjusting monetary income to allow for depletion of environmental assets" (Heal 1993, p. 7). Hence, the aptness of the metaphor hinges on the degree to which the capital concept for the individual is extendable to society as a whole and to the particular generation acting on behalf of society. This metaphor is not encumbered by critical examinations of welfare propositions and their illegitimacy in judging policy (Stringham 2001, p. 48). The dubious metaphorical aspects of this theoretical construct have been either forgotten or simply ignored.

Underpinnings of Sustainable Human Action: Back to Calculational Principles

In essence, sustainability is concerned with emerging scarcities and the ways in which human action identifies and deals with these scarcities. As it currently exists, the theory of intergenerational sustainability largely ignores (1)

the valuations and actions of individual human beings, (2) the critical function of private property rights and (3) role of market institutions based on voluntary monetary exchange. By ignoring these features of human life, the theory of intergenerational sustainability provides no rational framework for dealing with emerging scarcities. The concepts of valuation, capital, and income only take on valid or coherent meaning in the context of individual action, private property and market exchange. Hence, in this section of the paper, the ideas bearing on the calculational foundations are given particular emphasis because they are so fundamental to a legitimate understanding of issues faced by real human beings in coping with true sustainability. While these issues may appear disconnected from the central concerns of the economics of sustainability, they are in fact centrally germane. Private property and monetary exchange create the requisite foundations for entrepreneurial calculation of capital, income and requisite maintenance. Resource use that may appear to be unsustainable can only be made sustainable by securing better enforcement of existing property rights and expanding the scope of private ownership where current governmental institutions preclude private stewardship. *The critical goal of legitimate sustainability is to establish an expanded system of private property rights that allows the owners to manage resources as capital assets*.

Primacy of Action and Private Property

The economics of sustainability, as outlined above, is centrally concerned with resources but it never successfully marries this concern with actions of individual human beings employing resources to achieve chosen ends. In order to act, a human being must employ property even if that property is only one's own body (Hoppe 1989, p. 11). But beyond ownership of self, what determines the boundaries of what can ethically be viewed as property for the individual actor? The question highlights the fact that the role of private property in sustainability must first start with a discussion of its ethical origin. Private property devolves from the ethical principle of self-ownership. The self-owning actor acquires property through a variety of ethical means one of which is through the Lockean means of "original appropriation."[8] The actor legitimately acquires unowned property through a use that somehow transforms the object. A second means by which property is ethically acquired is through voluntary exchange of property and a third means is by the acceptance of a voluntarily bestowed gift (Rothbard 2004, p. 92).

[8]The reference is to John Locke (1948). In explaining original appropriation, Murray Rothbard observes: "man owns what he uses and transforms. . . . His property in land and capital goods continues down the various stages of production . . . all ownership reduces ultimately back to each man's naturally given ownership over himself and the land resources that man transforms and brings into production" (Rothbard 1998, pp. 34-40).

Why delineate the ethical origins of property in the context of an examination of the economic theory of sustainability? An important reason is to establish ethical bases of property transfer. The theory of intergenerational sustainability claims an ethical obligation to future generations of people and posits the need for governments to commit resources to the preservation of a "broadly-defined capital stock." Unfortunately, the ethics underlying the acquisition of private property is not even acknowledged in the economics of intergenerational sustainability. The entire resource base of the world's society is implicitly under the control of some government making allocative decisions. But if private property exists and is to be ethically defended, what does this interventionist agenda imply about the ethics with which current generations are treated? What is implicit in this public agenda is an involuntary and hence, unethical transfer of property to a governmental authority. This ethical breach is committed in the name of a purported ethical obligation to generations of people that do not even exist.

In ignoring the ethical origins of private property, this interventionist agenda also neglects the only process that can assure "efficient" adaptation to evolving scarcities and long-term sustainability. In subordinating private property rights, all activities within the economy appear to be candidates for the "market-failure" label. But, private property confers rights, powers, and responsibilities upon the property owner. *Private property creates incentives and imposes costs that assure sustainable services from what is owned. First*, the property owner can choose desired uses and obtain a price from other parties demanding the services of resources. In choosing from among these demands, the owner has the ability to exclude and in this sense *has the power to define its scarcity* in an economic sense. Power conferred through rights of property establishes what must be relinquished in order to harness the use of the resource for a particular use (Mahoney 2002, p. 43). The choice of employment afforded to the owner imparts a social signal of scarcity through the pricing process and assures sustainable use over time.

Second, ownership, *when properly defined and enforced*, also imposes responsibilities upon the property owner. In the use of one's property, one may damage or unintentionally invade the property of another. In such situations, the damaged property owner is entitled to compensation for demonstrable damage by the actor imposing damage. Hence, liability itself is also a signal of scarcity that has a policing effect on the use of property; this accountability indicates what uses are sustainable and which are not. Under properly delineated property rights, the owner of the resource reckons all of the advantages enjoyed from a chosen use and all of the disadvantages borne as a result the choice. "In dealing with his property, he would take into account all the expected results of his actions, those considered favorable as well as those considered unfavorable" (Mises 1998, pp. 650–51).

Unfortunately, the laws of liability have not always been defined and enforced in the manner outlined above. In the use of their property, some

actors may impose damage on the property of others and may not be fully accountable for the just compensation due the damaged party. But to the extent that the damaging party is held accountable or penalized for the damage imposed, his own pattern of resource use is rendered "more sustainable." The laws on liability for damage to property must be clearly delineated and strictly enforced. Ludwig von Mises has noted: "It is true that where a considerable part of the costs incurred are external costs from the point of view of the acting individuals or firms, the economic calculation established by them is manifestly defective and their results deceptive" (Mises 1998, pp. 651–52). But the corollary of Mises's observation is that properly designed and enforced rules of property protection would be one of the key elements in the sustainable use of resources. This very issue is one of the legitimate concerns that should be a central part of the sustainability agenda but is not.

Differential Valuations and Secure Ownership as Inducements to Exchange

In the currently received theory of intergenerational sustainability, the concept of valuation appears as an objectively measurable magnitude. While it is probably true that not all economists working on the issues of sustainability believe that valuation is objective, it is fair to note that the economics profession continues to struggle with the concept of valuation and the extent to which it implies a kind of "measurement." But valuation is solely a ranking of alternatives. Valuation is a subjective ranking on a single unified *ordinal scale* that each individual establishes for himself depending upon the range of choice with which he is confronted. This process of *value* is universally true for all human beings and is always the basis for all conscious action. No quantification is ever involved or even possible. Hence, not only is utility itself unmeasurable, it does not exist. The notion of imputing a *value* to an aggregation of incommensurable things is preposterous. In fact, valuation is always done by individual human beings and always involves preferring and relinquishing that which is not ranked more highly. But valuation is not immutable and is subject to change as the circumstances facing the actor changes. The economic theory of sustainability ignores this reality.

Valuation is essentially choice and choice cannot be divorced from action which, in turn, cannot be divorced from the use of property. Action is always an exchange of one state of affairs for one that is thought to be more satisfactory. The actions of individual human beings differ because people are inherently different from each other. They have dissimilar objectives and differing bundles of goods over which they have legitimate claims of ownership. The respective ranking of goods by their respective owners may diverge. Exchange is fostered by situations in which their respective ranking of goods differs. Two individuals value goods in the ownership of the other more highly than a certain items that they themselves possess and that they are willing to relinquish in exchange. Exchange reflects differences in valuation without reflecting any measure of valuation.

Exchange allows the individual to specialize and attain his goals by serving the needs of others. One can specialize in the production of goods that one knows to be exchangeable for other goods important to one's sustainability. It is even possible to be engaged in the manufacture of goods that are not for final consumption but can be used as "tools" or *capital goods* to be used in making goods intended for final consumption. But even with the employment of capital goods, such a society necessarily remains primitive. Sustainability under these circumstances is always precarious. Specialization is limited not only in the manufacture of goods for final consumption but also the manufacture and use of capital goods that could be applied to improve productive efficiency. The "double-coincidence-of-wants" drastically constrains the scope of mutually beneficial exchange. The implication of this latter handicap is that buyers and sellers are not able to complete all of the exchanges that they would prefer. These limitations would be an obvious detriment to the individual's sustainability. Moreover, the actor's ability to formulate plans for the future is significantly curtailed by the reality of the "double-coincidence-of-wants" as is his ability to determine if his manifold efforts have yielded a net gain.

Provision for the Future Fostered by Calculational Interest[9]

In principle, sustainability economics should be about rational provision for the future. Provision for the future requires a focus on the "rational creation of capital." But the economics of sustainability has ignored the importance of monetary exchange. So-called mainstream economic theory of capital as it has been applied to the metaphorical economics of sustainability manages to assume that calculational issues do not exist. No distinction is made between disparate "things" and capital as the latter can be reckoned by individual human beings. With transactions conducted in common units of exchange and with the appearance of exchange ratios denominated in common units of money, actors are able to rationally discern the net future gain to be achieved from a particular undertaking requiring a commitment of capital goods. The following discussion outlines why such a reckoning is critical in the emergence of calculational capital and rational provision for the future through the act of saving.

Capital goods come into existence only through actions in which the individual attempts to better provide for the future. These actions involve the forsaking of immediate consumption to reap net returns in the future over and above the amount saved and invested. But scarcity of time and consumption goods also induces each individual to subjectively rank consumption in the present more highly than an equivalent consumption enjoyed at some time in the future—after some period of delay. For the individual, this ranking reflects

[9]The author thanks an anonymous referee for suggesting a needed clarification of the extent to which the "time-preference component" and the "uncertainty component" of the interest rate are isolatable elements.

his "positive time preference" and represents a type of hurdle that must be surmounted before the individual is prompted to save and provide for the future. Obviously such acts of savings can only occur when the individual is assured of a sufficiently high net future gain to reverse the ranking of the present consumption over future consumption. This net return is reflective of the individual's rate of time preference; it is that rate that induces the individual to reverse his time ranking and relinquish current consumption. Since the rate of time preference will differ from one human being to the next, different individuals will respond differently to alternative prospective rates of return in relinquishing present consumption for future consumption. For some, a very high net return must be assured before one is willing to surrender current consumption and for others the reverse may be true. In any case, the individual's efforts to provide for the future make him a supplier of present goods and a demander of future goods. The act of saving could be described as a lending of present goods reflecting a demand for future goods of a value great enough to satisfy the lenders required rate of net gain.

When viewed in this way, saving becomes a genuine act of exchange. In some instances, this exchange of present goods for future goods may be *autistic* in that it does not involve other human beings. An isolated individual (a Robinson Crusoe, for example) may spend nearly all of his nonleisure time assuring an adequate level of food consumption in the present. But this same person may discover that by committing time in the present to building better fishing gear or fashioning better traps to be used in catching edible creatures, he will be able to enjoy greater consumption in the future and the option of choosing more lengthy periods of leisure. For this isolated human being, present consumption will have been exchanged for future consumption. But usually this act of exchange will involve other people. Some people with differing rates of time preference will be suppliers of future goods and demanders of present goods. In "borrowing" present goods, these individuals obligate themselves to paying back the equivalent of what was borrowed in addition to a *time premium* sufficient to satisfy the time preference of those exchanging present goods for future goods.

In this market in which some individuals want to exchange present goods for future goods and others seek to exchange future goods for present goods, one can see an equilibrating tendency toward equality between the "time premium" that must be obtained by lenders and the "time premium" that must be paid by borrowers. This time premium would be the *pure rate of interest* which is strictly a manifestation of time preference on the part of people in the society; this rate ignores any issues attendant to uncertainty. In these transactions, the items being exchanged have been described as present consumption and future consumption. No mention has been made of money in this process by which the pure rate of interest is to emerge. In other words, the pure rate of interest has been described as though it could emerge in a barter economy without monetary exchange. Goods or commodities would be borrowed and lent.

But could a rationally reckoned *pure rate of interest* emerge in a market environment limited to barter exchange? To answer this question, one can compare the nature of the exchange of present goods for future goods if money were not to exist with such exchange occurring with the benefit of monetary exchange. What would be the nature of interest without monetary exchange? First, one notes that to the extent that valuations of anything will differ between individual human beings, this *pure rate of interest* will differ between individuals depending upon their access to supplies of certain goods or commodities. Second, under barter, one would face a world in which, logically, there could be a pure of interest for each tradable commodity or good and a varying rate of interest for intertemporal exchange of one commodity for another. Third, under a barter market, the individual would be availed of no interest rate that would allow him to make a rational reckoning of prospective gains from saving and investment in capital goods. By contrast, with money and the exchange of goods against money, monetary reckoning of interest becomes a reality. With monetary calculation, all individuals could establish a personal ranking between the availability of a given quantity of money in the present and the availability of the same quantity of money at some time in the future. For all individuals contemplating the act of saving, a future dollar plus the certainty of some *pure rate of interest* denominated in dollars can be ranked in a rational way with a dollar in the present. Conversely, for all individuals contemplating the act of borrowing, a dollar in the present can be rationally ranked against a future dollar plus a certain *pure rate of interest* denominated in dollars (Mises 1998, pp. 211–12).

But all action is entrepreneurial, meaning that the saver is not guaranteed the pure rate of interest in attempting to exchange present goods for future goods. Saving and investing are always conditioned by savers' reckoning or understanding of future uncertainty. At some elevated rate, this premium, expressed as a percent of what is saved, is sufficient to induce the individual to reverse ranking and become a net supplier of present goods and net demander of future goods. Economic calculation facilitates a process by which the pure rate of interest (conditioned by subjective assessments of uncertainty) brings the money equivalent of the quantity demanded of future goods into an alignment with the money equivalent of quantity future goods supplied. This process could not occur without economic calculation. This rate of interest

> determines both the demand for and the supply of capital and capital goods. It determines how much of the available supply of goods is to be devoted to consumption in the immediate future and how much to provision for remoter periods of the future. (Mises 1998, p. 524)

As such, the market rate of interest is an expression of *economic scarcity*. Economic scarcity only reveals itself *rationally* in an economic environment in which property rights of individual human actors are secure. As noted earlier, prices are an expression of scarcity in which individual owners of property are able to exclude certain uses and commit property to more highly

appraised competing uses. This expression of economic scarcity would not exist without institutions of private ownership. Similarly, the market rate of interest becomes an expression of scarcity that would not emerge without secure rights of private property. The interest rate (adjusted by subjective assessments of uncertainty) is the inducement necessary to prompt property owners to save and make efforts to provide for a more sustainable future.

The universal fact of scarcity means that the rate of interest (the rate at which the future is discounted) can never legitimately be zero as suggested by Robert Solow, Geoffrey Heal, and other sustainability theorists (Solow 1992, p. 10; Heal 1998, pp. 14, 64). An imposed zero discount rate would mean that the rationing device of private property is no longer fully operative since a zero rate could only be applied by a governmental authority having confiscated resources through taxation or other takings. The notion that a zero discount rate should be employed in the name of sustainability also implicitly implies a public policy in which the time preferences of individual human beings would be overridden and private rights of property would be less secure. Moreover, governmental efforts to commit resources employing an artificially lowered discount rate will have the paradoxical effect of raising private rates of time preference since such endeavors are obviously premised on the appropriation of private property. Higher rates of private time preference would clearly mean lowered rates of saving and a diminished level of investment in calculational capital—a consequence counter to any legitimate definition of sustainability. This latter matter is addressed at greater length below. Governments defend such spending and confiscation of private property on the basis of the premise that sustainability is a public good. The illegitimacy of the public-good assumption is also critically examined below.

The Entrepreneurial Nature of Capital Reckoning and Maintenance

The concept of the balance sheet has a central importance in a legitimate reckoning of capital. A sharp distinction must be drawn between the more-commonly accepted neoclassical definition of capital and the definition that has emerged in the Austrian School of economics. In the neoclassical view, capital is comprised of those produced physical "things" such as "equipment, structures and inventory" (National Research Council 1999, p. 208). This definition makes reference to what some have referred to as "real capital." But in Austrian parlance such items would be classified as capital goods, not capital. Mises defines capital as

> *the sum of the money equivalent of all assets minus the sum of the money equivalent of all liabilities as dedicated at a definite date to the conduct of the operations of a definite business unit.* It does not matter in what these assets may consist, whether they are pieces of land, buildings, equipment, tools, goods of any kind and order, claims, receivables, cash, or whatever. (Mises 1998, p. 262; emphasis added)

What are the implications of this distinction between capital goods and capital? The critical difference is that capital can only be reckoned via the application

of accounting in monetary terms. Capital accounting only has rational meaning if it is grounded in private property, private appraisement, and *monetary exchange*.

What is being described here is a device to be used in planning and dealing rationally with market uncertainty. The entries in the accounts are, in fact, speculative judgments regarding the future of the market.

> The numerical exactitude of business accounts and calculations must not prevent us from realizing the uncertain and speculative character of their items and of all the computations based on them. . . . It is not the task of economic calculation to expand man's information about future conditions. Its task is to adjust his actions as well as possible to his present opinion concerning want-satisfaction in the future. (Mises 1998, p. 215)

Elsewhere Mises notes that "[t]he question it answers is whether a certain course of conduct increases or decreases the productivity of our future exertion" (Mises 1998, p. 511). One critical choice facing the actor involves decisions on the maintenance of capital. Actions undertaken to maintain capital are fundamentally speculative undertakings. But without economic calculation, no framework exists for rational decision-making with respect to the maintenance of capital.

The economics of sustainability is squarely in the neoclassical tradition. However, the realities of capital depreciation and maintenance have rarely been addressed in a forthright manner in the neoclassical economics. For example, note the following comment on the relationship between product prices and *depreciation or user costs*: "The optimal set of depreciation assessments, and the corresponding prices [for products produced], are those necessary for efficiency in the intertemporal allocation of resources" (Baumol, et al. 1988, p. 387). While, this statement is formally correct, what is totally misleading is that the authors do not see these depreciation decisions as conjectures to be made by property owners dealing with uncertainty. A more realistic perspective notes that "[a]n eternal capital investment is as non-existent as a secure one. Every capital investment is speculative; its success cannot be foreseen with absolute assurance . . . successful speculation is always required" (Mises 1936, p. 380). The owner of capital assets attempts to establish, at the margin, a balance between the valuation of current benefit of using capital and his valuation of future productive benefits relinquished because of current use. This depreciation or user cost is based on the entrepreneur's understanding of the market's future. Hence, the speculative action of maintaining capital is critically reliant on the institutions of private property and monetary exchange. Without private property, monetary exchange, and capital accounting, no rational economics of asset maintenance could exist.

In the theory of intergenerational sustainability, tremendous emphasis is placed upon aggregation of incommensurable things into a "broadly defined capital stock." There is a long tradition in neoclassical economics of aggregating capital so that the analyst is able to make reference to the capital stock

of the nation, for example. But Mises stresses the fact that capital calculation is necessarily undertaken by individual entrepreneurs—not by society as a whole. While it is true that monetary calculation allows reckoning of capital for the individual entrepreneur, it does not carry over into the reckoning of capital appraisals of many entrepreneurs or businessmen. Individual appraisals are based on the entrepreneur's individual plan for dealing with an uncertain and changing market. Acknowledgement that all markets are in disequilibrium at any instant in time and that each actor faces uncertainty means that any reckoning of capital is personal and entrepreneurial. To the extent that the fulfillment of entrepreneurial plans is contingent upon what may be mutually inconsistent assumptions, no aggregations of capital across individual enterprises can be legitimate. Some plans will be inconsistent with the plans of others and will fail. Hence, capital reckoning for society as a whole is meaningless. The extent that individual business plans may conflict and be incapable of mutual success creates a barrier to aggregation or "macro-reckoning." Hence, society or a government as its agent has no aggregated measure of capital for which it can legitimately presume to make decisions.

This admonition carries over into the reckoning of depreciation of capital. Entrepreneurial judgments with respect to capital and its depreciation are critical in accounting for the success or failure of a business plan. As Mises notes: "[c]apital is a praxeological concept . . . and its place is in the human mind. It [capital] is a mode of looking at the problems of acting, a method of appraising them from the point of view of a definite plan" (Mises 1998, p. 512). Similarly, depreciation itself is a praxeological concept that is unique to the entrepreneur's individual business plan and his understanding of the market's future. But to the extent that these imputations are not revealed as objective data in business audits, for example, one must always be aware that they are conditioned by judgments about future market conditions.

Sustainability of Income as an Entrepreneurial Plan by Property Owners

On the significance of economic calculation, Ludwig von Mises observed: "*Its practical meaning is to show how much one is free to consume without impairing future capacity to produce*" (Mises 1998, p. 212; emphasis added). In essence, the amount that can be consumed is income. *Income* is properly viewed as the correlative of *capital*; it is the amount that can be consumed or enjoyed as income within a definite period of time without diminishing the appraised level of capital. However, Solow, Heal, and others have tried to apply this relationship to metaphorical aggregates. The social value yielded from exploiting the "broadly-defined capital stock" is the "income" to be sustained by public expenditures on the maintenance (Solow 1992, pp. 16–19; Heal 1998, p. 14). But without the calculational foundations of private property ownership and monetary exchange, these ideas are rhetorical meanderings devoid of analytical content. Within their framework, income maintenance would be the central planning problem but would provide no coherent framework for rational action.

Only the individual actor can decide what uses of capital goods are consistent with the sustainability of income. Uncertainty necessarily implies that sustainability of income never emerges as a datum. Everything said above about the entrepreneurial nature of capital reckoning and depreciation must be said here with respect to the maintenance of income. Judgments about capital depreciation must be made in conjunction with decisions about the income to be siphoned off from the enterprise in the form of consumption. The extent to which consumption can occur without impairing the desired level of capital is a decision requiring entrepreneurial judgment. But, as Mises emphasizes, market change may reveal that some decisions have been in error.

> It is provident restraint in the use of factors of production, not their natural and physical properties, which convert them into somewhat durable sources of income. . . . Income . . . is the outcome of careful economizing of scarce factors. This is still more obvious in the case of capital goods. . . . Capital can be preserved as a source of income if the consumption of its products, market conditions remaining unchanged, is restricted in such a way as not to impair the replacement of the worn out parts. . . . Changes in the market data can frustrate every endeavor to perpetuate a source of income. . . . *The success of any provision for the uncertain future depends on the correctness of the anticipations which guided it. No income can be made safe against changes not adequately foreseen.* (Mises 1998, pp. 390–91; emphasis added)

But decisions on income maintenance can only be made in a coherent, rational way by owners of private property acting within a system of monetary exchange. That which is not owned is never a part of this process. Only property owners functioning in such an economy are capable of making the distinctions between an economic resource and the advantages yielded by its utilization. Monetary calculation facilitates the means by which owners are able to make such distinctions with respect to all classes of capital goods—whether man made or natural assets. In this sense, income is a prudent decision, made by property owners, based on the best available information and judgment on the future of the market. Hence, as capital is manifested in the actor's mind as part of a plan, so the same must be said for income itself.

Broader Implications of Economic Calculation for Human Sustainability

The implications of the preceding discussion are probably self-explanatory. As valuation is strictly a personal experience with no quantifiable manifestation, economic change and market uncertainty necessarily make capital and income matters of entrepreneurial judgment. In no convincing, coherent way can *valuation*, *capital,* and *income*, in themselves, be used as a rational guide for a government determined to intervene in the name of intergenerational sustainability. Some economists have conveyed a clearer insight into the full negative implications of this interventionist agenda. "To the extent that such policies go beyond the protection of individual rights and property—they become antisocial and destructive of capital and living standards" (Salerno

1990, p. 70). Sustainability is very much contingent on the maintenance of capital; on this matter, Solow, Heal, Pearce, and Warford have been quite correct. However, capital cannot be a type of all-inclusive social metaphor. Rather, capital must be private property and it must be protected by law as private property. Private property and monetary exchange allow the owner of capital to make *rational* decisions about the use and maintenance of privately owned capital goods including natural resources. Moreover, some "resources" may not be owned and may appear to be used in a way that may appear to be "undesirable" or destructive. In these cases, sustainability can only be assured either by privatization or by a stricter enforcement of existing rights of private property. These latter issues are explored in the remaining sections.

The bequeathing of resources to future generations is necessarily made by property owners making decisions about their own property. A beneficial feature of this adaptive process involves an evolution in the resource base that is bequeathed to future generations. Where private property is respected and institutions of monetary exchange are in place, the resource base of the society evolves to meet the changing wants and needs of the society. Private property allows the owner of property to exclude uses in a way that allows scarcities to be reflected in prices. These prices are the only legitimate indicators of scarcity. Increasing opportunity costs borne by property owners generate efforts to replace depleted resources, to develop new technologies and discover new resources to satisfy both old and new wants (Reisman 1996, pp. 63-67). Moreover, evolving scarcities induce the development of new forms of property rights and the emergence of prices for those goods and services that may previously have been un-priced.

> By devoting itself to improving the lot of the living, therefore, each generation, whether recognizing a future-oriented obligation to do or not, transmits a more productive world to those who follow. . . . The most important components of the inheritance are knowledge, technology, capital instruments and economic institutions. (Barnett and Morse 1963, pp. 248-49; emphasis added)

In other words, the resource base for any society is constantly being adapted to changing circumstances. Erich Zimmermann notes these implications:

> Resources are highly dynamic functional concepts; they *are not*, *they become*, they evolve out of the triune interaction of nature, man, and culture, in which nature sets outer limits, but man and culture are largely responsible for the portion of the physical totality that is made available for human use, . . . the world is not "a bundle of hay" but rather a living growing complex of matter and energy, *a process rather than a thing*. . . . The problem of resource adequacy is also one of social institutions [and] . . . will involve human wisdom more than limits set by nature. (Zimmermann 1951, p. 36)

Clearly, secure property rights and monetary exchange are critical in this evolutionary process. As Jerry Taylor has noted, "[t]he composition of the natural resource base of a century ago is substantially different from the natural resource base of today, not because of depletion but owing to advances in economy, technology and industrial society" (Taylor 2002, p. 4).

Applications of Calculational Foundations and a Reassessment of the Government's Role in Sustainability

The preceding discussion lays the groundwork for applying Austrian foundations to specific issues raised by the economics of sustainability. Austrian foundations have a direct bearing on the public good assumptions of sustainability, its environmental issues, private incentives to maintain the capital stock, the exhaustibility of resources, and the presumably fixed nature of the resource base available to society. Moreover, sustainability theorists are repeating the very same theoretical mistakes that were made by the theorists of socialism nearly a century ago. For example, the institution of private property is accorded little importance. This neglect, in itself, precludes any prospect for the success of economic sustainability. In particular, "[W]hat does not exist without private property is the means for objectively comparing different courses of action, given a judgement about the future" (Mahoney 2002, p. 48). Without private property, the presumed objects of sustainability are simply an incoherent hodgepodge of objects. *There can be no basis for a coherent public "investment" to maintain incommensurable things.*

The Nature of Valuation and Invalidity of the Public-Good Theory

The nature of valuation highlights the analytical barriers to applying the public-goods assumption to sustainability policy. Public goods allegedly possess properties that render market provision impossible. The presumed properties of public goods include the following: (a) that the services, once provided, are *nonexcludable in consumption* meaning that the provider cannot exclude the service to those who do not pay, and (b) that these services are *nonrivalrous in consumption* in that the use of these services by one user does not diminish the services available to another. "The original purpose of public-goods theory was to establish a rational criterion for government intervention. The whole point of the public-private distinction was to delimit the conditions under which it is useful or necessary that government takes action" (Hülsmann 1999, p. 17). As a public-policy agenda, intergenerational sustainability has been implicitly treated as a "public good" presumably because its provision is based on the reduction of external costs affecting large numbers of people, many of whom have yet to be born.

But the labeling of "sustainability" as a public good is an analytical dead end since it is premised on the ability of government to establish social need independently of the valuations of individual human beings. For example, one may ask: what exactly is an environmental amenity as it may affect differing

people? Unfortunately, environmental amenities cannot be defined with sufficient operational precision to warrant the imposition of draconian regulatory sanctions ostensibly intended to satisfy the demands of current or future generations. Each individual's reaction to certain features of the environment will define the individual's perception of environmental amenities. Where an individual decides to fall within this gradient of concerns determines the nature of "external cost" and, hence, what the "public good" is for the individual.[10]

Given that subjective valuations of individuals are central to a thing being classified as a good, "their private or public character depends on how few or how many people consider them to be goods, with the degree to which they are private or public changing as these [subjective] evaluations change" (Hoppe 1993, p. 7). Hence, the extent to which *nonexcludability* is present in the enjoyment of the "amenity" depends upon how the enjoyer subjectively chooses to define it. The decision to be an enjoyer of the good is volitional and obviously subjective implying that no empirical measure of nonexcludability is possible. Similarly, *nonrivalry* in enjoyment of environmental amenities cannot be separated from the fact that one's own perception and definition of the environmental amenity is strictly subjective. Again, it is an experience not open to empirical investigation. Given that the experience of a thing as a public good is personal and subjective, interventionist strictures are inappropriate as a means of its provision.

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[10]One may argue that the techniques of *contingent valuation* or *demand revelation* have overcome this empirical barrier. These techniques are labeled *incentive compatible demand revelation devices* (ICDRD) (Mitchell and Carson 1989, p. 129). Contingent valuation purports to educe valuations of things not traded in markets. The technique employs questionnaires that confront individuals with hypothetical alternatives and asks about willingness to pay or willingness to accept compensation. But in the absence of demonstrated preferences revealed through acts of exchange, are such answers meaningful? Murray Rothbard has been critical of such techniques:

> One of the most absurd procedures based on a constancy assumption has been the attempt to arrive at a consumer's preference scale . . . through quizzing him by questionnaires. *In vacuo*, a few consumers are questioned at length on which abstract bundle of hypothetical commodities they would prefer to another abstract bundle, etc. Not only does this suffer from the constancy error, no assurance can be attached to the mere questioning of people. Not only will a person's valuations differ when talking about them than when he is actually choosing, but there is also no guarantee that he is telling the truth. (Rothbard 1997, p. 217)

Demand revelation is aimed at disclosing the demand for a public good by imposing on individual voters the marginal cost to others of including his preference for the good in the collective decision. Such a charge has been labeled the Clarke Tax (Clarke 1971). However, since costs are subjective, *demand revelation* has no hope of being operational. In fact, the Clarke Tax has never been implemented (Foldvary 1994, p. 19).

Private Property as an Ignored Solution to Presumably "Public-Good" Issues

Sustainability theorists tend to see corrective policies in terms of central management and applications of severe regulatory sanctions. But the preceding discussion should amply demonstrate that such a policy agenda is unworkable and nonoperational. Rather, the solution can only be found in an expansion of the scope of property rights and governmental protection of those rights. Moreover, as noted above, tort protection of private property is a grossly under-recognized element in environmental sustainability. Environmental amenities are likely to be amenable to private provision in contexts in which private property is protected and obligations of liability and restitution are properly enforced. As Ludwig von Mises as observed:

> But if some of the consequences of his action are outside of the sphere of the benefits he is entitled to reap and of the drawbacks that are put to his debit, he will not bother in his planning about all the effects of his action. He will disregard those benefits which do not increase his own satisfaction and those costs which do not burden him. His conduct will deviate from the line which it would have followed if the laws were better adjusted to the economic objectives of private ownership. He will embark upon certain projects only because the laws release him from responsibility. . . . He will abstain from other projects merely because the laws prevent him from harvesting all the advantages. (Mises 1998, p. 651)

Would Mises's views be valid with respect to externalities that may be imposed on unborn or future generations? What about externalities arising from emissions into the atmosphere? In addressing the second question one must acknowledge that the atmosphere cannot be owned and cannot become part of a broadly defined capital stock as envisioned by Solow, Heal, Pearce, Warford, and other sustainability theorists. But sustainable use of the earth's air mantle requires a proper conception and protection of private rights of property. In this case, the property to be protected is one's own being. Air pollution is an aggressive act of invasion in which "unwanted and unbidden pollutants—from smoke to nuclear radiation to sulfur oxides—[move] *through* the air, and into the lungs of innocent victims as well as onto their material property" (Rothbard 1973, p. 271). Such actions constitute an injury to person or property of others and must be treated as acts of aggression. The proper role of government—courts and police—is to defend "person or property rights against invasion, and therefore to enjoin anyone injecting pollutants into the air" (Rothbard 1973, p. 74).

Ideally, the rules of property and property protection should accomplish two goals related to sustainability. First, means must be devised by which those who may cause damage are induced to take precautionary measures that reduce the likelihood of air pollution. Second, policy must establish institutions within which those who experience actual harm are assured of restitution from those responsible. Private property provides the only framework within which these tasks can be simultaneously accomplished. The issue of

restitution is a major reason that tradable pollution permits are an inappropriate policy tool in dealing with air pollution. "Yet, perhaps the major fault with trading permits is that, while they allow market forces to allocate resources, they entail a fundamental and pervasive violation of property rights" (McGee and Block 1994, p. 57). The violation of property rights has a dual nature. First, the competitive auction of "tradable pollution permits" (sometimes referred to a "tradable emission permits") is in fact the issuance of a license to the polluter to pollute and, hence, invade or damage property of other parties. But, second, the issuance of the licenses makes no provision for direct or even indirect restitution to the parties incurring damage (McGee and Block 1994, p. 59).

But does such protection of personal property address longer-term concerns over issues such as global warming presumably caused by emissions of so-called "green house gases"? One barrier to the implementation of policy based on the protection of property rights is that "global warming" has become the central environmental thrust of a very powerful political and ideological agenda. In part, this agenda has been advanced by what appears to be a systematic pattern of exaggeration on the part of "scientists" involved in climate research (Michaels 2004, pp. 5, 19–20). But in considering policy options from within a menu of solutions consistent with "calculational foundations" one must first of all acknowledge that the atmosphere cannot be owned; no legitimate means are available to create property rights in the atmosphere. Beyond the tort protection from invasive pollution, it is not clear that much can be usefully added. While the issuance of tradable emission permits is considered a "market based solution," it is really not a solution that fosters reliance on free markets. Rather, issuances of tradable emission permits actually allow governments to "harness market forces to achieve politically determined goals. . . . If a tradable permit implicitly grants the polluter the right to disregard the property rights of others, it is clearly inconsistent with a free market economy" (Cordato 2005, pp. 378–79).

While there is acknowledgement that the planet is in a warming phase and that human activity is likely to be contributing to this gradual increase in temperature, there is certainly no concurrence within the scientific community that anthropogenic warming is destructive or that it necessarily presents a long-term problem. Those who seem certain that a problem exists are apparently not in full agreement on its extent or nature. Models have been used in estimating the consequences of green-house-gas emissions but there is evidence that these models fail to generate reliably consistent results. In his 2004 book *Meltdown: The Predictable Distortion of Global Warming by Scientists, Politicians and the Media*, Patrick Michaels takes note of the complex interactions that all modelers must confront:

> the multiplying mess becomes obvious: Because each of these interacting processes is only partially understood, the mathematics of each depends on the choice of the modeling team. As a result different GCMs [global climate models] produce different patterns, rates and distributions of

> warming resulting from human alteration of the atmosphere." (Michaels 2004, p. 18)

But assuming that global-warming trends and the activities of modern man are linked, one observes that any detectable man-made climate change has occurred during periods of inadequate or nonexistent tort protection from air pollution. A sensible and thoughtful first crucial step in assuring a sustainable atmosphere for future generations is to assure adequate tort protection of the personal property rights for current generations.

One also notes the argument that "benefits" are likely to be generated by longer-term warming trends. Robert Bradley observes: "A moderately warmer, wetter world—whether its causes are natural or anthropogenic [man made]—is likely to be a better world" (Bradley 2003, p. 144).[11] Bradley notes the impacts on vegetation growth of increased levels of carbon dioxide (CO_2) in the atmosphere, the increased length of growing seasons and more active hydrologic cycles (Bradley 2003, p. 144). The climatologists Patrick J. Michaels and Robert C. Balling make reference to

> hundreds of experiments that have confirmed that rising levels of CO_2 have enhanced plant growth, total plant output, and the yields of all major food crops (cereals, legumes, roots and tubers, sugar crops, fruits and vegetables) . . . global agricultural output has increased 8 percent to 12 percent in the last 50 years due to the rising levels of atmospheric CO_2. (Michaels and Balling 1995, p. 179)[12]

Another perennial source of environmental alarm viewed as a public-good issue is the preservation of timber resources. Here again, an unfortunate mythology has grown around the mistaken idea that private property has been responsible for the rape and ruin of timberlands. This notion was ushered in during an age of centralized management of the nations' forests and the establishment of a series of Federal agencies responsible for "scientific stewardship" of these resources.[13] Hence, "[t]he bulk of the forests in the United States has been reserved to the ownership of the federal government; private firms can only lease the forests for current use" (Rothbard 2000, p. 184). Public timberlands are made available through heavily regulated leasing programs in which lessees are unable to manage the leased lands as capital

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[11]Bradley discusses the implications of discounting the costs and benefits of the interventionist agenda advocated by climate alarmists. Discounting reveals a dramatic loss arising from such an agenda. This result may be an important reason why sustainability theorists find themselves advocating a zero discount rate in assessing policies aimed at future sustainability (Bradley 2003, pp. 91–94).

[12]The experiments to which Michaels and Balling make reference are described in a book by Sylvan Wittwer titled *Food Climate and Carbon Dioxide* (1995).

[13]A critical examination of scientific agenda in the management of Federal lands can be found in Nelson (1995).

assets. Lessees are unable to appropriate the benefits of investment measures that would assure longer-term conservation of timber resources on public land. Given the perverse incentive structure inherent in the heavily regulated leasing programs, the lessees resort to intensive exploitation in the form of "clear cutting" (Rothbard 1977, p. 67). But the phenomenon of "clear cutting" is unique to the leasing of public timberlands; in general, it does not occur in the harvesting of privately owned timber. Sustainability is contingent of the resource being managed as a capital asset (Mises 1998, p. 653). Capital cannot exist without private property.

The creation and enforcement of property rights to assure sustainable use of ocean resources are more problematic but not insoluble. As noted above, one of the critical features of private rights of property is the ability to control and exclude. But the oceans have traditionally been exploited as common property resources because of the inability of private individuals to control and exclude. Hence, "the rule of capture" has tended to be the central organizing principle in the exploitation of fisheries, for example. The rule of capture means competition in catching and reaping resources before others are able to do so. One theory of property holds that when the benefits of establishing private property rights begin to exceed the cost associated with their absence, then such rights come into existence. Full rights of private property must be established before fisheries can become capital and before fisheries can be managed as capital assets. The capital owner must be able to appropriate the benefits of his investments and to enforce the property claim by excluding nonowners from access. Hence, migratory species of fish pose many difficulties that have not been fully resolved. But the economic value of solving these problems is increasing.[14]

Prescriptions based on protection of private property can also be applied to ecologically sensitive resources. One notes situations in which environmental groups have acquired ownership of "environmentally sensitive areas" and have been able to internalize the costs and benefits associated with alternative land uses. One example is the Audubon Society's ownership of the Rainey Wildlife Sanctuary, a 26,000-acre preserve in Louisiana. Recognizing that the use of the wildlife preserve has competing, valuable uses, the Society has allowed some petroleum drilling and production without compromising its fundamental commitment to environmental concerns; "obviously the Audubon Society appraises the benefits from drilling as greater than the costs, and it acts in accordance with that appraisal (Lee 2001, pp. 216–19). The management of the Rainey Sanctuary by the Audubon Society is not an isolated example of the way in which private property provides incentives for

[14]Development of new technologies may facilitate private control over fisheries. Heat sensing satellites can monitor ship locations and determine if ships are towing fishing nets. Such technologies will be invaluable in detecting trespass, in assuring long-term sustainability in fish yields and in the management of fisheries as capital assets (Anderson and Leal 2001, pp. 118–19).

environmental sustainability. Another example is provided by the Nature Conservancy's ownership and control of a productive oil field in Texas that happens to be one of the last known breeding grounds for the Attwater prairie chicken, a species that is considered highly endangered. "The Texas oil field isn't an exception; nearly half of the 7.2 million acres that the conservancy is protecting in the United States is now being grazed, logged, farmed, drilled, or put to work in some fashion" (Wilson 2002). Clearly the key to environmentally sustainable use of ecologically sensitive areas is found in private property rights in which true opportunity costs can be reflected in actions of those who bear these costs.

The anecdotal evidence supporting the importance of private property in addressing ecological concerns is critical in dispelling the myth that government ownership and control of land is critical in "protecting the environment." Usually public lands are managed so as to comply with or respond to political decree or political pressure. The opportunity costs of alternative uses are usually not borne by those choosing or influencing alternative uses and are frequently ignored (Brätland 2001, pp. 532–33). Land use in the case of government ownership usually devolves from political dispute and becomes a matter of pro forma compliance with existing laws, court rulings or regulations rather than a thoughtful stewardship of environmental assets.

The Canard of "Public Investment" to Replace the Value of Exhausted Resources

Part of the "logic" of sustainability is that we (the current generation as an acting entity) must replace what we deplete or exhaust. In commenting on an idea advanced by John Hartwick (Hartwick 1977, p. 972), Robert Solow observes

> the policy of investing resource rents in reproducible capital suggests irresistibly that some appropriately defined capital stock is being maintained intact and that consumption can be regarded as the interest on that stock. This interpretation turns out to be quite right. (Solow 1986, p. 146)

Geoffrey Heal has actually asserted:

> if a country invests an amount equal in value to the market value [user cost] of its use of exhaustible resources, then it . . . achieves the highest possible level of utility for the least well-off generation. Remarkably, it also achieves the highest feasible constant level of utility given the economy's initial stocks of capital and resources. (Heal 1998, p. 8)

Aside from the fact that generations of people do not act and objective utility does not exist, Solow, Hartwick, and Heal rely on several other untenable assumptions in advancing this investment rule. First, they assume that every unit of the resource used today means a loss of a unit available for later generations; every current use involves a user cost reflecting that relinquished later use by our posterity. Increasing current use of the exhaustible resource

is assumed to mean increasing scarcity for the future. Second, scarcity rents are equivalent to user costs and are assumed to appear as some "objective datum." The task for the governmental investor is to simply gather the existing data on user costs. But this idea is premised on an "intertemporal equilibrium" in which there is no entrepreneurial judgment in assessing the extent of the user cost (Brätland 2000, pp. 12–15). Third and most significantly, they *view the user cost of exhaustion as an external cost borne by society at large, not an internal cost privately borne.*

The Hartwick Rule is invalidated by the fact that user cost is not an external cost but rather an internal cost borne by individual investors. Investment to replace exhausting deposits is undertaken routinely and repeatedly by private entrepreneurs dealing with the cost implications of exhausting deposits. *In fact replacement of reserves is an entrepreneurial maintenance of capital.* For many so-called exhaustible resources, the reserve base has expanded through exploration and development by private property owners (Adelman 1993). In the case of petroleum, this replacement process is privately undertaken and requires no public investment in the name of "sustainability." One notes that the higher cost of finding petroleum in new fields will drive up development cost in known fields as the latter are more intensively developed. Without new discoveries, the petroleum developer must incur higher development cost as old reserves are depleted. Discovery staves this off (Adelman 1995, pp. 11–13). The important point is that it can only unfold as a process of continuous speculation in which the capital stock—as it is embodied in privately owned reserves—is being maintained and replaced.

The critical goal of sustainability is to establish a system of property rights that allows the owner to manage resources as capital assets. *But the system of property rights currently governing the exploitation of petroleum resources does not accomplish this task.* Under current law, petroleum is never actually owned until it is captured at the surface. The petroleum reservoir itself is never owned by the petroleum developer; petroleum is owned once it is produced at the surface, at which point surface owners obtain a percentage share of production or proceeds. This claim by the surface owner is protected by covenants that preclude management of reservoirs as capital assets (Brätland 2001, p. 695). But a resolution is found in a system in which first discoverers acquire full and complete ownership of petroleum reservoirs through the process of "original appropriation" or "homesteading" as described above (Bradley 1996, pp. 71–73). Under this system, first outlined by Murray Rothbard, surface owners would have the right to charge a price for surface access to accommodate exploration but they would have no contingent claim to a share of the petroleum discovered and produced from beneath their property and would not be able to use state-imposed law to supersede production decisions of the owner (Rothbard 1998, pp. 71–72). As a full owner of the petroleum reservoir, the petroleum developer would be able to manage the resource as a capital asset hence providing further assurance of long-term sustainability.

Intervention, Insecure Property Rights and Private Disincentives to Provide for the Future

Sustainability policy as previously outlined is explicitly premised on major intervention and a central management of resources. Recall Solow's admonition: "The split between private and public investment has to be made in essentially political ways, like the split between public and private saving" (Solow 1992, p. 20). But put more forthrightly, the intervention would be a process of property predation undertaken by democratic governments (Smith 1988, pp. 134–35). Interventionist efforts to sustain services yielded by Solow's "broadly defined capital stock" would need to be financed through taxes. But there appears to be scant understanding of the impact on private saving and investment behavior of property confiscation in the form of taxes. In fact "governmental interference with private-property rights reduces someone's supply of present goods and thus raises his effective time-preference rate" (Hoppe 2001, p. 13). Conventional wisdom is that the income-tax levy would leave the time-preference schedules of taxpayers unchanged. Unfortunately this assumption is invalid. First, the levying of the tax would raise marginal importance attached to incremental consumption. Consumption as a proportion of net income would increase. Second, the tax would deplete the value of monetary assets thus inducing an upward shift in time preference schedules. Less saving would reduce the rate of private capital accumulation. The net result would be a tendency to consume a higher proportion of net income than before (Rothbard 1977, pp. 96–97). On this issue, Hans-Hermann Hoppe notes:

> Regardless of its specific form, however, any such redistribution has a two-fold effect on civil society . . . [t]he mere act of legislating—of democratic lawmaking—increases the degree of uncertainty. Rather than being immutable and hence predictable, law becomes increasingly flexible and unpredictable. What is right and wrong today may not be so tomorrow. The future is thus rendered haphazard. *Consequently, all-around time-preference . . . will rise*, consumption and short-term orientation will be stimulated. (Hoppe 2001, pp. 30–31; emphasis added)

The assault on property rights that seems to be implicit in sustainability policy necessarily implies systematic takings either through regulation or taxation. These assaults on property rights reduce the rate of return on invested saving and reduces private incentives to save and provide for the future. Some writers assert that these perverse antisavings incentives arise from the institutions of democratic government. For example, T. Alexander Smith thoughtfully and accurately notes:

> *A society characterized both by large-scale political activity and low time preferences is difficult to imagine*. . . . Because they are essentially private in nature, property relationships pose a special difficulty to democratic theorists. Many, accordingly, treat property rights at best with cold

> indifference and at worst outright contempt, considering them strictly subsidiary to participation and the political life. Thus, they subordinate property to politics. . . . The American Supreme Court has . . . relegated the "due process" clause of the Fifth and Fourteenth Amendments concerning property to the fringes of individual rights; it has looked benignly upon the seizure of property by the state under the "eminent domain" and "police power" clauses. (Smith 1988, pp. 134–35; emphasis added)

The capital that sustains society is created through the saving and investment decisions of private individuals. Any popular intervention that subverts this process is unlikely to be anything but destructive to the legitimate ends of sustainability. In reality, the increase in time preference is a logical consequence of intervention by democratic governments undertaken in the name of sustainability. Hence public control of resources in the name of "sustainability" is not only contradictory but also self-defeating.

Conclusion

The theory of intergenerational sustainability is built upon metaphorical and fallacious approaches to valuation, capital, and income. "Value" is treated as a measurable scale, the "broadly-defined capital stock" is a physical aggregate, and "income" is an aggregated value or "flow of benefits" yielded by a physical capital stock. The "capital stock" includes incommensurables such as the atmosphere, oceans, and ecohabitats. Maintenance of the "broadly-defined capital stock" is treated as a public good and hence, a governmental responsibility to assure a sustainable "broadly-defined income."

In reality, capital and income only become a coherent reality within the calculational institutions of private property and monetary exchange. In the case of what appears to be "unsustainable use," these institutions must be expanded in scope. Calculation yields an operational framework for entrepreneurial reckoning of depreciation, depletion, resource despoliation, rational capital maintenance and replacement of capital. Sustainable income is properly viewed as a net return on maintained capital denominated in monetary terms. Hence capital and income become corollaries in entrepreneurial decisions made in the face of uncertainty.

Market failure is found to be a failure of the law and interventionist policy rather than the market. The externalities associated with the uses of the atmosphere, oceans, freshwater resources, and ecosystems all have workable solutions based on the creation and enforcement of personal property rights. Also, private property rights also explode the canard of public investment to replace the value of exhaustible resources. In fact, user cost is privately borne; extractive firms replace resources in efforts to obtain higher return on new discoveries. These incentives exist only because of private rights of property.

This same process also promotes an evolution of the resource base as entrepreneurs develop new technologies reliant on new materials and

resources. Moreover, elimination of government control of resources would be a major step in fostering more secure property rights; secure private property would decrease time preference and instill incentives to save and provide for the future. The consequence would be more private investment and the creation of more capital than would otherwise be the case. Clearly, the latter result is the central critical element in the economics of intergenerational sustainability.

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