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Evolutionary Theory and Economic Policy with Reference to Sustainability

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Synopsis: The policy recommendations of most economists are driven by a view of economic reality embodied in Walrasian general equilibrium theory. Ironically, the Walrasian system has been all but abandoned by leading economic theorists. It has been demonstrated to be theoretically untenable, its basic assumptions about human decision making have been empirically falsified, and it consistently makes poor predictions of economic behavior. The current revolution in welfare economics offers opportunities on two related fronts for an evolutionary perspective on human behavior to reshape economic theory and policy. The first opportunity is to incorporate empirically-based information about human behavior to the study of human wants and their formation. This includes information about the evolution of the genetic component of decision making as well as the cultural dimensions of behavior. Expanding the role of economic analysis beyond stylized market behavior to focus on well-being (real utility) has far-reaching consequences for microeconomic policy. Secondly, abandoning the Walrasian model also means rethinking the microfoundations approach to the economic analysis of sustainability. This opens the door for economists to engage with the growing body of research on the evolution of whole societies. One link between the evolution of human behavior and the evolution of human societies is the psychological phenomenon of considering sunk costs. Understanding and overcoming the sunk cost fallacy may be the key to creating a sustainable society.

Key words: behavioral economics, sunk costs, welfare economics

JEL classification: N0, O5, P0, Q2

1. Contemporary welfare economics: the empirical study of individual psychology and whole cultures

Two important theoretical developments in the 1930s set the stage for the dominance of Walrasian welfare economics for the rest of the twentieth century.[1] The first was recasting economics as the allocation of scarce resources among alternative ends. The second was the Kaldor-Hicks notion of a potential Pareto improvement (PPI). These ideas turned economics away from questions of genuine well-being by shifting the policy focus from utility to consumption. They also justified the neglect of questions of distribution and the emphasis on economic growth as a general solution to basic economic problems such as poverty and environmental pollution.

The Kaldor-Hicks criterion seems straightforward. If one person values his gains from an economic change more than a second person values her losses, potential

total welfare increases. After the change, the winner can compensate the loser and still be better off. This constitutes a potential Pareto improvement and according to Kaldor such a change is justified even if no actual compensation is paid.[2] Most economists have followed Kaldor's view that *economic* policy recommendations should be determined by efficiency; distribution is a problem for politicians. Undermining this separation argument are more than sixty years of theoretical work demonstrating that PPIs cannot be identified by comparing individual welfare changes. Theoretical difficulties were noticed soon after Kaldor and Hicks proposed the PPI criterion in 1939. Scitovsky (1941) demonstrated that if a movement from one point to another in utility space can be shown to be Pareto improving according to the Kaldor-Hicks criterion, then it may also be shown that a movement back to the original point is also Pareto improving. Samuelson (1950) showed that it is not certain that group **A** is better off than group **B** even if group **A** has more of everything. In the 1970 s a number of papers demonstrated the impossibility of using the Walrasian framework to make definitive statements about the gains and losses associated with various economic policies (Boadway 1974, Chipman & Moore 1978, Sen 1977). The earlier theoretical critique of Walrasian has been confirmed and extended in recent work (Ng 1997, Suzumura 1999). It is now clear that when comparing alternative policies, the one with the largest net monetary gain is not necessarily the best one.

The Scitovsky paradox and other anomalies in welfare theory arise from the fact that estimates of income-compensated welfare gains, at constant prices, are partial equilibrium measures. These measures coincide with general equilibrium measures only if consumers have identical and homothetic preferences.[3] If relative prices change with a redistribution of income, as they almost certainly would in a general equilibrium system, then PPI estimates are incorrect measures of potential welfare gains.[4]

The upshot of these results for welfare economics is that there is no theoretically justifiable way to make welfare judgments without making interpersonal comparisons of utility. Contemporary welfare theory shows that the assumption that preferences are exogenous (independent of social context and the preferences of others) cannot be invoked without internal contradictions. This is reinforced by empirical results now routinely reported in mainstream journals. This brings us to the second revolution within welfare economics, the growing body of empirical research in behavioral and experimental economics demonstrating that preferences are in fact endogenous. Economic behavior cannot be predicted without knowing its social, institutional, and evolutionary context.[5]

2. Human behavior and economic policy

The traditional model of human behavior contained in the assumptions of *Homo economicus* has been overturned by the results of carefully crafted experiments – experiments clearly demonstrating that the assumptions of Walrasian economics make

poor predictions of actual human behavior. Results from games such as the ultimatum game, the dictator game, the public goods game, and many others have demonstrated the prevalence of other-regarding behavior, altruistic behavior, and systems of rewards and punishment imposed by members of society even at costs to themselves.[6]

In the ultimatum game (Guth et al. 1982) a leader offers one of two participants a certain sum of money and instructs that participant to share it with the second player. The second player can either accept the offer or reject it in which case neither player gets anything. *Homo economicus* should accept any positive offer. If, for example, the first player gets $100 and offers the second player $1, he should accept it because more is always preferred to less. Results from the ultimatum game, however, show that offers under 30% of the total are usually rejected because they are not 'fair'. The majority of proposers offer between 40% and 50% of the total (Nowak et al. 2000). These results have held up even when played with substantial amounts of real money (Gowdy et al. 2003). Researchers in a large-scale research project undertaken by economists, anthropologists and other behavioral scientists have played the ultimatum game in a variety of non-western cultures. The model of behavior embodied in *Homo economicus* was not supported in any society studied (Henrich et al. 2001). There is considerable behavioral variation across groups and group level differences better explain behavior than do individual characteristics.

Another area of experimental research important to economic policy is the work among psychologists, economists, and behavioral biologists constructing empirical measures of subjective well-being. The pioneering work of Easterlin (1974), Frey & Stutzer (2002), and many others has shown that income is only weakly correlated with individual well-being. For example, since WWII per capita GDP has almost tripled in the U.S. but the percentage of people who report being 'very happy' has slightly declined. One reason for this is that industrial societies at least, income (and consumption) is 'positional', that is, its contribution to well-being depends on its position relative to the income of others. The simple act of using scientific measures of well-being, instead of income or consumption, as the index of well-being to be maximized in social welfare functions opens the door to a richer understanding of consumer behavior and economic policy.

Studies from behavioral science, experimental economics and evolutionary psychology show the following about well-being (Layard 2003):

(1) Genetic predisposition – About half of our 'happiness index' may be due to genetics. The correlation of well-being across pairs of twins is a striking example of this.

	Identical	Non-Identical
Raised together	.44	.08
Raised apart	.52	−.02

The correlations between the happiness of identical twins are very high whether they were raised together or apart and the happiness correlation between non-identical twins is near zero (Lykken & Tellegen 1996).

(2) Habituation – Studies of lottery winners show that a large increase in income initially makes people happier but after a while happiness falls back to where it was before (Brickman et al. 1978). This works the other way too – stroke victims suffer greatly immediately after the stroke but after a while their happiness level returns to near that of the general population (Brickman et al. 1978).

(3) Income (and consumption) is a rival good – Rich people are generally happier than poor people and people in rich countries are generally happier than people in poor countries. But the marginal happiness of income declines quickly after a certain point and reaches zero at a fairly low income level. This is true within countries and between countries (Layard 2003, lecture 2). Past some point, the effect of income changes on well-being is relative and income becomes a rival, zero-sum contributor to well-being (Solnick & Hemenway 1998).

(4) Leisure is a non-rival good – Solnick & Hemenway (1998) asked the following question, which would you prefer: (A) you have 2 weeks vacation and others have 1 week; or (B) You have 4 weeks vacation and others have 8 weeks. Most people picked (B) indicating that leisure time, unlike income, is a non-rival good.

(5) Economic incentives may produce perverse results – Paying people for 'doing good' may reduce socially desirable behavior (Frey 1997). Titmuss (1971) found that paying people for blood donations substantially reduced the amount of blood donated. Decci & Ryan (1985) gave puzzles to two groups of students, one group was paid and the other not. The paid group quit working when the time was up, the other group kept on working because they were intrinsically interested in solving the problem. Raising prices to reduce undesirable behavior may also have the opposite effect.

Gintis (2000, 2001) makes a strong case that economic theory is changing for the better because of the on-going unification of the social sciences. Interdisciplinary experimental research will take the social sciences to the point that models of human behavior in anthropology, economics, psychology, and sociology will be consistent with one another. Economists are increasingly concerned with identifying how people really respond to incentives, the role of cultural conditioning in preference formation, and even the role of genetics in economic behavior. All of these have important implications for public policy. Here are just a few policy implications suggested by Ng (1987), Frey (1997), Corning (2000), Layard (2003), Gowdy & Seidl (2004), and Hopkins & Kornienk (2004):

(1) Basic Needs – Focusing policies on basic biological and psychological needs should have a high payoff in terms of adding to the happiness of society

(Corning 2000). In particular, how happy we are depends a great deal on whether or not we have had a happy childhood. More public money spent on family counseling, childhood health and nutrition, should substantially increase social well-being.

(2) Tax Policy – Most economic studies treat leisure and income as rival goods or substitutes so there is a 'trade-off' between income and leisure. Taxes on income are said to 'distort' markets since they make people work less than they want to. In contrast, Layard (2003) argues that if everyone works less and gets less income, happiness will increase because income taxes on everyone do not affect relative income but they do result in more leisure time. Taxes on luxury goods will yield a double dividend because of the Veblen effect (Ng 1987). A higher price increases the utility of the purchaser and the tax revenue can be used to finance public goods contributing to well-being.

(3) Income Distribution – Since the marginal utility of income is higher for the poor than for the rich, redistributing income from the rich to the poor will increase social well-being. Prior to the ascent of Walrasian economics economists recognized that the marginal utility of income is higher for the poor. The Kaldor-Hicks potential Pareto improvement allowed economists to avoid the radical implications of this.[7]

(4) Market Incentives – These should be used with caution especially in the case of public goods. Price incentives may have 'perverse' effects. When formulating policies to protect or increase public goods, appealing to altruistic motives and social responsibility may be a more effective and socially acceptable strategy (Frey 1997, Frey & Oberholzer-Gee 1997). Even market behavior may be governed by non-market organizations such as ethnic trade networks and non-market informal institutions like codes of ethics (Landa 1981).

These policies are in sharp contrast to those recommended by neo-Walrasian economists. But they are based on a more realistic view of human psychology and a return to the roots of welfare economics with its concern with genuine well-being rather than per capita consumption. To the extent that a policy focus on well-being reduces consumption and increases leisure time, it should also reduce the human impact on the environment. In a well-being framework the environment would be seen as a contributor to human welfare and a source of evolutionary potential rather than as just another market commodity.

3. Welfare economics and environmental crises

Walrasian models of sustainability are based on the work of Solow (1974) and Hartwick (1977) on the allocation through time of an exhaustible resource. The basic idea is that social welfare (defined as the sum of individual utilities) should be non-declining through time. Welfare is (explicitly or implicitly) equated with

consumption, broadly defined, so sustainability across generations is assured by maintaining the total stock of capital used to generate economic goods, broadly defined (Arrow et al. 2004). In this framework, the transformation of the natural world into manufactured capital not only permitted, it can be a moral imperative: if the net present value generated by transforming natural capital into human-made capital is greater than the net present value generated by leaving natural capital intact, then this transformation should be done. Otherwise the inefficient use of capital will mean that future generations will be needlessly worse off. Furthermore, there is a circularity in using present value as the criterion for deciding how much capital of different types should be left to future generations since present value calculation requires an assumption about future incomes and wealth.

This view of humans and the natural world would be no more than a minor annoyance if it did not have such a significant impact on public policy. The environmental policy recommendations of leading economists are based on the Walraisan model of human nature and on identifying intergenerational potential Pareto improvements (Arrow et al. 2004, Nordhaus 2001).[8] Walrasian environmental policy recommendations focus almost exclusively on 'getting the prices right' so that economically rational individuals can make choices at the margin insuring the efficient allocation of society's scarce resources (Bergh & Gowdy 2003, Gowdy 2004b, 2005).

Ironically, the more out of touch with reality the environmental policy recommendations of economists have become, the more evidence there is of the fragility of the natural systems the human economy is perturbing.

3.1. Climate Change

The link between atmospheric CO2 and the earth's temperature is well-established. It is also well-established that the increase in CO2 levels from about 280 ppm in the 1800 s to 380 ppm today is due primarily to human activity, especially burning fossil fuels. This increase is unprecedented during the lifetime of our species. CO2 levels have not been above 300 ppm for at least 400 000 years and possibly for as long as 40 million years. During the Holocene CO2 levels did not fluctuate more than 20 ppm until the birth of the industrial revolution. Especially alarming is the sharp increase in CO2 levels in recent years. In recent decades the increase in CO2 levels has been about 1.5 ppm a year. But in the last two years the increase jumped by 2.08 ppm and 2.54 ppm respectively (Brown 2004). Two years do not make a trend and these increases may be temporary. But even with no surprises, climate change models show an increase in average world temperature of between 3C and 5.5C by the end of this century. Current research suggests that temperature increases toward the upper end of this range may be the most plausible (Hansen 2005). A growing body of evidence indicates that human biological and social evolution has

been driven by climate change (Richerson et al. 2001). A growing body of evidence suggests that abrupt climate change has played a major role in past societal collapse (Weiss & Bradley 2001). The impending reorganization of the earth's climate system will have an unknowable but most likely dramatic impact on the biosphere and on human industrial society.

3.2. Biodiversity Loss

As in the case of climate change, the impact of humans on the rest of the biosphere is unprecedented. Stephen Meyer (2004) writes: 'For the past several billion years evolution on Earth has been driven by small-scale incremental forces such as sexual selection, punctuated by cosmic-scale disruptions – plate tectonics, planetary geochemistry, global climate shifts, and even extraterrestrial asteroids. Sometime in the last century that changed. Today the guiding hand of evolution is unmistakably human, with earth-shattering consequences.'

Biologists estimate the average rate of extinction over the past hundred million years amounts to only a few species per year. New species evolve at a rate of about one per year. It is estimated today the extinction rate is over 3000 species per year. This rate is accelerating rapidly and we have built up an 'extinction debt' that will push this rate up to tens of thousands per year. Over the next century as many as half of the Earth's species will either become extinct or will exist only as non-functional remnants (Meyer 2004). Life on earth will continue to be abundant but it will be a collection of homogenized species selected to be compatible with the global human presence. A growing number of biologists have come to the conclusion that nothing can now be done to change this reorganization of the planet's biomass. Human activity in the last 100 years or so has set the course of evolution for the next million years at least.

The current worldwide impact of the human species and its industrial economy may be unique in the history of the planet. But examples abound of pre-industrial human societies that so degraded their local resources bases that they collapsed. The inability of cultures to adjust their behavior in response to obvious impending disaster may have a behavioral basis rooted in genetics and cultural group selection. To the extent that this is true, studying past societies can be highly relevant for formulating sustainability policies today.

4. Individual psychology and social sustainability: the sunk cost effect

A sunk cost is a prior investment (measured in money, capital stock, time or effort) that cannot be recovered (Field 1998). One of the canons of 'thinking like an economist' is the admonishment to ignore sunk costs. In the words of Frank &

Bernanke (2004, p. 10): 'Because sunk costs must be borne *whether or not an action is taken*, they are irrelevant to the decision of whether to take the action.' From the point of view of a strictly rational individual a prior investment should not influence a choice among current options, only incremental costs and benefits should count. In spite of this, research indicates that humans do consider previous investments in decision-making. For example, Thaler (1980) found that people who paid for an all-you-can-eat lunch at a dinner ate substantially more than people who were allowed to eat for free. Arkes & Blumer (1985) conducted an experiment in which three groups of people who wanted to buy season tickets to a local theater were charged three different prices. Even though the groups were randomly chosen, those who paid higher prices attended more plays. Those who had higher sunk costs were more motivated to use their tickets.

Surprisingly at first thought, evidence seems to indicate that non-human animals act rationally (in the economic meaning of the term) and ignore sunk costs (Arkes & Ayton 1999, Arkes & Blumer 1985).[9] Maestripieri & Alleva (1991) tested the behavior of mother albino mice in defending their young. They found that the degree of defensive behavior depended on the number of offspring in the litter, not the amount of time invested in caring for them. A similar finding was reported by Wiklund (1990) in a study of brood defense by merlins, a kind of raptor. Fantino (2004) gave a similar task to college students and to pigeons. Both subject groups were rewarded (with money or food) for pressing a computer keyboard an undetermined number of times until the screen flashed an award. The experiment was designed to model a bad investment with the chances of success diminishing as the number of responses increases. Results indicated that pigeons were less susceptible than students to the sunk cost effect.[10]

The animal behavior literature suggests that letting sunk costs influence decision-making is a human trait that must have something to do with uniquely human characteristics such as the presence of complex capital investments and complex institutions in human societies. It is sometimes argued that although individuals may exhibit irrational behavior, such behavior is corrected in groups (as in the rational expectations literature). In fact, research shows that groups are probably more susceptible to the sunk cost effect than are individuals. Whyte (2003) uses the term 'escalating commitment' to describe the phenomenon and he found that: 'Group decision making amplified trends apparent at the individual level in terms of the frequency with which escalation occurs and its severity.' Several reasons have been suggested as to why the sunk cost effect is more pronounced in groups than in individuals:

(1) *Conformist cultural transmission* – According to Henrich & Gil-White (2001) this generates a preference for 'popular' ways of behaving. Such biased cultural transmission is reinforced by conferring prestige and punishing deviants (Boyd & Richardson 1992, Henrich & Boyd 1998). Such prosocial emotions as guilt, shame, or remorse encourage conformity in social animals and may

reinforce the sunk cost phenomenon in groups. Emulating the most successful group members also reinforces the status quo because high status members have a larger stake in protecting existing patterns of behavior.

(2) *Group polarization* – Studies indicate that when group members have a moderate preference for a particular opinion, group discussion will increase the intensity of that opinion (Whyte 1993). A group is more likely to increase its commitment to a risky strategy than is an individual before group interaction.

4.1. Sunk Costs and the Ability of Societies to Adapt to Environmental Change

Sunk costs may act as an impediment to environmental sustainability. Patterns of overshoot and collapse have characterized cultures as diverse as Ur in Mesopotamia, the Mayans, and the Greenland Norse. Many cultures exploited their environments to a point at which they were so vulnerable they were unable to maintain the cultures they had so painstakingly established (Tainter 2000). Probably the best-known example is Easter Island. Over the course of about 500 years Polynesian settlers so eroded the resource base that the peak population of about 10 000 people was reduced to a few hundred living in a state of constant warfare and deprivation (Bahn & Flenley 1992, Brander & Taylor 1998, Erickson & Gowdy 2000, van Tilberg 1994). The burning question in the Easter Island case is why the population could not correctly assess their situation and change their socially destructive behavior. It is a very small island—from the highest vantage point it is possible to see the whole island—and the destruction caused by deforestation should have been obvious. A similar pattern of overshoot and collapse also occurred on the islands of Mangaia (Kirch et al. 1992), Mangareva, Pitcairn, and Henderson (Diamond 1997).

Figure 1 below (adapted from Janssen et al. 2003) shows a generalized model of overshoot and collapse. If resources are high the population grows rapidly and goes beyond the bifurcation point B_2. The resource collapses and the population falls rapidly to another stable state past the second bifurcation point B_1.

Some past societies, like Easter Island, have moved rapidly down the curve in Figure 1 toward the two attractor states B_2 and B_1. Others have taken much longer to make the transition from a stable state to instability and collapse. But some post hunter-gatherer societies have managed to avoid the bifurcation trap altogether. One society that apparently escaped the fate of so many others is the South Pacific island culture of Tikopia. Archaeological data indicates that Tikopia was headed down and rapid population growth–but somehow managed to achieve a stable existence. Archaeological and ethnographic evidence indicates that the South Pacific Island of Tikopia is one of only a few cases of a successful *transition* from non-sustainability to sustainability (Erickson & Gowdy 2000). The island was settled about 3000 years B.P. (Kirch & Yen 1982, p. 312) by the seafaring Lapita people who colonized the Western Pacific beginning about 3500 years ago. The first

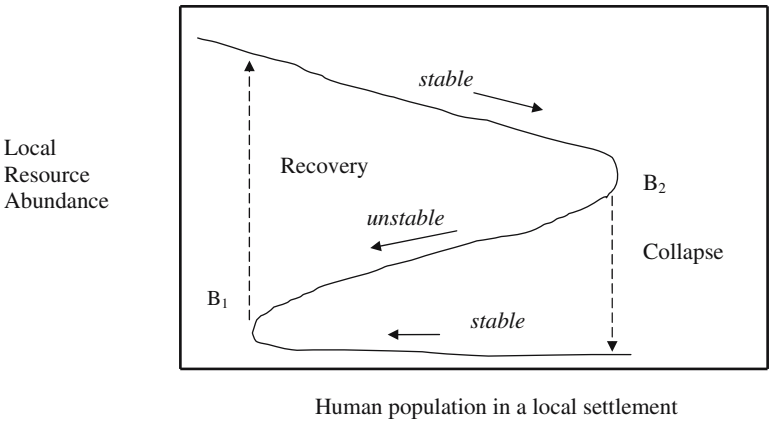

Figure 1. Overshoot and collapse of a local population

inhabitants of Tikopia quickly began transforming the landscape through forest clearing and slash and burn agriculture. Many species of native birds were hunted to extinction and it appeared that the island was headed down the same overshoot and collapse path as Easter Island.

As shown in Figure 2, soon after Tikopia was first settled it began to follow the familiar destructive path of intensive resource exploitation and rapid population growth.

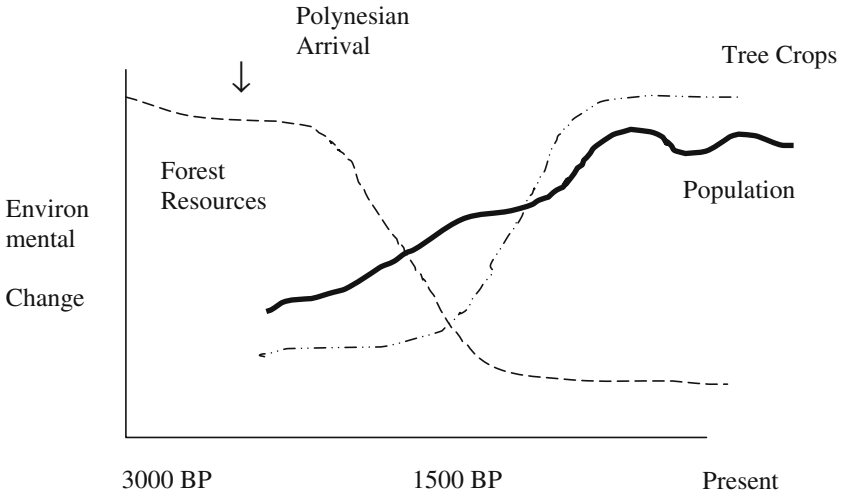

Figure 2. Diagrammatic model of Tikopia (based on Kirch 1997, figure 5)

But somehow the people of Tikopia were apparently able to assess the precarious situation they were in and take corrective measures to prevent collapse. Sometime around 1700 A.D. archaeological evidence shows that pigs and dogs were eliminated from the island (Kirch & Yen, 1982, p. 353). Slash and burn agriculture was replaced with a complex system of sustainable cultivation with fruit and nut trees shading yams, taro, and other ground crops. Some varieties of fish that once formed a significant portion of the diet were no longer eaten and from the ethnographic record considered *taboo*. The Tikopians also adopted a variety of customs to insure sustainable resource use and zero population growth. Fortunately we know a great deal about the culture of Tikopia thanks to the work of the anthropologist Raymond Firth (1936, 1939, 1967). Firth (1967) records a number of cultural practices designed to stabilize the population of Tikopia and to promote sustainable resource use. For example, he discusses in detail the *fono*, an address to the people of Tikopia by the leader of the island's chiefs. The *fono* outlines a conduct of behavior for Tikopians to insure a low birth rate (sexual restraint), proper care of coconut and areca nut trees, and maintenance of the social order.

Something fairly unique about Tikopia allowed this culture to overcome institutional sunk costs and move to a sustainable way of living. This had something to do with the interaction between the characteristics of the resource base and the selection mechanisms for institutional change and institutional lock-in.

5. Sunk costs and resource gradients: the selection of (un)sustainable cultures

Considering sunk costs is likely to be detrimental to individuals at some basic level. But it must play some positive role to individuals or to groups or it would not have been 'selected'. With altruistic punishment, the willingness of individuals to sacrifice well-being to punish others for violating perceived norms, almost any kind of social behavior can be generated (Boyd & Richerson 1992). How does the existence of sunk cost relate to the sustainability, or lack thereof, of human societies? How do fitness-reducing internal norms persist? Tainter (1988, p. 50) asks: 'If a society cannot deal with resource depletion (which all societies are to some extent designed to do) then the truly interesting questions revolve around the society, not the resource. What structural, political, or economic factors in a society prevented an appropriate response?'

The cultural evidence for the contrasting cases of Easter Island and Tikopia is extremely sketchy but enough is known to suggest important differences between the two islands. These differences can be related to the previous discussion and generalized based on the sustainability literature.

Proposition I – The greater the degree of hierarchical organization the greater the intensity of group sunk cost effects

It is generally agreed that Easter Island culture collapsed because of forest clearing and the effects of the resulting soil erosion on agriculture. When new islands were settled by Polynesian colonists, forest clearing for agriculture always occurred. Sometimes the effects were disastrous and sometimes not. Forest clearing on Easter Island was exacerbated by the existence of a hierarchical religious cult that held prestige by constructing the giant (up to 80 tons) stone heads for which the island is famous. These huge stone heads were moved using trees as skids and this soon led to the extinction of the main tree species (a relative of the Chilean palm) on the island. The island's population was apparently divided into rival clans who competed with one another in constructing these statues. So in this case we have cultural conformist transmission reinforced by a religious hierarchy and also group polarization with the division of the island into competing groups.

Tikopia, on the other hand, seems to have had a cultural tradition of encouraging consensus by moral suasion (as through the *fono* mentioned above) rather than through coercion. The cultural conformity demanded of Tikopians was one of adherence to resource husbandry and zero population growth. The population of Tikopia (1000) was much smaller than Easter Island (10 000 or more) and apparently was not divided into competing groups. Tikopia was also smaller and more fertile than Easter Island. These factors made it easier to overcome the sunk cost effect and radically change the island's system of agricultural production.

Proposition II – The greater the initial returns to exploiting a particular resource the more pronounced are group sunk cost effects

Tainter et al. (2003) argue that systems characterized by steep resource gradients in terms of kcal energy gained per kcal of energy directly and indirectly expended (Hall et al. 1992), have characteristics making them more vulnerable to overshoot and collapse. High gain and low gain systems are depicted in Figure 1. According to Tainter et al. (2003), systems with steep resource gradients (high gain systems) exhibit these characteristics: (1) large difference exist between the state of the resource before and after its use; (2) resources are likely to be used profligately; (3) high gain systems are perturbed only by the most extreme environmental disruptions; and (4) high-gain systems self-organize around the exploited resource.

All of these features of high-gain systems characterize Easter Island. After human settlement the island went quickly (within 800 years) from being heavily forested to being barren of trees. A relatively large unpopulated island full of trees encouraged the first settlers to quickly move toward a social system of rewards and punishment organized around the easy exploitation of a seemingly endless resource. Deforestation persisted in the face of increasing economic hardship and

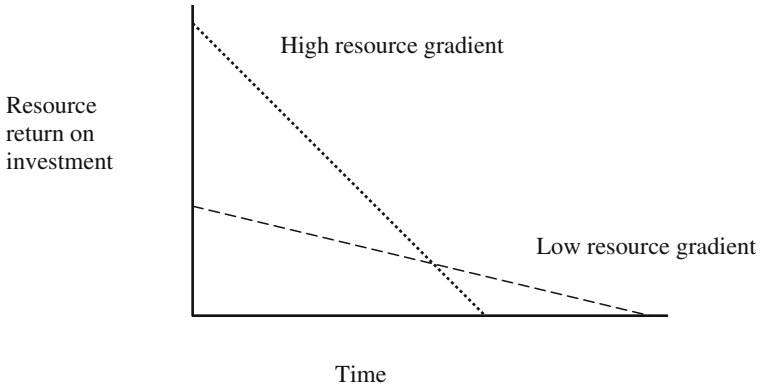

Figure 3. High and low resource gain systems

increasing political instability (Bahn & Flenley 1992). The exploitation of the forest resource was linked to an escalating system of religious fervor.

Factors favoring the intensification of the sunk cost effect were apparently present on Easter Island to a much greater extent than on Tikopia. Tikopia was a younger volcanic island with rich soil and the vegetation on such islands are more resilient than on older weathered islands like Easter Island. Vegetation regrowth occurs faster in warmer climates like Tikopia than on high latitude climates like Easter Island (Diamond 2000, p. 396). These features of Tikopia indicate that its physical characteristics gave it a less steep resource gradient (Figure 3) than Easter Island. The physical differences between the two islands may partially explain why one culture was able to modify its cultural norms and its technology to adjust to increasing scarcity and the other was not.

6. Avoiding self-organized extinction: can evolutionary economics help?

This paper began with the argument that the field of economics is changing rapidly and is now positioned to bring its powerful tools of analysis to bear on the current human predicament. By embracing scientific models of human behavior and human needs, economists can once again turn their attention to developing policies designed to bring 'the greatest good to the greatest number'. The loosening of grip of the microfoundations approach to macroeconomics also presents an opportunity for economists to apply broader, evolutionary methods to the study of whole systems. Once we shed the straightjacket of the Walrasian general equilibrium system, powerful tools of economic analysis can be applied to more fruitful ways to explore the issue of sustainability.

How does an evolutionary approach differ from Walrasian economics? The key points of departure in an evolutionary approach are *time* and *context*. Walrasian

models of sustainability (for example, Arrow et al. 2004) reduce the problem of sustainability to a single criterion (net present value of world income) to be evaluated at a single point in time (the present). There is no notion of time as an unfolding processes with contingencies, positive and negative feedbacks, and continual adjustments.[11] Neither is there any notion of context in the Walrasian system. In the tradition of Hobbes, economic man does not interact with others nor is he bound by social conventions.[12] Context and contingency is, of course, central to evolutionary explanations of economic change. Considering time and context necessitates a broader definition of rationality, a central place for the role of institutions, and time as an unfolding historical process.

Economics became the 'Queen of the Social Sciences' by doggedly applying the notion of individual rationality to an ever-expanding range of economic and social phenomena. This remains a powerful approach. But economists are now beginning to realize that 'rationality' is a broad, socially constructed concept. It is rational to care about others, to punish free riders, and to internalize group norms (Landa 1999, Gintis 2000). Individual rationality cannot be judged outside of cultural context. Likewise, economic production systems are not self-contained engines of optimization independent of the characteristics of surrounding biophysical systems.

We like to think our current socio-economic system is something different in world history. We view ourselves as being unique in terms of our storehouse of scientific knowledge, our unprecedented technological development, and our democratic institutions that we are immune from the forces that caused the demise of other cultures. In fact our now worldwide industrial society is subject to the same psychological and biophysical principles that caused earlier civilizations to collapse (Tainter 1988). The success or failure of whole societies is a function of the interplay between individual human psychology, social organization, and the particular characteristics of the resource base. Some behavioral patterns are adaptive in the long run and others are not. But all of them are subject to the same general laws of selection based on variation, replication, and inheritance (Hodgson & Knudsen 2004). Likewise all individuals are guided by basic psychological predispositions that are now being identified by behavioral scientists. By examining in depth the social and physical characteristics of past societies there is hope that we may develop some general principles of sustainability that will guide our own culture to avoid collapse.

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Notes

1. Following Bowles & Gintis (2000), Colander (2000) and others, I use the term 'Walrasian' to refer to the general equilibrium model based on self-interested exogenous preferences and complete and costless contracting. The field of economics is changing so rapidly that the more widely used term 'neoclassical' no longer represents the monolithic core it once did. Many who call themselves 'neoclassical' do not accept the core Walrasian assumptions.
2. According to Kaldor (1939, p. 550): 'There is no need for the economist to prove – as indeed he could never prove—that as a result of the adoption of a certain measure nobody in the community is going to suffer. In order to establish his case, it is quite sufficient for him to show that even if all those who suffer as a result are fully compensated for their loss, the rest of the community will still be better off than before. Whether the landlords, in the free-trade case, should in fact be given compensation or not, is a political question on which the economists, *qua* economist, could hardly pronounce an opinion.'
3. The usual way cost benefit measures are obtained (Harberger 1971) is shown by this equation:

$$\int dU/\lambda = \Delta Y - \int \sum X_i dD_i \tag{1}$$

   The change in welfare from a policy change is equal to the change in income minus the net effect on consumer and producer surplus of price changes in the 'distorted' goods (D_i). The basic problem, identified by Boadway (1974), is that λ (the marginal utility of income in constrained maximization equilibrium) will vary as income is redistributed so that changes in *all* goods must be considered, not just changes in the immediately affected goods. The only way to get around the problem is to make the unrealistic assumption that the marginal utility of income is constant and is the same for all consumers. But to make this assertion is to make an interpersonal comparison of utility (Gowdy 2004b).
4. Other theoretical problems with the PPI approach have been identified. Brekke (1997) shows that the choice of a numeraire matters when the marginal rates of substitution differ among consumers. The axioms of consumer choice refer to a single individual or a representative agent, and they break down in the case of two or more persons. As Chipman & Moore (1976) point out, in the case of two or more persons, even *within* the narrow framework of neoclassical welfare theory, it cannot even be proved that more is preferred to less–perhaps *the* basic assumption of current economic policy.
5. A brief but fascinating account of the 'rationality' debate in economics from an evolutionary perspective is given by Field (2001, prologue).
6. It has been known for decades that game theoretic results demonstrate that behavior does not conform to the canonical model of consumer choice. The old warhorse of microeconomics texts, the Prisoner's Dilemma game, would seem to be (at least to any economist) a case where a strategy of cooperation would never be played by a rational individual. As Field recounts (2001, pp. 4–5) in the first ever Prisoner's Dilemma experiment UCLA economist Armen Alchian and John Williams, the chair of RAND's math department played the game 100 times in succession. One could hardly call these two brilliant and analytically trained men 'irrational' but Alchian cooperated 68 times and Williams cooperated 78 times.
7. Mishan (1980) argued that the PPI criterion might be justified if adequate safeguards are in place to insure that its effects will not be regressive and Little (1950) believed that the question of income distribution is logically prior to the question of ideal output.
8. Assumptions behind Walrasian models of sustainability include the following: (1) social welfare is equated to per capita consumption; (2) there is near perfect substitution between natural and

human-made capital; (3) money is a perfect substitute for anything so if we leave future generations more money per capita they will be better off; (4) there will be no irreversibilities or unexpected negative environmental surprises; and (5) technological advance will be smooth and continuous.

9. In the animal behavior literature the sunk cost effect is known as the 'Concorde fallacy' (Arkes & Ayton 1999). The sunk cost debate in evolutionary biology can be traced to an article by Trivers (1972) who argued that the level of parental investment explains a wide variety of phenomena of animal behavior. Trivers' argument was quickly refuted by Dawkins & Carlisle (1976) and Trivers (1976) conceded his error. For a more detailed discussion of the Concorde fallacy debate, see Whyte (1999).
10. The study of animal behavior is a growing source of insights about human evolution and cognition (Witt 2003, Corning 2003). The more we find out about animal behavior the more apparent it is that the gap between humans and animals is not as wide as once thought.
11. Walras (*Elements of Pure Economics*, 1874, p. 242) is frank about the absence of real time in his welfare framework: 'Once the equilibrium has been established in principle, exchange can take place immediately. Production, however, requires a certain lapse of time. We shall resolve the second difficulty purely and simply by ignoring the time element at this point.'
12. '[Let us] ... return again to the state of nature, and consider men as if but even now sprung out of the earth, and suddenly (like mushrooms), come to full maturity, without any kind of engagement with each other' (Thomas Hobbes 1651, quoted in Bowles (2004, p. 93).

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