



About time: An integrative approach to effective environmental policy

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ABSTRACT

Intertemporal trade-offs are ubiquitous in environmental decision-making and policy, yet comprehensive, practical guides are lacking. This paper introduces an adaptive, iterative approach to environmental policy, combining the insights of economics, psychology, and anthropology. We first summarize the major paradigms of each discipline, including models, concepts of time preference, strengths, and blind spots. Subsequently, we illustrate the integrative approach through four real-world environmental examples: a shopper purchasing a light bulb, an organization doing building renovations, a community considering a new source of renewable energy, and international organizations developing index insurance for farmers in the Horn of Africa. One-dimensional approaches are ill-suited to real-world challenges such as these, because each discipline only tackles one facet of the issue. In contrast, with each discipline informing the others, the integrative approach is more than the sum of its parts. This paper provides a concise guide for applied researchers and policy makers alike.

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1. Introduction

People often choose immediate gratification at the expense of future benefits. The further off an event is, generally, the more we discount it. For example, one reason people fail to invest in profitable retirement accounts is that the costs are immediate while the benefits are far in the future (Thaler and Benartzi, 2004). Many other social ills, such as obesity (Chabris et al., 2008; Reimers et al., 2009), smoking (Bickel et al., 1999), and over-exploitation of natural resources (Farber and Hemmersbaugh, 1993; Kortenkamp and Moore, 2006; Markandya and Pearce, 1991) can similarly be traced to temporal short sightedness. The role of time is especially salient for environmental decisions, which have consequences that unfold over decades, centuries, or millennia. This paper offers a concise and practical guide for an integrative approach to time preference and environmental policy, based on three disciplines – economics, psychology, and anthropology.

In brief, the economic approach is useful for modeling intertemporal costs and benefits, the psychological approach offers a catalogue of mental and contextual factors that often influence time preferences, and the anthropological approach illuminates the unique cultural modes of making intertemporal trade-offs in a particular time, place, and social group. An

integrative approach combining the three perspectives is more than the sum of its parts: each method should inform the others in an iterative, adaptive process. For example, economic analysis may identify a potential problem, such as the popularity of energy-inefficient home appliances that are cheap initially but quite expensive over time (e.g., Hausman, 1979). Anthropological field studies are then required to identify consumption groups and patterns, revealing potential targets for future large scale psychological survey research and interventions, informing the design of methods and materials so they are culturally appropriate.

This approach builds on previous interdisciplinary proposals but has some key differences (see [Online Supplemental A](#) for a detailed literature review). Perhaps most importantly, our approach offers a practical guide to solving real-world problems, based on concrete examples. Of course, this framework has been successfully employed in the past by behavioral economics (Thaler and Sunstein, 2008), a model we admire and draw upon.

One way in which our model improves on behavioral economics is the inclusion of anthropology, which we see as a critical component, providing the unique details of a particular culture and place that can enable the acceptance and success of a new policy initiative. Our index insurance example (see Section 4 and [Online Supplemental B](#)) illustrates this strength. In addition to helping to design and tailor the intervention, the anthropological approach builds trust and legitimacy by engaging with and listening to the stakeholders (the failure to do this resulted in problems and delays for the Cape Wind project discussed in Section 3.3).

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A second way our integrative approach improves on behavioral economics is the explicit incorporation of an iterative process, using each disciplinary approach to inform the others in turn. This process takes longer, but yields better results. Again, the index insurance example shows the effectiveness of this approach: an economic tool was developed and refined through a lot of back-and-forth with local communities, and tested through behavioral experiments before it was deployed.

A third contribution that sets our paper apart from previous work is our focus on intertemporal choice. To the best of our knowledge, ours is the first paper to explore time preferences using the combination of economics, psychology, and anthropology.

Why the combination of these three disciplines and not others? Economics, psychology, and anthropology are complementary, providing nearly orthogonal social science analysis: objective, subjective and collective. Other social sciences, such as sociology or marketing, offer valuable perspectives but overlap somewhat with our three chosen disciplines. When additional disciplines are added, the complexity and bureaucratic overhead are increased. So why not be more parsimonious, and stick with only two disciplines, as behavioral economics does? Any real world application requires domain and culture specific knowledge and methodologies, which the anthropological approach is uniquely equipped to uncover. It is unsurprising, then, that the biggest success story of behavioral economics is in retirement savings (Thaler and Benartzi, 2004) – a domain with which economists are already highly familiar. Many successful policy interventions incorporate anthropological analysis in an informal way; it is often used but unacknowledged.

For many real-world applications (including the index insurance project), physical science expertise and analysis are absolutely essential. Our integrative approach is meant to address only the social science side of policy. Integration with the physical sciences is also necessary, but is beyond the scope of this paper. Furthermore, the particular physical science(s) required will vary from situation to situation, which complicates the writing of a general guide.

2. Comparison of economic, psychological, and anthropological approaches to intertemporal choice

While there are always variations and exceptions within each discipline; this section briefly summarizes the major paradigms, models, concepts of time preference, strengths, and blind spots (see Table 1).

2.1. Paradigms

2.1.1. Paradigm in economics

Economists study how individuals allocate resources to satisfy their desires – in other words, decision makers are seen as navigating problems of *constrained optimization* (Pindyck and

Rubinfeld, 2008). People try to satisfy their particular desires in a consistent manner while strategically navigating various real-life constraints, such as economic budgets and time limitations. Economic methods and models are grounded in a number of core assumptions (discussed in Section 2.4.1), which create a framework within which to mathematically state, analyze, and solve problems.

In many respects, economists treat intertemporal choices like any other choice: the decision is simply a trade-off between streams of costs and benefits available at different times. For example, if a city government is deciding whether to build a new power plant, it faces a trade-off between the costs of building and maintaining the plant, and the benefit of a continuous stream of electricity that would begin in the future and continue for the lifetime of the plant. The merit of the project is determined by comparing the stream of costs and benefits predicted to come from building the plant with available alternatives (such as investing the money in a fund and buying power each year from a nearby city).

People generally want to acquire benefits as quickly as possible and push off costs as far into the future as possible, for a number of reasons. For example, getting \$100 today is better than getting \$100 in 10 years because the immediate \$100 could be put in the bank to earn interest in the meantime. Furthermore, \$100 today is relatively more useful today than it will be in the future (even after accounting for inflation), because most people (and nations) grow richer over time. Thus, according to economic analysis, it is perfectly rational, even advisable, to *discount* future costs and benefits. The *net present value* of a project or choice is a single number meant to indicate its worth, after adjusting for time delay. It is calculated by subtracting the discounted costs from the discounted benefits.

In the examples to follow (in Section 3), the individual shopper choosing a light bulb, the group renovating a building, and the community deciding whether or not to build a wind power plant, are all, from the standpoint of economics, facing investment choices and performing cost benefit analysis.

2.1.2. Paradigm in psychology

Psychologists have focused on describing the cognitive, emotional, motivational, and contextual factors that influence time preference, and particularly on *impulse control* or delay of gratification. For example, it is much easier to resist a dessert if it is out of sight or if it is thought about in an abstract way (Liberman and Trope, 2008; Metcalfe and Mischel, 1999; Mischel and Baker, 1975; Mischel and Gilligan, 1964; Mischel et al., 1989). Thus, one's time preference for immediate dessert versus future health may vary from situation to situation or from one frame of mind to another, strongly affected by “decision architecture” – by the way in which a choice is posed and the order in which the alternatives are considered (Appelt et al., 2011; Dinner et al., 2011; McKenzie, 2004; Weber et al., 2007).

Table 1

An overview of the economic, psychological, and anthropological approaches to intertemporal choice.

	Economics	Psychology	Anthropology
Paradigm	Mathematically evaluate expected outcome streams over time; discounted utility is maximized	Choice between an immediate, small reward versus a larger, delayed reward	Culturally and institutionally defined choices and ways of reasoning
Models	Exponential	Hyperbolic	Cyclical, sacred, routine
Temporal preferences	Known, stable preference exists between any two outcome streams	Preferences are constructed in the situation, and depend on perceptions and self-control	Preferences are culturally determined
Method	Mathematical models with clearly specified assumptions to make predictions	Experimental research	Ethnography, based on interviews and participant observation
Strength	Systematic framework to prescribe choices under given assumptions about utility and growth	Describes the emotional and cognitive factors that shape intertemporal choices	Explores unique cultural and institutional sources of time preference; legitimacy and consent are critical
Blind spots	Overly reliant on quantitative cost benefit analysis; unrealistic assumptions may lead to poor predictions	Weak prescription for choices	No universally applicable guidelines for prescribing or describing choices

Other motivational factors, like a desire to fit in with a group, to live up to the expectations of others, and to be evaluated positively when compared with others (Shultz et al., 2007), also affect intertemporal choice and suggest areas for intervention.

2.1.3. Paradigm in anthropology

Anthropologists analyze how people's connection to an enduring community influences the *time horizon* considered in their choice process and the long-term goals – often community-related – that they pursue (Gell, 1992; Nilsson, 1920). Long-term goals are not readily represented as economic “streams of consumption” in distinct time periods. They can include long-term preservation of objects, relationships, and species. In a community living near a glacier, many inhabitants might view melting as a massive loss, not in the sense only of period-by-period “consumption” (water, recreation, tourism, etc.) but also in a more timeless sense, the loss of its iconic value (Orlove, 2009).

Anthropological research has often focused on the cultural construction of time. In this sense, time is not the objective dimension studied by economists, nor the personally subjective dimension studied by psychologists, but a collective dimension. Many cultures emphasize the repetitive nature of time (often called “cyclical” time); people choose actions that are appropriate to a particular season, or a particular stage in the life-cycle, or to day or night, or to a phase in a calendar that marks ritual and secular periods (Wood, 2008). An American might want to eat turkey on Thanksgiving, whether that day falls tomorrow or in a number of months. Similarly, that American might save an old toy with the thought of giving it to some grandchild that would be born years or decades in the future; the value of the toy would not vary in any simple fashion with the interval between the present and the date of the possible birth of the grandchild.

This cultural construction of time can be important in policy-relevant arenas as well as in the more personal and familial contexts just mentioned. The residents of a town that has had a major decline in a key economic activity (such as a former lumber or mining town in the western U.S., or a rust belt town with closed factories) may frame decisions, whether in the near or distant future, in terms of shared narratives that contrast earlier periods of well-being and present impoverishment. These narratives might lead them to emphasize a return to former prosperity or might lead them to seek the establishment of a new, distinctive period within local history. These frames would influence their evaluation of projects that the town would consider for the near or distant future (Hodges, 2010).

2.2. Models

2.2.1. Model in economics

Traditionally, the economic approach uses an exponential model, such as $V = Ae^{-kD}$, where V is the present value, A is the future amount, e is the constant (2.72...), D is the delay (in years), and k is the discount rate (Samuelson, 1937). For example, consider an investment that will yield a lump sum of \$1000 after 3 years. With a 6% discount rate, this investment would be worth $\$1000 e^{-0.06 \times 3}$, or \$835.27, in today's dollars. In this way, the discounting model functions much like an interest rate in reverse. This model is generally considered the normative standard for how future outcomes ought to be valued.

2.2.2. Model in psychology

The psychological approach, in contrast, typically uses a descriptive, hyperbolic model, such as $V = A/(1 + kD)$ (Mazur, 1987). As seen in Fig. 1, the hyperbolic model drops off more steeply than the exponential model, but later levels off. In other words, the difference between now and next year is quite large, but

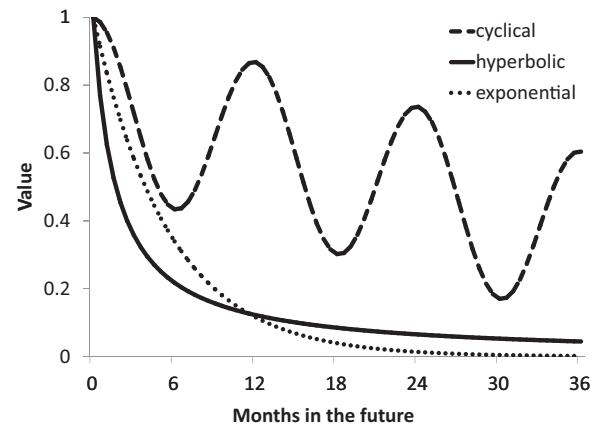


Fig. 1. Models of value over time in economics, psychology, and anthropology. The exponential model, $V = e^{-kD}$, is the normative standard in economics. The hyperbolic model, $V = A/(1 + kD)$, is a popular descriptive model in psychology. The cyclical model (which is not a formal mathematical model, but is illustrated here with a sine function that varies according to the seasons) is one of many cultural models considered in anthropology.

the difference between 2 years and 3 years is small. An important feature of the hyperbolic model is that, unlike the exponential model, it can accommodate preference reversals, such as someone who prefers \$10 today rather than \$11 next month, yet simultaneously prefers \$11 in 13 months over \$10 in 12 months. Another advantage of the hyperbolic model is that it has generally been found to fit people's actual choices and preferences better than the exponential model, for both humans and non-human animals (e.g., Kirby, 1997; Kirby and Marakovic, 1995; Myerson and Green, 1995; Rachlin et al., 1991).

2.2.3. Model in anthropology

The anthropological approach avoids relying on a single model of time preference, and rather is open to multiple, alternative patterns of time preference. One such alternative is cyclical time preference; working professionals in one community might be more impatient on weekdays than weekends, while farmers in another community might seem more impatient during the planting season than during harvest. Another alternative is sacred time (as opposed to secular, or ordinary time), which has been conceived as an eternal now, or the complete conflation of past, present, and future into timelessness. It “includes notions of a sense of time ‘bending’ or ‘stretching,’ particularly during private or public rituals; accompanying psychological or physical trauma; or resulting from deep encounters with an extraordinary event, object, or being.” (McFarland, 2009). In many modern societies, the state has partially replaced religion as the source of sacred time, and the narratives and celebrations of national history occupy the foundational role that religious texts and rituals held.

2.3. Concepts of time preference

2.3.1. Temporal preferences in economics

The economic approach assumes that time preference is stable for a given individual (Pindyck and Rubinfeld, 2008). So, if someone is very impatient, valuing their immediate welfare over future considerations, that should be equally true for decisions about money, health, or the environment. Similarly, an organization or government ought to use the same discount rate when evaluating all future projects, no matter the details of what they are considering (Lind, 1982). Therefore, when an economist observes that a person's choices have changed, the economist looks for an external factor that might be responsible, such as a change in

market prices (for example, the formerly chosen item might now be too expensive), changes in technology (the formerly chosen item might now be less useful) or changes in law. Thus, the associated change in observed behavior need not indicate a shift in underlying preferences.

2.3.2. *Temporal preferences in psychology*

In contrast to economic perspectives, the psychological approach often considers preferences to be constructed in the situation. For example, if the default is to receive a payment right away, someone may be more impatient than if the default is to receive it in the future (Appelt et al., 2011; Weber et al., 2007). It is not merely that different situations lead to different behaviors, but that time preferences themselves change depending on the situation. Often, people are aware of this instability and struggle against themselves to control their impulses (Ainslie, 2005): fearing a future change of preference, a recovering alcoholic may take Antabuse to ensure that he is not tempted to drink in the future. However, many psychologists believe time preference is *also* a somewhat stable individual difference, as documented by the (weak but significant) correlations between discount rates measured in the lab and important life outcomes including smoking, drug use, body mass index, exercise, and infidelity (Chabris et al., 2008; Madden and Bickel, 2010; Reimers et al., 2009).

Choices between immediate and delayed rewards also depend on perceptions of delay and scale (Ainslie, 1975; Zauberman and Lynch, 2005). For example, the difference between 1 day from now and 2 days from now is much more important to people than the difference between 365 days from now and 366 days from now. Factors which influence subjective time perception (such as auditory tempo, sexually arousing stimuli, or perceived lifespan) in turn influence intertemporal preferences (Kim and Zauberman, 2009; Zauberman et al., 2009).

2.3.3. *Temporal preferences in anthropology*

Anthropologists examine the cultural frameworks and social dynamics that place greater or lesser value on particular points or periods in time (Gell, 1992; Nilsson, 1920). Preferences are collective and rooted in a shared framework – indeed, the cultural group is often the unit of analysis, rather than the individual. Some groups have very long collective memories (e.g., Mormons, Serbs, Chinese), and long future time horizons, while other groups have much shorter time horizons. For example, the 99-year lease of Hong Kong from China to Britain was honored by both parties, outlasting the lives of the individuals involved.

Anthropology also introduces the idea of long-term goals associated with community affiliations. For example, an individual may have a goal of providing a good life or a good environment for his descendants or for future members of his community. Since this goal will not be achieved or realized until after he is dead, it is not easily captured by the standard, additive, period-by-period consumption architecture of economic analysis.

2.4. *Methods*

2.4.1. *Method in economics*

Economists often employ models with explicit assumptions (Pindyck and Rubinfeld, 2008). When faced with a large data set, the idea is to make sense of it and make predictions using a parsimonious mathematical model. Assumptions, even silly ones, are useful if they fit the objective data and help make predictions.

Economic models typically assume that individuals act in a way that maximizes their utility, and firms are assumed to act in a way that maximizes their profits (Friedman, 1953; Rappaport, 1996). Thus, people act logically and strategically on the basis of their preferences. They do not make mistakes. Individuals know what

satisfies them and they choose accordingly. Although these assumptions may seem unrealistic, it is not necessary that they be true but only that people and firms act approximately *as if* they were true. Therefore, the key question is often not “are the assumptions true?” but rather “does the model make useful predictions?”

Most economic models require that all costs and benefits be converted into a common metric – typically dollar amounts (Boardman, 2006). This can make it tricky to establish values in domains like human life, health, and environmental impacts, particularly due to the unreliability of self-reported measures such as willingness-to-pay (Schkade and Payne, 1994). Rather, economists prefer to infer values from revealed preferences. For example, if workers receive higher pay for dangerous jobs (as compared to otherwise equivalent, risk-free jobs), this can be used to infer the value they place on their lives and health. Using this method, economists at the EPA calculated the value of a life to be \$6.1 million (U.S. Environmental Protection Agency, 2000). Environmental concern is perhaps more difficult to capture in a single number, given that it reflects a multidimensional blend of egotistic, altruistic, and biospheric considerations (Shultz, 2001).

2.4.2. *Method in psychology*

Psychologists typically employ controlled, laboratory studies. For example, participants might complete a survey of hypothetical intertemporal choices between immediate and future outcomes. A few factors (such as the wording of the questions) are manipulated, while all other factors are held constant, allowing the researcher to clearly and confidently establish causality.

Using this method, psychologists have catalogued a number of reliable deviations from the economic model of discounting, including gain-loss asymmetries (Benzion et al., 1989; Hardisty and Weber, 2009), magnitude effects (Baker et al., 2003; Estle et al., 2006), preferences for spread (Frederick and Loewenstein, 2008), and preferences for improving sequences (Chapman, 1996; Guyse et al., 2002; Schmitt and Kemper, 1996), to name a few.

2.4.3. *Method in anthropology*

A staple method of anthropologists is the ethnography, or case study, based on interviews and participant observation. This is an empirical, qualitative research method aimed at understanding the ordinary activities and social meanings guiding the life of a group of people (Geertz, 1973; Philipsen, 1992). It is critical to avoid assumptions and biases, and understand the world outlook of the cultural group in question on its own terms (Brewer, 2000).

However, conceptions of time and time preferences present unique challenges for ethnographic research (Birth, 2004): walking up to someone and directly asking “What are your cultural ideas of time?” is likely to confuse more than illuminate. Therefore, it is important to begin with careful observation of activities, conversations, and sequences, before following up with interviews that use appropriate cultural idioms as question prompts.

2.5. *Strengths*

2.5.1. *Strengths of the economic approach*

For modeling intertemporal decisions, the notion that people are maximizing a consistent objective function helps to organize and integrate a wide range of choices into a coherent unifying framework (Browning and Crossley, 2001). Therefore, when one approaches a new situation involving intertemporal choice, the discounted utility framework can always be applied to help understand the situation and make some predictions.

Rational modeling also provides a normative standard for how we *ought* to treat future outcomes. While it may not necessarily be the *best* standard, it at least provides a clear and somewhat

reasonable standard: a choice is superior if it provides greater discounted utility than other choices do.

2.5.2. Strengths of the psychological approach

The main strength of the psychological approach is that it offers a generally applicable description of the emotional and cognitive factors that shape intertemporal choices. Because psychological interventions often consist of changes in information presentation, they are relatively cheap to implement (compared with, say, economic subsidies).

A recent success story of applying psychology research to real life policy making is the case of cigarette package labeling: putting graphic images of smoking related health problems onto cigarette packages makes the future negative consequences of smoking more vivid, memorable, and immediate to people, leading to lower rates of smoking ([International Tobacco Control Policy Evaluation Project, 2009](#)). This has been demonstrated with evidence from 30 nations, over a period of more than 10 years, increasing awareness of the health risks of smoking and decreasing the number of people who take up smoking.

2.5.3. Strengths of the anthropological approach

A great strength of the anthropological approach is its ability to uncover cultural and institutional sources of time preference. For example, [Lemos \(2008\)](#) traces the institutional factors which lead water managers in Brazil to have longer time horizons than their counterparts in the US. A study of residents in coastal Peru ([Orlove et al., 2004](#)) shows that local traditions influence the timing of responses to forecasts of dangerous rain events, leading residents not to act after early warnings but to take preparatory steps after hearing later predictions. Anthropologists recognize that elected officials, despite the mandate to address collective interests, are often concerned about the next election ([Rifkin, 1987](#)).

Furthermore, because anthropological investigation requires spending time with and talking to stakeholders, this builds trust, legitimacy and consent. For example, implementation of water management policies may be more successful if participatory processes are employed ([Broad et al., 2007](#); [Lems et al., 2011](#); [Peterson et al., 2010](#)).

2.6. Blind spots

2.6.1. Blind spots of economics

Perhaps the most important shortcoming of the economic approach is its reliance on discounted cost–benefit analysis, which requires monetizing all the anticipated consequences of a given decision. This is problematic when assessing things like the value of human life, environmental resources, or moral principles (for an overview of these difficulties, see [Ackerman and Heinzerling, 2004](#)): choosing an exact dollar figure is a contentious process, with no clear “right” answer, yet it has enormous implications for the net present value of environmental policies. Similarly, the choice of discount rate is somewhat arbitrary, but has huge implications; indeed, it has been argued that the greatest uncertainty in all the economics of climate change is the choice of what discount rate to use ([Weitzman, 2007](#)): with a low discount rate, such as 2%, we should take immediate and forceful action, but with a higher rate, such as 6%, we should ignore the problem entirely. Thus, although net present value calculations may seem to give clear and objective recommendations for policy, they are often extremely sensitive to the arbitrary details of exactly how human life is valued and how the discount rate is chosen.

A further blind spot in mainstream economics, as played out dramatically in the recent financial crisis of 2008, is the assumption of continuing economic growth. Most economic models select a discount rate based on a historical average rate

of growth, and thus make poor predictions and recommendations if the economy contracts rather than expands. Climate change poses a small risk of catastrophic economic damage, which would challenge the growth assumptions of many models, and suggests we should take action to avoid these risks ([Weitzman, 2007](#)).

Finally, although most people and nations have some regard for the welfare of other people and future generations, these “social” preferences are rarely incorporated into economic models. Thus, in contrast to *temporal* preferences, which are carefully specified, social preferences are often assumed to be zero.

2.6.2. Blind spots of psychology

Psychology, in its emphasis on describing the factors affecting intertemporal choice, offers no clear guide for how intertemporal trade-offs *ought* to be made (other than the implicit notion that it is good to avoid inconsistencies). In addition, psychology has not systematically investigated how people conceptualize and evaluate long streams of outcomes; it offers no alternative to the period-by-period additive model of economic analysis. Furthermore, psychology has also often neglected the lessons of anthropology concerning the social goals that arise from affiliation with an enduring community. Such goals are often not discounted in the conventional sense.

2.6.3. Blind spots of anthropology

Finally, anthropology offers neither a systematic framework for analyzing alternative social policies over time nor any guidelines for good decision architecture at the level of the individual decision maker. Each situation is considered afresh, to be understood on its own terms, without the help (or impediment) of a formal model.

3. Three decisions about energy use

To illustrate what an integrative approach combining these disciplines can tell us about intertemporal choice, we turn to three concrete examples about energy use.

3.1. Purchasing a light bulb

3.1.1. Details of the situation

Most people have continued to buy incandescent light bulbs, rather than compact fluorescent light bulbs (CFL), even though CFLs last longer, save considerable energy, and are better for the environment ([U.S. Department of Energy, 2010](#)). Considering all these advantages, why has uptake been so slow, and what measures would an integrative approach recommend?

A 25-W CFL has light output equivalent to a 100-W incandescent bulb, but costs more up-front: \$3.40 (in 2010 U.S. dollars) for a typical CFL, compared with \$0.60 for a typical incandescent ([U.S. Department of Energy, 2010](#)). This difference in up-front price is dwarfed, however, by electricity costs over the lifetime of the bulb: operating a 25-W CFL for 10,000 h uses 250 kWh of energy, costing \$28.25 at typical prices for electric power (11.3 cents/kWh, as per [U.S. Department of Energy, 2010](#)), while a 100-W incandescent would cost \$113 for the same 10,000 h. Furthermore, 1 kWh of home energy in the U.S. produces about 1.6 pounds of CO₂ ([U.S. Environmental Protection Agency, 2010](#)). This means that over the typical 10,000 h life of a single CFL, it will save 416 pounds of CO₂ (compared with a 100-W incandescent). For comparison, this is equivalent to driving 475 miles in a typical car in the U.S. (getting 22.6 miles/gallon; [U.S. Department of Transportation, 2010](#)).

Many governments have legislated energy-efficient bulbs. For example, in the U.S., the Energy Independence and Security Act of 2007 requires that by the year 2020 all general-purpose light bulbs be as energy efficient as current CFLs. But why has legislation been required, when the financial and environmental costs alone should

have led people to make the change? The issue becomes more pressing with the recent arrival of LED bulbs, which are even more expensive, efficient, and long-lasting than CFLs: \$60 for a bulb that lasts 20 years (Daily Herald, 2012).

3.1.2. How economists look at purchasing light bulbs

From the perspective of economics, the shopper selecting a light bulb is making an investment decision. An initial upfront outlay of cash (the extra cost for the CFL bulb) will yield a return of a stream of benefits over time (reduced monthly expenditure on electricity and reduced cost of replacement bulbs). Whether or not the purchase is appropriate depends on the decision maker's opportunities for borrowing, opportunities for investment, and cost of capital. Variability in these factors is assumed to account for the observed high variability in discount rates implied by the purchases of different consumers (Hausman, 1979). Thus, if the shopper is short on cash and does not have access to credit at all, it might be sensible for her to forgo the investment even if it has a very favorable rate of return.

If an environmental or government agency were interested in encouraging shoppers to adopt CFLs, economists might suggest trying to manipulate the relative price of the two kinds of bulbs by offering a subsidy for CFL bulbs (perhaps a promotional discount) or by taxing the incandescent ones. Lowering the upfront cost of CFLs (while the flow of future benefits remains the same) makes the percentage rate of return on that investment more attractive, and shoppers should be more inclined to buy them.

However, since the cost of CFLs is already so favorable, one would have to ask whether these interventions would work. It is difficult to understand from the economic perspective why consumers are not already purchasing CFLs in droves. The best explanation may be that shoppers either do not *understand* or do not *believe* the benefits of CFLs. But understanding and believing are outside the realm of economics.

3.1.3. How psychologists look at purchasing light bulbs

Insofar as understanding is an issue, one effective intervention might be to make the future costs more salient: for example, a requirement that a 10-year overall cost, including electricity cost and a reasonable rate of return on investment, be displayed prominently along with the immediate purchase price (e.g., \$38 for the CFL versus \$128 for the incandescent bulb, along with \$3.44 versus \$0.60, respectively). This is similar to the way prices are displayed in some drugstores and supermarkets, with the total price displayed alongside the per-unit price, so customers can easily compare the value of a 10-oz. bottle of shampoo with that of a 12.3-oz. bottle.

A different sort of intervention would address the fact that people are generally biased in favor of the default, or status quo (Johnson and Goldstein, 2003). Whichever option shoppers consider first sways their opinion, and their subsequent decision-making is influenced accordingly, reinforcing their initial reaction (Hardisty et al., 2010; Johnson et al., 2007). Currently, people generally have incandescent bulbs at home and thus consider these the default option when they shop. A possible intervention, therefore, would be to make CFLs the default in new building construction (Dinner et al., 2011). Similarly, asking that CFLs be positioned prominently in store displays is a traditional marketing device, which may influence shoppers' first impressions, leading them to weight more heavily the future benefits that CFLs provide. Questions of economics come back to the fore when one asks about incentives for builders to adopt or for retailers to market CFLs more vigorously.

3.1.4. How anthropologists look at purchasing light bulbs

Anthropologists have conducted ethnographic research on the shopping activities and on the use of light bulbs to learn how

people act in stores and how they use bulbs in their homes. A study of electricity use in China (Wu, 2008) showed that men, rather than women, typically purchase light bulbs, but that electric light is more important for women's economic activities (such as sewing clothes) than for men's, so that men and women might have different priorities in selecting bulbs. This study also showed that more expensive electric items are often purchased in stores, while less expensive ones are purchased in street markets. Men and women differ in their interactions in these two settings. This information, or similar information in other settings, could influence the design of campaigns to support CFLs.

Cultural considerations also lead to different interventions at different places and times. A comparative study of domestic use of electric light in Oslo, Norway and Fukuoka, Japan, found that Japanese prefer to light their houses with fewer, brighter lamps, often located on the ceiling, while Norwegians place a strong value on having a larger number of smaller lamps distributed around the room (Wilhite et al., 1996). The Norwegians also dislike the white tone of most fluorescent lamps, while Japanese actively prefer it to the yellower light of incandescent bulbs. Interestingly, this study found that the average size of homes and the cost of a kWh as a proportion of average annual income were very close in the two study cities, so economic differences do not account directly for the national differences. This study suggests that Japanese would more readily adopt CFLs, while some technical changes – producing CFLs with a softer tone and in a variety of brightness levels – could assist the uptake in Norway.

3.1.5. An integrative approach to light bulb purchase

The ideal integrative approach uses the insights and methods of each discipline to inform the others in an iterative, adaptive process. One may start by observing and talking to shoppers as they are choosing new light bulbs. What factors are they considering? Are they mainly thinking about making trade-offs between immediate and future costs, or are they choosing based on other factors, such as tradition (buying what they have bought before), aesthetics (perhaps they prefer one kind of light to the other) or values (choosing the CFL for environmental reasons)? One should also investigate the rational costs and benefits of different choices. Knowing the answers to these questions can subsequently inspire and inform experiments. For example, if consumers are not aware of the long-term benefits of CFLs, these should be highlighted. Alternately, if tradition is the most important factor (buying what looks like what they had before), then perhaps the appearance of CFLs should be changed to match incandescent as much as possible. Of course, before scaling up a successful intervention, it should be evaluated for long-term sustainability, perhaps using a blend of life cycle assessment and multicriteria decision analysis (Seager and Linkov, 2008). For example, if a new CFL bulb offers the same quality of light as incandescent bulbs but also has dramatically reduced lifespan, the increased sales of this type of CFL may or may not be worth the trade-off. If the results of an experiment do not turn out as expected, further qualitative insight from shoppers may be instructive for understanding how the intervention was perceived. In this way, the prescriptive, descriptive, and collective insights of economics, psychology and anthropology can inform each other, creating an integrative approach that is more than the sum of its parts.

3.2. Building renovation

3.2.1. Details of the situation

When companies decide to renovate their office buildings, they have the opportunity to plan renovations that qualify them for LEED (Leadership in Energy and Environmental Design) certification. LEED certification verifies a building's overall effectiveness in

energy efficiency, water efficiency, CO₂ emissions reduction, and other factors (U.S. Green Building Council, 2009), and is the most widely used and trusted environmental certification system in the U.S. (Fowler and Rauch, 2006; Ross et al., 2007).

LEED-compliant renovation and certification typically requires a substantial up-front premium (in the form of both money and time) but brings continual future benefits for the life of the building. In a case study of a small commercial office building, a conventional renovation was estimated to cost \$975,000, while LEED-certified renovation cost \$1,086,143 (Ross et al., 2007). The total cost broke down as follows: \$156,938 for the design team, \$418,279 for materials, \$504,762 for labor, \$1850 for LEED administration fees, and \$4314 for renewable energy credits. Although the LEED renovations cost an additional \$111,143 upfront, they cut gas and electric consumption in half, thereby saving an estimated \$20,724 per year on energy costs. The organization undertaking the renovation did not have enough cash on hand to pay the entire cost of construction, but it was able to borrow money at a 5.72% interest rate.

In addition to the energy savings, LEED improvements bring improved employee productivity, reduced water consumption, and a positive image for the company (Kats et al., 2003). Other long-term impacts, such as reduced CO₂ emissions and reduced strain on the electricity grid, benefit future tenants of the space and society, but not the company in particular. A study of LEED renovation for 33 building projects in California included these “socialized” benefits in their cost–benefit analyses and found that “an upfront investment of less than two percent of construction costs yields life cycle savings of over 10 times the initial investment” (Kats et al., 2003).

3.2.2. How economists analyze choices about building renovations

Although the long-term financial, energy, and social benefits of LEED certified construction and renovation are clear, LEED-certification is not always in the short-term financial interests of a particular company, given their alternatives for investment. LEED improvements are tied to a building, not to an organization. So, if the decision makers that are considering LEED certification rent rather than own the building, they would need to consider the length of their lease and intended stay.

If the organization were expecting to occupy the building for 10 years, the LEED renovations would be expected to cost \$111,143 in year 1, but provide \$20,723 of energy savings in years 2 through 10. However, an economic analysis would discount the future savings at a rate of 5.72% per year, as seen in Table 2. Therefore, given a 10-year time horizon, the LEED improvements yield energy savings of \$133,774. This means that the net present value of the project is positive. Note that this analysis depends critically on the time horizon considered, as well as the discount rate used. If the organization considered only a 5-year time horizon, the expected energy savings would be only \$67,991, and the net present value would be negative. Alternately, with a discount rate of 10%, the energy savings over 10 years would be only \$105,803, and again the net present value would be negative.

Although economists analyze building renovation and light bulb purchase in essentially the same way, the problem of LEED certification might involve a couple of additional complications. Because employees work more productively in a LEED-certified

environment and LEED certification enhances the corporate image of companies housed in the building, these factors ought to be quantified and added into the financial analysis as increasing the stream of benefits that would accrue over time. It is quite difficult, however, to accurately assign dollar values to these predicted benefits, so conservative economic analyses will often leave them out altogether.

If policy makers want to encourage the adoption of LEED improvements, economists might advise them to work with governments and banks to offer loans that are tied to the property (one example of this practice is the PACE program; see Property Assessed Clean Energy, 2008). These loans cover the extra upfront cost of energy improvements and are repaid by present and future tenants. Assuming the savings from efficiency and productivity are greater than the cost of loan repayment, present and future tenants would benefit. This strategy would lower the risk for the current tenant, the decision maker, making the choice of LEED certification more appealing. Another strategy would be to subsidize the actual materials that go into LEED improvements, thus making the improvements cheaper and decreasing the investor's financial risk (and in turn the risk to the bank considering the mortgage).

3.2.3. How psychologists analyze choices about building renovations

Although the future benefits of LEED improvements are delayed, and hence discounted heavily, social comparison and social goals can provide an immediate psychological payout. In recent field studies, providing feedback on how much energy consumers were using relative to their neighbors led to significant improvements in conservation (Handgraaf et al., 2012; Shultz et al., 2007). In fact, social incentives were more effective than monetary incentives. Social goals, such as competition, are especially strong between groups (McCallum et al., 1985; Sherif, 1966). Therefore, policy makers could publicize those businesses who have signed up for (or already enacted) LEED improvements. This would provide an immediate social incentive for other companies to sign up, balancing out the immediate financial cost. Additionally, businesses with LEED-certified buildings could advertise this to their (environmentally conscious) clients and could potentially use the long-term savings from LEED renovations as a selling point (e.g., “passing the savings on to the client”). Highlighting this potential competitive advantage could improve the attractiveness of LEED improvements, despite their initial cost.

3.2.4. How anthropologists analyze choices about building renovations

Ethnography of the decision processes within enterprises reveals key insights: One recent study of building projects at a private U.S. college showed that while some aspects of enterprise culture (such as satisfying the often conflicting goals of units within the enterprise or associated with it) may work against LEED improvements, others (such as an enterprise's role as a regional leader, or a manager's desire to leave a legacy) may be beneficial (Brown, 2010); it also showed that the larger goal of sustainability and the narrower goal of optimizing a score within the LEED framework often enter into conflict with each other. Moreover, anthropological studies in the closely related area of green labeling of houses suggest the importance of building long-term trust of new regulations. In a detailed qualitative study of a small sample of

Table 2
Future savings of \$20,723 per year (due to decreased energy usage), in years 2 through 10, with a continuously compounded discount rate of 5.72%.

	Year									
	2	3	4	5	6	7	8	9	10	
Discounted savings	\$18,483	\$17,455	\$16,485	\$15,568	\$14,703	\$13,885	\$13,114	\$12,384	\$11,696	

households, Gram-Hanssen et al. (2007) found that Belgians placed greater trust on energy assessments for houses than Danes did. This difference reflects both the status of the assessment (it was obligatory in Denmark but voluntary in Belgium, so Belgium excluded unmotivated people from the assessments) and the source of the assessment (Danish households received a label provided by an impersonal government agency, while Belgian households were visited personally by an engineer from a professional organization). Kosheleva and Elliott (2006) show high levels of distrust of LEED and other green labeling for buildings in Russia, which they attribute to scanty information, weak regulation and fragmentation of political authority in the post-Soviet period. These studies suggest that the routes to adoption of LEED labeling will differ from country to country and from enterprise to enterprise, and that those who promote LEED labeling should seek to build trust with decision-makers.

3.2.5. An integrative approach to building renovations

A policy analysis should first assess the costs and benefits LEED improvements, considering both what is best in the long term for individual buildings and for society. This assessment of costs and benefits need not (and should not) be purely quantitative – making decisions based on shared values and goals is legitimate and has many advantages (Ackerman and Heinzerling, 2004; Crompton, 2010; Krantz and Kunreuther, 2007). If it makes sense to promote LEED, the next step is to find out who considers it, when, and why. For example, is it something that is considered by company executives, or proposed by architects or construction companies? Is it considered mainly for new buildings, or for renovations of existing buildings? What are people's short- and long-term goals when they consider LEED? Building on the answers to these questions, one should design psychological and economic interventions in an iterative and adaptive process. For example, if the main problem is that no one has heard of LEED, a local government might offer a tax break or other incentive for architecture firms to always introduce and explain LEED to clients. The design of this information could be tailored to prime corporate responsibility or other pro-LEED goals, which will vary depending on the local culture. For example, although energy efficiency is the most relevant LEED benefit in western countries, issues of water and sanitation are more pressing in India (Mukherjee et al., 2010; Nadu, 2012). Therefore, efforts to encourage sustainable building there would be better served by focusing on water usage.

3.3. Building a new source of energy

3.3.1. Details of the situation

As demand for energy grows and costs rise, state and federal policy makers are eager for new sources of power. The choice of what type of capacity to build has impacts occurring on very long time scales, outlasting the lifetime of the decision makers. The CO₂ emitted from coal plants stays in the atmosphere anywhere from a few centuries to many thousands of years (Archer, 2008), and the radioactive waste from a nuclear plant remains dangerous for hundreds of thousands of years.

In 2002, a private developer proposed constructing an off-shore wind farm in Nantucket Sound off Cape Cod in Massachusetts. Although this Cape Wind project was endorsed at the state and federal levels, local communities and environmental groups had concerns about the long-term impact of the project on local wildlife, scenery, fishing, tourism, and energy prices. More recently, a group of Native Americans challenged the project because it would obscure the view from an ancient burial ground (Jesmer, 2009). Thus, while the wind farm was once expected to be operational in 2005, construction has been continually delayed and is currently not expected to produce electricity until after 2015 (Lindsay, 2012).

Clearly, the Cape Wind project involves multiple stakeholders and decision makers at local, state, federal and tribal levels. Unlike the previous examples discussed above (light bulb purchase and building renovations), most of these decision makers are concerned primarily with the future, lasting consequences of the project, rather than the immediate costs.

3.3.2. How economists look at building a new source of energy

From an economist's point of view, the decision about whether to build a wind farm is an investment problem analogous to the previous two examples. In this case as well, the environmental benefits present additional costs: power generated from offshore wind is projected to be roughly twice as expensive as fossil fuel sources such as coal and natural gas (U.S. Energy Information Administration, 2010). However, according to analysis by the energy consulting firm La Capra, Cape Wind would nonetheless exert a downward pressure on energy costs in the northeast through bid-stack displacement, leading to market savings of \$25 million annually (La Capra Associates, 2003). Similarly, an analysis by the U.S. Department of the Interior (2008) concluded "the rate of return for the proposed site... exceeded 14%, which is greater than 10% to 12% rate that might be required by the offshore wind developer," using a 7% discount rate. The wind farm would provide public benefits through decreasing CO₂ and particulate matter emissions, diversifying the region's electricity mix, and accelerating the development of wind power nationally. Therefore, the project appears to provide long-term benefits on the regional, national, and global levels. Unfortunately, certain local individuals and groups will suffer costs (e.g., they will lose their view) without receiving direct benefit or compensation. Thus, the value of the project depends on the level of analysis: at the local level, many of the benefits are "externalities" which are ignored by most economic models.

In one way, the Cape Wind project is a testament to the effectiveness of economic incentives for long-term development: the private developer clearly was motivated by and benefited from state and federal financial incentives. Without them, the developer probably would not have proposed the project. However, disagreements with the local community have led to years of delay and possible derailment of the project. Therefore, an economist might suggest improving the attractiveness of the project (and other similar projects) by offering or increasing financial incentives to the local community as well as to the developer.

3.3.3. How psychologists look at building a new source of energy

Psychologists rarely consider decisions of this scale and complexity. One insight psychology does offer is that intertemporal decisions by direct democracy (rather than representative democracy) can be problematic: the discount rates implied by survey research vary wildly, depending on how options are presented (Frederick et al., 2002; Read et al., 2012). Both extremely low discount rates and extremely high discount rates are often observed, both of which would lead to disastrous policy (Weitzman, 2007). Therefore, appropriate discount rates for evaluating public projects (such as the construction of a new power plant) may be best chosen by elected and appointed experts rather than by public opinion. Similarly, although willingness-to-pay surveys of the public are sometimes employed to judge the value of environmental benefits (Mitchell and Carson, 1989), people's answers to these questions are often erratic and inconsistent, constructed on the spot (Frederick, 2006; Schkade and Payne, 1994). Thus, the results of these surveys often say more about how the questions were posed than about the public will.

Psychology can also offer a solution to the NIMBY ("not in my back yard") problem by reframing the decision in ways that

highlight the long-term and socially far-reaching advantages of the wind farm (also promoting the region as a leader), which may deflect attention from the downsides to local residents.

3.3.4. How anthropologists look at building a new source of energy

Two anthropological studies bear directly on the Cape Wind project. One study (Firestone et al., 2009) compared the project with a hypothetical project off the coast of Delaware. They found stronger support for wind power in Delaware, though residents in both areas expressed a number of similar concerns about tourism and the scenic value of the shore. The study attributed this difference to several factors. Concern for air quality is greater in Delaware, where coal-fired power plants have significant health impacts and sudden increases in electricity prices have also created a concern for supply. Several unique features of Nantucket Sound, the location of the Cape Wind project, may have also led Massachusetts residents to fear for the impacts of a wind energy project more than Delaware residents did.

Brown (2007) discusses a third coastal state, New Jersey, where wind energy projects were also debated. The author reviews the state's Blue Ribbon Panel on Development of Wind Turbine Facilities in Coastal Waters. A large number of concerns were raised at this panel. The panel developed a positive view of wind energy projects after one member proposed that they consider these projects as investments in knowledge that could pay off over many years in less expensive energy and in making New Jersey a leader in this new energy source. The member found a social framing that was culturally appropriate and that gave cultural meaning to a possibly distant future. Taken together, these studies show the multiplicity of cultural values associated with wind energy, and suggest that mobilization of certain values can lead to support. Following the panel's report, wind energy projects were approved within both state and federal waters.

This study shows the advantage of involving local communities early on in the processes. In the Cape Wind project, surrounding communities were not involved in the early plans and decisions, partly because the developer proposed construction on federal waters. Local people became concerned that the developer had received privileged treatment, while they were in a disadvantaged position and unable to participate in formulating the project. This lack of participation by residents was a serious problem: though some of the local concerns (such as detrimental impact on wildlife) proved unfounded, other legitimate issues (such as loss of livelihood for local fishers) were uncovered that had not been considered by higher authorities.

Talking to people on the ground and doing ethnography thus has two types of benefits. One is improved information. The second is the trust and legitimacy derived from participatory processes. Thus, even if the final decision is not improved, involving stakeholders from an early stage brings benefits in execution down the road (Peterson et al., 2010).

3.3.5. An integrative approach to building a new source of energy

In this case, the first step might be to identify the relevant stakeholders, including current and future residents in the local area and the world (Science and Environmental Health Network, and The International Human Rights Clinic at Harvard Law School, 2008). Determining the "best" new power source will depend on many factors, including the goals of the stakeholders and costs and benefits of each option over time. One recent study emphasized the different temporal horizons of participants in a government-led evaluation of wind energy in Germany (Gee and Burkhard, 2010). Importantly, the preferences of the stakeholders may depend on how options are framed. For example, people might support a "surcharge" to pay for a new source of green energy, but oppose a "tax" with the same purpose (Hardisty et al., 2010; Parag et al.,

2011; Sussman and Olivola, 2011). Similarly, people might reject an immediate tax when considered on its own, but still prefer it over the idea of saddling future generations with the consequences. When gathering the support of government officials for a new energy source with high initial cost but excellent long-term benefits, a key consideration will be how to avoid the NIMTOF ("not in my term of office") phenomenon. What methods or interventions can be used to overcome this? Whether practical or psychological, it depends on the particulars of the place and the people, so an initial anthropological assessment will be instructive.

4. Conclusion: real-world application of the integrative approach

The CFL light bulb purchase, LEED building renovation, and renewable power source construction examples each illustrate the potential environmental policy benefits of an integrative approach to intertemporal choice. While there is a lot of promise in theory, does it really work in practice? A current application of this approach to index insurance in the horn of Africa suggests that it does (for a detailed description, see Online Supplemental B). In this project, a new economic tool was developed using this framework, iterating between interviews with local farming communities, experimental research, and economic modeling. This process required significant time, effort, and adaptation, but the result has been a huge success, accomplishing much more than would have been possible through any one discipline.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.gloenvcha.2012.05.003.

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