



## The entrepreneur–environment nexus: Uncertainty, innovation, and allocation

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### ABSTRACT

We build upon a recent stream of research that has proposed entrepreneurship as a solution to, rather than a cause of, environmental degradation. Our proposition is that under certain conditions entrepreneurs are likely to supplement, or surpass, the efforts of governments, NGOs and existing firms to achieve environmental sustainability. Entrepreneurs can contribute to solving environmental problems through helping extant institutions in achieving their goals and by creating new, more environmentally sustainable products, services and institutions. Our model illustrates how entrepreneurs 1) address environmental uncertainty, 2) provide innovation and 3) engage in resource allocation to address environmental degradation.

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### 1. Executive summary

This article builds upon a recent stream of research that has proposed entrepreneurship as a solution to, rather than a cause of, environmental degradation. We present a model outlining how entrepreneurial action can address fundamental factors of environmental degradation. We examine environmental degradation through the lens of entrepreneurship theory and argue that uncertainty, innovation and resource allocation all have direct bearing on environmental problems. We then present a theory outlining under what conditions entrepreneurial action will address each of these elements, along with illustrative examples of environmentally focused firms and industries.

We make three primary contributions. First, we challenge the common notion that there is an inherent trade-off between environmental and economic goods. Although there has been recent work which demonstrates how large firms can gain competitive advantage through “greening” (Esty and Winston 2006; Willard 2002) little has been said about entrepreneurs’ role in the environmental realm. Second, although there has been recent interest in the concept of environmental or sustainable entrepreneurship, *under what conditions* and *how* entrepreneurial action can address such problems remains unclear. We distill our analysis into empirically testable propositions which outline the expected relationships between entrepreneurial action and environmental problems. Finally, the role of environmental entrepreneurs has been primarily described from an economic perspective (Dean and McMullen 2007). We build on this literature by taking a broader, more philosophical view of the role of the entrepreneur in addressing environmental problems.

For theory, our research advances the literature on environmental entrepreneurship by offering a framework which relates the fundamental drivers of entrepreneurship and environmental degradation. For practice, it presents a view that embraces the potential of entrepreneurship to supplement regulation, corporate social responsibility and activism in resolving environmental problems. Entrepreneurs can supplement the effectiveness of incumbent firms and institutions, but they can also create a new world through doing things existing firms and institutions do not.

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By demonstrating how entrepreneurial and ecological goals can align, this article provides a useful framework for managers, policy makers and entrepreneurs struggling to understand how to address the problem of environmental degradation.

## 2. Introduction

Environmentalists commonly perceive the intersection of business and the natural environment as a zero-sum game where nature loses every time (Carson et al., 2003; Flannery, 2005). No demonstrations have been held by Greenpeace to support free markets, and seldom will anyone take up housing in a tree to ensure that entrepreneurs have access to funding. A common view is that business, especially the establishment of new business, does little to ensure or increase the social justice of providing long-term renewable resources for future generations (Quinn, 1992). But this view may not be as accurate as once believed.

Because current theories on environmental degradation do not adequately address the entrepreneurial role in addressing the uncertainty of environmental problems, creating innovations to solve them and allocating diverse resources and preferences, entrepreneurship offers a complementary vantage point. From an entrepreneurship perspective, the problem of environmental degradation represents an opportunity for new value creation. In this article we seek to address under what conditions entrepreneurial action will address the opportunity of resolving environmental issues while creating economic and ecological value.

To examine this question we build on a recent stream of research that has proposed entrepreneurship as a solution to, rather than a cause of, environmental degradation (Cohen and Winn, 2007; Dean and McMullen, 2007; Larson, 2005). First, we look at the incentive sets for firms to engage in creating environmentally beneficial products and services. We then examine environmental degradation through the lens of entrepreneurship theory. We develop a model which illustrates how entrepreneurs 1) address environmental uncertainty, 2) provide innovation and 3) engage in resource allocation to address environmental degradation. Our arguments were developed from the literature, as well as from exploratory conversations with executives in the renewable energy and green building industries. We utilize quotes from some of these conversations to help bring our theory to life. We do not use them to develop or prove our theory; they simply illustrate the concepts embedded within our theory. We have provided Appendix A which outlines these discussions, a subset of which we took quotes from.

This article makes three contributions to the literature on entrepreneurship and sustainable development. First, we challenge the common notion that there is an inherent trade-off between environmental and economic goods. Although there has been recent work which demonstrates how large firms can gain competitive advantage through “greening” (Esty and Winston, 2006; King and Lenox, 2001; Willard, 2002) and the role of collective activism in encouraging firms to act (Sine and Lee, 2007), little has been said about the entrepreneurial role in correcting environmental degradation. Second, although there has been some recent interest in the concept of environmental or sustainable entrepreneurship, under what conditions and using what methods entrepreneurial action can address such problems remains unclear. We distill our analysis into empirically testable propositions which outline the expected relationships between entrepreneurial firms, incumbent firms and environmental problems. Finally, the role of environmental entrepreneurs has been primarily described from an economic perspective, focused on market failure (Cohen and Winn, 2007; Dean and McMullen, 2007). We supplement this literature by taking a broader, more philosophical view of the role of the entrepreneur in addressing environmental problems.

In recent years, much has been written about incorporating concern for the natural environment into corporate goals (for an overview, see Jermier et al. (2006)). Traditionally, much of the focus has been on how existing companies can move towards environmental sustainability, encouraged by either regulation or activism (Hart and Milstein, 2003; Porter and van der Linde, 1995; Reinhardt, 2000; Shrivastava, 1995). Our focus is on factors of entrepreneurial action and how environmental degradation can be addressed by each one. By supplementing the corporate social responsibility literature (Starik and Marcus, 2000) and focusing on the role of the entrepreneur, entrepreneurship scholars can make a unique theoretical and empirical contribution to addressing pressing environmental problems.

## 3. Theoretical development

Environmental issues can have a powerful influence on our society and business. Economic development has contributed to many of the environmental issues our society faces (IPCC, 2007c; United Nations, 2005) including climate change, ozone decline, nuclear radiation, industrial toxins and widespread air and water pollution (Cohen and Winn, 2007; IPCC, 2007a,b,c; United Nations, 1992, 1999, 2004, 2005). Efforts to address these issues have generally oriented around four incentives to address environmental degradation: 1) governmental regulations and control (the visible hand), 2) stakeholder action (activism in the form of non-governmental organizations and consumers), 3) ethical motivation (corporate social responsibility), 4) competitive advantage (realizing reduced costs or increased revenue through environmental innovations). We review each of these traditional incentives below, and propose that an entrepreneurship perspective can augment these views.

### 3.1. Traditional incentives for environmental action

#### 3.1.1. Regulatory action: the visible hand

Over the past 25 years, there has been an accelerated increase in environmental regulation. From 1870 to 1970 only 25 federal environmental laws were enacted in the United States; today there are over 120 in effect (Anastas, 2003). The exponential increase in environmental regulation offers evidence of the belief that laws, measurements, and government supervision are effective mechanisms for curbing environmental degradation. While regulation after the fact may deter some behavior, it is clearly not the

only answer. Despite the massive increase in regulation which has occurred over the past thirty years, environmental degradation persists and, in many areas, has consistently worsened (Anastas, 2003; United Nations, 2005, 2006). Yet, for advocates of the regulation solution, the dominant paradigm is that government is the ideal mechanism for resolving environmental issues (Freeman et al., 2008; Freeman et al., 1999).

### 3.1.2. Stakeholder action: activism

Activism is the perspective of most environmental non-governmental organizations (NGOs). Believing that businesses take inadequate responsibility for environmentally destructive acts, and that governments fail to force the issue as regulators, environmental NGOs seek to work to directly address the issues their members are most concerned with. Environmental NGOs may emphasize conservation (preserving natural resources through protection) such as Ducks Unlimited's efforts to preserve wetlands for waterfowl breeding. Alternatively, they may engage in a direct action (blocking environmental degradation through confrontation) perspective, such as Greenpeace's famous exploits to block whaling ships from their prey. Regardless of the perspective and tactics used, NGOs put the locus of responsibility for environmental issues on public citizens. Environmental NGOs typically derive their philosophical stance from an environmentalist, moral perspective (Hardin, 1982).

Instrumentally, activists will often leverage the tools of government intervention through lobbying, and CSR through partnership to reach their goals. Also, by informing consumers about the environmental impacts of certain firms or products, activists can often enlist consumer support to their cause, exerting market pressure on firms. However, entrepreneurial action has largely been left out of the activist tool box; there are seldom partnerships between NGOs and venture capitalists, firm founders or angel investors.

### 3.1.3. Ethical action: corporate social responsibility

The concept of corporate social responsibility (CSR) originated in 1953 with *Bowen Social Responsibilities of the Business Man* (1953) and has been the topic of lively academic debate ever since (Basu and Palazzo, 2008). CSR is the belief that “business and society are interwoven rather than distinct entities; therefore society has certain expectations for appropriate business behavior and outcomes” (Wood, 1991).

From an environmental perspective the key principle is one of private responsibility, or the idea that businesses are responsible for problems they cause or have associations with (Starik and Marcus, 2000). For example, a paper manufacturer is responsible for managing the effects of its effluent into rivers, auto manufacturers are responsible for managing the air pollution caused by their products, and farms are responsible for the side effects of the pesticides they use. While CSR offers a compelling approach for many social problems, when dealing with environmental issues such as carbon emissions or toxic waste, it is inherently reactive, often focused on doing “less bad” rather than more good (Aguilera et al., 2007). The perspective of CSR squarely places the burden of environmental issues with corporations for ethical reasons, regardless of regulatory or economic incentives.

### 3.1.4. Corporate action: cost savings and differentiation

Firms are in a constant quest for competitive advantage. To the extent the adoption of environmentally friendly practices can reduce costs or risk, or create differentiation from competitors, firms may be motivated to do so. In a recent review piece, Ambec and Lanoie (2008) outline 7 mechanisms by which firms may be motivated to address environmental degradation: (a) better access to markets; (b) differentiating products; (c) selling pollution-control technology; (d) risk management; (e) cost of material; (f) cost of capital; and (g) cost of labor. In these cases, there may be no need for regulatory change, ethical motivation or stakeholder action in order for change to take place. However, the review concludes that there is little evidence of firms achieving revenues from environmental differentiation (Ambec and Lanoie, 2008). On the other hand, there has been a clear relationship demonstrated between the adoption of more efficient, lean processes and the reduction of pollution in several cases (King and Lenox, 2001), with perhaps the most famous example being 3M's Pollution Prevention Pays(3P) program.

From 1975 to 1989, 3M saved over \$500 million through this program, while preventing 500,000 tons of pollution (Shrivastava, 1995); as of 2004, the company puts its total cost savings at \$1 billion and pollution prevention at 2.2 billion pounds (3M, 2004). As demonstrated by a split-adjusted stock price increase from \$1.96 to \$77.86 over the past 30 years, this commitment does not appear to have inhibited 3M's competitiveness; in fact, CEO W. James McNerny cites “a combination of solid top-line growth combined with continued improvement in operational efficiency” which has been driven to a large extent by the 3P program (3M, 2004).

As the 3M example demonstrates, firms can be economically motivated to engage in reducing their impacts on the natural environment, but it is equally clear that this does not happen in every case. There are often trade-offs to be made, and many firms have been unable to find the economic rationale for reducing their environmental negative externalities. While regulation, responsibility, stakeholder action, efficiency and differentiation may motivate incumbent firms to change their practices, these incentives have not led to the resolution of environmental problems. We suggest the time is ripe for considering the expansion of our options to more adequately consider entrepreneurial action. As we will illustrate, entrepreneurs act under a different set of trade-offs and incentives, expanding the realm of potential solutions.

## 3.2. Entrepreneurship: uncertainty, innovation and resource distribution

We define the act of entrepreneurship as one of discovering and evaluating opportunity (Shane, 2004; Shane and Venkataraman, 2000) as well as creating new opportunities and possibilities (Sarasvathy, 2001; Sarasvathy and Venkataraman, 2009; Sarasvathy and Dew, 2005; Venkataraman, 1997). Entrepreneurs can contribute to solving environmental problems by

1) contributing to helping extant institutions reviewed above in achieving their goals, and 2) creating new, more environmentally sustainable products, services and institutions through doing things incumbent institutions do not, and cannot do. Fig. 1 maps our review of the incentives for environmentally beneficial actions and how entrepreneurship can play a role.

Environmental entrepreneurs may address the found world, but they can also make a new one (Sarasvathy and Venkataraman, 2009). When entrepreneurship is viewed this way, it is inherently concerned with solving problems of uncertainty, innovation, and resource allocation. These three elements represent the key areas in which entrepreneurs uniquely act, and thus, represent the keys to clarifying the role of entrepreneurs versus other societal actors. Canonical theories of entrepreneurship show how entrepreneurs take on uncertainty (Knight, 1921), provide innovation (Schumpeter, 1942) and engage in the allocation of scarce resources (Hayek, 1945; Hayek, 1968). We submit that the entrepreneur's role should be similar in the environmental realm. Entrepreneurship is the process of addressing these three factors for the creation of personal wealth and societal benefit (Venkataraman, 2002). In the following section, we briefly review each of these concepts and how each relates to environmental degradation.

### 3.2.1. Uncertainty

Following Knight, we differentiate “risk”, defined as a measurable unknown to which we can assign probabilities, and can be dealt with through various means of insurance, from “uncertainty”, or risks we cannot assign probability to or predict in an accurate manner (Knight, 1921). While some environmental issues could be construed as risk, such as the emission of known carcinogens, larger environmental dilemmas, such as human-induced climate change, *inherently involve uncertainty*. Despite scientific consensus that human action is causing climate change (IPCC, 2007c), it is impossible to predict what effects such changes will have; the effects all depend on future, unknowable actions. In this article we are concerned with issues, like climate change, that are cast as problems for continuing sustainability, which could hinder the options of “future generations” (WCED, 1987). If there was certainty around the inability for the Earth's water supply to support our projected population, action would follow. If there was certainty around the ability for new technologies to enable production of enough clean water for growing populations, no action would be required. But, there can be no certainty on such matters. Therefore, there is not only uncertainty around the existence and severity of some environmental problems, but also uncertainty about the best methods to address these problems and the consequences of various solutions. Because issues of sustainability deal with future options, the solution offered must address uncertainty and create action in the face of ambiguity.

### 3.2.2. Innovation

Many believe that environmental degradation has gone too far for conservation practices to offer solutions, and that the negative effects of human activity on ecosystems require massive innovation to be addressed (Hawken, 1995; Larson, 2000b). In this view, conservation theories are viewed as necessary, but almost passé. We suggest innovation as an alternative to “returning to a simpler time.” In order to solve current environmental issues, current ways of life must be evolved by new, innovative methods of living and conducting business. In the realm of environmental issues, we define innovation more broadly than the Schumpeterian role of the entrepreneur to “reform or revolutionize the pattern of production by exploiting an invention or, more generally, an untried technological possibility” while improving the production of or creating new products (Schumpeter, 1942). For our analysis innovation includes not only technological advancements that allow for reduced environmental degradation, but also innovations in the formation of new markets and the distribution of information to consumers (Dean and McMullen, 2007) and new methods of organizing (Casson, 1982). Environmental problems will not be solved only by innovations which create new products and services, but also by creating new ways for society to answer the question of “How should we live?” (Gladwin and Kennelly, 1995).

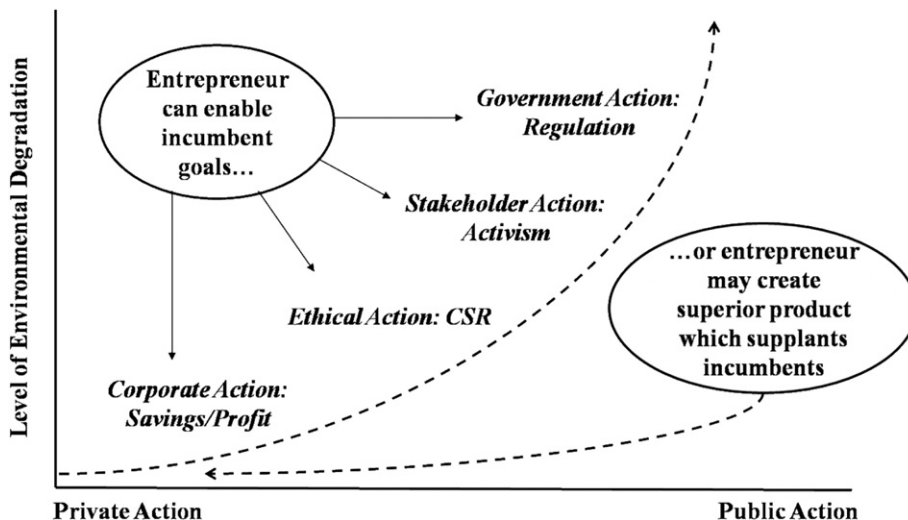


Fig. 1. The opportunity space for environmental entrepreneurship.

### 3.2.3. Resource allocation

Many environmental problems are inherently problems of resource distribution and allocation. Solutions must assure that there is accurate information available to individuals in order for them to make environmentally sustainable decisions and place value on limited natural resources (Hawken et al., 1999; Hayek, 1945). The exclusion of negative externalities, misallocation of resources, and resultant poverty and suffering must be addressed in order for solutions to be found (United Nations, 1999, 2004, 2005). While entrepreneurship is an effective tool for solving allocation problems, recent history suggests that it is most effective under conditions of political freedom and decentralized power (Shane, 2004). Thus, for entrepreneurial solutions to environmental problems to emerge, a political environment maximizing experimentation would seem to be one critical component. Unfortunately, in many cases the legislation of one solution can lead to a lack of accurate pricing. For example, national forests in the U.S. have been severely decimated since coming under control of the U.S. Forest Service not because of environmental threats, but because of unprofitable and mismanaged logging (Anderson and Leal, 2001).

Successful entrepreneurs solve a problem for some members of society; that is why they are rewarded, financially with profits, and socially with prestige, and that is why their firms succeed. As environmental degradation is one of the most complex and pressing issues faced by society today, it seems reasonable that a process which reduces uncertainty, increases and facilitates innovation, and increases efficiency in resource distribution would be worthy of closer examination. In the following section we review in greater detail the three factors of entrepreneurial action and how each might have an impact on environmental problems to address three puzzles: 1) When will entrepreneurial firms address uncertainty to enable incumbent firms to reduce environmental degradation? 2) When are environmental innovations more likely to come from entrepreneurial rather than incumbent firms? and 3) What are the political and institutional conditions which will enable environmental entrepreneurs to perform these roles?

### 3.3. Dealing with the ultimate uncertainty

In this section we attempt to detail how entrepreneurial firms address uncertainty to assist incumbent firms in adopting environmentally beneficial practices. In this way, entrepreneurs can interact with the found world to move towards superior environmental sustainability. Environmental issues are, by their nature, uncertain; the future is unknowable, and the framing of environmental issues occurs in a future context. The exception is in the realm of regulation addressing clearly defined and well understood problems (i.e. Exxon Valdez oil spill, regulation against chlorofluorocarbons (CFCs) to reduce ozone depletion, hunting laws focused on conserving game). The larger, more intractable environmental issues, such as climate change, are based on forecasts and beliefs about what will occur in the future (Kluger, 2006). As such, they are open to debate, and often stymied by the inability of governmental and corporate bodies to act in the face of ambiguity; despite mounting evidence, a proactive stance is stymied because of the uncertainty of future events. In order to find solutions to problems such as global warming, action in the face of ambiguity will be an essential ingredient.

For established firms, ambiguity is not often a welcome condition. Incumbent firms are subject to strong inertial forces which make it difficult for them to alter their strategy, even in the face of public demand for environmentally beneficial goods. Organizational inertia is caused by both internal and external influences. First, internal factors, such as sunk costs in plants and equipment and personnel which are specialized towards the production of current goods and services, can lead to competency traps in which a firm becomes fixed on doing on continuing down a path in which it has proven abilities (March and Simon, 1958). When this occurs, there is a tendency towards routines (March and Simon, 1958) and these precedents can become normative standards (Hannan and Freeman, 1984). Second, external factors such as legal barriers to exit or entry, loss of legitimacy, and relationships with other organizations can all inhibit a change in direction by incumbent firms.

Even when incumbent firms do attempt to change, the context of environmental problems is likely to cause “loose coupling” of intentions and outcomes. When there is a diversity of interests amongst members of an organization, and greater uncertainty around the proposed changes, adaptation may be more difficult to achieve, and will be beholden to internal politics (Hannan and Freeman, 1984). In the case of change to the production of more environmentally friendly products and services, the greater the current environmental harm of the organization's activities, the more likely there will be inherent conflict amongst organization members seeking change. Because many members of the organization have a vested interest in maintaining the “core” of the organizational identity built around current products and services, and because creating more environmentally friendly alternatives challenges the normative legitimacy of current practices, movement towards creating environmentally superior products and services may be even more difficult to achieve than other types of changes.

To claim that the inertia inherent within large organizations will exert pressure against the creation of new products and services which reduce environmental degradation is not the same as claiming large organizations will *never* produce environmentally superior products. The literatures on intrapreneurship (Antoncic and Hisrich, 2001), exploration and exploitation (March, 1991), innovation (Ahuja et al., 2008) and real options (McGrath, 1997) have each demonstrated that new, innovative products can emerge from existing firms. However, existing firms are hard pressed to introduce new products and services which deal with regulations which may or may not be implemented, regarding environmental outcomes which may or may not happen. Because it is unclear that an environmentally friendly strategy will be rewarded by governments, consumers and markets, there is often limited change by those firms which have profitable and established revenue streams at risk (Hage, 1999; Hannan and Freeman, 1984).

Exploration for entrepreneurial opportunities happens by definition under circumstances of uncertainty; research has demonstrated the preference of expert entrepreneurs for conditions of uncertainty (Dew et al., 2008; Sarasvathy, 2001;

Sarasvathy, 2008). Read and his colleagues have demonstrated that when entrepreneurs engage in non-predictive action under conditions of uncertainty, they may also create more successful ventures (Read et al., 2009). Entrepreneurs' ability to deal with uncertainty addresses ecological issues in two ways: first, entrepreneurial action is driven by uncertainty rather than stymied by it, and second, through this action, an alternative future is created rather than anticipated (Knight, 1921; Sarasvathy, 2001; Sarasvathy and Venkataraman, 2009; Sarasvathy and Dew, 2005). Through taking action in the face of uncertainty, entrepreneurial action transforms uncertainty into opportunity. Entrepreneurial action often cannot be based on known facts, as the opportunity for exploration relies on the existence of true uncertainty, unknown factors which cannot be optimized (Knight, 1921).

### 3.3.1. Addressing environmental uncertainty

Entrepreneurs are not motivated by uncertainty, but seek to address the underlying technical challenges inherent in uncertainty. This process can be operative in terms of environmental uncertainty just as it is operative in terms of economic uncertainty. By embracing uncertainty, and privatizing it through accepting risk, entrepreneurs are able to simultaneously create value and profit from the creative process. The uncertainty surrounding environmental problems is reduced when entrepreneurs absorb (privatize) risk, and act. When new businesses are founded and new innovations brought to market, a selection process is activated, in which consumers' choice is expanded, but this process may require many trials and errors (Aldrich, 1999). The evolutionary selection process is generated when new organizations enter markets to take advantage of new opportunities (Hannan and Freeman, 1984). As reviewed above, incumbent firms have a much greater opportunity cost when pursuing new opportunity, and they stand to lose more by cannibalizing existing businesses, thus, uncertainty is an unwelcome factor. For the entrepreneur, uncertainty presents the opportunity to begin the selection process anew. When entrepreneurial action occurs, new information and options are generated, and ultimately new institutions which can efficiently embody uncertainty are created in the form of a new venture.

Entrepreneurial action privatizes risk by making an initial resource investment in products and services that may or may not produce profits. Entrepreneurs can be viewed as individuals who have a way of producing *value* out of *uncertainty*. While this process could take place in incumbent firms, past work has shown that existing firms tend to engage in exploitation and improvement of existing practices, whereas new firms tend to produce radical innovations that destroy existing capabilities (Tushman and Anderson, 1986). Entrepreneurial income is not a "reward" for these acts; income is derived from the residual left from the sale of product once the factors of production costs have been reduced (Knight, 1921). However, this residual is *maximized by the uncertainty* which prevails around future prices of both the product of production and the labor inputs to the product. In other words, greater uncertainty can lead to greater residuals and greater rewards.

Because environmental issues are surrounded by uncertainty, they represent large opportunities for entrepreneurial activity. Entrepreneurs allocate resources towards resolving issues that have not been addressed by other means. For example, it has not been clear in the past that consumers would pay a premium for household cleaning products that utilized a non-toxic, environmentally friendly chemical composition. However, Method Home Products Inc. (Method) was founded on formulas emphasizing the environmental and emotional aspects of household cleaners (Clifford, 2006). Because there was uncertainty around the viability of the market for these products, the founders of Method were able to exploit the inaction by larger, established firms and engage in the necessary research to formulate safe and effective cleaning products (Larson, 2007). Through bringing together chemical engineers, cutting edge designers and the nationwide distribution power of Target stores, the founding team brought disparate resources to bear on a critical environmental issue. By 2007 the company had 45 employees and annual revenues of over \$40 million (Clifford, 2006). The uncertainty that surrounded the market for these products has been *reduced because of the willingness of entrepreneurs to make a "risky" bet*.

Through their actions, environmental entrepreneurs can also provide new information to society regarding the costs and benefits of solutions while also generating new options. In the case of Method, the small company's success has demonstrated that consumers will pay a premium for more ecologically sound cleaning products, *if they are marketed and distributed effectively*. Their action triggered the selection process, and forced producers to reconsider their environmental impacts, and for consumers to change their perceptions regarding the types of products they purchase.

Renewable Energy Certificates (RECs) are another example of such a risky bet. A REC allows firms and individuals to support the production of renewable energy through purchasing certificates for the amount of non-renewable energy they use. In the year 2000, the demand for this product was unclear at best. The founder of a REC firm describes the situation:

In fact, the environmental organization I was working for was struggling to find a way to be relevant in a renewable energy market. And we discovered that, you know, a lot of people just didn't have choice about buying green power. There was no way to do it. If your utility didn't offer green power, you couldn't get green power.

There was little clarity about the demand for green power, much less the desire for RECs when entrepreneurship began in the area. So while the inability for individuals to choose renewable energy represented an opportunity, large existing power companies did not offer such services. By 2005, there were 3890 MW h of RECs sold, representing an average annual growth rate of 144% (Gillenwater, 2008) and RECs are being purchased by many Fortune 500 corporations including Dell, PepsiCo, FedEx and Staples, subsidizing the development of renewable energy sources.

These examples illustrate our first proposition:

**Proposition 1.** *The higher the entry rate of new firms providing environmental information, the less uncertainty incumbent firms will perceive regarding environmental degradation and more effectively they will address environmental issues.*

Entrepreneurship is not about action within existing frameworks, but rather consists of creating new frameworks through the creative process of new means-end relationships (Shane, 2004). Entrepreneurial action can address opportunities when there is no clarity around the best path forward. Through attempting new solutions to environmental problems, entrepreneurs can provide valuable information to society. Through engaging in bets about the ability of a product or service to address an environmental issue, they provide information about the costs and benefits of solutions, and about what works and what does not. When successful, these experiments create new options for resolving issues.

In addition to the uncertainty of demand outlined above, there are at least two types of uncertainty that contribute the inability of large firms to address environmental problems. First, the benefits of environmentally beneficial products unknown to consumers; there is asymmetry in the information between producers and consumers regarding the environmental practices behind a product or service. Second, even when larger firms wish to engage in more environmentally friendly practices, they also require products and services to help them do so. They need alternatives in their supply chain to enable environmentally proactive change. The investment in moving to environmentally superior practices without such a supplier network is often too prohibitive and uncertain.

The evolution of the U.S. green building industry provides an example of how entrepreneurial action can address both of these uncertainties. Green building is defined as “design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants” (USGBC, 2004). Broadly speaking, green buildings are high performance properties constructed with consideration of their impact on human health and the natural environment. Green buildings are designed to use less energy and thus represent the efficiency side of renewable energy (Yudelson, 2007). While the U.S. construction market has fallen upon hard times, a surge in green building has provided a “notable shot in the arm”, continuing to provide growth in a struggling industry (National Association of Homebuilders, 2008). The founder of a green real estate office said:

I mean, I know that's where my interest is and that's where, you know, I want to make money. That's where I see my future, is in the world of green building. Is it always going to be selling and buying? Is it always going to be building? You know, I don't know. But I think... at least I'm trying to kind of position myself so, you know, I can go in a couple of different directions, you know, wherever the market... needs me.

Two entrepreneurial acts have driven this growth. First, in an act of institutional entrepreneurship (DiMaggio and Powell, 1983) the US Green Building Council, founded by a small group of architects, created the Leadership in Energy and Environmental Design (LEED) standard which allows construction customers to assess the environmental benefits of a building. Second, a vast network of new firms has sprung up, offering an array of services from LEED consulting to the rooftop solar energy systems (Yudelson, 2007). These two modes of entrepreneurial action have acted as intermediaries which allow larger firms to invest in adopting green building.

The adoption of new institutional standards by incumbent firms is important because it acts to legitimize the standard and new environmentally productive practices (Suchman, 1995; Suddaby and Greenwood, 2005). Why would incumbent firms require the help of intermediaries? Couldn't they simply adopt such practices, triggered by competitive pressures? From our view, larger, incumbent firms may require intermediaries in many cases because they have historical constraints; they may be subject to competency traps which hold them to outdated practices. Incumbent firms are likely to perceive that they must change their direction in the face of new entrants (Barnett and Hansen, 1996) and they may have greater resources to put towards creating new products and services. However, it is unlikely that they will be able to create such intermediary services because a) they have a sunk cost in the current products and practices, b) the investment in these types of services and products may not be immediately scalable, and c) because of the overall uncertainty of the environmental context, moving into such products may competitively and normatively undermine core offerings (Barnett and Hansen, 1996; Hage, 1999; Hannan and Freeman, 1984).

Intermediaries can also benefit new ventures which seek to establish environmentally preferable alternatives. Intermediary services, such as LEED registration, increase the legitimacy (Scott, 1995; Suchman, 1995; Suddaby and Greenwood, 2005) of environmentally sound practices, thus reducing the ‘liability of newness’ (Stinchcombe, 1965) for subsequent new entrants and increasing the likelihood that new firms be founded offering environmentally superior products.

This leads to our next two propositions:

**Proposition 2a.** *The higher the number of entrepreneurial intermediaries which provide information and services supporting environmentally superior products, the less perceived uncertainty there will be about these products, and the more likely it is that incumbent firms will offer such products.*

**Proposition 2b.** *The higher the number of entrepreneurial intermediaries which provide information and services supporting environmentally superior products, the less perceived uncertainty there will be about these products, and the more likely it is that new firms will emerge to offer such products.*

Even with reduced information asymmetry regarding environmentally beneficial products and services, it seems unlikely that environmental crises will be resolved through simple conservation or by just doing more with less; in the case of global climate change, it may be a matter of minimizing further damage rather than conserving resources (IPCC, 2007b). Sustainable solutions will inherently involve massive innovation and mind-set changes that cannot be anticipated. Entrepreneurs who rely on their beliefs and knowledge to create a different future will be a key element of bringing about the innovations required to address

environmental degradation. In doing so, they may replace incumbent firms, rather than assisting them. In the following section, we theorize on the conditions that will favor the emergence of entrepreneurial innovations that can create environmentally superior products and services successfully replacing those currently offered.

### 3.4. Innovation through creative destruction

Environmental innovations from existing firms have received a great deal of attention from management theorists (for an overview see [Berchicci and King \(2007\)](#)). We wish to focus this analysis on the role entrepreneurship plays in creating these innovations in situations where incumbent firms have failed to do so. In this section we seek to understand when entrepreneurial firms will create discontinuous innovations which successfully compete with the offerings of existing firms. The innovative role of the entrepreneur was first defined by Schumpeter when he wrote that “new consumers' goods, the new methods of production, or transportation, the new markets” not only evolve the capitalist system, but they are a force that “incessantly revolutionizes the economic structure from within, incessantly destroying the new one, incessantly creating a new one” (1942). Creative destruction has been the focus of many entrepreneurial theories, driving much of the literature to focus on the role of entrepreneurs in bringing technological and environmental innovation to the world ([Larson, 2000a, 2005](#); [Larson, 2000b](#)). The role of the innovating entrepreneur is not only technological innovation, but also evolving and innovating societal and institutional concepts and ideas ([Aldrich and Fiol, 1994](#); [Sarasvathy and Venkataraman, 2009](#)). As Hardin points out in his classic work, environmental problems cannot be solved by a technical solution that “requires a change only in the techniques of the natural sciences, demanding little or nothing in the way of change in human values or ideas of morality” (1968). Through creating new firms, as well as markets, products, information sources and institutions, environmental entrepreneurs can create new opportunity and also societal change.

Entrepreneurial innovation may “reform or revolutionize industries by exploiting an invention or an untried technological possibility” while improving the production of or creating a new product ([Schumpeter, 1942](#)). However, empirical tests of both Schumpeter's early theory of creative destruction, and late theory of the need for large firms to provide innovation are inconclusive (for a review see [Ahuja et al. \(2008\)](#)). Environmental entrepreneurship could provide a rich context for additional theorizing and empirical work. As environmental issues represent an area in which we clearly have not advanced technology to the point of diminishing returns on innovation, innovation offers a framework for addressing these issues. Because environmental entrepreneurship is inherently tied not only to the creation of new products and services, but also to the public good of reducing environmental degradation, we can advance new answers to the question “When will innovation come from new versus existing firms?” In the sections that follow, we theorize on conditions in which entrepreneurial environmental innovations may supplant existing firms.

#### 3.4.1. Environmental innovation and entrepreneurial action

Innovations could emerge from within NGOs, government or incumbent firms, but due to organizational inertia and the inherently contradictory nature of firms producing both environmentally harmful products, and environmentally beneficial alternatives, it seems likely that innovations may emerge from new firms.

In the context of environmental entrepreneurship in existing industries, the process of creative destruction plays an important role. For example, if entrepreneurs are able to successfully create energy alternatives that provides a cheap, reliable, and endless supply of energy, it seems likely that the existing power industry would be rendered obsolete. Surely existing power distributors and fossil fuel miners may evolve, but the end effect would be the same; the destruction of a previously existing industry while reducing environmental degradation. Just as in more familiar examples of creative destruction, when entrepreneurs enter a sector built on environmentally unsustainable practices, the likely outcome is that industries will indeed be destroyed, although in many cases, this will be a prolonged process ([Pernick and Wilder, 2007](#)). Climate change is an area in which entrepreneurs are creating innovations that could erode existing industries. As human-induced climate change is generally associated with the expulsion of carbon, primarily due to power generation and automobiles, a surge in entrepreneurial activity has taken place in renewable energy ([Pernick and Wilder, 2007](#)).

Through engaging in the process of initiating renewable energy projects, entrepreneurs are engaging in experimentation that provides data back to society about the viability of their innovations; producers can create renewable energy at comparable prices to non-renewable resources in many cases, and consumers can now choose to purchase “green” energy if they are concerned with the problem of climate change ([Pernick and Wilder, 2007](#)). Through taking action entrepreneurs can create new markets ([Sarasvathy, 2001](#); [Sarasvathy and Dew, 2005](#)), not merely capitalize on existing ones. Entrepreneurial action is not just about exploiting information asynchronies regarding the value of resources, but also combining resources into new combinations that bring about future goods and services ([Kirzner, 1979](#); [Sarasvathy, 2006](#); [Schumpeter, 1942](#)).

A founder of a solar water heating business described the early years of attempting to establish his business:

Ninety-four percent of the people that were in it when I started got out because it was just so difficult to stay in. But I stayed in and managed to maintain...But, the fact is that it's turning out to... it is the right industry. It's something that's really needed. It was the right choice. But for a long time it was just pure hell. And I mean... It's very difficult. In a lot of industries, if it's a pizza parlor or something or another, you know, if you do a good job you're going to have a successful pizza parlor. But it's not too often you get into something that you don't know is going to be coming into the fore, you know, twenty-plus years from the time you start it.



Today this industry is still made up of a patchwork quilt of small entrepreneurs, but one could anticipate that with rising fuel prices it is on the cusp of expansion. Certainly the rapid adoption of this technology in China portends change on the horizon. The founder of a solar water heating firm in China said, "...the industry is growing so rapidly, the industry's almost at a vertical...it's hard to keep up with the industry's expansion, much less our own expansion."

Solar water heating is an example of an early stage industry where entrepreneurial action is demonstrating viability, and may soon erode market share of traditional manufacturers. Why is this change being driven by small firms and not the larger, incumbent manufacturers? Due to the sunk cost of existing resources, firm size can be a deterrent to the adoption and creation of new technologies (Oster, 1982). Because environmentally beneficial products and services are also likely to cannibalize existing firms' product lines, there is less motivation for firms with a substantial investment in both processes and infrastructure to produce them. In the case of new, simplified technology replacing existing products, even the individual who identifies the opportunity in an existing firm will struggle to gain buy in for their innovation (Dew et al., 2004). This helps explain why the solar hot water industry is not made up of current hot water heater producers, but instead by smaller start-ups who have little to lose and everything to gain by disrupting the market. Because entrance by these new firms will erode market share of existing firms which do not quickly evolve we offer the following proposition:

**Proposition 3.** *In industries in which environmental innovations are likely to supplant existing products, entrepreneurial firms will be more likely than incumbents to introduce these innovations.*

Schumpeter offers a hopeful vision to would-be environmental entrepreneurs in his view that a capitalist society is evolutionary and organic (Schumpeter, 1942). Returning to the example of renewable energy, the opportunity for technological innovation in the energy industry is massive and increasing exponentially. In 2006, renewable energy investing represented more than 9% of total venture capital investing in the US, and represented \$2.9 billion in funding (Pernick and Wilder, 2007). Annual revenue for these technologies has steadily ramped up, growing 39% from \$40 billion in 2005 to \$55 billion in 2006; projections place the potential value of the industry at \$226.5 billion by 2016 (Makower et al., 2007). Solar power in particular is an area which has been flooded with new entries seeking technological breakthroughs. The cost barrier has been the traditional challenge of the solar industry, creating an area ripe with opportunity for the right innovation. One solar firm founder described this climate as:

I'd always been interested in solar...I developed the idea in 2004, just sitting amongst a group of people while speaking about how you could tap into nature to create energy...you look at the potential and just go "Oh my God." You know, it hit me and I was like...there's a lot of energy that's being wasted and should be recaptured.

The public focus on climate change caused by traditional energy sources, and the lack of an economically viable solution in solar power has combined to create an industry of entrepreneurial growth and innovation. Opportunity for innovation is the flipside of environmental degradation; the greater the environmental challenges we face, the greater the opportunity for innovations to address them. However, entrepreneurial start-ups and incumbents are likely to compete in bringing these innovations to market. Under what conditions will entrepreneurs successfully compete with incumbent firms to provide environmentally superior innovations?

As discussed above, environmental opportunities are inherently uncertain; this uncertainty also has implications for the emergence of innovations. Dew et al. (2004) argue that the dispersion of knowledge (Hayek, 1945) and Knightian uncertainty combine to create heterogeneous expectations across individuals regarding the value of entrepreneurial innovations. Thus, it is the nexus of the individual and the opportunity which create the likelihood of an individual founding a firm. We build on Dew et al.'s (2004) work to suggest that the degree to which there is intersubjective agreement within the firm and outside the firm regarding the severity of environmental degradation, and the potential of an innovation to address it, will play a central role in this question. In situations with high intersubjective agreement within and outside a firm about the ability of an innovation to be helpful in addressing environmental problems, we are unlikely to need or see entrepreneurial innovations. For example, when a firm can simultaneously reduce production costs and environmental degradation, there will be little need for entrepreneurial intermediaries or innovators (King and Lenox, 2001).

However, things are not so clear when we come to our most challenging environmental problems, such as human-induced climate change. When there is little intersubjective agreement within existing firms about the value of an opportunity, such as addressing climate change, it is more likely that a new firm will be the only method available for the individual to bring their innovation to market *even if they work at an existing firm* (Dew et al., 2004). In cases in which there is little agreement at the societal level about the value of a given innovation, it is even less likely that an existing firm will act because "the opportunity resides totally in the individual's mind" (Dew et al., 2004). Thus:

**Proposition 4.** *The lower the degree of intersubjective agreement regarding the ability of an innovation to address environmental degradation and create economic profits, the higher the likelihood the innovation will be brought to market by an entrepreneurial rather than incumbent firm.*

We offer two examples to illustrate this proposition and develop more specific formulations: 1) proximity of supply and 2) ethical motivations. First, because of localized markets, some industries will favor environmental entrepreneurs rather than incumbent firms. Proximity of production has emerged as an important factor in the emergence of environmental markets. As

carbon emissions have become of greater concern for consumers and businesses due to human-induced climate change (IPCC, 2007a) localized production of products and services have become of more concern. The demand for local products favors multiple entrepreneurs operating at a small scale to provide a local market, rather than incumbent firms attempting to break out of current distribution systems. For example, the recent emergence of the local foods movement (Salatin, 2007) has been based on the work of social movements to link the transportation of food to harmful carbon emissions, the degradation of land and industrialization of food production (Weber et al., 2008). Similarly, the green building industry focuses on locally sourced materials and the LEED certification program rewards points for the local sourcing of materials (USGBC, 2005). Because locally sourced products are also generally not technological, but rather, business model innovations, they allow entry by entrepreneurs with limited resources.

Time to market can be a critical factor in pushing environmental innovations to a localized market. For example, in the emerging competition to bring biofuels to market, entrepreneurs may struggle to continue funding research while waiting for automobile technology to evolve in support of their fuels. As British Petroleum and other large fossil fuel producers have increasingly invested in biofuel production, small entrepreneurs have seen increasing prices for feedstock. One biofuel entrepreneur describes this process:

The biodiesel industry during the last two years has gone through huge peaks and valleys, mostly because of the feedstock, the price of feedstock and agricultural products... I had written a plan for a 10-million-gallon-a-year plant... So we went to Wall Street... did the dog-and-pony show and they were like, "Ten million gallons a year, we don't want to give you any money. If you have a 50-million-a-year plant..., you know, we'll give you money." And I was like, oh man, how are we going to find the raw material for that?... feedstocks pretty much locked up at that point... So it was just not feasible... that's when I just kind of went back into like the smaller, personal model. Just tried to be self-sustaining.

Because biofuel refinement requires massive economies of scale, long production times, and the creation of new infrastructure it seems unlikely that, in the long term, entrepreneurs will successfully compete with incumbents. However, small, localized markets for locally produced products may enable some entrepreneurs to produce and supply biofuel on a local level. Because localized production is inherently differentiated from current firms' existing activities, even if this opportunity is recognized by managers within existing firms, they are likely to struggle to create intersubjective agreement within the firm (Dew et al., 2004). Thus:

**Proposition 5.** *Environmental entrepreneurs will successfully compete with incumbents when supplying environmentally superior innovations based on localized production.*

While in the biofuel industry solutions are clear and in need of scale, many other environmental opportunities have no clear solution. In the case of unanticipated innovations, it may be more likely that entrepreneurs will produce them than incumbent firms. An evolutionary process of multiple attempts, and failures, to create environmentally beneficial offerings are likely necessary to shift towards an environmentally stable economy (Aldrich, 1999). There is empirical evidence that dissatisfaction with current practices (Shepherd and DeTienne, 2001, 2005) and moral beliefs regarding the legitimacy of current practices (Cliff et al., 2006) can influence both the likelihood of new firm foundings, but also the degree of innovation offered by new firms.

For many environmental entrepreneurs, environmental degradation represents not only an opportunity, but also an ethical issue (York, 2009). Because ethical concerns with current practices can influence innovation, it seems reasonable to assume that discontinuous innovation is likely to emerge from entrepreneurs who are outside of existing industry, and who are motivated to challenge the legitimacy of existing practices. For example, Weber et al. (2008) described how early producers in the grass-fed beef industry founded their businesses to challenge incumbent practices. In such cases, it is more likely that the innovation will be more difficult for existing firms to replicate, due to the inherent challenge of the normative legitimacy of extant practices (Suchman, 1995). Because the entrepreneur's particular set of beliefs and individual knowledge helps them to create the opportunity, it is unlikely that existing firms could achieve intersubjective agreement (Dew et al., 2004). Thus:

**Proposition 6.** *Environmental entrepreneurs will successfully compete with incumbents when bringing ethically motivated environmentally superior innovations to market.*

The opportunity for both technological and informational innovation is typified by current environmental issues. Whether or not these opportunities are addressed will depend on the nexus between a particular entrepreneur's beliefs regarding environmental degradation and the nature of the environmental opportunity (Cliff et al., 2006; Dew et al., 2004; Venkataraman, 1997). Because the innovations which are required are not refinement of existing technologies, but discontinuous innovations which lead to environmentally superior ways of living, it is important that institutional conditions favor such innovations.

### 3.5. Ecological resource allocation

In order for entrepreneurs to act under uncertainty and produce innovation through the application of intuitive and future changing exploration, history has demonstrated a need for political and economic freedom. Country level measures such as those provided by the World Economic Forum have shown measures of political freedom to be positively correlated with self employment and new firm formation (Shane, 2004). Nobel Prize winning Economist Amartya Sen has presented research suggesting that freedom is both the goal of, and the means to, economic development (Sen, 2001).

Some have argued for viewing environmental issues as examples of market failure in which environmental degradation represents opportunities for innovation in the establishment of new technologies, business models and institutions (Cohen and Winn, 2007; Dean and McMullen, 2007). Following this stream of thought, it would appear that in order for these opportunities to be seized, markets must operate openly and with minimal interference (Anderson and Leal, 2001; Hayek, 1945; Hayek, 1968; Lomborg, 2007; Simon, 1998). However, many have argued that without the firm hand of the state intervening, the invisible hand of the market will produce externalities which render the destruction of public goods, including the natural environment (Brown, 2006; Carson et al., 1962; Hardin, 1968). A pragmatic approach could suggest that these arguments create a false duality (Dewey, 1925) between government and market solutions, and create the appearance that we must choose between them. Economist Mancur Olson's concept of "market augmenting government" provides us with a way out of this false choice (Olson, 2000). Olson described both the invalidity of the state/market dichotomy and defines market augmenting government in a seminar on entrepreneurship in 1997:

Now it's customary as we know, to think of markets and government as alternatives. Should the role of the market or the role of the government be larger? And of course we know there are times when governments and markets are alternatives when decisions are made that something should be done by the government or privatized and done by the market and of course that happens. But I would argue that the governments of the successful economies are net market augmenting. That is to say they generate, account for, explain more markets than they replace or repress. Those governments are a source of markets in a big way when economies work well. (Olson in Saravathy, 2000:21)

Olson went on to clearly articulate the characteristics of market augmenting governments; they (a) facilitate trade when a spot market is not available, when "the quid is available at one time and place and the quo at another time and place", (b) provide third party enforcement of contracts and (c) provide financing but not production (Saravathy, 2000). In this section, we expand on Olson's concept to develop the concept of an eco-market augmenting government based on policies which create markets and environmental goods.

Following the idea that market augmenting governments supply funding, but not production, the state could influence the direction of industrial sectors through providing incentives, such as tax breaks, for specific practices. Studies have shown such incentives to have a strong effect on the development of emergent industries including renewable energy (Sine et al., 2005; Sine and Lee, 2007). These types of efforts are selective, and aim to promote particular sectors or practices over others. Thus, state policies which are created to support the adoption of environmentally friendly practices or standards will be expected to have a positive effect on the adoption of those standards.

An additional key role Olson outlined for the state was to provide enforceable contracts. In terms of environmental goods, enforceable contracts can only be made with the help of clear environmental standards and definitions. We turn again to the example of LEED green building certification. Public policy has been created from 2000 to 2008 at the state level incentivizing the adoption of LEED. As of May, 2008, there were 41 state-level policies and incentives for green building enacted (USGBC, 2008). These incentives ranged from tax rebates to expedited permitting processes with the most frequent incentives being payments from utility energy-efficiency programs and direct monetary payment in the form of a grant or rebate (Yudelson Associates, 2007). These programs provided a selective incentive available only to those who adopted the LEED certification program, and thus, would be expected to encourage the adoption of the program. As adoption of LEED has increased, so has the entrepreneurial opportunity for suppliers, consultants and other new ventures in the green building industry (Yudelson Associates, 2007; Yudelson, 2007). Through endorsing voluntary certification standards, the state may help to increase entrepreneurship that addresses environmental degradation. Thus:

**Proposition 7.** *Financial incentives that encourage the adoption of voluntary environmental standards will be positively related to entrepreneurial action that addresses environmental degradation.*

An eco-augmenting state would need to strike a delicate balance between encouraging valuation of the environmental resources, and reducing overall freedom and experimentation. Recall that a clear criteria Olson laid out is that a market augmenting state must produce more markets than it suppresses. Entrepreneurs are particularly susceptible to the effect of regulation which suppresses entry of new products into markets. New firms are resource-constrained and unable to allocate time and capital to managing an onerous regulatory process. Many have pondered how a nation such as the U.S. whose citizens consistently express concern about the natural environment can consistently fail to move towards less environmentally destructive practices (Friedman, 2008). The founder of a renewable energy firm in China described the problem of gaining certification to sell his product in the U.S.:

One thing I should say, and this is a massive, massive, massive problem in the U.S., is that the Solar... the SRCC...which is the Solar Rating Certification Committee, ...They're the ones who administer and manage the whole certification process, which is OG 100 for collectors and OG 300 for systems. Now, we're trying to get our system OG 300 certified, or it will be in the next few months. And they are unbelievably unresponsive....When you think about it, why would you put what can potentially save lots of energy and is a good-quality product... it's going to have to wait 18 months or probably even two years before it can get to market and be legally sold in the U.S. market. And if it was in Europe, you've basically got two months. Two months and I can get it certified.

The central problem of economics is to secure the best use of resources known to any of the members of society, for the best ends that can be identified (Hayek, 1945). This argument addresses a key point of environmental issues; natural resources are not being allocated to their optimal use due to an incomplete calculus. However, governments often struggle to utilize knowledge distributed across a myriad of individuals in “designing an efficient economic system” (Hayek, 1945). Comparing centralized versus distributed control of planning (i.e. socialism versus capitalism), the choice tends to focus on which system would be more efficient, however, efficiency in the allocation of resources often does not include consideration of natural resources such as clean air and safety from an increasingly unstable planetary weather system (Hawken et al., 1999). Thus, the cost–benefit calculation inflates the economic benefits of many choices, and reduces the ecological costs, leading to distorted markets creating the classic market failure of incomplete information (Stern, 2006).

Creating sustainable solutions to the environmental crisis is a large unexploited opportunity. Because of the traditional separation between sustainability and profitability, there is only now an increasing focus by entrepreneurs on solving the environmental problem. In addition, the continuing shortages of resources and increasing societal concern around climate change has driven the price for environmentally friendly solutions higher (Russo, 2003). Through entrepreneurship, those with knowledge of environmental degradation will be able to understand and seize the opportunity for reallocation.

In an industry where non-renewable resources are overutilized, or renewable resources are underutilized, entrepreneurial solutions can be brought to bear in markets that allow for the consideration of all resources. However, in markets under strict command and control systems, the ability for entrepreneurs or existing firms to perform this function is suppressed. For example, U.S. subsidies of ethanol production may suppress the creation of new firms that look for more ecologically sustainable alternative fuels. Strict regulatory requirements for alternative energy plants may suppress the ability for new entrants to initiate production. Supporting incumbent firms may suppress potential future options which cannot be foreseen. These policies can create what architect Bill McDonough refers to as “eco-efficiency” (McDonough and Braungart, 2002), a slowed march to obsolescence rather than the creation of new ideas and solutions.

Thus,

**Proposition 8.** *Regulations which constrain the introduction of new products and services will reduce rates of environmental entrepreneurship, and increase the environmental degradation caused by incumbent firms.*

In our examination of allocation we see a problem of adaptive efficiency (North, 1990) in which maximizing the number of trials, experiments and attempts at new products will maximize the likelihood of success. Entrepreneurial action is the engine of such trials, but to address environmental degradation it relies on an institutional environment which 1) supports the establishment of voluntary environmental standards, 2) provides financial incentives for the adoption of environmentally superior practices and 3) does not favor incumbents through regulatory constraints on new entry.

#### 4. Discussion and conclusion

Our survey of canonical theories of entrepreneurship provides a framework for understanding the contribution of entrepreneurial activity to addressing environmental issues.

Our analysis raises several important implications. First, we illustrated that environmental issues clearly represent the type of opportunity that entrepreneurs have a particular orientation toward. Second, our analysis suggests that environmental entrepreneurship is most effective in for-profit, new ventures. Finally, our propositions imply that the more uncertain and intractable the environmental problem we face, the greater likelihood that entrepreneurs can make a contribution to resolving it. We review these implications in the following section.

##### 4.1. Ecological opportunity

Environmental issues represent a tremendous entrepreneurial opportunity. The time appears right for the creative destruction of unsustainable businesses and paradigms. A recent influx of venture capital funding to the “clean tech” sector is clear evidence of this phenomenon (Pernick and Wilder, 2007). Similar examples abound in other markets typified by environmental challenges. Because we have to some extent reached market equilibrium in our current methods of production, the time is ripe for innovation (Casson, 1982). One way to address environmental dilemmas is through the power of the market to communicate information and motivate the right individuals to bring those innovations about. Through the process of continual discovery fostered by free-market competition, solutions that can help solve the sustainability riddle appear more likely to emerge.

Recent work by Porter and Kramer (2006) has pointed out that the “most important thing a corporation can do for society, for any community, is contribute to a prosperous economy. Governments and NGOs often forget this basic truth”. The realm of environmental degradation is far from outside of this basic truth; it in fact offers the one of the clearest examples of how businesses can produce economic and societal value when social responsibility is perceived as “building shared value” rather than managing risk (Porter and Kramer, 2006).

##### 4.2. For profit for solutions

Our analysis implies that environmental entrepreneurship would benefit from a focus on for-profit action taken to seize opportunities offered by environmental degradation. While NGOs and the government play a role in environmental solutions, our

perspective on entrepreneurship is that of a *for-profit* action. Entrepreneurship theorists can make their greatest contribution by seeking to explain the simultaneous production of economic and ecological goods; that is the unique contribution of entrepreneurship to solving the problem of environmental sustainability.

Centralized planning and control of environmental issues is an exhaustively studied, and to date, largely unsuccessful approach to solving environmental problems (Simon, 1998). In the U.S. for example, the Environmental Protection Agency, the National Forest Service, and the myriad of subsidies given to the oil, coal, and forestry industries have been offered as examples of the failure of government to act as a steward of natural resources (Anderson and Leal, 2001). When governments inappropriately interfere in the market, solutions are slower to emerge, as unsustainable industries are given an advantage (Dean and McMullen, 2007). We argue that the issue of resolving our current crisis is not one of regulation, but of innovation and motivation. To facilitate these processes, many actors must be aware of differences in market prices, and entrepreneurs must have a profit incentive to act on them. The lure of profit helps to not only encourage entrepreneurs, but also makes them alert to the opportunities that exist (Kirzner, 1979).

#### 4.3. Big problems, small solutions

Bringing these ideas together, we see that the greater the uncertainty, the higher the opportunity for innovations. The less restrictive regulation is on new solutions, the more likely we are to see innovations which address environmental problems emerge through entrepreneurial action. The most intractable environmental problems are surrounded by the greatest uncertainty. Human-induced climate change is one obvious example, but overfishing, the effect of pervasive toxins in our society, and species extinction are others.

Our analysis suggests that because the environmental uncertainty of these problems translates into business uncertainty for existing firms, they are unlikely to act. The remedy for the situation then is the creative destruction of harmful industries by environmental entrepreneurship. However, regulations that put in place command and control mechanisms to deal with these problems have not only proven to be largely ineffective, but they can reduce uncertainty and entrepreneurial incentives. While clearly command and control regulation is needed for known, well understood environmental problems, for our larger, more intractable and uncertain problems, these regulations could systematically repress our best bet for solutions. Entrepreneurs must be granted the freedom to address the found world in a way that enables existing firms and goals to meet their goals, but they should also be encouraged to create a new, more environmentally sustainable world (Sarasvathy and Venkataraman, 2009). Rather than seeking to control these factors, our analysis suggests that we should focus on maximizing the conditions for multiple experiments, thus increasing our odds to find new solutions.

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#### Appendix A. Exploratory conversations

	Firm type	Principal activities	No. of discussions	Firm stage
1	Wind energy	Developed technology for wind energy turbines	3	Defunct
2	Biomass	Developing technology for rural energy production and distribution in emerging economies	2	Startup
3	Biomass	Creates and implements co-generation plants for industry	1	Growth
4	Biofuel	Refines and markets biodiesel	1	Startup
5	Thermal solar	Manufactures thermal solar water heating systems	2	Growth
6	Carbon consulting	Markets renewable energy credits, consulting and direct purchase of renewable energy	2	Growth
7	Magnetic turbines	Developed patented technology for magnetic turbines	2	Startup
8	Small-scale wind	Develop home-based wind energy	1	Pre-venture
9	Biomass	Develops and constructs biogas energy production units	1	Growth
10	Geothermal	Project management and engineering consultation	1	Mature
11	Thermal solar	Manufactures thermal solar water heating systems	2	Growth
12	Renewable energy investing	Makes early stage investments in renewable energy firms	3	Mature
13	Marine energy	Develops large-scale marine installations	1	Growth
14	Solar	Installs home photovoltaic systems	1	Growth
15	Solar	Builds utility-size concentrated solar power systems	1	Growth
16	Marine energy	Builds small-scale marine energy generators	1	Startup
17	Biodiesel	Produced biodiesel	2	Startup
18	Solar	Develops new solar technology	2	Growth
19	Renewable fuels	Renewable fuel stations	1	Startup
20	Green building	Consults on energy efficiency of new construction	1	Startup
Total			31	

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