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CROWDING OUT EFFECTS OF WELL-INTENDED ENVIRONMENTAL POLICIES

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Abstract

Using a computer simulation model spanning more than a century, this study explores the potential "crowding out" effects that arise when protective environmental policies inadvertently reduce the financial opportunities available to entrepreneurs. The principal aim is to examine the extent to which the quantity and quality of innovations produced by entrepreneurs are impacted by government policies that are intended to protect the environment. Framing these dynamics in the context of the entrepreneurship pillars developed by Baumol, Litan, and Schramm (2007), our findings suggest that government policies unintendly limiting the Coasian or Schumpertarian rents available to entrepreneurs will have an adverse long-term effect on firm formations, average firm fitness, entrepreneurial innovativeness and the achievement of sustainable growth.

Introduction

The purpose of this paper is to examine well-intended environmental policies in order to assess the extent to which they facilitate or inhibit environmentally desirable entrepreneurial activities. While existing literature, primarily emanating from environmental economics (Popp, 2010; Jaffe and Stavins, 1999; Jaffe and Palmer, 1997; Newell; Jennings and Zandbergen, 1995) and corporate social responsibility (e.g. Bansal and Roth, 2000; Hoffman, 1999; Shrivastava, 1995) has provided a rich body of work relating public policy to corporate behaviors by incumbent firms, there are no detailed accounts of what happens when environmental policies are successful in achieving their immediate aims but run the risk of failing longer term by fundamentally changing the incentive structures (Baumol, 1993) and property rights (Anderson and McChesney, 2003; Bromley, 1991) impacting new generations of innovating entrepreneurs. At the center of this issue is a difficult conundrum: both non-market-based governmental policies and free-market entrepreneurial innovation have been vigorously touted as being indispensable to the achievement of sustainable development, but it is not obvious that they can fruitfully co-exist. While some scholars have sought to establish a middle ground of compatibility between the two (Lenox and York, 2012; Porter 1991; Porter and Van der Linde, 1995), this paper seeks to demonstrate that the pursuit of the former can unwittingly imperil the latter. Our central argument is that the crowding out effects of government-sponsored sustainability programs (Hussinger, 2003; Popp, 2006) and the over-investment in average or below-average technical solutions through innovation path dependencies (Arthur, 1989; David, 2007; Dosi, 1982; Rogers, 2010), may conspire to transform near-term environmental victories into long-term impediments to sustainable development.

Among sustainability, management and entrepreneurship scholars, Dean and McMullen have developed the most thorough and useful conceptual framework for understanding and

analyzing the interplay between policy actions and environmental entrepreneurship, which they define as "the process of discovering, evaluating, and exploiting economic opportunities that are present in environmentally relevant market failures" (2007:58) The Dean-McMullen market-failure framework offers a compelling roadmap to better discern the ways in which entrepreneurs have the ability to influence sustainability efforts. However, the approach leaves open the equally important, reciprocal question: *How do sustainability efforts influence entrepreneurial action?* If certain public policies achieve their near-term goals of arresting environmental degradation, but crowd out entrepreneurs and their innovations, then sustainability policies may unwittingly facilitate the terribly ironic outcome of having arrested both degradation and the ability to achieve sustainability. Through our analysis, we extend and enhance existing theory by adapting economics-based perspectives on environmental degradation (Jaffe and Palmer, 1997; Newell, Jaffe and Stavins, 1999; Popp, 2006, 2010) and crowding out (Ahmed, 1986; Arrow and Mordecai, 1970; Aschauer, 1985; Barro, 1987) to innovation management-based theories on path dependency (Arthur, 2007; Dosi, 1982; Teece, 1996) in offering a framework that better describes and predicts the relationship between sustainability aims and market-based forces.

If, as Dean and McMullen asserted, entrepreneurial action represents an opportunity "that can lead to the enhancement of ecological sustainability" (2007: 51), then it is important to assess the ways in which environmental policy-makers may unwittingly crowd out the indispensable contributions of environmental entrepreneurs. However, to date, crowding out effects have not been studied in the context of environmental degradation. In addressing this gap, we hypothesize that government policies unintendly limiting the economic rents available to entrepreneurs will have a deleterious effect on quantity and quality of innovations that are developed and marketed. This, in turn, is predicted to result in the creation of an upper bound on the extent to which environment-friendly policies are able to facilitate the progression towards sustainability. Longer term, this asymptotic function may suppress environmental entrepreneurship and breakthrough innovations to such an extent that sustainability efforts would have been better served by not instituting well-intended environmental policies in the first place.

In building this line of analysis, we underscore and extend the work of Baumol, Litan, and Schramm (2007), who identified four key pillars that are required for constructive support of an entrepreneurial economy: (i) ease of starting and expanding a business; (ii) rewards for productive entrepreneurship; (iii) disincentives for unproductive entrepreneurship; and, (iv) incentives to keep the winners on their toes. In their model, government policies that intentionally or unintentionally abridge one or more of these four pillars are likely to have a deleterious impact on the quantity and quality of entrepreneurial activity.

Based on the formulation of Baumol, et al., our research reveals that even while protective environmental policies may succeed near-term in mitigating the adverse effects of over-use and degradation, these same policies will circumvent the long-term aims of society-wide sustainability if they abridge any of the four pillars of an entrepreneurial economy. Accordingly, the elimination of economic rents for innovative breakthroughs is expected to adversely affect the quantity and quality of entrepreneurial activity.

Theoretical Development

The extent to which entrepreneurs are successful in bringing novel technological innovations to market is a primary determinant of whether or not society can arrest the effects of environmental degradation (Anderson and Leal, 1991; Beise and Rennings, 2003; Popp, 2010;

Rennings, 2000; Shrivastava, 1995). The development and commercialization of technologies that enable environmental protection and support sustainable development is complex and fluid (Popp 2010), and the effects are likely to be very long lasting. As Shrivastava wrote, "Since environmental problems are likely to last a long time, environmental technologies will have sustained impacts" (1995:186). Commitments to specific technological paradigms may result high switching costs, oligarchical industry structures and limited entrepreneurial opportunities.

Crowding Out Effects

The study of crowding out effects originated in macroeconomics and refers to the phenomenon in which the market participation of one party reduces or eliminates the participation of one or more other parties (Atiq, 2014). Most often it has been used to explain the phenomenon in which increases in government spending, and the attendant issuance of debt, tends to lead to higher interest rates, which in turn causes a reduction in private investment (Ahmed 1986). There are, however, numerous other contexts for crowding out effects, including instances in which "the government provides products or services that would otherwise constitute a business opportunity for private industry" (Aschauer, 1989). Research concerning crowding out has examined it as a potent force affecting charitable giving (Abrams and Schitz, 1978), social welfare programs (Kenworthy, 1999), education vouchers (Hoxby, 1996), foreign direct investment (De Backer and Sleuwaegen, 2003), technological innovation (Czarnitzki and Fier, 2002), research and development (Lach, 2002; Lööf and Heshmati, 2005), and venture capital investing (Wallsten, 2001). For example, government venture capital investment programs in Canada (Brander, Egan and Hellmann, 2008), Israel (Avnimelech and Teubal, 2006) and Europe (Giacomo, 2004) have partially crowded out private sector venture investments. In each of these contexts, crowding out results in a substitution effect as the participation of one party (often government, but not necessarily so) fundamentally changes the incentive structure so that one or more other parties partially or wholly withdraw from participation. To date, crowding out effects have not been studied in the context of environmental degradation and environmental entrepreneurship, despite the fact that the widespread, long-term impact of environmental policy mechanisms on entrepreneurship and innovation remain are likely to be pronounced (Jaffe, Newell and Slavin, 2003; Popp, 2003, 2010).

Crowding out effects in environmental entrepreneurship occur when government policies compete with entrepreneurs for the rents associated with solving the market failure of externalities. Key to entrepreneurial activity – inside or outside the domain of environmental degradation -- is the ability of individuals to appropriate rents for their respective innovations. Dean and McMullen (2007:61) labeled the activities of profit-motivated economic actors to "establish the excludability for public goods" as "Coasian entrepreneurship", reflecting the theoretical heritage of Coase's commentaries on the development and enforcement of property rights in such matters (Coase, 1974). Using both political and technological mechanisms, "Coasian entrepreneurs translate public goods into excludable private ones" (Dean and McMullen, 2007:61; Dean and Pacheco, 2005), thereby creating profits from their innovations. When government involvement through policy actions eliminates the viability of these mechanisms, then there ceases to be Coasian entrepreneurs. For instance, subsidies are a common policy tool to increase the development and use of environmentally preferable products, such as renewable energy alternatives that may not be able to compete with the cost of fossil fuels. By subsidizing the use of solar energy, the government hastens the adoption of solar power, but it also co-opts the rents associated with technological breakthroughs that may make alternatives to fossil fuels cost effective. "Despite research efforts that began during the energy crises of the 1970s," wrote Popp, "solar is still only cost competitive

in niche markets, such as remote off-grid locations" (2010:18). By artificially making a technology cost competitive, the government inadvertently eliminates financial opportunities that would otherwise be accrued to individuals through Coasian entrepreneurship.

Building on prior research, our proposition of how policies crowd out entrepreneurial activity is one in which governmental policies subsidize desirable, environmentally friendly products or tax undesirable, environmentally destructive products so that breakthrough innovations do not generate any entrepreneurial rents. Innovations that improve upon existing technologies could potentially be developed, but in this stylized presentation, these innovations will not provide the inventor with incremental, risk-adjusted, excess profits. In all instances for which appropriable rents are a precondition for entrepreneurial action, governmental participation through subsidies or taxes is expected to largely or wholly crowd out profit-seeking individuals, who might otherwise produce marketable innovations that improve upon existing technologies.

Path Dependency

It might be argued that crowding out effects, in and of themselves, are not necessarily a bad thing. For example, if the government can, through policy-driven fiat, accomplish desired aims better, faster or cheaper than the private sector, then it stands to reason that government should perhaps play a pronounced role in addressing market failures that lead to environmental degradation. In fact, this is a widely held belief, despite crowding out effects and other complications that may arise when market-based pricing mechanisms are abandoned (Anderson and Leal, 1991). The most significant of these complications pertains to path dependency.

The path-dependent nature of innovation has been a subject of inquiry by economists (Arthur, 1989; David, 1985, 2007; Freeman, 1990; Schumpeter, 1950), management scholars (Dosi, 1982; Nelson and Winter, 1982, 2002), geographers (Rogers, 2010). Paul David, the economist best known for his famous study of the adoption and diffusion of the QWERTY typewriter keyboard (1984), defined path dependence "as the property of systems whose dynamics are non-ergodic" (2007:96), meaning that there can be no presumption of non-independence between the components and interactions of an historically formed sequence. A stochastic path dependent system therefore possesses "an asymptotic distribution that evolves as a consequence [its] own history." (97) Building on this premise, Rennings emphasized that a non-random innovation process is largely determined by a given technological trajectory" (2000).

Path dependence makes emerging and even competing technologies susceptible to what Arthur calls "lock-in," a set of circumstances in which commitments made to a specific technological trajectory dominates to such a degree that migration to alternative trajectories is seriously impeded (Arthur, 1989, 2007). Rogers similarly noted that path dependence, by virtue of its historical context, may "lock in certain technologies," thereby influencing the long-term course of technological developments (2010). Lock-in occurs for a number of reasons, all of which trace back to the fact that technological development is non-ergodic (David, 2007).

More pointedly on the issue of environmental economics and policy, Jaffe, et al. (2003) reasoned that because the time horizon for the evaluation of environmental problems and policy responses is so long, "the cumulative impact of technological changes is likely to be large" (2003:463). The potential problem that arises, however, is that by abandoning market-pricing mechanisms, government policy interventions may unwittingly select the wrong technologies. "Often times," noted Popp (2010: 23), "a technology that appears to surpass competing technologies in performance and cost will not immediately be chosen over existing technologies."

Method

Methodologically, we chose to employ a stochastic computational simulation model for two reasons: (i) the long-term costs stemming from environmental degradation and the long-term impacts stemming from environmental policies extend so far into the future that they defy inclusion in even the most ambitious longitudinal study; and, (ii) crowding out effects are important because of what they cause to not happen; that is, the effects inherently involve "non-occurrence" of some condition or outcome. Each of these dimensions suggests the use of a simulation. "Among the relatively noncontroversial claims," wrote Nelson and Winter (2002:41) "is that a simulation model can provide an "existence proof" for the ability of a certain sort of dynamical system to produce results of a characteristic kind" (2002:41). This is precisely the intent of our simulation model for the study of non-occurrence, and the Nelson and Winter perspective underscores the legitimacy of its analytical payoff.

Crowding out effects are notoriously difficult to investigate because they involve the quantification of non-occurrence (Kenworthy, 1999). In our study, the potential non-occurrences include innovations, firm foundings, and product launches. Since it is impossible to directly measure the absence of innovation -- that is, innovations that are neither developed nor marketed – one way to constructively engage the topic is through simulations, using game theoretic logics that are applied to the dynamic interplay between societal needs, institutional policies and prospective entrepreneurs. Simulations are ideal when focal relationships are weakly understood, yet the underlying theory regarding phenomenon is sufficiently developed to design a simulation model that displays internal validity and lends itself to experimental rigor (Davis, Eisenhardt and Bingham, 2007; Sastry, 1997; Zott, 2003). Simulations are also highly applicable to circumstances involving non-linearities (Carroll and Burton, 2000; Rudolph and Repenning, 20022006) and where empirical data are impossible to obtain (Davis, et al., 2007), as in the case of non-occurrence.

Simulation Framing

By their very nature, simulations involve the probability that one or more events will occur in succession. Given our assumptions regarding the non-ergodic nature (David, 2007) of the focal phenomena, the ability to build and test theory through a computational model is methodologically appropriate and analytically productive (Harrison, Lin, Carroll and Carley, 2007). Our model consists of a series of probability distributions that are applied to the cross products of two matrices: one representing individual environmental entrepreneurs and the other representing the environmental entrepreneurship context. Through this, an Index score was assigned to each entrepreneur (discussed in detail below and in Appendix A). This individual Index score was then used to determine the occurrence or non-occurrence of environmental entrepreneurship activities: firm formation, market entry, marketable innovation, ongoing business operations and exit. Since the aim of our inquiry was to explore the relative differences in environmental entrepreneurship activity with and without government subsidies and taxes, we held constant individual demographic factors that are known to influence one's propensity to engage in entrepreneurial activities: age, gender, education, income, parental background, etc.

Instead, we sought to employ a comprehensive accounting of contextual factors, which would reliably capture the array of conditions that are (a) likely to be influenced environmental policies and (b) are likely to have an effect on the conditions and outcomes of environmental entrepreneurship. For this purpose, we used the entrepreneurship pillars developed by Baumol, Litan, and Schramm (2007), who identified key facets that are required for constructive support

of an entrepreneurial economy: (i) ease of starting and expanding a business; (ii) rewards for productive entrepreneurship; (iii) disincentives for unproductive entrepreneurship; and, (iv) incentives to keep the winners on their toes. We made one important modification to this model, consisting of a splitting of the two elements contained in Pillar 1. The environmental factors influencing starting and expending can be one and the same, but that is not the norm, especially in the domain of environmental entrepreneurship. For example, even relative differences in bankruptcy laws have been shown to impact business foundings differently from ongoing business operations (Armour and Cumming, 2008).

Simulation Structure

Given the data and design constraints associated with an examination of non-occurrence, we built the model and conducted the analysis in Matlab using Monte Carlo simulation experiments with stochastic process modeling. Our simulation model included three key dimensions: environmental policy, Baumol's entrepreneurial support pillars (Baumol et al., 2007) and the propensity by environmental entrepreneurs to develop and market breakthrough innovations. In the Monte Carlo approach, each experiment is a simulation with fixed and variable parameter settings that is run multiple times (Law and Kelton, 1991). The results are then averaged and confidence intervals calculated (Kalos and Whitlock, 1986). Thus, for any given experiment, the result is the mean performance over multiple runs. Stochastic process modeling allowed us to flexibly test multiple structures (Davis, et al., 2007, 2009). Each experiment consisted of 50 runs, which represented the upper limit for incremental improvements in precision.

Duration and Entrants

Each period in the simulation represented one year. Durations ranged from 10 to 250 years. Each experiment began with 1,000 entrepreneurs, who continued or exited based matrix products described below. For each additional year the simulation is run, 1,000 new entrepreneurs were added at the beginning of the year.

Operationalizing Baumol, Litan and Schramm's Entrepreneurship Pillars

As noted above, our simulation structure is embedded in the logic of the Entrepreneurship Pillars developed by Baumol, Litan and Schramm (2007). Other studies have also examined the role of governmental rules and cultural expectations in shaping the activities of entrepreneurs and the overall effect on society at large (e.g. Baumol, et al., 2007; Garrett and Wall, 2006; Jaffe and Lerner, 2004; Lawless and Warren, 2005). We chose to frame our simulation using the Baumol et al. model due its comprehensiveness, adaptability and testability. We did, as noted above make one major modification to their taxonomy by splitting Pillar 1 – "Ease of Starting and Expanding a Business" – into two separate categories. To distinguish Baumol et al's original 4 Pillars from our modified categories, we refer to our categories as "Elements." In order to operationalize each of the 5 Elements, we called upon empirical data from extant management and economics literature to develop five "Factors, " each of which is an arithmetic expression of a key driver of the 5 Elements. As detailed above, the first four factors for each element consists of a unique probability distribution related to a key driver of that factor. For the fifth factor, the state (i.e. 00, 01/10 or 11) is randomly assigned with equal probability.

Each of the 5 Elements was cast in terms of issues that pertain to environmental degradation, sustainable development, environmental policy and environmental entrepreneurship. Since Baumol et al.'s Pillars were not specifically focused on environmental issues, this contextualization

insures that our model benefits from the comprehensiveness of the Pillars while also being directly relevant to sustainable development. Specifically, we have sought to cast each Element in terms of how the factors would impact entrance, survival and innovation in the Cleantech sector, which consists of firms that sell "products, services and processes intended to provide superior performance at lower cost, while greatly reducing or eliminating negative ecological impact and at the same time improving the productive and responsible use of natural resources" (Cleantech Group, 2014). The base case probabilities for each factor reflect the extent to which the factor is a weak, moderate or strong determinant in favorably influencing entrepreneurial activity.

Results

The purpose of this inquiry was to address two questions. First, do even well intended environmental policies, involving subsidies or taxes, crowd out entrepreneurial activity that might otherwise occur? Second, if crowding out does occur, would the path dependent nature of innovative technologies hinder or help societal efforts to achieve sustainable development? Our theory, previously summarized in Figures 1 and 2, argues that environmental entrepreneurs are crowded out by government polices that are intended to protect the environment and that over long periods of time these crowding out effects will have a deleterious impact on society's ability to arrest environmental degradation, primarily due to path dependent effects of technological innovation, which are inadvertently exacerbated by government attempts to select technological "winners" and "losers" through subsidies and taxes.

In total, we ran more than 500 complete simulations of our model, for periods ranging from 10 to 250 years. Since the focus of our research involved an attempt to identify and quantify the non-occurrence of potentially beneficial entrepreneurial activities, the analytical cornerstone consists of head-to-head comparisons of scenarios involving market-based and policy-based conditions. Accordingly, our reporting of the results in this paper is comprised of a series of graphs that are intended to display the critical areas in which our core argument succeeded or failed to find support. For the sake of comprehensibility and consistent reporting, all the data was standardized and indexed, ranging from 0 to 1, so that the year-to-year fluctuations of each dimension can be studied over time in a comparable fashion.

Overall, the results show strong support for our core premises: Government environmental policies elicit an escalation of favorable activity that quickly dead-ends in a sub-optimally restrictive asymptote, due to the effects of crowding out and path dependence. However, the storyline is more temporally dramatic than we had predicted in that both short-term effects and long-term effects are more pronounced and conflicted than we had predicted. This suggests a sharp disjunction between short-term optima and long-term optima. Throughout the review of our results this disjunction is a continuing theme. Along virtually every dimension we analyzed, policy-based subsidies for environmentally desirable products and behaviors or taxes on environmentally undesirable products and behaviors are both associated with heightened near-term entrepreneurial activity. However, since this relative benefit (versus a no-policy condition) arises as a consequence of massive investments in existing technological paradigms, there are longer term effects that gradually erode the policy benefits, before erasing the benefits of subsidies and taxes altogether.

Consistent with prior literature comparing the relative impacts of subsidies and taxes (Baumol and Oates, 1988; Jaffe, Newell and Stavins, 2003) our simulation results also reveal that taxes on unwanted behaviors and products results in more long-term innovation than subsidies for environmentally friendly behaviors and products. This finding led us to modify the analysis

and report the models by separating subsidy effects from tax effects. The cause of this difference between taxes and subsidies is likely related to the fact that taxes increase the cost structure of product manufacturers and service providers, creating an incentive to reduce that cost structure through innovations. This is tantamount to leaving the entrepreneurial rents at least partially intact. The finding also provides support for work by Dean and McMullen (2007), Popp (2010) and others, who have predicted that policies specifying specific technical development trajectories are likely to underperform policies that create new incentives, while keeping intact market forces. While taxes appear to be preferable to subsidies, they too significantly underperform market mechanisms over long time horizons.

Discussion and Implications

Using a computational model to simulate entrepreneurial actions over timeframes that extend well beyond the expanse of most environmental policies, our study augments and extends existing frameworks from environmental economics (Jaffe, Newell and Slavins, 2003; Ostrom, 1990; Popp, 2006, 2010), policy theory (Baumol and Oates, 1988). strategic management (Porter, 1991) and environmental entrepreneurship (Dean and McMullen, 2007; Pacheco, Dean and Payne, 2010; Lenox and York 2012; Sine and Lee 2009) that have sought to reconcile two difficult, and sometimes conflicting, challenges. The first challenge is to arrest environmental degradation and facilitate society's evolution towards sustainable development. The second challenge is to solve the first challenge through the contributions of environmental entrepreneurs, who require a supportive entrepreneurial ecosystem that allows for financial vitality. "To ignite venture creation and growth," wrote Isenberg (2010:40), "governments need to create an ecosystem that sustains entrepreneurs." As the foregoing analysis demonstrates, even the most well intended environmental policies play a questionable role in sustaining entrepreneurs and, more pointedly, in sustaining the environment. Jaffe, et al., (2003), referred to this "as the tale of two market failures," involving both technology and environmental policy. Through our research, we have sought to address this conundrum, and to contribute to existing theories in economics, policy management and entrepreneurship, by brining to the discussion the dual effects of crowding out and path dependence, which have proven to be so instrumental to the study of policy impacts and innovation trajectories, respectively.

Our study responds to multiple calls for careful scrutiny of the differences between policy-based and market-based approaches. "Empirical studies which attempted to differentiate the impact of environmental entrepreneurship from action by government, incumbent firms and social movements would offer great advancement," wrote Lenox and York (2012: 147). The results of our simulation provide strong evidence that significant differences exist. Our contribution also serves a growing theoretical need to address lingering gaps in the study of short-term versus long-term outcomes of policy-based actions. Our theory builds on existing frameworks grounding the core causes of and solutions for environmental degradation as fundamentally involving market failures (Dean and McMullen, 2007; Jaffe, Newell and Stavins, 2003; Lenox and York, 2012; Popp, 2003, 2006, 2010; York and Lenox, 2013). However, our revelation that even well intended policies crowd out environmental entrepreneurs fundamentally changes the landscape with respect to how best to address market failures. As Dean and McMullen (2007) hinted, it is far from clear that governmental action is the only answer, or even the best answer.

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