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EFFECTS OF CORRUPTION ON ENTREPRENEURSHIP ACTIVITIES: AN AGENT-BASED MODEL

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ABSTRACT

In this paper, we develop an agent-based simulation model in NetLogo to model entrepreneurs in economic environments with various levels of corruption (using the income potential from unproductive opportunities relative to productive opportunities as a proxy for this). The income potential from unproductive opportunities, and how easily productive entrepreneurs can be enticed into transitioning into exploiting unproductive opportunities, are critical parameters in determining to what extent unproductive and productive forms of entrepreneurship are engaged in by entrepreneurs. The results suggest that the corruptibility of productive entrepreneurs has a strong effect on increasing economy-wide earnings from unproductive forms of entrepreneurship, and that the earnings potential of unproductive opportunities plays an important role in influencing how entrepreneurial earnings are distributed.

INTRODUCTION

Transparency, consistency, and "fair play" have been argued to be necessary for economies to thrive, and corruption has been viewed as something to be minimized. There is empirical support for the undesirable impact of corruption. Economies with high levels of corruption have been found to have lower economic growth than those with lower levels of corruption (Del Monte & Papagni, 2001; Mo, 2001), and high levels of corruption have been shown to be negatively related to innovation (Anokhin & Schulze, 2009). With innovation being associated with entrepreneurship activity (Acs & Audretsch, 1988), it would be implied that high levels of corruption are negatively associated with entrepreneurship. This "sand the wheels" hypothesis asserts that corruption is a force that constrains growth and development (Aidt, 2009). While corruption can certainly lead to a number of negative economic and social outcomes, such relationships are not clear due to their complexity. Countering the "sand the wheels" hypothesis, the "grease the wheels" hypothesis proposes that high levels of corruption may enable important economic activities to occur that would not in the absence of corruption (Aidt, 2009). Corruption may essentially serve as a hedge against bad policy by allowing economic actors a way around bad policies that governments implement (Leff, 1964).

Less explored has been the exact relationship between corruption and entrepreneurship activities. Some research finds that high corruption has been associated with increased levels of entrepreneurial activity (Dreher & Gassebner, 2013). While high levels of corruption may hurt some entrepreneurs, it may weed out the less efficient ones but still allow more efficient entrepreneurs (those that can afford to bid more for favors) to survive (Leff, 1964). An important aspect that is often missed in the corruption literature is that entrepreneurs are not always productive; they can be unproductive and even destructive

(Baumol, 1990). Corruption is likely to influence the attractiveness of productive, unproductive, and destructive entrepreneurship in complex and nuanced ways. Being mindful of this, in this paper we explore the following research question: *What is the effect of corruption on entrepreneurship activity*?

While efforts have been made to do so, corruption is difficult to define and measure because it can be highly intertwined with non-corrupt activities. Therefore, it can be difficult to examine the relationship between corruption and a whole host of economic and social outcomes using traditional data collection methods. To address this issue and better answer the research question, we construct an agent-based simulation model. Simulation has been suggested as a means for building theory, especially for exploratory research (Axelrod, 1997; Davis, Eisenhardt, & Bingham, 2007; Harrison, Lin, Carroll, & Carley, 2007). Our agent-based simulation model is based upon the "Mafia Model" developed by Ordemann and Neto (2014) in NetLogo, which allows the interaction between police, mafia, and storeowners to be explored. We extensively modify this model to have different agents (productive and unproductive entrepreneurs), different patches (productive and unproductive opportunities), as well as different parameters and outputs. The developed model allows us to assess how wealth attained by productive and unproductive entrepreneurs varies depending on the level of corruption in an economy.

LITERATURE REVIEW

Corruption can occur in a number of forms, including bribery, influence peddling, patronage, cronyism, embezzlement, extortion, unholy alliances and involvement in organized crime (Vargas-Hernandez, 2009). Bribery is a commonly practiced and known form of corruption that can occur in the context of a business relationship, in which one individual bribes another in order to gain some sort of favor. An example would be an individual owning a small component manufacturing firm bribing a purchase agent in another company in order to gain a contract as a supplier. Bribery can occur sporadically or only once between parties, or it may occur frequently as part of an ongoing relationship (Vargas-Hernandez, 2009). Bribery often occurs in the context of rent-seeking, which refers to the resource-wasting activities involved in competing for artificially contrived wealth transfers (Tollison, 1982). An individual or firm may engage in rent-seeking by bribing public officials for favors, although rent-seeking is often less formal, such as simple influence peddling in the context of lobbying. Instigating frivolous litigation is another common form of rent-seeking (Krueger, 1974; Murphy, Shleifer, & Vishny, 1993). Rent-seeking activities are sometimes viewed as an alternative to self-employment, and that increased engagement in rent-seeking will lead to fewer individuals engaging in entrepreneurship (Scully, 1991). However, Baumol (1990) views corrupt, rent-seeking activities as a form of entrepreneurship, albeit of the unproductive type.

Some of the literature on corruption has not focused directly on entrepreneurship, but instead on economic growth. Higher levels of corruption have been found to be associated with lower levels of economic growth (Del Monte & Papagni, 2001; Mo, 2001) and innovation (Anokhin & Schulze, 2009). Such findings are consistent with the "sand the wheels" hypothesis, which states that corruption is detrimental to economic growth (Aidt, 2009). Other researchers have examined the relationship between corruption and entrepreneurship or entrepreneurial intentions. McMullen Bagby and Palich (2008) examined the relationship between corruption and both opportunity and necessity-motivated entrepreneurial activity. However, no statistically significant relationship was found. Dreher and Gassebner (2011) find that the existence of a large number of procedures required to start a business tends to lead to lower amounts of entrepreneurship. However, it is found that corruption actually leads to higher levels of firm entry in economies that are highly regulated. Likewise, Dejardin and Laurent (2014) find evidence for the "grease the wheels" hypothesis in their examination of the Global Entrepreneurship Monitor data. While they found that regulations and corruption reduce the

likelihood of individuals being entrepreneurs, and that corruption actually increases this likelihood when startup regulations were substantial. Bologna and Ross (2015) in their examination of Brazilian municipalities found that high level of corruption tends to be associated with a reduced number of business establishments, and that the effect increases over time. However, they did find that this relationship can become insignificant or positive when institutions are of poor quality. Costa and Mainardes (2015) found that higher levels of perceived corruption tend to decrease the probability of an individual having entrepreneurial intentions, although the effect size was small compared to the relationship between risk aversion and entrepreneurial intentions. Conversely, Gohmann (2010) found a positive relationship between the level of corruption in a country and preferences for self-employment. However, one limitation of much of the research that examines the relationship between corruption and entrepreneurship is that no distinction is typically made between productive and unproductive forms of entrepreneurship as described by Baumol (1990). Entrepreneurship is often implicitly assumed to be of the productive variety.

Corruption can be difficult to define and measure, because it can be highly intertwined with non-corrupt activities. Thus, it can be difficult to examine the relationship between corruption and a whole host of economic and social outcomes. An example of this can be seen with the development of the mafia in Sicily. Dimico, Isopi and Olsson (2012) argue that the mafia arose due to weak institutions in Sicily during the 1800s and the need for producers of citrus fruit (oranges and lemons) to be protected from thieves. Citrus production was a very profitable business at the time, since demand was high and substantial fixed costs served as an entry barrier. The mafia stepped in to offer protection to these producers, as well as to shopkeepers, farmers, and other businesses (Bandiera, 2003, Gambetta, 1996). While the mafia of today is also known to provide protection services, these are often viewed as "rackets," as the mafioso is usually the one in which the business owner is paying to be protected from. However, it is difficult to determine when and to what degree such protection services are legitimate, and when and to what degree they are simply extortion.

METHOD

To explore the relationship between corruption and entrepreneurship activities, we develop an agent-based simulation model in NetLogo. Such modeling has been suggested as a means for building theory (Axelrod, 1997; Davis, Eisenhardt, & Bingham, 2007; Harrison, Lin, Carroll, & Carley, 2007). Agent-based modeling allows researchers to build experiments from the ground up and test theorized relationships contingent upon varying resources and constraints in the environment (McKelvey, 2004). Agent-based simulation models have been used to study a number of phenomena in the social sciences, including segregation in residential areas, trade patterns, migration, and military battles (Epstein & Axtell, 1996; Wilensky & Rand, 2015). A number of agent-based models have been developed that model human behavior in the presence of forms of corruption, such as bribery and extortion. Troitzsch developed the ARDERS model (2014) and NOERS (2015) model which can be used to examine extortion rackets. Dzutsati (2015) developed a model of corruption which is a replication of Hammond's (2009) corruption model. The model examines the conditions for a social transition from a high-to a low corruption state. The Mafia Model developed by Ordemann and Neto (2014) is a model that allows the interaction between police, mafia, and storeowners to be explored. Our model builds on both the Mafia Model (Ordemann and Neto, 2014) as well as the Wolf Sheep Predation Model (Wilensky, 1997).

A difficulty when examining the impact of corruption specifically on entrepreneurship is that entrepreneurship can be productive, unproductive, or even destructive (Baumol, 1990; Desai & Acs, 2007). In the model developed, both productive and unproductive entrepreneurs are agents that move around the simulation looking for opportunities to exploit. Patches represent either productive or

unproductive (such as rent-seeking) opportunities. When they find an opportunity, the entrepreneur exploits it for its entire life. Once the opportunity is fully exploited, the entrepreneur can then move on to another opportunity. It is assumed that the entrepreneur will exploit the next opportunity that they find. Each opportunity provides a certain amount of income for each "tick" (time period) that passes in the model. It is assumed that the income each period provided by an opportunity (productive or unproductive) follows a uniform distribution, with a maximum income which can be entered into an input box in the interface. Different values can be entered for productive and unproductive opportunities. The user can also select the ratio of productive to unproductive opportunities in the model, and the maximum lifespan of opportunities (in ticks). Opportunity lifespan is assumed to follow a uniform probability distribution, with the maximum lifespan (selected by the user, the slider allows values up to 250 periods) representing the largest value of the distribution. By allowing the ratio of productive to unproductive opportunities to be selected as well as the distribution of possible period incomes for unproductive opportunities, the user can implicitly model more or less corruption in the environment. In addition, the number of productive and unproductive entrepreneurs can be selected, via a slider which allows ranges of inputs from 0 to 100. See the table summary of model parameters (Table 1) in Appendix 1 for a summary of the inputs into the model.

In the default setting of the model unproductive entrepreneurs can only take advantage of unproductive opportunities, and productive entrepreneurs can only take advantage of productive opportunities. However, an "on/off" switch added to the model interface easily allows this assumption to be relaxed. Turning on the "let unproductive entrepreneurs switch to productive entrepreneurship" switch allows unproductive entrepreneurs to exploit any opportunity they find, let it be productive or unproductive. Likewise, the slider "corruptibility of productive entrepreneurs" allows the model to be adjusted to loosen the assumption that productive entrepreneurs cannot exploit unproductive activities. A productive entrepreneur will exploit an unproductive opportunity they find when: *[(Corruptibility) X (value of the unproductive opportunity found)] >= maximum period income derived from a productive opportunity*. Since the income derived from a productive opportunity is assumed to follow a uniform distribution, the maximum period income represents the maximum value that can be derived from a productive opportunity (and is an input itself into the model described previously).

RESULTS

Seven separate models were run with varying assumptions using BehaviorSpace in NetLogo. The results are shown in Table 2. BehaviorSpace allows multiple models to be easily run one after another with varying assumptions. While many factors are kept constant throughout the models for simplicity, a select number of factors are allowed to vary, including the maximum income that can be earned from unproductive opportunities each tick, the corruptibility of productive entrepreneurs, and the initial number of unproductive entrepreneurs. With simulation modeling, slightly different results are obtained when models are run multiple times with the same assumptions. Thus, each of the seven models were run ten times. The results in Table 2 are the averages for the ten runs. Each model was run 480 ticks, representing a 40-year span, as ticks are roughly analogous to months in the model.

Several things stand out in the results. In Model 1, the expected return from productive and unproductive opportunities are the same, as are the number of productive and unproductive entrepreneurs. However, unproductive entrepreneurs can exploit productive opportunities that they happen to find. Under these assumptions, not surprisingly, most of the earnings at the end of the run are from exploiting productive opportunities (78.3%), with only 21.7% of the total earnings coming from the exploitation of unproductive opportunities. Model 2 indicates that as the potential earnings available from exploiting unproductive activities increases, total earnings from exploiting

such opportunities increases. However, in Model 3, there was not a substantial change, as corruptibility increased from 0 to 0.5. This indicates there is not enough incentive for the productive entrepreneurs to begin to exploit unproductive opportunities. However, in Model 4, as corruptibility increases, the earnings from exploiting unproductive opportunities makes up 52.1% of total earnings. Thus, at least some of the "productive entrepreneurs" have switched to exploit unproductive opportunities.

In Model 5, the corruptibility of productive entrepreneurs is set back at 0.5, but the initial number of unproductive entrepreneurs doubles to 100. Compared to Model 3, there is an increase in the earnings from exploiting unproductive opportunities (42.7% verse 33.2%). However, a majority of earnings in the economy are still coming from entrepreneurs exploiting productive activities, as "unproductive" entrepreneurs are exploiting both unproductive and productive opportunities, depending on what they find. In Model 6, the starting number of unproductive entrepreneurs is set back to 50, and the maximum income from exploiting unproductive activities increases to $8,000 per tick, which is twice the maximum for productive activities. Compared to Model 3, a larger percentage of earnings are from exploiting unproductive activities (39.5% verse 33.2%). Finally, Model 7 is identical to Model 6, except that the corruptibility of productive entrepreneurs increases to 1. This combined with the high earnings of exploiting unproductive opportunities, causes many of the initially productive entrepreneurs to switch and begin exploiting unproductive opportunities. As a result, 64.7% of total earnings in the run are from exploiting unproductive opportunities.

DISCUSSION & IMPLICATIONS

The results show that the corruptibility of productive entrepreneurs (and thus their engagement in unproductive forms of entrepreneurship) has a strong effect on increasing economy-wide earnings from unproductive forms of entrepreneurship. Secondly, the earnings potential of unproductive opportunities (one of our proxy measure of corruption in the economy) plays an important role in influencing how entrepreneurial earnings are distributed.

There are several limitations to the agent-based simulation model developed. The model is set up so that productive entrepreneurs will exploit any productive opportunity they find, and unproductive entrepreneurs will exploit any unproductive opportunity that they find. The level of income from the opportunity is not considered (except when productive entrepreneurs are allowed to consider unproductive opportunities) and neither are opportunity costs. Startup costs are assumed to be zero, and no capital is required to exploit the opportunity. Thus any possible capital constraints are ignored. Likewise, it is assumed that the entrepreneur has the skills to exploit any opportunity they find. The model assumes that entrepreneurs are productive or unproductive, but that switching can be allowed depending on the selection of model parameters. Perhaps classifying entrepreneurs as productive and productive is a simplification of reality, but it is a simplification assumed in this model. The model also does not consider that unproductive entrepreneurship may be directly detrimental to productive entrepreneurship (Baland & Francois, 2000; Murphy et al., 1993) by decreasing returns to productive entrepreneurship (Acemoglu, 1995). Unproductive entrepreneurs may crowd out productive entrepreneurs in several ways, such as through frivolous lawsuits, wealth transfers, or lobbying for the passage of restrictive regulations that hurt productive entrepreneurs.

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APPENDIX I

Table 1: Summary of Model Parameters	
Parameter	**Description**
Initial number of unproductive entrepreneurs.	Slider with values that can be selected from 0 to 100.
Let unproductive entrepreneurs switch to productive entrepreneurship.	On/off switch. On allows unproductive entrepreneurs to exploit productive opportunities.
Initial number of productive entrepreneurs.	Slider with values that can be selected from 0 to 100.
Corruptibility of productive entrepreneurs.	Slider with values that can be selected from 0 to 1.
Maximum opportunity lifespan.	Slider with values that can be selected from 0 to 250.
Productive to unproductive opportunity ratio.	Slider with values that can be selected from 0 to 100.
Unproductive opportunity maximum income.	Input box. Value represents maximum value of a uniform distribution of possible period incomes from exploiting an unproductive opportunity.
Productive opportunity maximum income.	Input box. Value represents maximum value of a uniform distribution of possible period incomes from exploiting a productive opportunity.

Table 2: Summary of Results	
Model 1 Parameters	**Results**
Initial number of unproductive entrepreneurs = 50. Let unproductive entrepreneurs switch to productive entrepreneurship = True. Initial number of productive entrepreneurs = 50. Corruptibility of productive entrepreneurs = 0. Maximum opportunity lifespan = 250. Productive to unproductive opportunity ratio = 0.5. Unproductive opportunity maximum income = $4,000 Productive opportunity maximum income =$4,000	% Earnings from exploiting unproductive opportunities = 21.7% % Earnings from exploiting productive opportunities= 78.3%
Model Parameter Changes	
Model 2 Unproductive opportunity maximum income = $6,000	% Earnings from exploiting unproductive opportunities = 33.1% % Earnings from exploiting productive opportunities = 66.9%
Model 3 Unproductive opportunity maximum income = $6,000 Corruptibility of productive entrepreneurs = .5.	% Earnings from exploiting unproductive opportunities = 33.2% % Earnings from exploiting productive opportunities = 66.8%
Model 4 Unproductive opportunity maximum income = $6,000 Corruptibility of productive entrepreneurs = 1.0	% Earnings from exploiting unproductive opportunities = 52.1% % Earnings from exploiting productive opportunities = 47.9%
Model 5 Initial number of unproductive entrepreneurs = 100 Unproductive opportunity maximum income = $6,000 Corruptibility of productive entrepreneurs = .5	% Earnings from exploiting unproductive opportunities = 42.7% % Earnings from exploiting productive opportunities = 57.3%
Model 6 Unproductive opportunity maximum income = $8,000 Corruptibility of productive entrepreneurs = .5	% Earnings from exploiting unproductive opportunities = 39.5% % Earnings from exploiting productive opportunities = 60.5%
Model 7 Unproductive opportunity maximum income = $8,000 Corruptibility of productive entrepreneurs = 1	% Earnings from exploiting unproductive opportunities = 64.7% % Earnings from exploiting productive opportunities = 35.3%