Entrepreneurship, innovation, and corruption☆

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ABSTRACT

Efforts to control corruption increase levels of trust in the ability of the state and market institutions to reliably and impartially enforce law and the rules of trade. Such trust facilitates the development of arms-length trade and the coordination of complex economic activities. We posit that better control of corruption will also be associated with rising levels of innovation and entrepreneurship. Absent such trust, however, monitoring and other transactions cost should restrict the scale and scope of trade and thus, hamper productivity and investment in innovation and entrepreneurship. Longitudinal data from 64 nations lends support to our propositions, thus helping unpack the puzzling relationship between entrepreneurship, innovation, and corruption.

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1. Executive summary

What effect does corruption, typically defined as abuse of public power or authority for private benefit (Rodriguez et al., 2006), have on entrepreneurial and innovative activity across nations? Interestingly, and despite the fact that a growing stream of research documents a uniformly positive relationship between the control of corruption and improvement in a variety of important indicators of economic welfare including foreign direct investment (Lambsdorff, 2003; Mauro, 1995), productivity (Lambsdorff, 2003; Rivera-Batiz, 2002), the United Nations’ Human Development Index (Rose-Ackerman, 2004), and growth in income (Kaufmann and Kraay, 2003), the relationship between the control of corruption and cross-national rates of entrepreneurship and innovation has received scant attention.

In this paper, we draw on the political economic (e.g., Barro, 1991, 1996; DeSoto, 1989; Olsen, 1996; Romer, 1986, 1994; Rose-Ackerman, 2001, 2004), corruption (e.g., Kaufman and Kraay, 2003; Lambsdorff, 2003; Mauro, 1995), strategic management (e.g., Rodriguez et al., 2005; Uhlenbruck et al., 2006), and entrepreneurship/innovation literatures (e.g., Acs and Audretsch, 1988; Audretsch and Feldman, 1996; Baumol, 1990; Dosi, 1988; Thursby and Thrusby, 2002) to argue that corruption undermines the foundations of institutional trust that are needed for the development of trade and entrepreneurial and innovative activity.

We argue that the decision to pursue an entrepreneurial or innovative opportunity depends on “the portion of the value that the venture creates that the entrepreneur is able to capture for their own purposes” (Baker et al., 2005: 497). But when corruption is present, entrepreneurs and innovators face greatly increased risk that those involved in her value chain will be opportunistic and appropriate profits to which the prospective entrepreneur is entitled. And in the absence of impersonal enforcement of the law, it becomes risky to rely on legal contracts and/or signals about the reliability and integrity of the providers upon whose services and goodwill entrepreneurs and innovators must rely. Trust’s alternative foundations like affect, kinship, or ethnic identity are economically inferior because they necessarily limit the size of the provider pool and expose promising entrepreneurs to greater risk of adverse selection (Alchian and Woodward, 1988). Corruption also creates disincentives for investment in innovation and

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other complex economic activities whose payoffs are difficult or costly to monitor because they are uncertain and/or temporally distant (Teece, 1981). The result is increased transaction cost and further limits on the potential scale and scope of the entrepreneur’s market (Luhmann, 1988).

We draw on longitudinal data from sixty-four nations to test the proposition that the level of corruption affects rates of entrepreneurial activity and innovation across nations. Results indicate that there is a positive curvilinear relationship between the control of corruption and three independent measures of entrepreneurial and innovative activity across nations. We also document that these relationships are moderated by foreign direct investment — which prior research has established as a driver of technological advancement in developing nations.

The results of the study are intriguing. First, although they do not explicitly predict economic growth, they add to a growing stream of research which suggests that corruption and the quality of a nation’s institutions play an important role in accounting for disparities in rates of entrepreneurship and innovation across nations. Corruption may, in this sense, be one of the missing variables in the search for robust relationships between entrepreneurship, innovation, and economic prosperity. Second, the findings we present in the paper are consistent with increasing evidence that corruption’s effects are pervasive and can have far-reaching consequences for an economy. Third, the study underscores that entrepreneurship and innovation do not occur in an institutional void. Rather, and consistent with arguments advanced by Baumol (1990), institutional factors appear to play an important role in determining whether entrepreneurial and innovative initiative will arise. Lastly, this study has implications for governance and institutional reform in developing nations. Simply put, efforts aimed at improving the control of corruption seem to have a powerful but indirect influence on a wide swath of economic activity. The time-lagged and curvilinear form of the observed empirical relationships suggests that it takes time for institutional reforms to generate positive outcomes. Patience and persistence are thus essential parts of the reformer’s toolkit.

2. Introduction

While entrepreneurship and innovation are widely viewed as key drivers of economic growth, researchers have yet to document a robust relationship between entrepreneurial activity and economic development across nations (Acs and Audretsch, 2005). Van Stel et al. (2005), for example, observe positive relationships between entrepreneurial activity and per capita GDP growth in rich nations but negative relationships in poor nations. Reynolds et al. (2003) identify negative relationships between entrepreneurial activity and real per capita GDP among all nations studied. Similar relationships are reported by Schultz (1990), Yamada (1996), and Iyigun and Owen (1998). And while an abundance of data points to a positive relationship between knowledge spillovers, innovation and entrepreneurship in developed nations (Audretsch and Feldman, 1996; Jaffe, 1989; Romer, 1994), researchers have yet to document such relationships in developing countries.

Despite the variety of theories that have been advanced to account for this conundrum, the lack of a robust correspondence between entrepreneurship, innovation and economic development remains perplexing. In this paper, we advance an alternative hypothesis that, surprisingly, has yet to be explored. Specifically, we posit that corruption, or the abuse of public power or authority for private benefit (Rodriguez et al., 2006), affects the magnitude of the rewards that can be earned from entrepreneurship and innovation (Winthrop, 1995), and makes it less likely that prospective entrepreneurs or innovators will be able to capture or appropriate a portion of these proceeds (Baker et al., 2005; Baumol, 1990). The level of corruption therefore helps explain whether those with innovative ideas or entrepreneurial initiative in different nations have incentive to pursue promising productive opportunities. It follows that better control of corruption should be associated with rising domestic levels of innovation and entrepreneurship. Longitudinal data from 64 nations suggest that, after controlling for the effects of relative wealth, there is a positive relationship between the control of corruption and levels of entrepreneurial activity and innovation across nations. We begin with a brief review of the corruption and entrepreneurship literatures and then turn to the task of developing and testing propositions. We conclude with a brief discussion about the results of this study and their implications for theory and practice.

3. Literature and hypotheses

A growing stream of research documents a uniformly positive relationship between the control of corruption and a variety of indicators of economic welfare including per capita growth in GDP (Kauffman and Kraay, 2003), the United Nations Human Welfare Index (Rose-Ackerman, 2004), bond spreads (Ciocchini et al., 2003), income inequality (Carmignani, 2005; Li, Xu, and Zou, 2000), capital investment and foreign direct investment (Lambdorff, 2003; Mauro, 1995), and total factor productivity (Lambdorff, 2003; Rivera-Batiz, 2002). While the precise form of the hypothesized relationship varied greatly across these studies (some suggest it is positive and direct while others found it was positive but curvilinear), a recent meta-analysis of 89 such studies confirmed that the quality of a nation’s governance (of which the control of corruption is an important component) moderated a variety of important economic indicators and thus played an important role in shaping economic performance across nations. (Doucoudias and Ulubasoglu, in press: 7). Further, the results suggest that governance explained a significant portion of the variance in the economic performance of nations at all levels of economic development and across time (Kauffman et al., 2006). Yet, the mechanisms through which the control of corruption affects economic welfare are not well understood. While some argue that economic development makes the control of corruption possible (Bardhan, 1997), Susan Rose-Ackerman (2001, 2004) makes a persuasive case that the control of corruption and development of “institutionalized trust” plays a key role in creating an institutional context in which entrepreneurship and innovation can flourish.

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In her treatment of the relationship between corruption and the state-building process, Rose-Ackerman observes that trust based on affect, kinship, or ethnic identity – which is known to facilitate trade within specific geographic regions (Fadahunsi and Rosa, 2002) – can frustrate the development of arms-length trade and the coordination of activity across distance and over time that is needed to support complex high-value-added economic activities like entrepreneurship and innovation. The development of institutional trust – that is, wide-spread confidence that office holders and others who are directly and indirectly party to a transaction will, regardless of their identity, impartially and fairly enforce the rules that govern exchange is crucial because it makes investment in innovation and other forms of complex and high-value added economic activity feasible (Luhmann, 1988; Rose-Ackerman, 2001).

Trust implies a level of confidence, but not certainty, that persons who are party to an exchange or proposed set of interconnected exchanges will behave as expected (Luhmann, 1988). While trust can be one-sided or non-reciprocal, which is the case when decisions about an individual’s reliability are made by the entrepreneur and are based solely on reputation, professional qualifications, or other signals of reliability, the more general case is that trust is the product of repeated interaction with others (Rose-Ackerman, 2001). Confidence in the trustworthiness of those actors is reinforced through repeated positive experience and eroded otherwise. Variance in the quality of these experiences across groups of actors, moreover, can determine whether trust rises and becomes generalized across the population at large or becomes limited to portions of it. The latter, for example, is likely to arise when poor outcomes cause individuals to limit exchange to those whom they know or share a common identity with; e.g., kinship or ethnic identity. Similarly, repeated experience with institutions teaches individuals whether one can rely on the fairness and neutrality of their officials or if personal connections or bribes are needed to secure and assure the delivery of services. While interpersonal trust and institutional trust are independent constructs, they are causally related in the sense that the latter serves as a “backstop” that helps discourage opportunism in personal dealings. At least some of Ebay’s success, for example, can be attributed to the assurances it provides to individuals using its markets. Its success, in turn, facilitated the growth of popular online markets, like Craigslist, that do not provide similar guarantees. Institutional trust thus serves as a foundation on which generalized interpersonal trust develops (Rose-Ackerman, 2001: 12).

While corruption may arise strictly between private parties (Svensson, 2005), the corruption that concerns us takes place between profit-driven organizations and government officials or representatives (Luo, 2004). Corruption typically involves the behavior that violates the trust placed in public officials and serves to undermine the foundation on which generalized interpersonal trust relies. Yet the ability to rely on others with whom the entrepreneur has only indirect contact is essential to the success of new ventures and the creation of high-value-added product and services. The problem here is that the decision to pursue an entrepreneurial opportunity depends on “the portion of the value that the venture creates that the entrepreneur is able to capture for their own purposes” (Baker et al., 2005: 497). When corruption is present, the entrepreneur faces greatly increased risk that those involved in her value chain will be opportunistic and appropriate the profits or rents to which the entrepreneur believes she is entitled. Corrupt agents are able to do so because of the relatively high levels of information asymmetries that characterize any complex economic activity — whether it be novel or imitative. In the absence of institutional trust, it becomes risky for prospective entrepreneurs to rely on one-sided trust. Moreover, institutional trust’s alternative foundations, like affect, kinship, or ethnic identity, are economically inferior because they necessarily limit the size of the prospective entrepreneur’s market and expose them to agency costs associated with adverse selection (Alchian and Woodward, 1988). Corruption also creates disincentives for investment in innovation and complex economic activities whose payoffs are difficult or costly to monitor because they are uncertain and/or temporally distant. Corruption thus increases transaction costs, which further limits the potential scope of their activities (Luhmann, 1988).

On the other hand, corruption seems to disappear from the entrepreneur’s calculations when it is controlled. In these environments, one-sided trust seems to be sufficient to motivate trade since the parties to a transaction tend to share similar values, communication channels are efficient and quickly signal negative and positive information about firm quality, and legal and market mechanisms exist that facilitate dispute resolution and reduce its costs (Rose-Ackerman, 2001). Perhaps as a consequence, corruption is often excluded from many modern analyses of the appropriation problem (e.g., Teece, 1981; Schilling, 2005). Its exclusion, moreover, suggests that the appropriability problem has little effect on the economic valuation of an opportunity (Acs and Audretsch, 2005; Baker et al., 2005; Milgrom and Roberts, 1990). Although the economic development and international business literatures recognize that corruption can dramatically affect firm behavior (Uhlenbruck et al., 2006), FDI (Hannafey, 2003; Lenway and Murtha, 1994), and mode of entry decisions (Rodriguez et al., 2005), the impact of corruption on innovation and entrepreneurial activity is less understood. Our analysis describes how corruption shapes the magnitude of the incentive facing the prospective innovator or entrepreneur.

Corruption, just like other deficiencies in a nation’s infrastructure, increases agency and transactions costs, limits revenues, and erodes the potential value of the returns of the opportunity. Conversely, the control of corruption should increase the likelihood that prospective entrepreneur or innovator will be able to capture a larger portion of the revenues they generate, increase the reliability of those cash flows, and thus motivate higher levels of entrepreneurial and innovative activity. The precise form of the relationship among these variables is, however, an open question. While it is possible that the relationship is direct, several arguments suggest that the relationship is complex; that is, upward sloping but concave or convex in shape.

On the one hand, it stands to reason that the effects of a unit of improvement in the control of corruption may have greater impact when corruption is high than when it is low. If this is the case, one might expect the relationship between the control of corruption and entrepreneurial activity to be positive and convex. On the other hand, Rose-Ackerman’s (2001, 2004) arguments suggest that institutional trust may rise slowly in response to improvements in the control of corruption. Simply put, institutional
trust may take time to accumulate. In the early stages of an improved corruption climate, venturing and other forms of innovative activity will be viewed by others as an experiment. Domestic rates of entrepreneurial activity might then be expected to rise slowly at first, but accelerate as early experiments pay off and institutional trust rises. Barro (1991, 1996), for example, documented a positive concave relationship between improved control of corruption and economic development. We find this line of reasoning persuasive and expect that the empirical relationships among these variables will take the form of a positive (or generally upward sloping) concave curve. Accordingly:

**H1:** There is a positive concave relationship between the control of corruption and the amount of domestic entrepreneurial activity that occurs across nations.

Pursuit of innovative opportunities is characterized by the presence of uncertainty and information asymmetries that stem from the fact that innovation is comprised of new, previously untried combinations of ends-means relationships. Inasmuch as the innovators’ value chain must at some stage involve those entrusted with official power and authority, corruption necessarily increases the level of uncertainty and ambiguity the innovator must bear. Corruption is also often arbitrary (Hoffman, 2002; Rodriguez et al., 2006) and ex post opportunistic (Luo, 2004). That is to say, because corrupt practices may arise at any time and are not codified in any explicit way, it becomes difficult and expensive for the innovator to implement strategies to guard against it. Corruption thus exposes the prospective innovator to agency costs associated with holdup, or the risk that an agent on whom the innovator must at some point rely might later demand additional payment for services rendered. In corrupt environments, agents are able to demand bribes without fear or concern that the innovator might retaliate or take counter measures against them. As a result, the ex post uncertainty associated with a corruption can be formidable, especially for those from whom the bribe is demanded. (Luo, 2004: 124). Put differently, higher levels of corruption raise levels of uncertainty and transactions cost, and can thus make an otherwise promising innovative opportunity difficult to commercialize profitably. As a result, the profit margin the entrepreneur needs to earn to compensate for these risks will make only a small subset of innovative opportunities attractive for exploitation. The control of corruption, in contrast, reduces the threshold of minimally required profitability such that more innovative opportunities might be brought to fruition. In other words, one should expect a positive association between the control of corruption and the level of innovative activity that occurs within an economy.

Interestingly, this line of reasoning is consistent with Baumol (1990) who argues that the structure of incentives largely determines whether entrepreneurs will be drawn to productive outcomes like innovation, or to non-productive outcomes like the exploitation of monopoly or crime. In nations where corruption is high, those with talent and initiative have incentive to direct their energy toward rent-seeking — that is, the accumulation of private wealth via the abuse of powers granted to them by office holders (Murphy et al., 1991). Conversely, Baumol argues that in nations where the institutional context supports property rights and rewards risk-taking and invention, individual initiative will be directed toward innovation and other economically productive ends.

Again, the precise form of the relationship between control of corruption and innovation is an open question, but we think it is likely to be positive but concave in form. Institutional trust takes time to accumulate and the level of uncertainty that hinders those with innovative talent is not easily or quickly changed. Modest improvements in control of corruption may stimulate simple forms of entrepreneurship, but more complex innovative activities (that necessarily involve higher levels of uncertainty) might still be seen by the majority of prospective innovators as risky and imprudent until proven otherwise. As early innovative experiments pay off, the situation may change and more innovators would rush in to pursue their entrepreneurial agenda. Accordingly, we expect that the empirical relationships between control of corruption and innovative activities will take the form of an upward sloping concave curve. Therefore:

**H2:** There is a positive concave relationship between the control of corruption and the amount of domestic innovative activity that occurs within an economy.

An abundance of theory and research supports the view that foreign direct investment (FDI) plays a critical role in the economic development of a nation. Porter (1990), for example, suggests it is the primary vehicle for the transfer of technology to a developing country, and enhances the quality of its human capital through employment, training, and knowledge spillovers into the domestic economy. FDI also plays a prominent role in the highly regarded economic growth theories advanced by Krugman (1991) and Romer (1986, 1994). Al-Awazzi (2004) examined patent data across thirty countries and found that foreign firms are 57% more likely to receive information from foreign firms located in host nations than from abroad, and that an extra $1 million in FDI leads to a 4% increase in knowledge flows from the investor to the host nation. Interestingly, these knowledge flows are three times higher in newly industrialized countries than in more developed nations.

Sadly, there is an equally large literature which documents that corruption not only deters FDI (e.g., Hannafey, 2003; Mauro, 1995; Wilhelm, 2002) but also influences the source of investment, such that corrupt nations tend to attract FDI from other corrupt nations, and less corrupt nations tend to attract FDI from less corrupt nations (Hellman and Kaufmann, 2004). Firms with better technologies, human capital, training programs, and so forth are understandably reluctant to enter markets where gains may be more than offset by the potential costs of corruption. Corruption nations are thus less likely to benefit from investment by high-quality companies that employ sophisticated technologies. Equally important, corruption affects the type of entry strategies that multinational enterprises might employ when considering expansion into other nations (Rodriguez et al, 2005; Uhlenbruck et al., 2006). Wei and Smarzynska (2000) find that firms from less corrupt home nations are more likely to enter using direct
investment and to export more sophisticated technology to the host country (Wei et al., 2000). In corrupt economies, however, FDI tends to be in the form of joint venture – an organizational form that is associated with the use of less sophisticated managerial and production technology. Corruption thus reduces the types and amount of technical knowledge that FDI might bring to the host nation.

We believe that FDI and corruption interact to create important consequences for domestic rates of innovative activity. First, and as mentioned previously, FDI plays a crucial role in the accumulation of human and technological capital that is needed to enhance domestic productivity (Lambsdorff, 2003; Mauro, 1995), and is the primary source of modern production technology in many nations (Wei et al., 2000). As such, higher levels of FDI should be associated with rising levels of domestic economic productivity. Second, Audretsch and Feldman (1996) and Griliches (1992), among others, argue that the effects of knowledge spillovers are geographically constrained and captured in local innovation, which can take the form of domestic investment in technology and patent activity, and the creation of new firms. A number of studies, including Acs and Audretsch (1988), and Audretsch and Thurik (2001) confirm this intuition. The research data about patent activity in lesser developed nations is also consistent with this hypothesis (da Motta e Albuquerque, 2000; Lerner, 2002; Wade, 2003). Thus:

H3: The level of foreign direct investment positively moderates the relationship between the control of corruption and the amount of domestic innovative activity that occurs within an economy such that greater levels of innovative activity will be observed when FDI is high than when FDI is low.

4. Data, measures, and methods

4.1. Data

The dataset used in this study covers a seven-year period from 1996 to 2002 and contains information on 64 different countries. Data were collected from multiple independent sources. Information about domestic innovation, foreign direct investment, gross domestic product and population was obtained from the World Bank’s World Development Indicators (WDI) data series (World Bank, 2003). Our estimates of entrepreneurial activity were obtained from the Global Entrepreneurship Monitor (GEM), which uses survey methods to estimate levels of entrepreneurial activity around the world. Our measure of control of corruption is from Kaufmann, Kraay, and Mastruzzi’s (2006) World Governance Indicators (WGI), who track this information for the World Bank. Finally, data about international trade was obtained from the Penn World Table (Heston et al., 2002).

Fig. 1. Intertemporal production frontier.
4.2. Dependent variables

This study uses one measure of entrepreneurial activity and two indicators of domestic innovative activity as dependent variables. Total entrepreneurial activity (TEA) is from the Global Entrepreneurship Monitor and identifies the percentage of individuals in the nation, ages 18 to 64, that are actively engaged in starting or managing a new business; entrepreneurs that are engaged in both activities are counted only once (Bygrave et al., 2003). Since GEM does not survey each country in its survey every year, we use the average of these estimates over the time period of the study as our measure.

Our first measure of domestic innovative activity is the number of Patent applications filed by the country’s residents in each of the years covered by the study. Since the award of a patent is contingent on whether the applicant is first-to-file, patent applications should rise promptly in response to improvement in a nation’s innovative climate.

Our second measure, rate of Realized Innovation represents the rates of technological advancement achieved in each country in our sample and is calculated using a nonparametric programming technique known as Malmquist productivity index decomposition (Fare et al., 1994; Malmquist, 1953), which is a member of Data Envelopment Analysis (DEA) family of methods (Coelli, 1996). Rates of improvement in domestic factor productivity are a relatively unambiguous indicator of improvement in a nation’s vitality and economic health. This technique, long used in economics and the study of international trade, has recently made its way into the strategic management (Delmas and Tokat, 2005; Durand and Vargas, 2003) and innovation literatures (Thursby and Thursby, 2002).

The intuition behind the method is that each nation uses different combinations of inputs (e.g., labor and capital) to produce similar outputs (as represented by its gross domestic product). While some nations use less labor than others and some use less capital, other nations use relatively large quantities of both labor and capital to produce the same amount of output. By comparing the data on inputs and outputs for all nations included in the sample, DEA identifies a production frontier that represents the best use of these resources. Nations whose economy is efficient would find themselves on or close to this frontier while nations characterized by lower levels of efficiency would be distant from the frontier. This distance is conceptualized as a measure of relative economic efficiency. Over time, as nations experience productivity gains, they require less labor and capital to produce the same amount of output. Fig. 1 provides an illustration of the inter-temporal production frontier for the nations included in our sample. One can easily see the movement of some nations over time from the upper-right corner, where large quantities of labor and capital are required to produce a unit of GDP, to the lower-left corner where smaller quantities of both resources are required to produce a unit of GDP.

We use DEA to compute an annual estimate of economic efficiency or factor productivity for each nation and track changes in these estimates over time. We then employ the technique explained in Thursby and Thursby (2002) to decompose the DEA productivity estimates to identify the portion of efficiency improvement that is attributable to better utilization of existing resources, and use it as our estimate of Realized Innovation. Because previously cited theory and research suggests it takes time for the benefits of corruption control and investment in technology and human capital to accrue within an economy, we model Realized Innovation using a two-year time lag.

4.3. Independent variables

Control of corruption is from the World Bank’s Worldwide Governance Indicators research project (Kaufmann et al., 2006). This measure is widely used and has the widest coverage (184 nations) of all available corruption indices (Cuervo-Cazurra, 2006). The World Governance Indicators are based on 31 different data sources that are provided by 25 different organizations, and so represent the view of a large and diverse set of stakeholders. The sources employed in creating these indicators cover a wide range of issues typically associated with corruption, ranging from the frequency and size of the “additional payments” needed to get things done to “grand corruption” in the political arena. Control of Corruption is one of six dimensions of governance measured by Kaufmann et al. (2006) and is scaled with an interval ranging from −2.5 (low) to 2.5 (high).

4.4. Moderator variable

Net inflows of foreign direct investments as a percentage of GDP are used as our measure of foreign direct investment.

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<thead>
<tr>
<th>Table 1</th>
<th>Descriptive statistics</th>
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<td>Mean</td>
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<td>Resident patent applications</td>
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<td>Rates of realized innovation</td>
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<td>Foreign direct investments</td>
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<tr>
<td>Total entrepreneurial activity</td>
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<td>Control of corruption</td>
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<tr>
<td>Wealth</td>
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<td>International trade</td>
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<td>Population</td>
<td>16.67</td>
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</table>

*p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001.

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4.5. Controls

We account for the effect of Wealth on rates of domestic innovative activity by using the log of per capita GDP in constant 1995 US dollars as a covariate in our regressions (Olsen, 1996). Since the economy’s level of Trade with other nations influences foreign direct investment, we use foreign trade as a percentage of GDP in constant prices (log-transformed) as a control. Finally, since both the sheer volume of patent applications and the amount of foreign direct investment may be a function of the size of the nation, we control for it with the log of Population.

4.6. Methods

While the advantage of using GEM data is that it provides a direct measure of entrepreneurial activity, its use in this study created challenges because of missing values due to coverage (not all of the countries included in our sample were surveyed by GEM) and method (some countries included in the sample were not surveyed every year). We addressed these problems by first averaging the

<table>
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<th>Variable</th>
<th>Model 1a</th>
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<th>Model 1c</th>
<th>Model 1d</th>
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<td>(0.72)</td>
<td>(1.15)</td>
<td>(0.89)</td>
<td>(0.78)</td>
<td>(0.20)</td>
<td>(0.10)</td>
<td>(0.28)</td>
<td>(0.20)</td>
<td>(0.13)</td>
<td></td>
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<tr>
<td>Control of corruption</td>
<td>-0.29</td>
<td>-0.01</td>
<td>-0.34</td>
<td>2.96***</td>
<td>0.16*</td>
<td>-0.05</td>
<td>0.40**</td>
<td>0.10</td>
<td>-0.09*</td>
</tr>
<tr>
<td>squared</td>
<td>(0.25)</td>
<td>(0.48)</td>
<td>(0.41)</td>
<td>(0.07)</td>
<td>(0.03)</td>
<td>(0.14)</td>
<td>(0.08)</td>
<td>(0.04)</td>
<td></td>
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<tr>
<td>FDI</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-0.05*</td>
<td>-0.04</td>
</tr>
<tr>
<td>FDI * control of corruption</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.00</td>
<td>-0.01</td>
</tr>
<tr>
<td>FDI * control of corruption squared</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.01*</td>
<td>0.01*</td>
</tr>
<tr>
<td>Constant</td>
<td>28.42***</td>
<td>28.75**</td>
<td>27.84*</td>
<td>51.59***</td>
<td>-5.02**</td>
<td>-1.08</td>
<td>-2.53</td>
<td>-4.02*</td>
<td>-3.22***</td>
</tr>
<tr>
<td>(5.96)</td>
<td>(10.42)</td>
<td>(10.26)</td>
<td>(5.29)</td>
<td>(1.79)</td>
<td>(0.72)</td>
<td>(1.76)</td>
<td>(1.78)</td>
<td>(0.82)</td>
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<tr>
<td>Model fit</td>
<td>R²=0.35</td>
<td>R²=0.30</td>
<td>R²=0.26</td>
<td>R²=0.42</td>
<td>χ²(5)=218.96***</td>
<td>χ²(5)=23.91***</td>
<td>χ²(5)=140.27***</td>
<td>χ²(8)=222.45***</td>
<td>χ²(8)=65.52***</td>
</tr>
</tbody>
</table>

Fig. 2. Control of corruption and TEA.

Standard errors in parentheses.

⁎⁎⁎p<0.001, ⁎⁎p<0.01, ⁎⁎p<0.05, ⁎p<0.10, *p<0.16. 

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country-level observations across our time period and retaining data for the 33 nations for which GEM reported at least one observation. Thus, we test H1 (Entrepreneurial Activity) using cross-sectional, not panel data. However, the resulting small sample along with observed heteroscedasticity in the distribution of the data (Breusch–Pagan test produced $\chi^2(1)$ of 4.53, $p < 0.05$) made the use of conventional parametric methods inappropriate. Accordingly, we test H1 with quantile regression, a non-parametric technique that compensates for these distributional properties and so allows for more robust inference (Koenker and Hallock, 2001).

Unlike ordinary least squares regression, which implicitly assumes that the relationships of interest are uniformly distributed around the mean value of the response variable (and so makes it possible for OLS to estimate a single rate of change that is valid across its distribution), quantile regression is suitable for situations where variance is unequal across the distributions that the regression equation models. When variance is unequal, there is no single relationship that accurately describes the rate of change for all values of the dependent variable (Cade and Noon, 2003). Accordingly, quantile regression examines the relationships at specified levels across the distribution of the response variable (e.g., the 10th or 20th quantile). This is especially useful when there are reasons to believe that the nature of the relationships of interest may not be uniform for all values of the variables included in the study. For example, the effects of wealth are not uniform across nations because wealth is not distributed identically within each nation (Audretsch and Thurik, 2001; Olsen, 1996). Research seems to suggest that TEA may exhibit similar distributional properties (Tang and Koveos, 2004). Another benefit of quantile regression is that the results and their meaning are presented and interpreted just like OLS, which facilitates its use in this study (Koenker and Hallock, 2001).

Unlike TEA, our innovation data has almost no missing values for all 64 countries. This makes it possible for us to use high quality panel data comprised of multiple country-year observations to test H2 and H3. However, the use of panel data along with differing types of dependent variables requires us to use several econometric methods to test our hypotheses. Since the number of patent applications by the country's residents is a count variable, random effects negative binomial regression is used to test H2 and H3 on patent data. We test H2 and H3 on Realized Innovation using feasible generalized least squares (FGLS) which

![Fig. 3. Control of corruption and domestic innovation.](image)

![Fig. 4. Control of corruption and realized innovation.](image)
allows us to correct for the autocorrelation and heteroscedasticity that are common in this type of data (Audretsch and Thurik, 2001).

6. Results

Descriptive statistics and correlations are presented in Table 1 and results are presented in Table 2. While the size of the correlations among Control of Corruption, Wealth, and Trade (which range from .70 to .73) initially raised concern about multicollinearity, tests indicate they did not pose a threat to statistical inference. (VIF values ranged from 1.18 to 5.80, and all condition indices were under 30). Kaufmann et al. (2007) found similar relationships between Control of Corruption and Wealth in their studies and commented that they too did not threaten the statistical validity of their conclusions. Inspection of the table confirms that the relationship between Wealth and Control of Corruption is highly significant and positive. However, the relationships between Wealth and Realized Innovation, Patents, and TEA vary greatly in significance and sign. These findings are consistent with research cited earlier and underscore complex nature of the relationships that are being examined.

We use quantile regression to test the relationship between Control of Corruption and Total Entrepreneurial Activity (H1) at every decile of our distribution. Significant positive linear relationships were found at 10th, 20th, and 30th quantile. The relationship is positive and curvilinear at the 90th quantile. As shown in Models 1a to 1d, the influence of the Control of Corruption on Entrepreneurial Activity is strong in nations where entrepreneurial activity is either somewhat rare or quite commonplace, but not influential in the range of the mean for the Control of Corruption (see Fig. 2). This pattern of results is largely consistent H1. We discuss possible interpretations of these findings in the discussion section of this paper.

In Model 2 (Patents), the presence of a non-significant main effect for Control of Corruption, accompanied by a significant positive squared coefficient implies that that overall relationship between these variables takes the form of an upward sloping (or
positive) concave curve (Fig. 3). In Model 3 (Realized Innovation), our tests identified a marginally significant main effect for Control of Corruption, but no effect for its square. These results imply a positive linear (not curvilinear) relationship between Control of Corruption and Realized Innovation (Fig. 4). Together, the results for H1 indicate support for a positive relationship between the control of corruption and innovation, but mixed support for the notion that these relationships are curvilinear.

Before modeling the relationship implied by H3 we validated our conceptual arguments by regressing FDI on the set of variables employed in testing H2. As in Model 2, and consistent with results from a wealth of other studies about the relationship between corruption and FDI, the presence of a non-significant main effect for Control of Corruption in Model 4, accompanied by a significant positive squared coefficient implies that that overall relationship between these variables takes the form of a positive convex curve (Fig. 5).

H3 builds on Al-Awazzi’s (2004) research on knowledge spillovers to suggest that, in addition to the direct effects on patents observed in H2, control of corruption also enhances domestic innovation indirectly, through its relationship with foreign direct investment. Accordingly, we use negative binomial regression and include the main and squared terms for the Control of Corruption and FDI, along with the required product terms, in Model 5. The significant positive relationship for FDI x Control of Corruption Squared indicates marginal support (p < 0.08) for the hypothesized relationship. The plot of the observed relationship (Fig. 6) is consistent with earlier models but suggests that the positive relationship between control of corruption and patent activity is stronger when FDI is high than when it is low. Model 6 provides support for the positive relationship between the interaction term of FDI x Control of Corruption Squared and Realized Innovation. The plot of the observed relationship (Fig. 7) indicates that the positive relationship between control of corruption and realized innovation is strong when FDI is high. We conclude that the data from these tests suggests support for H3 and the notion that the overall relationship is curvilinear. The convexity of this relationship in Fig. 7, however, contrasts with the concave relationship described in Fig. 6. We discuss this issue in the following section.

7. Discussion

In this paper, we drew on the corruption, economic development, and entrepreneurship and innovation literatures to advance the hypothesis that better control of corruption will be associated with rising levels of innovation and entrepreneurship. In corrupt environments, we argue that agency and transactions costs, along with other non-productive consequences of corruption necessarily limit the scale and scope of economic activity (Wintrobe, 1995) and hence, reduce the magnitude of the incentive facing the prospective entrepreneur or innovator. Uncertainty about the entrepreneur/innovator’s ability to appropriate future benefits is also likely to limit investment in innovation, venturing, and other speculative endeavors (Baker et al., 2005; Baumol, 1990). Finally we argue that the relationships between corruption and FDI play a crucial role in fostering or frustrating domestic innovative activity. Longitudinal data from 64 nations lent moderate to strong support for all propositions concerning the relationship between entrepreneurship/innovation and corruption.

While the use of longitudinal cross-national data from a variety of sources created a variety of intriguing empirical challenges, it remains that the analyses presented herein describe a relatively uniform set of positive relationships on three different dependent variables. These variables serve as reasonable proxies for the level of entrepreneurial activity undertaken in an economy as well as for both potential (patents) and realized innovation. The results, moreover, control for the effect of relative wealth (measured as the

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3 While this relationship was not hypothesized, we model it as this relationship plays an important role in H3.

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The data are also somewhat intriguing in that the results concerning the precise form of the relationship between corruption and our dependent variables is mixed. The data indicate the relationship is positive and concave for H2 and H3 on patents (Fig. 6) but not on realized innovation (Fig. 7). Rather, the graph of the relationship between corruption, FDI, and realized innovation is positive but convex. It is also interesting that Figs. 6 and 7 both indicate that levels of patent activity and domestic innovation are greater when FDI is low than when it is high. Given the strong curvilinear relationships indicated in Fig. 5, this pattern of results is puzzling and surprising. This pattern of relationships might be the product of the type and quality of FDI that is flowing into the country. For example, if corrupt nations only attract FDI from other corrupt nations (Al-Awazzi, 2004), then high levels of FDI in some host nations may be characteristic of corruption, and, in these instances, low rates of domestic innovation. Alternatively, the observed curvilinear patterns may reflect the relative availability of patent opportunity in lesser developed nations, or may simply be an artifact of the data. We simply cannot tell with the data that we have in hand which explanation better suits the data. It remains, however, that that data which suggests the overall relationship is curvilinear may help explain why earlier studies, that tended to search for linear relationships, failed to find them.

The data about rates and form of the relationship between corruption and entrepreneurial activity is also somewhat ambiguous. While the use of quantile regression is appropriate and statistically justified, it remains that the hypothesized relationships were observed primarily in the lower quantiles. While this seems reasonable — the benefits of a unit of improvement in the control of corruption may be greater when corruption is high, it remains speculation. The form of the relationship at the 90th quantile was positive and curvilinear as hypothesized but, again, given data constraints, should be viewed with caution. Better, more fine-grained data is needed to fully probe these relationships and to flesh out our understanding of this phenomenon.

It was also surprising to find robust results based on patent data — an activity that one would not anticipate to be commonplace in developing economies. This data may also be influenced by patent activity that is conducted domestically by foreign-owned firms. The consistent pattern of results for patent activity and realized innovation, however, is tantalizing. Again, more fine-grained data about patent ownership is needed before the real meaning of these results is revealed.

Taken together, the theory and empirical results presented in this paper suggest a number of policy implications. Most important, the theory and evidence suggest that efforts to foster entrepreneurship and innovations within an economy will be more productive if accompanied by policy reforms aimed at controlling corruption. Inasmuch as entrepreneurial and innovative activity may contribute to the accumulation of economic welfare, such efforts may serve a greater goal of contributing to economic development — a contribution largely consistent with the positive effects of corruption control on economic development reported by others.

The fact that we find curvilinear relationships among our variable is of particular importance — not so much because we find significant relationships associations where prior research has not — but rather due to the implications they have for the policy makers. First, since most of our results imply that the form of the relationships among these variables is positive and concave, one needs to factor in long time horizons for the effects of control of corruption to generate visible consequences: substantial changes in the level of institutional trust are unlikely to accumulate and pay off instantaneously. Thus, firm commitment to fighting corruption despite the likely absence of early results is essential. Second, the study underscores that entrepreneurship and innovation do not occur in an institutional void. Rather, and consistent with arguments advanced by Baumol (1990), institutional factors appear to play an important role in determining whether entrepreneurial and innovative initiative will lead to productive welfare enhancing outcomes, or to non-productive outcomes like graft and the exploitation of monopoly.

Ultimately, the lesson for policy makers is that the control of corruption and its relationship with entrepreneurship/innovation is a complex issue. The role of institutional trust in the appropriation problem goes well beyond somewhat naïve linear formulations. Until these sophisticated mechanisms are better understood, stimulation of entrepreneurship and innovation will remain a non-trivial task.

While limitations with the data and methods indicate prudence, the results suggest that corruption may indeed play a powerful role in unpacking the connection between economic development and entrepreneurship and innovation. As always, more research is needed to fully unpack the puzzle of the connections among these variables. The theory, data, and analyses presented herein, however, represent a promising step on the path toward accomplishing a task that has long vexed researchers and hint that corruption may, indeed, be one of the missing variables in that search.

References


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