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Firm Innovation in Emerging Markets: The Role of Finance, Governance, and Competition

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Abstract

We investigate the firm characteristics associated with innovation in over 19,000 firms across 47 developing economies. While existing finance literature on innovation is limited to large public firms in developed markets such as the United States, our database includes public and private firms, and small and medium-sized enterprises. We define innovation broadly to include introduction of new products and technologies, knowledge transfers, and new production processes. We find that access to external financing is associated with greater firm innovation. Further, having highly educated managers, ownership by families, individuals, or managers, and exposure to foreign competition is associated with greater firm innovation.

I. Introduction

While much progress has been made in identifying the critical conditions that promote growth, the channels through which the effects operate are not well understood. In particular, while many economists have taken as a given that innovation is essential for economic growth and development,[1] the finance literature is silent on how innovation in developing countries is affected by access to finance and corporate governance.

Studies such as Baumol (2002) and Aghion and Durlauf (2005) have examined the role of technological change at the macro level, but the little we know of firm innovation is based on the study of large, publicly traded firms in developed countries such as the United States. However, recent research has shown

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[1] See, for example, Schumpeter (1942), Baumol (2002), and Aghion and Durlauf (2005) on the importance of innovation for growth and development.

that small and medium-sized enterprises (SMEs) are a significant contributor to overall value added in developing countries.[2] And yet, studies of the innovative practices of small firms in emerging markets have been missing, largely due to lack of data. It is not clear to what extent knowledge of innovation in large firms is relevant in filling this gap, as small firms in developing countries face a very different operating environment than that faced by large, public U.S. firms.

In this paper, using a new data set consisting largely of SMEs in developing countries, we study the determinants of the rate at which firms innovate and adapt their organizations to meet market conditions. We first identify the characteristics of innovative firms and then focus on how access to finance, governance, market competition, and managerial talent is associated with firms' ability to innovate. Specifically, we seek to answer the following:

- Are certain types of firms more innovative than others? How are firm size, age, legal status, and industry sector associated with a firm's innovative activities?
- Is access to external finance associated with innovation, and is this association stronger for some firms than others?
- Are state-owned enterprises more or less innovative than other firms? Is family ownership in developing economies associated with higher firm innovation rates?
- How is competition, both the number of competitors and the identity of the competitor, associated with innovation?

To answer these questions, we use a rich multicountry data set, the World Bank Enterprise Surveys, with information from over 19,000 firms in 47 countries[3] taking measures of firm innovation from firms' responses to a stratified random survey. The survey also reports data on each firm's organization and ownership, the type of product market competition it faces, the education level of its managers, and the amount and sources of external financing.

We define the innovation process broadly to include not only core innovative activities, such as the introduction of new products and new technologies, but also other types of activities that promote knowledge transfers, such as joint ventures with foreign partners or new licensing agreements, and other actions that affect the organization of the firm's business activities, such as opening a new plant or outsourcing a productive activity. Thus, we focus on new-to-firm innovation, which is of greater relevance for our sample of developing countries than the development of globally new technologies.

[2]See Ayyagari, Demirgüç-Kunt, and Maksimovic (2011), Ayyagari, Beck, and Demirgüç-Kunt (2007), and Beck, Demirgüç-Kunt, and Levine (2005).

[3]The Enterprise Surveys and their precursor, the World Business Environment Survey (WBES), have been used to investigate a series of questions in development economics, including the relation between property rights and contracting institutions (e.g., Acemoglu and Johnson (2005)), investment climate and business environment obstacles to growth (e.g., Beck, Demirgüç-Kunt, and Levine (2005), Ayyagari, Demirgüç-Kunt, and Maksimovic (2008)), firm financing patterns (e.g., Beck, Demirgüç-Kunt, and Maksimovic (2008), Cull and Xu (2005), and Ayyagari, Demirgüç-Kunt, and Maksimovic (2010b)), dispute resolution via courts (e.g., Djankov, La Porta, Lopez-de-Silanes, and Shleifer (2003)), and corruption (e.g., Barth, Lin, Lin, and Song (2009)).

We find that the externally financed proportion of a firm's investment expenditures is positively related to firm innovation, controlling for investment opportunities. This external financing is most likely to be bank financing for our sample of mainly SMEs in the absence of well-developed equity markets and other market-based sources in developing countries, as shown by Beck et al. (2008). Firms are also more innovative if a greater share of their borrowing is in a foreign currency. Interestingly, we find that state-owned firms are an exception to these findings. State firms that obtain external financing are not significantly more likely to innovate (and in some cases, are even less likely to innovate) than those state firms that do not obtain external financing.

When we look at firm characteristics, we find that firm ownership, identity of the controlling shareholder, and legal organization are important for firm innovation. Privately owned firms are, in general, more innovative than state-owned enterprises. Family firms and firms with insider ownership (managerial shareholding) are more innovative than firms with other ownership structures, whereas among privately owned firms, those with a financial institution as a controlling shareholder are the least innovative. Firms organized as corporations are more innovative than those organized as proprietorships, partnerships, or cooperatives.

We find a strong association between the type of competition faced by a firm and its innovation. In particular, foreign competition is positively associated with higher innovation rates. By contrast, we find no association between state-owned competition and firm innovation. Reinforcing our results on foreign competition, we find that exporters are more innovative than nonexporters. These results have policy implications for the role of globalization and foreign trade in exposing firms to foreign competition.

We also find that managerial education and experience and the education level of the workers are associated with firm innovation. Higher innovation rates are associated with a higher education level of the top manager and a larger percentage of workers who have completed university education or higher.

Together, our results not only identify the firm characteristics associated with innovation in developing economies, but also provide new evidence on a potential channel through which access to finance contributes to overall growth. While there has been very little research on firm-level innovation practices, our findings contribute to the small and emerging cross-country literature examining the link between finance and innovation across countries. King and Levine (1993b) show that financial intermediaries foster more efficient resource allocation by lowering information costs, thereby accelerating technological innovation and long-run growth. Aghion, Howitt, and Mayer-Foulkes (2005) hypothesize that financial constraints prevent poor countries from taking full advantage of research and development (R&D) or technology investment, causing them to diverge from the growth rate of the global technology frontier.

There is also a parallel literature on innovation in developed countries. Most of this literature uses U.S. data, and focuses either on large publicly traded firms (e.g., Atanassov, Nanda, and Seru (2009)) or on venture capital financing (e.g., Gompers, Kovner, Lerner, and Scharfstein (2006), Kortum and Lerner (2000), and Hellmann and Puri (2000)), both of which have limited implications for innovation in emerging markets.

Our study differs from the earlier studies in that we are able to use firm-level data for a large number of developing countries. We are also able to investigate the innovative processes of SMEs, which are believed to be critical in generating innovative activity and economic growth in these economies.[4]

In the rest of the paper, Section II presents the motivation and hypotheses, Section III discusses the data and summary statistics, and Section IV presents the empirical model. We discuss our main results in Section V. Section VI concludes.

II. Motivation

Firms in emerging markets are far from the technology frontier and have a number of different ways in which they can innovate. As argued by Kremer (1993) in the O-ring theory of development and the large literature it spawned, these innovative activities potentially reinforce each other and are complementary. Kremer argues that differences in firm productivity across countries can be explained by the failure of firms in developing countries to adopt existing best practices. Thus, we consider innovation, both narrowly defined as a firm's adoption of new technology and introduction of new product lines, as well as a broader definition that takes into account changes in the firm's operations, such as a decision to outsource certain activities or open a new plant.[5] We ask how the availability of external financing, differences in governance structures, and competition are associated with this process.

A. Finance and Innovation

There is a large empirical literature establishing that financial development is associated with long-term economic growth (see Levine (2005) for a review). Specifically, at the cross-country level, King and Levine (1993a), (1993b) and Levine, Loayza, and Beck (2000) show that financial development promotes growth. Cross-country time-series studies by Bekaert, Harvey, and Lundblad (2001), (2005) also show that financial liberalization boosts economic growth by improving the allocation of resources and the investment rate. Demirgüç-Kunt and Maksimovic (1998) and Rajan and Zingales (1998) provide evidence at the firm and industry levels, respectively, showing that reduced access to external finance is associated with slower growth.

However, the channels through which access to finance affects firm growth are not well understood. Clearly, access to external finance can facilitate capital accumulation. However, on a macro scale, historians have identified innovation and technological progress as the principal causes of material progress over extended periods of time (e.g., Landes (1969), Rosenberg (1982), and Mokyr (1990)). Solow's (1957) pathbreaking analysis of growth in labor productivity in the United States has established that technological advances (broadly defined) and skill, rather than capital accumulation, are the prime drivers of increases in

[4]See Audretsch (2006) for a collection of articles on this topic.

[5]In the next section, we define the activities we analyze more precisely.

labor productivity. Solow argues that approximately 80% of the increase in labor productivity in the United States over the period 1909–1949 was due to more productive use of capital and increases in the skill level of the labor force.

The types of innovations that drive productivity increases in developed and developing countries differ. Most firms in emerging markets are engaged in activities far from the technological frontier, and entrepreneurs innovate not just through original inventions but also by adopting new means of production, new products, and new forms of organization already in use in more developed countries. Schumpeter (1942) was one of the first to distinguish invention, which is the creation of new products or processes or the ideas that underlie them, from innovation, which covers the realization of new ideas in marketable products and processes. As shown by Segerstrom (1991) and Grossman and Helpman (1991), while both innovation and imitation fuel economic growth and technological progress, imitation is more common in the less-developed countries. More recently, Acemoglu, Aghion, and Zilibotti (2006) have argued that innovation becomes more important relative to imitation only when a country approaches the world technology frontier. Dutz (2007) also argues that innovation in emerging markets is less of shifting outward the global technological frontier and rather more of improving practices across the entire economy and includes innovations in processes and organizational models.

To take into account the importance of imitation in developing countries, applied researchers have defined "new-to-firm" innovation as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations." This definition has been adopted by the Organisation for Economic Co-Operation and Development (OECD) for its Innovation Microdata Project launched in 2006.[6] Similar definitions have been used by Cosh, Hughes, and Wood (1999) and Carayannis and Provance (2008), who argue that in measuring innovation in SMEs, it is important to consider new-to-firm innovation. Both Levitt (2006) and the recent United Nations Conference on Trade and Development (UNCTAD) Report (2007) argue that new-to-firm innovation or innovative imitations (new-to-firm innovations where firms create imitative equivalents of innovative products) are as important for facilitating economic growth as "new-to-world" innovations, in developing economies.

Given the importance of technological advances for growth, it is important to ask whether financial development is related to growth by fostering new-to-firm innovation and thus increasing efficiency in developing countries. Such an effect would occur if the financial system has an important role in supplying capital to firms that are innovating or restructuring their operations in ways that make them more efficient. We investigate below whether access to external finance is associated with higher innovation rates.

[6]See the *Oslo Manual* (OECD (2005)), which articulates the OECD/Eurostat definitions of innovation. The questions in the Enterprise Surveys we use align closely with the definition in the *Oslo Manual*.

B. Firm Governance and Innovation

Firm governance has been shown to be associated with firm value, share price, and profitability in several corporate finance studies.[7] However, most of these papers do not explore the role of firm governance in promoting innovation. We explore how 4 aspects of firm governance relate to innovation. First, we examine whether innovation rates differ between privately owned businesses and state enterprises, 2 ownership structures with very different incentive mechanisms. The work of Shleifer (1998), La Porta, Lopez-de-Silanes, and Shleifer (2002), and Dewenter and Malatesta (1997), (2001) on the performance differences between state and privately owned firms suggests that the rate of innovation should be significantly higher in private businesses.

Second, we examine whether the organizational form of private businesses is associated with their innovation. Demirgüç-Kunt, Love, and Maksimovic's (2006) investigation of the incorporation decision suggests that corporations become more prevalent and have comparatively higher growth rates in better institutional environments. However, we do not know if the differences in organizational forms, with their concomitant differences in governance, affect the rate of innovation.

Third, we also examine if the identity of the controlling shareholder of a privately owned business affects its innovation. Recent work by Villalonga and Amit (2006) suggests that family-controlled firms may be systematically different from other businesses.[8] Family ownership is likely to be particularly important in developing countries where the protection of minority shareholders is limited. Hence, we investigate whether the identity of the controlling shareholder is correlated with innovation.

Fourth, we examine how educational attainment, prior work experience, and tenure of the firm's top management relate to the rate of innovation. A negative relation between tenure in top management and firm innovation might suggest failure in the market for managers, which prevents efficient turnover. While there has been much research in finance and economics on the effects of managerial entrenchment (proxied by tenure of the manager) on capital structure decisions and firm performance, not much is known about the importance of individual managers' characteristics. There is some U.S. evidence on the importance of quality and type of education for firm performance. Bertrand and Schoar (2003) find that in a sample of *Forbes* 800 U.S. firms, older-generation chief executive officers (CEOs) are more conservative in their overall decision making, while managers with master in business administration (MBA) degrees appear to follow more aggressive strategies. Chevalier and Ellison (1999) find that the quality of education also matters, as in the case of U.S. mutual funds, where funds managed

[7]The studies linking governance to firm performance include Black (2001), Black, Jang, and Kim (2006), Durnev and Kim (2005), Klapper and Love (2004), Gompers, Ishii, and Metrick (2003), Lang, Lins, and Miller (2003), and Doidge, Karolyi, and Stulz (2004). Most of these studies are based on large firms and do not include SMEs that dominate our study.

[8]See Anderson and Reeb (2003), Burkart, Panunzi, and Shleifer (2003), Villalonga and Amit (2006), and Bertrand and Schoar (2006) for in-depth reviews of the advantages and disadvantages of family ownership and control within publicly traded corporations.

by managers educated at better universities (those with higher average Scholastic Aptitude Test (SAT) scores) tended to outperform other funds on a risk-adjusted basis.[9]

C. Competition and Innovation

We also examine the relation between firm innovation and the intensity of competition in the product market. The link between market power and innovation has been a recurrent question in industrial organization since Schumpeter (1939). The effect of the product market on firm innovation is also of particular policy interest, since it is likely to be easier to control the amount of competition and the openness of the product market to foreign competition than to reform a country's legal and financial institutions. Allen and Gale (2000) argue that for most firms in developing countries, the relevant disciplining device for controlling agency costs is the intensity of competition in the product market.[10] As the intensity of competition increases, a firm's freedom to deviate from efficient investment and innovation policies declines. A counterargument would suggest that as the level of competition increases, the firm's ability to enter into beneficial implicit contracts with customers and suppliers may decrease because the value of maintaining a reputation also decreases.[11] Such a decrease might disproportionally affect innovating firms, which are introducing new processes or products that may not be well understood by customers, and whose failure might expose them to unpredictable costs.

The literature on the link between competition and innovation is unsettled. While a large body of empirical evidence is favorable to the positive effect of competition on innovation (Geroski (1990), Nickell (1996), Blundell, Griffith, and Van Reenan (1995), and Galdon-Sanchez and Schmitz (2002)), the theoretical models suggest that increased competitive pressures reduce R&D effort (e.g., Dasgupta and Stiglitz (1980), Spence (1984), and Vives (2004)). More recently, Aghion, Blundell, Griffith, Howitt, and Prantl (2009) have shown that the intensity of competition, as measured by entry into an industry, spurs innovation among the more technologically advanced incumbent firms and slows it among the less efficient incumbents.

There is also much work in economics on the benefits of foreign competition and exporting status. The evidence on the impact of foreign competition has been very mixed. For instance, Aitken and Harrison (1999) showed that increases in foreign presence reduced the market share and total factor productivity (TFP) of local producers, whereas Haskel, Pereira, and Slaughter (2002) found that foreign presence in a U.K. industry raised the TFP of that industry's domestic plants.

[9] A large management literature has explored the link between managerial characteristics (e.g., tenure, education) and firm performance. In a survey of the literature, Barker and Mueller (2002) find that more educated CEOs have greater preferences toward higher R&D spending as part of being more receptive to innovation. Belliveau, O'Reilly, and Wade (1996) and Burt (1992) also argue that managerial education is a measure of the firm's social capital, and that CEOs with higher education have weaker ties to government officials, which can improve firm performance.

[10] See also Scharfstein (1988), Alchian (1950), Stigler (1958), and Hart (1983).

[11] See, for example, Maksimovic (1988) or Maksimovic and Titman (1991).

Javorcik (2004) found evidence suggesting that foreign presence is more likely to benefit supplying industries rather than industries in which multinationals operate. Other papers (e.g., Bernard and Jensen (1995), (1997), Richardson and Rindal (1995)) study U.S. manufacturing plants and find that exporters not only have more workers and pay higher wages, but also have higher productivity, capital intensity, and technology intensity. However, Bernard and Jensen (1999) argue that while good plants become exporters, once they become exporters, there is no evidence of higher productivity growth over the longer horizon.

We explore the relation between competition, governance, and firm innovation. We measure the number of competitors a firm faces, their relative technological sophistication, and the quality of competition. In our sample, firm organization and governance are likely to be important predictors of efficiency. Thus, we track domestic private competitors, foreign competitors (who, in our developing country sample, are likely to be more sophisticated), and competitors who are state enterprises. The latter are likely to be poor competitors based on the findings of earlier literature.

We also consider the relation between firm size and innovation. Since Schumpeter (1947), there exists a large literature relating the rate of innovation to firm size in developed economies.[12] Below, we explore differences in the rate of innovation across firm size categories in our sample of developing country firms. Firm size is also used as a control variable in all our regressions.

In summary, the literature on firm growth and financial development suggests that innovation is likely to be an important channel through which financial development affects growth. Later, we test this hypothesis by examining the relationship between firm innovation and external financing, product market competition, and firm governance, where the governance factors that are likely to be important in our sample are firm ownership, legal organization, and human capital.

III. Data and Summary Statistics

The World Bank Enterprise Surveys database consists of firm survey responses of over 19,000 firms in 47 developing countries.[13] The surveys sample from the universe of registered businesses in each country and follow a stratified random sampling methodology. The core survey uses standardized survey instruments to benchmark the investment climate of individual economies across the world and to analyze firm performance. All the country surveys in our sample were administered in one of the following years: 2002, 2003, or 2004.

[12]According to Schumpeter, firm size is essential for innovation, since larger firms can provide economies of scale in production and innovation. Other studies, by contrast, have emphasized the role of small firms, including Rothwell and Dodgson (1994), Acs and Audretsch (1987), and Scherer (1965), to name a few.

[13]The data used in this paper were last updated in December 2006. While the core survey instrument was administered to over 44,000 firms in 67 countries, the questions on firm innovation were administered to a smaller sample of firms in fewer countries. In addition, while a few countries in our sample were surveyed in multiple years over the time period 2002–2004, the innovation module of the survey was implemented in only one of the years. Hence, our sample consists of 19,813 firms in 47 countries, with at least 100 firms surveyed in each country.

A great advantage of these surveys is their broad coverage of the extent of innovation that the firms undertake. Previously, there has been very little consistent data across countries on the nature of innovative activities undertaken by firms. Moreover, the available data typically cover only the developed countries and focus on patents and R&D expenditures. However, as discussed in Section II.A, the issues are likely to be different for most developing countries, where imitation and adaptation of already-created and tested innovations, rather than cutting-edge innovations, are likely to be more important. Thus, in studying innovation in developing countries, we need to define innovation broadly rather than as just new inventions. The Enterprise Surveys allow us to capture the rate of firm innovation in this broader sense. Specifically, the surveys ask firms if they have undertaken any of the following 8 innovative activities in the last 3 years: i) developed a major new product line, ii) upgraded an existing product line, iii) introduced new technology that has substantially changed the way that the main product is produced, iv) opened a new plant, v) agreed to a new joint venture with a foreign partner, vi) obtained a new licensing agreement, vii) outsourced a major production activity that was previously conducted in-house, or viii) brought in-house a major production activity that was previously outsourced. The firm responses are coded as 0–1 (No–Yes) dummy variables for each of the 8 questions.[14]

In addition to the 8 individual indicators of firm innovation, we analyze 2 aggregate indices for each firm. Our approach parallels La Porta, Lopez-de-Silanes, Shleifer, and Vishny's (1998) use of aggregate indices in the study of corporate governance. *Aggregate Innovation Index* is an aggregate index obtained by summing the number of activities in which the firm engages. *Core Innovation* is an aggregate index obtained by summing firm responses to developing a new product line, new technology and upgrading an existing product line, to reflect the narrow definition of core innovation as used in existing literature.[15]

One of the concerns with using any survey data is the accuracy of the reported information, and the survey organization (the World Bank) takes several steps to ensure data reliability. First, to ensure a high degree of firm participation, confidentiality of the data is assured and firm identifiers are never disclosed. Second, while government statistics are relied on for creating the sampling frame, the survey is conducted by private contractors rather than government agencies or organizations associated with the government to ensure confidentiality. The survey supervisors also perform random checks to detect irregularities and inconsistencies, check key responses for accuracy, and recontact enterprises to correct any discrepancies.

To ensure that the survey questions elicit valid answers, all the surveys are piloted prior to launch to make sure that questions are properly translated, worded, and understood in the context of the particular country's business environment. The survey is administered to upper-management personnel who are

[14]Firms in the survey were also asked about whether they *discontinued at least 1 product (not production) line* and *closed at least 1 existing plant or outlet.* While these activities are a measure of firm flexibility and dynamism, we do not include them as measures of innovation.

[15]Our results are robust to using a *Core Innovation Index* that does not include upgrading product lines.

knowledgeable about the business. Two separate interviews are conducted: The managing director or senior manager answers questions on the business environment and different lines of business, and the chief accountant answers questions on productivity measures and balance sheets. One other concern may be that individual firms subjectively report on their innovation and that these may have different meanings in different institutional contexts. First, to the extent that this represents pure measurement error in the dependent variable, which Wooldridge (2006) argues is less important than that in an explanatory variable, it biases our estimates only if the measurement error is systematically related to 1 or more of the firm characteristics. Second, in all our regressions we control for country-specific characteristics via fixed effects. World Bank survey data, both the Enterprise Surveys and their precursor, the WBES, have been used in a large number of studies, including Djankov et al. (2003), Acemoglu and Johnson (2005), Beck, Demirgüç-Kunt, and Maksimovic (2005), (2008), Cull and Xu (2005), and Barth et al. (2009). More recently, Hallward-Driemeier and Aterido (2009) examine how well firm responses in the Enterprise Surveys on questions related to obstacles in the business environment correspond to other data sources, and they find a high degree of correlation between firm responses and measured objective outcomes from external data sources.

Table 1 summarizes the proportion of firms in each country that undertook each of the 8 innovative activities over the year prior to the survey. All the countries in the sample are developing economies with gross domestic product (GDP) per capita in 2000 ranging from $192 USD in the case of Tanzania to $11,646 USD in the case of Slovenia.[16]

The countries in the sample show a great deal of variation across the 8 different categories of firm innovation. In no single country are firms uniformly less or more innovative across the different categories. Nevertheless, the aggregate indices, *Aggregate Innovation Index* and *Core Innovation*, suggest that firms from Cambodia, Brazil, and South Africa are the most innovative, while firms from Egypt, Oman, and Turkey are the least innovative. For instance, 68% of Brazilian firms introduced a new product line, 95% upgraded an existing product line, and another 68% introduced a new technology, compared to Egyptian firms that were the least active in each of these categories, with corresponding numbers of 15%, 23%, and 11%, respectively. However, Brazilian firms are not innovative across all categories. Only 4% of Brazilian firms signed joint ventures, and only 7% entered into new licensing agreements (the numbers for Egypt, Oman, and Turkey are similar) compared to 23% of firms in Belarus that signed new joint ventures and 38% of Russian firms that entered into new licensing agreements.

When we look at the numbers across different firm size groups, we find that larger firms are more innovative across all activities compared to smaller firms. The aggregate indicators also reveal that larger firms are more innovative than smaller firms.

[16]Firms in the following countries—Bhutan, China, Egypt, Syria, and Uganda—were only asked about a subset of the 8 innovations, and hence the *Aggregate Innovation Index* is not computed for the firms in these countries. Firms in Bhutan and Uganda were also not asked about their core innovation and hence do not have the *Core Innovation* reported.

TABLE 1

Indicators of Firm Innovation

Table 1 presents the proportion of firms in each country undertaking different types of innovations. The variables are described as follows: GDP/capita is real GDP per capita in U.S. dollars in 2000. Developed a major new product line, Upgraded an existing product line, Introduced new technology that has substantially changed the way that the main product is produced, Opened a new plant, Agreed to a new joint venture (JV) with foreign partner, Obtained a new licensing agreement, Outsourced a major production activity that was previously conducted in-house, and Brought in-house a major production activity that was previously outsourced are all dummy variables that take the value 1 if the firm undertook the corresponding innovation, and 0 otherwise. *Aggregate Innovation Index* is an aggregate measure that is formed by adding 1 if the firm has undertaken any of the 8 different innovative activities described above. *Core Innovation* is an aggregate measure of innovation that is formed by adding 1 if the firm has developed a new product line, upgraded an existing product line, or introduced a new technology. Small firms employ 1–19 employees, medium-sized firms have 20–99 employees, and large firms have more than 100 employees.

Nation	GDP/ Capita	New Product Line	Upgraded Existing Product Line	New Technology	Opened a New Plant	New JV with Foreign Partner	New Licensing Agreement	Outsourced a Major Activity	Brought In-House a Previously Outsourced Activity	*Core Innovation*	*Aggregate Innovation Index*
Albania	1,007.95	0.43	0.45	0.33	0.02	0.05	0.05	0.04	0.12	1.20	1.47
Armenia	629.91	0.31	0.42	0.26	0.04	0.09	0.13	0.11	0.10	0.98	1.44
Azerbaijan	533.48	0.31	0.31	0.22	0.06	0.09	0.32	0.06	0.04	0.84	1.42
Belarus	1,896.41	0.44	0.62	0.33	0.06	0.23	0.37	0.21	0.14	1.40	2.41
Bhutan	532.21			0.59							
Bosnia and Herzegovina	1,594.60	0.39	0.61	0.33	0.16	0.16	0.09	0.07	0.06	1.29	1.82
Brazil	4,626.34	0.68	0.95	0.68	0.16	0.04	0.07	0.28	0.21	2.30	3.06
Bulgaria	1,544.94	0.57	0.54	0.31	0.14	0.06	0.26	0.04	0.10	1.42	2.01
Cambodia	367.51	0.53	0.90	0.60	0.18	0.21	0.21	0.33	0.41	2.04	3.38
China	824.63	0.24	0.40	0.33						0.97	
Croatia	5,077.08	0.51	0.74	0.37	0.27	0.09	0.13	0.05	0.13	1.59	2.25
Czech Republic	5,380.49	0.28	0.48	0.23	0.28	0.06	0.08	0.05	0.14	0.99	1.61
Ecuador	1,705.06	0.52	0.84	0.51	0.06	0.11	0.08	0.20	0.10	1.86	2.42
Egypt, Arab Rep.	1,216.65	0.15	0.23	0.11		0.02	0.01	0.04		0.48	
El Salvador	1,759.68	0.62	0.82	0.51	0.06	0.09	0.04	0.11	0.08	1.95	2.33
Estonia	3,792.29	0.29	0.51	0.32	0.22	0.05	0.21	0.12	0.06	1.12	1.76
Georgia	768.13	0.33	0.44	0.29	0.14	0.06	0.13	0.04	0.08	1.06	1.51
Guatemala	1,562.57	0.53	0.82	0.43	0.08	0.12	0.04	0.13	0.14	1.78	2.29
Honduras	713.11	0.47	0.72	0.46	0.07	0.09	0.04	0.08	0.09	1.65	2.03
Hungary	5,439.15	0.24	0.35	0.15	0.20	0.04	0.08	0.14	0.09	0.74	1.29
Indonesia	1,014.63	0.38	0.68	0.22	0.07	0.06	0.08	0.13	0.10	1.23	1.65
Kazakhstan	1,547.98	0.34	0.43	0.19	0.05	0.06	0.27	0.06	0.03	0.96	1.43
Kyrgyz Republic	443.96	0.41	0.54	0.30	0.11	0.12	0.20	0.08	0.04	1.24	1.77
Latvia	2,608.12	0.37	0.56	0.33	0.23	0.05	0.26	0.05	0.03	1.25	1.86
Lithuania	2,617.61	0.49	0.40	0.29	0.09	0.07	0.19	0.16	0.06	1.14	1.70
Macedonia, FYR	2,541.06	0.35	0.40	0.32	0.15	0.21	0.08	0.22	0.08	1.07	1.80
Mali	292.81	0.46	0.59	0.50	0.11	0.06	0.05	0.06	0.07	1.51	1.85
Moldova	424.47	0.51	0.59	0.30	0.28	0.07	0.29	0.07	0.14	1.40	2.25
Nicaragua	502.65	0.47	0.85	0.53	0.05	0.09	0.02	0.10	0.08	1.85	2.19
Oman	5,921.12	0.36	0.46	0.32	0.21	0.04	0.07	0.04	0.08	0.33	0.46
Philippines	1,173.14	0.49	0.64	0.42	0.13	0.06	0.13	0.21	0.14	1.50	2.14
Poland	4,337.37	0.43	0.56	0.27	0.08	0.01	0.09	0.02	0.02	1.25	1.48
Romania	1,461.46	0.47	0.70	0.31	0.31	0.06	0.21	0.07	0.22	1.48	2.35
Russian Federation	2,944.13	0.39	0.50	0.30	0.12	0.04	0.38	0.08	0.01	1.17	1.77
Serbia and Montenegro	1,631.59	0.38	0.58	0.36	0.26	0.17	0.11	0.07	0.10	1.30	2.01
Slovak Republic	4,303.32	0.33	0.77	0.34	0.24	0.05	0.17	0.06	0.09	1.44	2.04
Slovenia	11,646.10	0.28	0.41	0.33	0.12	0.17	0.19	0.14	0.13	1.02	1.77
South Africa	4,022.63	0.68	0.84	0.61	0.20	0.09	0.10	0.20	0.34	2.12	3.06
Syrian Arab Republic	792.82	0.42	0.46	0.33		0.04	0.06			1.19	
Tajikistan	229.49	0.41	0.55	0.35	0.03	0.06	0.18	0.06	0.04	1.30	1.67
Tanzania	191.75	0.33	0.58	0.32	0.11	0.04	0.09	0.05	0.09	1.20	1.57
Thailand	2,827.62	0.50	0.71	0.52	0.08	0.04	0.11	0.18	0.11	1.72	2.23
Turkey	3,047.65	0.18	0.27	0.15	0.06	0.04	0.03	0.05	0.04	0.60	0.81
Uganda	348.64			0.47							

(continued on next page)

TABLE 1 (continued)
Indicators of Firm Innovation

Nation	GDP/ Capita	New Product Line	Upgraded Existing Product Line	New Technology	Opened a New Plant	New JV with Foreign Partner	New Licensing Agreement	Outsourced a Major Activity	Brought In-House a Previously Outsourced Activity	*Core Innovation*	*Aggregate Innovation Index*
Ukraine	880.88	0.45	0.57	0.37	0.10	0.19	0.19	0.10	0.11	1.40	2.10
Uzbekistan	654.31	0.28	0.44	0.22	0.06	0.05	0.19	0.06	0.05	0.95	1.35
Zambia	403.82	0.49	0.69	0.50	0.34	0.06	0.06	0.11	0.17	1.67	2.41
Small (1–19)		0.33	0.49	0.28	0.08	0.05	0.10	0.08	0.09	1.08	1.61
Medium (20–99)		0.44	0.63	0.40	0.12	0.06	0.11	0.15	0.14	1.43	2.17
Large (100+)		0.51	0.70	0.50	0.18	0.12	0.16	0.18	0.15	1.69	2.60

Table 2 contains the sample statistics of the variables we consider. Panel A shows that across countries, a higher percentage of firms are more actively engaged in core innovation (42% introduced new product lines, 60% upgraded existing product lines, and 39% introduced new technology) than in other types of innovative activities (e.g., only 7% signed joint ventures). The aggregate indicator, *Aggregate Innovation Index*, shows that firms on average undertake around 2 out of 8 activities.

In addition to the rich detail on the innovative activities undertaken by firms, the survey has information on firm size, age, legal organization, number of establishments, and capacity utilization, all of which are used as firm-level controls in our study. The survey defines firms of 3 different sizes: small ($<$20 employees), medium (20–99 employees), and large firms ($\geq$100 employees). As shown in Panel A of Table 2, the sample is largely dominated by small (37% of the sample) and medium-sized firms (35% of the sample). Thus, the survey provides data across a broader cross section of firm sizes than is available in commercial databases such as Worldscope. The average firm age in the sample is 16 years, and while most firms are single establishment firms (73%), the mean number of separate operating facilities is about 2 establishments per firm, where establishment is a physical location that has its own management, controls its payroll, and prepares its own financial statement.

The survey also covers both public and private firms. It indicates that 8% of the sample is composed of firms where the government owns 50% or more of the firm. Of the remaining firms, 81% of the sample consists of the domestic private sector (owns $\geq$ 50%), and 11% consists of foreign private sector firms (owns $\geq$ 50%).[17]

The firms in the survey are broadly classified in terms of legal organization into corporations, cooperatives, sole proprietorships, partnerships, and all other forms. *Corporation* is a dummy variable that takes the value 1 if the firm is organized as a corporation, and 0 if the firm is organized as a cooperative, sole proprietorship, or partnership, or has some other form. Panel A of Table 2 shows that 43% of the sample is composed of corporations. In unreported statistics, we

[17] All our main results are robust to dropping state and foreign firms from the sample.

TABLE 2

Summary Statistics

Panel A of Table 2 presents the summary statistics for the variables, Panel B presents the correlation matrix between the firm innovation variables, and Panel C between the aggregate innovation variables and firm-level variables. The variables are described as follows: Developed a major new product line, Upgraded an existing product line, Introduced new technology that has substantially changed the way that the main product is produced, Opened a new plant, Agreed to a new joint venture (JV) with foreign partner, Obtained a new licensing agreement, Outsourced a major production activity that was previously conducted in-house, and Brought in-house a major production activity that was previously outsourced are all dummy variables that take the value 1 if the firm undertook the corresponding innovation, and 0 otherwise. *Aggregate Innovation Index* is an aggregate measure that is formed by adding 1 if the firm has undertaken any of the 8 different innovative activities described above. *Core Innovation* is an aggregate measure of innovation that is formed by adding 1 if the firm has developed a new product line, upgraded an existing product line, or introduced a new technology. Small firms employ 1–19 employees, medium-sized firms have 20–99 employees, and large firms have more than 100 employees. Firm age is the year of the survey–year established. Number of establishments is the number of separate operating facilities a firm has. Corporation is a dummy variable that takes the value 1 if the firm is legally incorporated, and 0 if the firm is organized as a cooperative, sole proprietorship, partnership, or has another legal form. Capacity utilization takes values from 1 to 3 corresponding to capacity utilization levels below 50%, between 50% and 80%, and above 80%. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Summary Statistics

Variable	*N*	Mean	Std. Dev.	Min.	Max.
Individual Innovation Indicators					
New product line	19,031	0.42	0.50	0	1
Upgraded existing product line	19,028	0.60	0.49	0	1
New technology	19,417	0.39	0.49	0	1
Opened a new plant	15,121	0.13	0.33	0	1
New JV with foreign partner	16,638	0.07	0.26	0	1
New licensing agreement	16,647	0.12	0.32	0	1
Outsourced a major activity	16,093	0.13	0.34	0	1
Brought in-house a previously outsourced activity	15,127	0.13	0.33	0	1
Aggregate Innovation Indicators					
Core Innovation	19,415	1.38	1.16	0	3
Aggregate Innovation Index	15,478	2.08	1.68	0	8
Control Variables					
Firm size	19,684	1.91	0.80	1	3
Small	19,684	0.37	0.48	0	1
Medium	19,684	0.35	0.48	0	1
Large	19,684	0.28	0.45	0	1
Age	19,760	16.55	16.31	0	202
Number of establishments	15,314	2.05	5.89	0	200
Corporation	18,963	0.43	0.49	0	1
Capacity utilization	17,982	2.40	0.67	1	3

Panel B. Correlation Matrix between the Firm Innovation Indicators

Variable	New Product Line	Upgraded Existing Product Line	New Technology	Opened a New Plant	New JV with Foreign Partner	New Licensing Agreement	Outsourced a Major Activity
Upgraded existing product line	0.4612***						
New technology	0.3787***	0.4424***					
Opened a new plant	0.1678***	0.1186***	0.1485***				
New JV with foreign partner	0.1366***	0.1112***	0.1177***	0.1340***			
New licensing agreement	0.1281***	0.0827***	0.1066***	0.1595***	0.2229***		
Outsourced a major activity	0.1672***	0.1735***	0.1882***	0.1151***	0.1509***	0.1267***	
Brought in-house a previously outsourced activity	0.1746***	0.1699***	0.1832***	0.1292***	0.1114***	0.0966***	0.2946***

Panel C. Correlation Matrix between the Aggregate Innovation Indicators and the Firm-Level Variables

Variable	*Aggregate Innovation Index*	*Core Innovation*	Size	Age	Number of Establishments	Corporation
Core Innovation	0.8588***					
Size	0.2405***	0.2125***				
Age	0.0513***	0.0431***	0.2767***			
Number of establishments	0.0477***	0.0151**	0.1354***	0.0764***		
Corporation	0.2089***	0.2305***	0.2555***	0.0148**	0.0102	
Capacity utilization	0.0172**	0.0607***	0.0937***	–0.0563***	0.0378***	0.0295***

find that only 5% of these corporations are publicly listed, whereas the remaining 37% are privately held limited companies.

The investment opportunities available to a firm may be an important determinant of the extent and type of innovative activities a firm is engaged in. While we do not have a direct measure of a firm's investment opportunities, we believe the use of industry fixed effects (that proxy for industry-level growth opportunities) and firm age dummy variables help account for the investment opportunities at the firm level. Furthermore, following a literature in economics that has used industry capacity utilization rates as a proxy for industry investment opportunities (e.g., Ghosal and Loungani (1996)) we use firms' capacity utilization rates as an approximate proxy for investment opportunities of the firm. Business analysts (e.g., Baumohl (2008)) have also argued that capacity utilization rates measure the amount of slack in an economy and are good leading indicators of business investment spending. In the survey, capacity utilization is defined as the amount of output actually produced relative to the maximum amount that could be produced with the firm's existing machinery, equipment, and regular shifts. The variable *Capacity Utilization* takes on values from 1 to 3 corresponding to firms that have low investment opportunities (capacity utilizations $< 50\%$), medium level of investment opportunities (capacity utilization between 50% and 80%), and high investment opportunities (capacity utilization rates $> 80\%$). More than 50% of the firms in the sample have high capacity utilization rates, indicating high investment opportunities.

Panel B of Table 2 presents the correlations between the different innovation indicators, and Panel C presents the correlations between the aggregate innovation indicators and firm-level variables. Panel B shows that all aspects of firm innovation are highly correlated at the 1% level. The correlation coefficients range from 0.08 to about 0.46. The highest correlation coefficient of 0.46 indicates that firms that introduce a new product line are also highly likely to upgrade an existing product line. Panel C of Table 2 shows that the aggregate indices, *Core Innovation* and *Aggregate Innovation Index*, are very highly correlated with each other, with a correlation coefficient of 0.86.

IV. Firm Characteristics and Firm Innovation: The Empirical Model

To study the relation between firm innovation and financing, governance, and competition, we proceed in 2 steps. First, we analyze innovative activities controlling for broad firm characteristics (e.g., size, age, legal status, number of establishments, industry, and capacity utilization). Next, we introduce variables that enable us to examine the relations between innovation and firm financing, governance, and the competition environment. We do not include all variables at once so as to not overload the specification and to avoid reducing the sample size significantly, since some of these variables are available for only a subset of observations. Country fixed effects are used in all regressions, with standard errors clustered at the country level. In the first step, the regression equations we estimate are of the following form: For firm i in industry j in country k, we have

$$
\begin{aligned}
(1)\quad \text{Firm Innovation}_{i,j,k} \;=\; & \alpha + \beta_1 \text{Medium Firm Dummy}_{i,j,k} \\
& + \beta_2 \text{Large Firm Dummy}_{i,j,k} + \beta_3 \text{Age}_{i,j,k} + \beta_4 \text{Corporation Dummy}_{i,j,k} \\
& + \beta_5 \text{Number of Establishments}_{i,j,k} \\
& + \beta_6 \text{Dummy for Capacity Utilization between [50\%, 80\%]}_{i,j,k} \\
& + \beta_7 \text{Dummy for Capacity Utilization above 80\%}_{i,j,k} + \mathbf{I_j} + \mathbf{C_k} + \varepsilon_{i,j,k}, \\
& \qquad k = 1, \ldots, 47; \qquad j = 1, \ldots, 26,
\end{aligned}
$$

where $\mathbf{I_j}$ and $\mathbf{C_k}$ are vectors of industry and country fixed effects and Firm Innovation$_{i,j,k}$ is either 1 of the 2 aggregate indicators (Aggregate Innovation Index or Core Innovation), or 1 of the 8 underlying indicators of innovation based on firms' responses to survey questions.

All regressions are estimated using firm-level data across 47 countries. Since the 8 individual indicators of firm innovation are 0–1 variables, these regressions are estimated using a logit probability model. For the aggregate indicators, we use ordered logit. Since this is a cross-country estimation with >100 observations for each country as well as each industry, our analysis is not subject to the incidental parameters problem. Moreover, in validation tests using the linear probability model, we find all our results materially unchanged.

We use equation (1) as the baseline and build on it to examine the relation between innovation and access to external finance and governance (i.e., ownership and human capital) and competition. In the second step the regression equations we estimate are of the form

$$
\begin{aligned}
(2)\quad \text{Firm Innovation}_{i,j,k} \;=\; & \alpha + \beta_1 \text{Medium Firm Dummy}_{i,j,k} \\
& + \beta_2 \text{Large Firm Dummy}_{i,j,k} + \beta_3 \text{Age}_{i,j,k} + \beta_4 \text{Corporation Dummy}_{i,j,k} \\
& + \beta_5 \text{Number of Establishments}_{i,j,k} \\
& + \beta_6 \text{Dummy for Capacity Utilization between [50\%, 80\%]}_{i,j,k} \\
& + \beta_7 \text{Dummy for Capacity Utilizations above 80\%}_{i,j,k} + \mathbf{I_j} + \mathbf{C_k} \\
& + \mathbf{X_{i,j,k}} + \varepsilon_{i,j,k}, \quad k = 1, \ldots, 47; \quad j = 1, \ldots, 26,
\end{aligned}
$$

where $\mathbf{X_{i,j,k}}$ is a vector of variables characterizing different aspects of the firm's financing, governance, and competition environment.

To establish a causal effect between finance, governance, competition, and innovation we would need to be able to show the counterfactual that had the firm not had access to external finance, particular governance characteristics, and a particular competition environment, it would not have been able to innovate.

However, our data source is secondary survey data that are randomized across firms and countries but do not allow us to control the random assignment of firms to external finance, governance, and the competition environment. To identify causal effects in the absence of random assignment, one can rely on quasi randomization either through instrumental variable (IV) techniques or by identifying a natural experiment such as a policy change that produces an exogenous variation, both of which have their own limitations and cannot be implemented due to our data limitations. IV techniques that would enable us to address firm-specific

counterfactuals require the use of firm-level instruments, which are not available in our survey data. While randomized control trials or natural experiments provide ways of identifying causal effects in the presence of heterogeneity, the survey data used in the paper cover 47 countries over the period from 2002 to 2004, and in a cross-country study such as this, it is nearly impossible to identify an exogenous policy change that occurred across all these countries during the same time.

Overall, we acknowledge the data limitations that prevent us from exploring causal relations in our study but believe our results to be a necessary first step in assessing the links between external finance, governance, competition, and innovation in SMEs across emerging markets.[18] Our findings provide broad insight from a large set of firms and countries that is more generalizable than the evidence from a local experiment.

V. Results

Table 3 reports the estimated coefficients of baseline regression (1). The table shows that individual firm characteristics are closely related to firm innovation. Compared to small firms, medium-sized and large firms are more likely to develop new product lines, upgrade existing product lines, introduce new technology, open a new plant, sign a new joint venture with a foreign partner, sign new licensing agreements, outsource a major activity, and bring in-house a previously outsourced activity. Larger firms are also more innovative when we look at the aggregate indicators. The marginal effects (not shown in the table) calculated for the most innovative firms (*Core Innovation* = 3) show that large firms are 16% more likely to innovate than smaller firms.[19] The relation between innovation and size is robust to controlling for the number of product lines of the firm and also to estimating on a subsample of single establishment firms.

The number of establishments increases the probability that a firm will open a new plant, as expected.[20] Firms with a larger number of establishments are also more likely to sign new joint ventures and outsource a major activity and are more innovative based on the *Aggregate Innovation Index* as well.

Controlling for size and the number of establishments, firms organized as corporations also report more innovative activity than other businesses. The marginal effects show that the probability of core innovation increases by 3.7% for

[18]In unreported results available from the authors, we find our results robust to the use of IVs at the country-industry level. We used 3 sets of instruments for external finance: country-industry averages of external finance, and firms' ranking of the extent to which access to financing and the legal system are obstacles to the growth and operation of their business. We also found our results robust to doing the analysis at the country level by averaging the aggregate innovation indicators (dependent variables) and external financing (independent variable) across countries and using historical variables commonly used in the literature, namely *Latitude* of a country's capital city and the country's *English Legal Origin* dummy variables as instruments. While all our instruments pass various tests of good instruments, we are reluctant to rely heavily on these results due to the obvious issues with identifying the counterfactuals and concerns with exclusion restrictions.

[19]Throughout the paper, the marginal effects reported are evaluated at the mean value of the control variables and are computed for *Core Innovation* = 3.

[20]If we use a dummy variable for single establishment firms, we find that single establishment firms are less likely to open a new plant compared to firms with more than one establishment.

TABLE 3

Characteristics of Innovating Firms

The regression model estimated for firm i in industry j in country k is $\text{Innovation}_{i,j,k} = \alpha + \beta_1 \text{Firm Size Dummies}_{i,j,k} + \beta_2 \text{Age}_{i,j,k} + \beta_3 \text{Corporation}_{i,j,k} + \beta_4 \text{Number of Establishments}_{i,j,k} + \beta_5 \text{Capacity Utilization Dummies}_{i,j,k} + \beta_6 \mathbf{I_j} + \beta_7 \mathbf{C_k} + \varepsilon_{i,j,k}$, for firm i in industry j in country k. The variables are described as follows: Innovation is one of the following variables: Developed a major new product line, Upgraded an existing product line, Introduced new technology that has substantially changed the way that the main product is produced, Opened a new plant, Agreed to a new joint venture (JV) with foreign partner, Obtained a new licensing agreement, Outsourced a major production activity that was previously conducted in-house, and Brought in-house a major production activity that was previously outsourced are all dummy variables that take the value 1 if the firm undertook the corresponding innovation, and 0 otherwise. *Aggregate Innovation Index* is an aggregate measure that is formed by adding 1 if the firm has undertaken any of the 8 different innovative activities described above. *Core Innovation* is an aggregate measure of innovation that is formed by adding 1 if the firm has developed a new product line, upgraded an existing product line, or introduced a new technology. Firm size dummies consist of 3 dummy variables corresponding to small, medium-sized, and large firms. Small firms employ 1–19 employees, medium-sized firms have 20–99 employees, and large firms have more than 100 employees. Number of establishments is the number of separate operating facilities a firm has. Corporation is a dummy variable that takes the value 1 if the firm is legally incorporated, and 0 if the firm is organized as a cooperative, sole proprietorship, partnership, or has another legal form. Age is the year of the survey–year established. Capacity utilization dummies consist of 3 dummy variables corresponding to capacity utilization levels below 50%, between 50% and 80%, and above 80%. $\mathbf{I_j}$ and $\mathbf{C_k}$ are a vector of industry and country fixed effects, respectively. Logit regressions are used for the individual indicators (columns 1–8), and ordered logit regressions are used for the aggregate indices (columns 9–10). Standard errors clustered at the country level are reported in parentheses. The *p*-values for the joint significance test of the industry dummy variables, and the *p*-values for *F*-test of medium-sized firms being the same as large firms are also reported. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

	1	2	3	4	5	6	7	8	9	10
Firm Characteristics	New Product Line	Upgraded Existing Product Line	New Technology	Opened a New Plant	New JV with Foreign Partner	New Licensing Agreement	Outsourced a Major Activity	Brought In-House a Previously Outsourced Activity	*Core Innovation*	*Aggregate Innovation Index*
Medium	0.422***	0.427***	0.331***	0.622***	0.627***	0.336***	0.358***	0.424***	0.453***	0.528***
	(0.054)	(0.057)	(0.057)	(0.105)	(0.103)	(0.078)	(0.079)	(0.098)	(0.052)	(0.040)
Large	0.718***	0.745***	0.740***	1.155***	1.353***	0.773***	0.537***	0.572***	0.829***	0.995***
	(0.105)	(0.103)	(0.093)	(0.101)	(0.133)	(0.110)	(0.104)	(0.111)	(0.099)	(0.074)
Number of establishments	0.000	0.003	0.003	0.022***	0.009**	0.003	0.008**	−0.007	0.003	0.010**
	(0.003)	(0.004)	(0.004)	(0.007)	(0.004)	(0.005)	(0.004)	(0.007)	(0.004)	(0.004)
Corporation	0.156***	0.252***	0.222***	0.102	0.284**	0.330***	0.223***	0.198***	0.247***	0.323***
	(0.047)	(0.051)	(0.068)	(0.081)	(0.134)	(0.098)	(0.078)	(0.076)	(0.047)	(0.051)
Age	−0.004**	−0.003*	−0.004***	−0.011***	−0.004	−0.002	−0.001	−0.006*	−0.005***	−0.006***
	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.001)	(0.001)
Capacity utilization between [50%, 80%]	0.238***	0.286***	0.342***	−0.079	0.030	0.139	−0.064	0.032	0.302***	0.198**
	(0.085)	(0.096)	(0.095)	(0.135)	(0.129)	(0.128)	(0.093)	(0.112)	(0.081)	(0.087)
Capacity utilization $\geq$ 80%	0.331***	0.295***	0.447***	−0.025	−0.221	0.087	−0.030	0.032	0.375***	0.229**
	(0.094)	(0.107)	(0.096)	(0.143)	(0.135)	(0.122)	(0.100)	(0.138)	(0.091)	(0.095)

(continued on next page)

TABLE 3 (continued)

Characteristics of Innovating Firms

Firm Characteristics	1 New Product Line	2 Upgraded Existing Product Line	3 New Technology	4 Opened a New Plant	5 New JV with Foreign Partner	6 New Licensing Agreement	7 Outsourced a Major Activity	8 Brought In-House a Previously Outsourced Activity	9 *Core Innovation*	10 *Aggregate Innovation Index*
Number of firms	13,823	13,818	13,889	13,476	13,763	13,791	13,472	13,483	13,886	13,541
Number of countries	43	43	44	42	42	42	42	42	43	42
Pseudo R^2	0.094	0.172	0.117	0.102	0.125	0.111	0.101	0.112	0.097	0.073
F-test (Medium = Large)	0.0075	0.0015	0.0002	0.0000	0.0000	0.0000	0.0088	0.1404	0.0008	0.0000
Joint significance test of industry dummies	0	0	0	0	0	0	0	0	0	0

incorporated firms compared to cooperatives, sole proprietorships, or partnerships. Being incorporated has no correlation with plant opening decisions, although it increases the probability of all other activities.

Looking at the aggregate indicators, we also find evidence that younger firms and firms with higher investment opportunities are more innovative. These relationships are also economically significant. The marginal effects of *Core Innovation* with respect to capacity utilization and age reveal that the probability of innovation increases by 7.5% for firms with high capacity utilization rates (>80%) compared to firms with capacity utilization rates <50% and decreases by –0.08% with a 1-year increase in age. The underlying innovation indicators suggest more diversity. For instance, younger firms are more likely than older firms to introduce new products or new technology, upgrade existing product lines, open a new plant, and bring in previously outsourced activities. Capacity utilization does not affect a firm's outsourcing/insourcing decisions or likelihood of opening a new plant or signing new joint ventures or licensing agreements.[21]

All industries are not equally innovative, as suggested by the *F*-tests reported at the foot of the table. Unreported results indicate that of the 26 industries that the firms in our sample belong to, those in electronics, metals and machinery, chemicals and pharmaceuticals, telecommunications, auto and auto components, and other manufacturing are the most innovative in this sample of countries.

A. External Financing and Innovation

In this section, we examine whether the availability of external finance is associated with the extent of innovation that a firm undertakes. In the Enterprise Surveys, enterprise managers were asked, "Please identify the contribution over the last year of each of the following sources of financing for your establishment's new investments that includes new land, buildings, machinery and equipment." The sources are *internal funds or retained earnings*, *local commercial banks* (loan, overdraft), *foreign-owned commercial banks, leasing arrangements*, *investment funds*, *trade credit*, *credit cards*, *equity, funds from family and friends*, *informal sources*, such as moneylenders, and *other* sources. The sum of these proportions adds up to 100%.[22]

We define *External financing* to be the proportion of new investments that are financed by all external sources of financing other than internal funds. This is most likely to be bank financing, since we are looking at a sample of mainly SMEs in developing countries for whom bank financing is the most dominant form of external finance (e.g., Beck et al. (2008)) in the absence of well-developed equity markets and other market-based sources. To look more specifically at the case of bank financing, we define 2 other variables to capture the use of bank financing: *Bank financing* is the proportion of new investments financed by the sum of financing from local and foreign commercial banks, and *Bank loan* is a

[21] A small percentage of firms (12%) in our sample open new plants, which may explain the absence of a significant association between investment opportunities and opening a new plant.

[22] The managers were also asked to report a similar breakdown of financing sources of working capital. All our results hold if we look at the proportions of financing working capital rather than new investments.

dummy variable that takes the value 1 if the firm has a bank loan or overdraft facility, and 0 if the firm reports not having a bank loan or overdraft facility. We also examine the share of total borrowing denominated in foreign currency, *Share of borrowing in foreign currency*.

The results in Table 4 show that there exists a significant positive relation between the use of external finance and the extent of firm innovation. In particular, external financing is significantly and positively related to introducing a new product line, upgrading existing product lines, opening a new plant, and signing new joint ventures with a foreign partner. Bank financing is positively associated with upgrading existing product lines, opening a new plant, and signing new joint ventures with foreign partners. In unreported results, we examine the underlying components of bank financing and find that local bank financing is significantly associated with upgrading existing product lines, while foreign bank financing is significantly associated with opening a new plant, signing new joint ventures with foreign partners, and signing new licensing agreements. Both external financing and bank financing are significantly and positively related to the aggregate innovation indices *Aggregate Innovation Index* and *Core Innovation*.

When we use dummy variables to define access to bank loans, we find that the *Bank loan* dummy coefficient is positive and significantly associated with all the individual and aggregate indices. In unreported results we looked at bank loans approved in the past (prior to 2002) and find that past access to bank financing is also significantly associated with the aggregate innovation indicators. We also find that firm innovation is associated with an increased share of borrowing in foreign currency.

In unreported interaction regressions, we find that foreign firms innovate more with external finance, whereas state firms are likely to innovate less with external finance. When we restrict our analysis to the small sample of state firms, we do not find external financing to be significant in the case of the aggregate innovation indicators. Size interactions show that large firms with external financing innovate more than small firms. However, external financing is still significant when we restrict the sample to just small firms or SMEs.[23] In other subsample analysis, we find that external financing is positively and significantly associated with the aggregate innovation indicators when we look at just family- or individual-owned firms and when we drop publicly listed firms from our analysis.

Several authors, including Demirgüç-Kunt and Maksimovic (1998) and Rajan and Zingales (1998), have shown that access to external finance is associated with higher firm growth rates. These papers do not specify the channels by which access to finance affects firm growth. Our results show that in developing economies, access to external financing is associated with higher innovation rates. While there have been no studies of innovation in SMEs in developing countries,[24]

[23]Looking at average sample statistics in each size category, we find that innovators use more external finance. Further, on comparing just the innovators, we find that SMEs that are Innovators (*Core Innovation* = 3) rely mostly on external financing from other sources (e.g., family and friends) for their external financing needs, whereas large Innovators rely mainly on bank financing.

[24]Ayyagari, Demirgüç-Kunt, and Maksimovic (2010a) examine innovation in developing countries but look at whether innovating firms are particular targets of government corruption.

TABLE 4

Financing and Firm Innovation

The regression model estimated for firm i in industry j in country k is $\text{Innovation}_{i,j,k} = \alpha + \beta_1 \text{Firm Size Dummies}_{i,j,k} + \beta_2 \text{Age}_{i,j,k} + \beta_3 \text{Corporation}_{i,j,k} + \beta_4 \text{Number of Establishments}_{i,j,k} + \beta_5 \text{Capacity Utilization Dummies}_{i,j,k} + \beta_6 \text{External Financing (or Bank Financing or Bank Loan dummy)}_{i,j,k} + \beta_7 \text{Foreign Currency Borrowing}_{i,j,k} + \beta_8 \mathbf{I_j} + \beta_9 \mathbf{C_k} + \varepsilon_{i,j,k}$. The variables are described as follows: Innovation is one of the following variables: Developed a major new product line, Upgraded an existing product line, Introduced new technology that has substantially changed the way that the main product is produced, Opened a new plant, Agreed to a new joint venture (JV) with foreign partner, Obtained a new licensing agreement, Outsourced a major production activity that was previously conducted in-house, and Brought in-house a major production activity that was previously outsourced are all dummy variables that take the value 1 if the firm undertook the corresponding innovation, and 0 otherwise. *Aggregate Innovation Index* is an aggregate measure that is formed by adding 1 if the firm has undertaken any of the 8 different innovative activities described previously. *Core Innovation* is an aggregate measure of innovation that is formed by adding 1 if the firm has developed a new product line, upgraded an existing product line, or introduced a new technology. Firm size dummies consist of 3 dummy variables corresponding to small, medium-sized, and large firms. Small firms employ 1–19 employees, medium-sized firms have 20–99 employees, and large firms have more than 100 employees. Age is the year of the survey–year established. Number of establishments is the number of separate operating facilities a firm has. Corporation is a dummy variable that takes the value 1 if the firm is legally incorporated, and 0 if the firm is organized as a cooperative, sole proprietorship, partnership, or has another legal form. Capacity utilization dummies consist of 3 dummy variables corresponding to capacity utilization levels below 50%, between 50% and 80%, and above 80%. External financing is the proportion of new investments financed externally and is given by 100 – Proportion of new investments financed through internal funds or retained earnings. Bank financing is the proportion of new investments financed by local or foreign commercial banks. Bank loan dummy takes the value 1 if the firm reported it had access to an overdraft facility or line of credit and 0 if it did not have a bank loan. Foreign currency borrowing is the total borrowing denominated in foreign currency. $\mathbf{I_j}$ and $\mathbf{C_k}$ are a vector of industry and country fixed effects, respectively. Each cell in the table corresponds to a particular regression. Logit regressions are used for the individual indicators (columns 1–8), and ordered logit regressions are used for the aggregate indices (columns 9–10). Standard errors clustered at the country level are reported in parentheses. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

	1	2	3	4	5	6	7	8	9	10
Financing Variables	New Product Line	Upgraded Existing Product Line	New Technology	Opened a New Plant	New JV with Foreign Partner	New Licensing Agreement	Outsourced a Major Activity	Brought In-House a Previously Outsourced Activity	*Core Innovation*	*Aggregate Innovation Index*
External financing	0.002**	0.003***	–0.000	0.003***	0.003***	0.001	0.001	0.001	0.001**	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
Bank financing	0.001	0.004***	0.001	0.003***	0.004***	0.002	0.001	0.001	0.002**	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Bank loan dummy	0.199**	0.418***	0.261***	0.567***	0.281***	0.442***	0.164*	0.353***	0.315***	0.394***
	(0.083)	(0.123)	(0.056)	(0.090)	(0.093)	(0.099)	(0.094)	(0.092)	(0.075)	(0.080)
Share of borrowing in foreign currency	0.005***	0.003**	0.001	0.006***	0.010***	0.005***	0.003**	0.003**	0.003***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)

Kortum and Lerner (2000) find consistent evidence in the case of U.S. manufacturing firms, where they show that firms that receive venture capital financing file more patents. Atanassov et al. (2009) focus on U.S. public firms and argue that established firms with innovative projects and technologies are more likely to use arm's length financing (e.g., public debt and equity) that allows them to give their managers greater discretion, whereas less innovative firms give the manager less discretion and use relationship-based borrowing (e.g., bank borrowing). Herrera and Minetti (2007) find that Italian firms with longer credit relationships are more likely to innovate. Benfratello, Schiantarelli, and Sembenelli (2008) show that local banking development in Italy has a positive effect on the probability of a firm introducing process or product innovation, and this is particularly so for small firms and for firms in sectors more dependent on external finance.

B. Governance and Innovation: The Role of Ownership, Competition, and Management

In this section, we examine the association between a firm's governance structure and its innovation. First, we look at the role of firm ownership, whether it is private or state owned; and for privately owned firms, the identity of the controlling shareholder. Second, we analyze the firms' competitive environment. Finally, we investigate the role of human capital (i.e., the education of firm managers and workers as well as the experience level of the firm's top manager).

Ownership Structure. The role of private versus public ownership has been a much researched area in finance and has been particularly relevant in developing countries, many of which opted for state ownership of the "strategic" sectors as a way of achieving their development goals. However, there has been little empirical evidence on the relationship between public/private ownership and firm innovation. In this section we examine the association between private/state ownership, and domestic/foreign ownership and firm innovation (see Table 5). *State (Domestic*) ownership is a dummy variable that takes the value 1 if the state (domestic private sector) owns 50% or more of the company, and 0 otherwise. We also break down domestic private ownership into the following 7 categories: *individual, family, financial institution, managers, employees, domestic corporation,* and *others*. These are dummy variables that take the value 1 if the largest shareholder or owner in the firm is an individual, family, financial institution, manager of the firm, employee of the firm, domestic company, or someone other than one of these categories, including the government or government agencies.[25]

Recent evidence in finance on the role of family firms has been mixed. Several papers posit that family owned and managed firms are better able to mitigate agency problems and that founders bring valuable skills to the firm and hence are more valuable (e.g., Khanna and Palepu (2000), Anderson and Reeb (2003)). Burkart et al. (2003), however, argue that hired professionals may be

[25]In the sample construction for the regressions, we first test state-owned firms against all other private sector firms (both domestic and foreign). For the regressions with the domestic dummy variable, we drop all firms with greater than 50% state ownership and test domestic versus foreign ownership. Finally, we drop all firms with greater than 50% foreign ownership and investigate how the identity of the firm owner is associated with innovation in a sample of domestic private sector firms.

TABLE 5

Ownership and Firm Innovation

The regression model estimated for firm i in industry j in country k is $\text{Innovation}_{i,j,k} = \alpha + \beta_1 \text{Firm Size Dummies}_{i,j,k} + \beta_2 \text{Age}_{i,j,k} + \beta_3 \text{Corporations}_{i,j,k} + \beta_4 \text{Number of Establishments}_{i,j,k} + \beta_5 \text{Capacity Utilization Dummies}_{i,j,k} + \beta_6 \text{State Ownership}_{i,j,k} + \beta_7 \text{Domestic Company}_{i,j,k} + \beta_8 \text{Individual}_{i,j,k} + \beta_9 \text{Family}_{i,j,k} + \beta_{10} \text{Financial Institution}_{i,j,k} + \beta_{11} \text{Managers}_{i,j,k} + \beta_{12} \text{Employees}_{i,j,k} + \beta_{13} \text{Corporation}_{i,j,k} + \beta_{14} \mathbf{I_j} + \beta_{15} \mathbf{C_k} + \varepsilon_{i,j,k}$. The variables are described as follows: Innovation is one of the following variables: Developed a major new product line, Upgraded an existing product line, Introduced new technology that has substantially changed the way that the main product is produced, Opened a new plant, Agreed to a new joint venture (JV) with foreign partner, Obtained a new licensing agreement, Outsourced a major production activity that was previously conducted in-house, and Brought in-house a major production activity that was previously outsourced are all dummy variables that take the value 1 if the firm undertook the corresponding innovation, and 0 otherwise. *Aggregate Innovation Index* is an aggregate measure that is formed by adding 1 if the firm has undertaken any of the 8 different innovative activities described previously. *Core Innovation* is an aggregate measure of innovation that is formed by adding 1 if the firm has developed a new product line, upgraded an existing product line, or introduced a new technology. Firm size dummies consist of 3 dummy variables corresponding to small, medium-sized, and large firms. Small firms employ 1–19 employees, medium-sized firms have 20–99 employees, and large firms have more than 100 employees. Age is the year of the survey–year established. Number of establishments is the number of separate operating facilities a firm has. Corporations is a dummy variable that takes the value 1 if the firm is legally incorporated, and 0 if the firm is organized as a cooperative, sole proprietorship, partnership, or has another legal form. Capacity utilization dummies consist of 3 dummy variables corresponding to capacity utilization levels below 50%, between 50% and 80%, and above 80%. State ownership is a dummy variable that takes the value 1 if the state owns 50% or more of the company, and 0 otherwise. Domestic company is a dummy variable that takes the value 1 if the domestic private sector owns more than 50%. Individual, family, financial institution, managers, employees, and domestic corporation are dummy variables that take the value 1 if the largest shareholder or owner in the firm is an individual, family, bank or investment fund, manager of the firm, employees of the firm, domestic corporation, or government/government agency. An *F*-test that all controlling shareholder coefficients are 0 is reported in each case. Logit regressions are used for the individual indicators (columns 1–8), and ordered logit regressions are used for the aggregate indices (columns 9–10). Standard errors clustered at the country level are reported in parentheses. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

	1	2	3	4	5	6	7	8	9	10
Ownership Variables	New Product Line	Upgraded Existing Product Line	New Technology	Opened a New Plant	New JV with Foreign Partner	New Licensing Agreement	Outsourced a Major Activity	Brought In-House a Previously Outsourced Activity	*Core Innovation*	*Aggregate Innovation Index*
State ownership	−0.364***	−0.475***	−0.378***	−0.683***	−0.532***	−0.453***	−0.130	−0.051	−0.469***	−0.545***
	(0.100)	(0.114)	(0.110)	(0.141)	(0.177)	(0.131)	(0.151)	(0.139)	(0.094)	(0.090)
Domestic	−0.082	−0.123	0.013	−0.043	−0.749***	−0.186	−0.164*	0.155*	−0.062	−0.140**
	(0.074)	(0.093)	(0.078)	(0.100)	(0.111)	(0.114)	(0.092)	(0.082)	(0.070)	(0.066)
Identity of Controlling Shareholder										
Individual	0.084	0.142*	0.276***	0.116	0.090	−0.022	−0.039	0.247***	0.219***	0.132*
	(0.066)	(0.080)	(0.076)	(0.137)	(0.216)	(0.180)	(0.095)	(0.087)	(0.073)	(0.076)
Family	0.269***	0.084	0.468***	0.402**	0.369*	0.062	−0.156	0.021	0.340***	0.211***
	(0.098)	(0.112)	(0.089)	(0.169)	(0.218)	(0.197)	(0.133)	(0.098)	(0.085)	(0.079)
Financial institution	−0.429	−0.203	−1.392**	−0.184	−0.373	−1.661**	0.454	0.885	−0.605**	−0.409
	(0.325)	(0.342)	(0.685)	(0.421)	(0.726)	(0.701)	(0.622)	(0.568)	(0.255)	(0.252)

(continued on next page)

TABLE 5 (continued)

Ownership and Firm Innovation

	1	2	3	4	5	6	7	8	9	10
Ownership Variables	New Product Line	Upgraded Existing Product Line	New Technology	Opened a New Plant	New JV with Foreign Partner	New Licensing Agreement	Outsourced a Major Activity	Brought In-House a Previously Outsourced Activity	*Core Innovation*	*Aggregate Innovation Index*
Managers	0.273	0.396**	0.564***	0.088	0.532*	0.385	0.196	0.292	0.521***	0.483***
	(0.174)	(0.197)	(0.179)	(0.301)	(0.287)	(0.236)	(0.320)	(0.252)	(0.147)	(0.181)
Employees	−0.156	−0.005	0.204	−0.369	−0.170	−0.072	−0.123	0.237	0.089	−0.007
	(0.153)	(0.196)	(0.212)	(0.375)	(0.469)	(0.281)	(0.210)	(0.265)	(0.174)	(0.167)
Domestic corporation	0.069	0.217*	0.164	−0.025	0.504**	−0.026	0.168	0.119	0.183*	0.132
	(0.096)	(0.114)	(0.111)	(0.205)	(0.237)	(0.229)	(0.130)	(0.152)	(0.098)	(0.086)
F-test	0.0161	0.2331	0.0000	0.0919	0.0002	0.0592	0.3001	0.0004	0.0000	0.0039

better managers than family founders or their heirs, and the decision to cede control to professional management depends on the investor protection environment. In other work, Morck, Stangeland, and Yeung (2000) and Villalonga and Amit (2006) show that whether family firms are more valuable or not depends on the presence/absence of control-enhancing features such as founder CEO or founder chairman with outside CEO. While we do not have data on controlling structures in family firms, we are able to separately study the importance of both family firms and management skills on innovation.

We find that state ownership is negatively associated with overall firm innovation. State-owned firms are less likely to introduce new products, upgrade existing products, introduce new technology, open new plants, or sign new joint ventures or licensing agreements than privately owned firms. When we compare domestic versus foreign ownership, we find that foreign ownership is associated with a higher probability of innovation, though the only significant results are that foreign firms are more likely to sign new joint ventures with foreign partners and outsource major activities, while domestic firms are more likely to bring in-house previously outsourced activities.

Next, we investigate whether there is a relation between the characteristics of the domestic private controlling shareholder and firm innovation. We find that only family ownership is associated with introducing new product lines and opening new plants. When we look at introduction of new technology, we find family ownership and ownership by individuals and managers to be associated with higher innovation rates, while private firms whose controlling shareholder is a financial institution tend to be less innovative.[26] The aggregate indicators also show that if the controlling shareholder is an individual, a family, or the manager of the firm, firms are more innovative than if the largest shareholder is the government.

While we previously found that access to bank finance is positively associated with innovation, we find that firms owned by a financial institution or investment fund are less innovative than other types of ownership structures. This is of interest, since firms owned by financial institutions presumably have easier access to finance, yet are less innovative. It could be that these firms are able to access funds more easily due to related lending (where banks lend to firms controlled by the bank's owners) rather than being provided finance on market criteria. This is consistent with recent evidence in La Porta, Lopez-de-Silanes, and Zamarripa (2003), who find that related lending is widespread in Mexico, but 33% of related loans were more likely to default and have lower recovery rates than unrelated loans. In related work in the United States, Guner, Malmendier, and Tate (2008) find that when commercial bankers join boards, bankers provide loans even when it is not in the interest of shareholders. Thus, external funding increases and investment-cash flow sensitivity decreases, but the increased financing flows to firms with good credit but poor investment opportunities. Looking

[26]In alternate specifications, we find that family-controlled firms are more likely to introduce new product lines, new technology, and open new plants compared to all other ownership structures. In addition, when we look at the introduction of new technology, we find that firms where the largest shareholder is a financial institution are less innovative than firms with all other ownership structures.

at the aggregate innovation indices, *Core Innovation* and *Aggregate Innovation Index*, the *F*-test for joint significance rejects that all coefficients are equal to 0.

Competition. We use 7 variables to study different aspects of firm competition: i) number of competitors; ii) does the firm have a foreign competitor (1/0 dummy variable); iii) does the firm have a state competitor (1/0 dummy variable); iv) foreign competition has the greatest influence to reduce production costs (dummy variable that takes the value 1 if foreign competition had the greatest influence to reduce production costs, and 0 if the greatest influence was instead from domestic competition, customers, creditors, shareholders, or the government); v) foreign competition has the greatest influence to develop new products (dummy variable that takes the value 1 if foreign competition was the most important influence on the firm to develop new products, and 0 if the greatest influence was instead from domestic competition, customers, creditors, shareholders, or government); vi) percentage of sales sold domestically; and vii) firm's technology compared to competitor (takes value 1, 2, or 3 depending on whether the technology is less advanced, about the same, or more advanced than that of its main competitor).

The results in Table 6 show that the higher the number of competitors, the less likely that the firm will open a new plant. Firms in our sample with >10 competitors are mostly firms with a single operating establishment, which could explain the lower likelihood of opening new plants. The other associations between number of competitors and innovation are statistically not significant, though there is some evidence that the higher the number of competitors, the more likely the firm is to engage in core innovation. In findings based on public firms in the United States, Atanassov et al. (2009) find similar results, in that they report a positive relation between industry concentration (Herfindahl index) and patent filings, though they also show that this relationship is nonlinear, since the squared Herfindahl index is negative. Their results are consistent with Aghion et al. (2005), who report a nonmonotonic relationship between R&D expenses and industry concentration.

Table 6 also shows that the identity of the competitor is important. Facing competition pressures from a foreign-owned firm is positively associated with most types of innovative activities except opening plants, signing new licensing agreements, and bringing in-house previously outsourced activities. The aggregate indices, *Core Innovation* and *Aggregate Innovation Index*, are also positive and significant, indicating the positive association between foreign competition and core innovation. Interestingly, having 1 or more state-owned firms as a competitor has no significant association with either the individual or the aggregate indicators of firm innovation.[27]

Given the positive correlation of foreign competition with innovation,[28] we further investigate if the influence of foreign competition works through its impact

[27]The variables capturing the identity of the competitor (foreign or state) and the influence of foreign competition are available for a much smaller sample (regression sample sizes range 4,300–4,900 firms).

[28]In unreported regressions, we also find that the percentage of foreign competition is positively associated with aggregate indicators.

TABLE 6

Competition and Firm Innovation

The regression model estimated for firm i in industry j in country k is $\text{Innovation}_{i,j,k} = \alpha + \beta_1 \text{Firm Size Dummies}_{i,j,k} + \beta_2 \text{Age}_{i,j,k} + \beta_3 \text{Corporations}_{i,j,k} + \beta_4 \text{Number of Establishments}_{i,j,k} + \beta_5 \text{Capacity Utilization Dummies}_{i,j,k} + \beta_6 \text{Competition}_{i,j,k} + \beta_7 \mathbf{I_j} + \beta_8 \mathbf{C_k} + \varepsilon_{i,j,k}$. The variables are described as follows: Innovation is one of the following variables: Developed a major new product line, Upgraded an existing product line, Introduced new technology that has substantially changed the way that the main product is produced, Opened a new plant, Agreed to a new joint venture (JV) with foreign partner, Obtained a new licensing agreement, Outsourced a major production activity that was previously conducted in-house, and Brought in-house a major production activity that was previously outsourced are all dummy variables that take the value 1 if the firm undertook the corresponding innovation, and 0 otherwise. *Aggregate Innovation Index* is an aggregate measure that is formed by adding 1 if the firm has undertaken any of the 8 different innovative activities described above. *Core Innovation* is an aggregate measure of innovation that is formed by adding 1 if the firm has developed a new product line, upgraded an existing product line, or introduced a new technology. Firm size dummies consist of 3 dummy variables corresponding to small, medium-sized, and large firms. Small firms employ 1–19 employees, medium-sized firms have 20–99 employees, and large firms have more than 100 employees. Age is the year of the survey–year established. Number of establishments is the number of separate operating facilities a firm has. Corporations is a dummy variable that takes the value 1 if the firm is legally incorporated, and 0 if the firm is organized as a cooperative, sole proprietorship, partnership, or has another legal form. Capacity utilization dummies consist of 3 dummy variables corresponding to capacity utilization levels below 50%, between 50% and 80%, and above 80%. Competition is one of the following variables: Number of competitors is the total number of competitors in the domestic market that are private domestic enterprises, state-owned enterprises or foreign-owned enterprises; Percentage of sales sold domestically is the percentage of establishment sales that are sold domestically (instead of being exported); Firm's technology compared to that of its competitor takes values 1, 2, or 3 depending on whether the technology is less advanced, about the same or more advanced than that of its main competitor; Foreign competition has greatest influence to reduce production costs and Foreign competition has greatest influence to develop new products are dummy variables that take value 1 if foreign competition had the greatest influence on the firm to reduce production costs or develop new products, respectively, and 0 otherwise; Does the firm have a foreign competitor and Does the firm have a state competitor are dummy variables that take the value 1 if over the last year, in the company's main product line, the firm had at least 1 foreign-owned firm as a competitor or a state-owned firm as a competitor, respectively. $\mathbf{I_j}$ and $\mathbf{C_k}$ are a vector of industry and country fixed effects, respectively. Each cell in the table corresponds to a particular regression. Logit regressions are used for the individual indicators (columns 1–8), and ordered logit regressions are used for the aggregate indices (columns 9–10). Standard errors clustered at the country level are reported in parentheses. ***, **, and * represent significance at 1%, 5%, and 10% levels, respectively.

	1	2	3	4	5	6	7	8	9	10
Competition Variables	New Product Line	Upgraded Existing Product Line	New Technology	Opened a New Plant	New JV with Foreign Partner	New Licensing Agreement	Outsourced a Major Activity	Brought In-House a Previously Outsourced Activity	*Core Innovation*	*Aggregate Innovation Index*
Number of competitors	0.001	0.002	0.002	−0.018***	−0.007	−0.010	−0.005	0.017	0.002	0.001
	(0.005)	(0.002)	(0.003)	(0.006)	(0.010)	(0.006)	(0.005)	(0.014)	(0.003)	(0.004)
Does the firm have a state competitor?	−0.048	−0.035	−0.030	0.157	−0.248	−0.145	−0.255	0.127	−0.024	−0.043
	(0.130)	(0.140)	(0.139)	(0.189)	(0.370)	(0.148)	(0.214)	(0.295)	(0.098)	(0.144)
Does the firm have a foreign competitor?	0.235***	0.298***	0.257***	−0.002	0.384***	0.003	0.368***	0.504	0.298***	0.377***
	(0.089)	(0.097)	(0.068)	(0.166)	(0.148)	(0.080)	(0.086)	(0.307)	(0.072)	(0.095)
Foreign competition has greatest influence to reduce production costs	0.183***	0.102	0.097	0.302*	0.707***	0.445***	0.063	−0.024	0.155***	0.268***
	(0.061)	(0.092)	(0.101)	(0.175)	(0.160)	(0.143)	(0.058)	(0.140)	(0.050)	(0.059)
Foreign competition has greatest influence to develop new products	0.142	0.084	0.166**	0.089	0.634***	0.113	0.212***	0.291**	0.163*	0.272***
	(0.136)	(0.073)	(0.077)	(0.142)	(0.093)	(0.096)	(0.078)	(0.146)	(0.097)	(0.081)

(continued on next page)

TABLE 6 (continued)

Competition and Firm Innovation

Competition Variables	1 New Product Line	2 Upgraded Existing Product Line	3 New Technology	4 Opened a New Plant	5 New JV with Foreign Partner	6 New Licensing Agreement	7 Outsourced a Major Activity	8 Brought In-House a Previously Outsourced Activity	9 *Core Innovation*	10 *Aggregate Innovation Index*
Percentage of sales sold domestically	−0.001 (0.001)	−0.002 (0.001)	−0.001 (0.001)	−0.002* (0.001)	−0.015*** (0.002)	−0.003*** (0.001)	−0.001 (0.001)	−0.001 (0.001)	−0.001 (0.001)	−0.003*** (0.001)
Firm's technology compared to competitor	0.315*** (0.040)	0.371*** (0.037)	0.492*** (0.042)	0.293*** (0.064)	0.327*** (0.059)	0.249*** (0.046)	0.109 (0.072)	0.146*** (0.056)	0.447*** (0.033)	0.415*** (0.036)

on firms' decisions to develop new products or reduce production costs. Firms reporting that foreign competition had the greatest influence to reduce their production costs were more likely to introduce new products, open new plants, and sign new joint ventures and licensing agreements. Firms reporting that foreign competition had the greatest influence to develop new products were most likely to introduce new technology and sign new joint ventures with foreign partners. In addition, differentiation strategies rather than cost reduction strategies had a greater association with firm sourcing decisions.

Our results on foreign competition are further reinforced when we look at exporters versus nonexporters. The results in Table 6 show that firms with a greater percentage of their sales sold domestically, rather than exported, are overall not as innovative as exporting firms. In particular, exporters are more likely to open new plants and enter into joint ventures or licensing agreements. Previous research has shown that exporters, in general, tend to be better firms with better investment opportunities (e.g., Bernard and Jensen (1995), (1997)) and, by definition, exporters compete on world markets and are exposed to foreign competition. Our findings suggest that exporters also tend to be more innovative than nonexporters. We also find that if the firm's technology is more advanced than that of its competitor, the firm is more likely to engage in all types of innovative activities except outsource major activities.

In unreported interactions of the competition variables with firm characteristics, we find interesting results that support our main findings. Looking at the aggregate indices, we find that state firms (which by themselves have been shown to be less innovative than nonstate-owned firms in Table 4) with foreign competitors are less innovative than state firms not facing foreign competitors. We also have some evidence at the 10% level that SMEs with foreign competitors are more innovative than large firms without foreign competitors.

Overall, the results in Table 6 suggest that rather than the number of competitors, it is the nature of the competition that is important for firm innovation. Firms with foreign competitors, exporters, and firms with more advanced technology than their competitors are more likely to innovate, whereas firms with state competitors are less likely to innovate. Our findings provide empirical support for the argument in Allen and Gale (2000) that in emerging markets where standard corporate governance mechanisms may be ineffective, encouraging dynamic competition in product markets via globalization or foreign trade is crucial for firms to innovate. To be able to survive in a constantly changing environment exposed to foreign competition, firms have to innovate, and the effects of foreign competition extend deep down into the industry structure, not just affecting the largest companies and exporters in these countries, but also smaller firms.

Managerial Education and Experience: *The Role of Human Capital*. Next, we examine if a firm's human capital is related to innovation. Human capital, as measured by the education and experience level of the management and workforce, has been shown to have an important influence on firm investment decisions and overall firm behavior.

The variables are defined as follows: *Top manager's total years of experience* is the total number of years of experience the top manager has had working in this sector, before running the establishment; *Mid-level experience* is a dummy

variable that takes the value 1 if the top manager has had between 3 and 10 years of experience working in this sector before running the establishment; *Highly experienced* is a dummy variable that takes the value 1 if the top manager has had more than 10 years of experience working in this sector before running the establishment; *Skilled foreign workers* is the percentage of permanent skilled workers that are foreign nationals[29]; *Percentage of workforce that has more than 12 years of education* summarizes the percentage of the workforce with formal university level education of 12 years or more; and *Highest education level of the manager* takes values from 1 to 6 according to the following categories: did not complete secondary school, completed secondary school, vocational training, some university training, graduate degree, and post-graduate degree.

As seen in Table 7, the number of years of prior experience the top manager has had in the same industry has no relation to whether the firm is likely to be innovative or not. On investigating deeper, we find that firms run by managers with 3–10 years of experience are more innovative than firms run by inexperienced managers. Specifically, these firms are more likely to upgrade existing product lines, introduce new technology, and sign new licensing agreements. Experience greater than 10 years is not associated with greater firm innovation. These results suggest the importance of management turnover and the existence of a market for CEOs and top managers for innovation.

When we look at the importance of skill, we find some evidence that foreign skilled workers are an asset when it comes to signing a new joint venture with a foreign partner. The education level of both the manager and the workforce is significantly related to the extent of innovation a firm undertakes. Firms with a workforce with greater than 12 years of education are more innovative along most dimensions, except with respect to opening plants and bringing in-house previously outsourced activities. Firms having a highly educated manager are also more innovative along most dimensions except with respect to bringing in-house previously outsourced activities.[30]

Overall, our results show that human capital, as measured by education and experience level of managers and workers, and the market for CEOs are positively correlated with firm innovation. While previous research in corporate finance has concentrated on the effects of managerial entrenchment in large U.S. firms, and others have shown the importance of managerial education on firm policy (e.g., Bertrand and Schoar (2003), Chevalier and Ellison (1999)), our results show that corresponding effects are associated with innovation in the case of smaller firms in developing countries.

To summarize, the results in this section show a strong association between ownership (firms not owned by the state or financial institutions), foreign

[29]As defined by the survey instrument, the workers are *skilled* in that they have some special knowledge or (usually acquired) ability in their work. A skilled worker may have attended a college, university, or technical school. Or, a skilled worker may have learned his skills on the job.

[30]On the education question, firms were asked to report what percentage of the workforce had the following education levels: less than 6 years (some elementary), 6–9 years, 10–12 years, and more than 12 years (some university), with the 4 values summing to a 100%. Dropping firms that had values greater than or less than 100 did not change any of the results.

TABLE 7

Human Capital and Firm Innovation

The regression model estimated for firm i in industry j in country k is: $\text{Innovation}_{i,j,k} = \alpha + \beta_1 \text{Firm Size Dummies}_{i,j,k} + \beta_2 \text{Age}_{i,j,k} + \beta_3 \text{Corporations}_{i,j,k} + \beta_4 \text{Number of Establishments}_{i,j,k} + \beta_5 \text{Capacity Utilization Dummies}_{i,j,k} + \beta_6 \text{Human Capital Indicator}_{i,j,k} + \beta_7 \mathbf{I_j} + \beta_8 \mathbf{C_k} + \varepsilon_{i,j,k}$. The variables are described as follows: Innovation is one of the following variables: Developed a major new product line, Upgraded an existing product line, Introduced new technology that has substantially changed the way that the main product is produced, Opened a new plant, Agreed to a new joint venture (JV) with foreign partner, Obtained a new licensing agreement, Outsourced a major production activity that was previously conducted in-house, and Brought in-house a major production activity that was previously outsourced are all dummy variables that take the value 1 if the firm undertook the corresponding innovation, and 0 otherwise. *Aggregate Innovation Index* is an aggregate measure that is formed by adding 1 if the firm has undertaken any of the 8 different innovative activities described above. *Core Innovation* is an aggregate measure of innovation that is formed by adding 1 if the firm has developed a new product line, upgraded an existing product line, or introduced a new technology. Firm Size Dummies consist of 3 dummy variables corresponding to small, medium-sized, and large firms. Small firms employ 1–19 employees, medium-sized firms have 20–99 employees, and large firms have more than 100 employees. Age is the year of the survey–year established. Number of establishments is the number of separate operating facilities a firm has. Corporations is a dummy variable that takes the value 1 if the firm is legally incorporated, and 0 if the firm is organized as a cooperative, sole proprietorship, partnership, or has another legal form. Capacity utilization dummies consist of 3 dummy variables corresponding to capacity utilization levels below 50%, between 50% and 80%, and above 80%. Human Capital Indicator is one of the following variables: Top manager's total years of experience is the total number of years of experience the top manager has had in working in this sector before running the establishment; Mid-level experience is a dummy variable that takes the value 1 if the top manager has had between 3–10 years of experience working in this sector before running the establishment; Highly experienced is a dummy variable that takes the value 1 if the top manager has had more than 10 years of experience working in this sector before running the establishment; Skilled foreign workers is the percentage of permanent skilled workers that are foreign nationals; Highest education level of the manager takes values from 1 to 6 according to the following categories: did not complete secondary school, secondary school, vocational training, some university training, graduate degree, and post-graduate degree; Percentage of workforce with more than 12 years of education is the percentage of workforce at the establishment that has attended university or higher and has had more than 12 years of education. $\mathbf{I_j}$ and $\mathbf{C_k}$ are a vector of industry and country fixed effects, respectively. Each cell in the table corresponds to a particular regression. Logit regressions are used for the individual indicators (columns 1–8), and ordered logit regressions are used for the aggregate indices (columns 9–10). Standard errors clustered at the country level are reported in parentheses. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

	1	2	3	4	5	6	7	8	9	10
Human Capital Variables	New Product Line	Upgraded Existing Product Line	New Technology	Opened a New Plant	New JV with Foreign Partner	New Licensing Agreement	Outsourced a Major Activity	Brought In-House a Previously Outsourced Activity	*Core Innovation*	*Aggregate Innovation Index*
Top mgr's total years of experience	0.002	0.002	0.004	−0.000	0.004	0.003	−0.000	0.006	0.002	0.001
	(0.005)	(0.004)	(0.006)	(0.008)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)
Mid-level experience	0.123	0.293***	0.160**	0.119	0.207	0.249**	0.115	0.110*	0.200***	0.191***
	(0.078)	(0.066)	(0.064)	(0.105)	(0.158)	(0.110)	(0.074)	(0.065)	(0.075)	(0.058)
Highly experienced	0.098	0.121	0.103	0.042	0.227*	0.131	0.019	0.242	0.092	0.103
	(0.125)	(0.105)	(0.126)	(0.203)	(0.125)	(0.096)	(0.111)	(0.195)	(0.130)	(0.134)
Skilled foreign workers	0.003	−0.001	0.004	0.002	0.009**	−0.004	0.006**	−0.008*	0.001	0.003
	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)	(0.005)	(0.003)	(0.004)	(0.003)	(0.002)
% workforce with >12 yrs years educ.	0.005***	0.003***	0.003***	−0.000	0.015***	0.006***	0.005**	0.002	0.004***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
Highest level of education of manager	0.111***	0.083***	0.052*	0.080**	0.267***	0.134***	0.110***	0.038	0.087***	0.111***
	(0.020)	(0.019)	(0.028)	(0.033)	(0.039)	(0.029)	(0.024)	(0.042)	(0.019)	(0.019)

competition, and quality of human capital (experience, education of the top managers and workforce) and firm innovation across developing countries. However, in the absence of time-series data and information on policy reforms across our sample of countries, we are unable to address endogeneity concerns and hence leave the identification issues in this area for future work.

VI. Conclusions

The strong and independent role of external finance in promoting growth has been demonstrated in recent literature using quantitative evidence from around the world. A large body of empirical work has also demonstrated the importance of good governance and market competition for value creation by firms.

Understanding how an effective financial system contributes to economic development and which characteristics of the business environment promote good governance is important in setting policy recommendations that help develop financial sectors that promote growth. Since innovation responses to a changing economic environment are widely viewed as the main driver of the growth process, understanding the links between external finance and firm innovation is an important step in identifying the channels through which financial development contributes to economic development. While SMEs are widely considered to be a significant contribution to overall value added in developing countries, our current understanding of innovation is limited to the case of large publicly traded firms in developed countries.

In this paper, we study the innovation practices of over 19,000 firms, including SMEs, across 47 developing countries. We define innovation broadly to include not only core innovation activities, such as introducing new product lines and new technology, but also sourcing decisions that affect the overall organization of firms activities, and other types of activities that promote knowledge transfers, such as signing joint ventures with foreign partners and obtaining new licensing agreements, all of which reflect overall firm dynamism.

The broad section of our data provides evidence across a large set of firms and countries. Our results indicate that the more innovative firms are younger but larger, and they are exporting firms characterized by private ownership and highly educated managers with mid-level managerial experience. Identity of the controlling owner seems to be particularly important for the introduction of new technology, and those private firms whose controlling shareholder is a financial institution tend to be the least innovative. When we look at the product market, we find that foreign competition, in particular, is associated with greater firm innovation.

We find that access to external financing is associated with greater firm innovation. This is most likely to be bank financing, since we are looking at a sample of mainly SMEs in developing countries for whom bank financing is the most dominant form of external finance (e.g., Beck et al. (2008)) in the absence of well-developed equity markets and other market-based sources. And indeed, we find that financing from banks is associated with high levels of innovation relative to financing from all other sources like internal funds, leasing arrangements, investment funds, trade credit, credit cards, equity, family and friends, and

other informal sources. Innovation also increases with a greater share of the firm's borrowing in foreign currency.

Our results have policy implications. First, by establishing a link between external finance and innovation, our results provide new evidence on a potential channel through which access to finance contributes to overall growth. Second, our results emphasize the importance of privatization in emerging markets. In our sample, state-owned firms are less innovative than private firms along all dimensions, even if state-owned firms have access to external finance or are exposed to foreign competition. Our results also have implications for the evolution of industry structure, since we find that having state firms as competitors in the product market is associated with lower innovation rates. Finally, our results have positive implications for the role of globalization and foreign trade in exposing firms to foreign competition. Exposure to dynamic foreign competition in product markets affects not only the largest companies and exporters in emerging markets, but also SMEs, forcing them to innovate to survive in a constantly changing environment. Our results suggest that in countries where standard corporate governance mechanisms are ineffective, foreign market competition is crucial for firm innovation and may even serve to substitute for the lack of good governance, as argued by Allen and Gale (2000).

Overall, our results identify the following critical firm characteristics—access to finance, governance, and competition—as being positively associated with innovation in emerging market firms.

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