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Financial Development and Innovation in Small Firms

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Abstract

This paper uses firm level data from a cross-section of 57 countries to study how financial development affects innovation in small firms. The analysis finds that relative to large firms in the same industry, spending on research and development by small firms is more likely and sizable in countries at higher levels of financial development. The estimates imply that among firms doing research and development in a country like Romania, which is at the 20th percentile of financial development, a 1 standard deviation decrease in firm size is associated with a decrease of 0.7 standard deviations in research and development spending. In contrast, this decrease is only 0.2 standard deviations in a country like South Africa, which is at the 80th percentile of the distribution of financial development. Small firms also report producing more innovations per unit of research and development spending than large firms, and this gap is narrower in countries at higher levels of financial development. As a robustness check, the author shows that these patterns are stronger in industries inherently more reliant on external finance.

This paper—a product of theEnterprise Analysis Unit, Financial and Private Sector Vice Presidency—is part of a larger effort in the Bank to study the effects of financial development on firm performance. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at SSharma1@ifc.org.

Financial Development and Innovation in Small Firms

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1 Introduction

In their seminal work on finance and growth, Rajan and Zingales (1998) were able to show that industries more dependent on external finance grow faster in countries that are more developed financially. More recently, Guiso et al. (2004a) find that the smaller the firm, the stronger this association between financial development and growth. In another paper, using regional data from Italy, Guiso et al. (2004b) find that regional financial development is more beneficial to the growth of smaller firms. Levine et al. (2006) show that industries which for technological reasons have a larger share of small firms grow faster in economies with well-developed financial systems. Aghion et al. (2007) report that there is greater entry of small firms relative to large firms in countries at higher levels of financial development.

This suggests that financial development does not affect firms of different sizes equally, and that it matters more to the growth of small firms. However, our understanding of this differential effect is limited. Why are smaller firms more sensitive to financial development? It is possible that the informational asymmetries which cause financial market failures also cause these failures to hurt small firms more than large firms. Lenders might know less about smaller firms because they are more opaque, or because given the small loan size, it is not profitable to spend resources on acquiring information about small firms and monitoring small loans. Another explanation is that financial innovations reduce the need for collateral, affecting smaller firms disproportionately because they have fewer tangible assets to put up as collateral.

Among the activities of a firm, innovation is most susceptible to adverse selection and moral hazard. This is because the innovator is likely to have much better information about the chances of success than potential investors, and the latter are unlikely to have the knowledge necessary to effectively monitor the research project.[1] Another key feature of investment in innovation is that much of it goes into intangible assets, such as the specialized knowledge embodied in researchers.

A stylized fact in the literature on innovation by firms is that the smaller the firm, the less likely it is to engage in research and development, and that among firms engaged in R&D, the amount spent on innovative activities rises with firm size (Cohen and Klepper (1996)). Yet, studies which estimate the productivity of R&D indicate that innovations produced per dollar of R&D are *higher* in smaller firms.[2] Acs and Audretsch (1991a) report that small firms contribute more than twice as many innovations per employee than do large firms, while Plehn-Dujowich (2006) finds that on average, smaller firms obtain three times more patent citations per dollar of R&D. This association of firm size with rising investment and falling productivity in R&D suggests that there is underallocation of R&D investment to small firms.

In addition, Hall (2005) reports evidence for the presence of liquidity constraints in a number of studies of R&D investment by firms in various developed countries. Her survey of research on the venture capital industry indicates that the industry is concentrated precisely where innovative startups, which are mostly small firms, are most active, and that in spite of considerable entry into the industry, returns remain

[1]In a recent paper, Herrera and Minetti (2007) show that the length of a bank's relationship with a firms is positively associated with more R&D by the firms. Interpreting the relationship length as a proxy for the bank's information on the firm leads them to conclude that bank's information matters to firm innovation.

[2]Cohen and Klepper (1996), Bound et al. (1984), Acs and Audretsch (1991b), Acs and Audretsch (1988).

high. Hall's conclusion is that "small and new innovative firms experience high costs of capital that are only partly mitigated by the presence of venture capital," while "evidence for high costs of R&D capital for large firms is mixed". In more recent work, Benfratello et al. (2006) use firm data from Italy to investigate the effect of regional banking development on innovative activities, and find evidence of a stronger positive effect for small firms.

Prior research thus suggests that financial development has a disproportionately positive affect on innovation by small firms. This innovation channel could be one reason behind the heterogenous impact of finance on firm growth. Moreover, the observed higher productivity and lower spending on innovation in small firms suggests that financial growth could lead to a more optimal interfirm allocation of spending on innovation. This hypothesis implies that as financial markets develop, there is relatively more R&D investment by *smaller* firms, and that relative R&D productivity in *larger* firms rises. In this paper, I use data on firms from 57 countries to see if this dual pattern shows up in cross-country data from developing economies.

I find that within industries, relative R&D spending in smaller firms is more likely and sizable in countries at higher levels of financial development. The estimates imply that among firms doing R&D in a country at the 20th percentile of financial development, a one standard deviation decrease in firm size is associated with a decrease of 0.7 standard deviation in R&D spending. In contrast, this decrease is only 0.2 if financial development is at the 80th percentile of its distribution across countries. My second finding also supports the hypothesis: small firms report producing more innovations per unit R&D than large firms, but this gap is narrower in countries at higher levels of financial development.

To verify further that the observed patterns relate to financing, I exploit the cross-industry dimension of my data, interacting financial development with a measure of an industry's inherent reliance on external finance. I find that the association between financial development and innovation by small firms relative to large ones is stronger in industries more dependent on external finance. I also show that the patterns are robust to controlling for another factor that could have a heterogeneous effect on innovation, namely entry regulation.

Finally, I find that relative R&D by small firms is significantly associated with bank development but not with measures of stock market development. This is consistent with previous research on the source of financing of R&D projects. While banks are the main source of R&D financing in European countries, and a significant source in the U.S. (Herrera and Minetti (2007), Berger and Udell (1998)), the sources of funds vary with the size of the R&D project. Aghion et al. (2003) find that UK firms that report positive but low R&D use more debt finance than firms that report no R&D, but the use of debt finance falls with R&D intensity. They suggest that this is so because firms go first for debt as it involves giving up less control rights than new equity. But eventually, debt is harder because R&D involves intangible assets.

An ideal test of the hypothesis that financial development spurs innovation by small firms relative to large firms would involve comparing small and large firms across markets that randomly differ in the degree of financial development. Such exogenous variation is rarely possible in cross-country analysis, where it is likely that financial development is correlated with other determinants of innovative activities. For example, countries with better financial institutions might also have better intellectual property rights. Since plausible correlates are too numerous to control for, any observed relationship between finance and innovation is open to alternative interpretations.

Subject to this caveat, the problem of correlated unobservable country level determinants is less of a concern in the present paper. The reason for this is that I focus on the *differential* effect of finance across firm size. Correlates of financial development which affect small and large firms to the same degree do not matter to the interpretation of my results. Moreover, such unobserved determinants of R&D activity are unlikely to cause both *lower* relative R&D spending and *higher* relative R&D productivity in small firms.

Another caveat that goes with this study is that the analysis essentially compares firm size and R&D activity across *different* industry-country cells. Unlike a panel study, it cannot distinguish between changes in the allocation of R&D to firms and in the composition of firms. The results are thus consistent with theories in which financial development affects the distribution of innovation across firms by either encouraging the entry of small innovative firms, or re-allocating finance from existing large firms to small firms.

The rest of the paper is organized as follows. Section 2 describes the data. Next, section 3 presents preliminary evidence to suggest that finance might matter to innovation by small firms. Section 4 spells out the estimated equations. I present the main probit and OLS estimation results in Section 5, robustness checks in Section 6, and then conclude in Section 7.

2 Data

2.1 Firm Data

I use firm level data from World Bank Enterprise Surveys[3] that were carried out between 2003 and 2006. Every survey consisted of a random sample of firms from one country, stratified by firm size and broad 2-digit industry. Enterprise Survey data from different countries are comparable because of similar sampling strategy and survey instruments. Since no country in my data set was surveyed twice during this period, I treat the data as a pooled cross-section of firms.[4] The focus being investment in R&D, firms from the service industry are excluded from the sample.[5]

The full sample consists of nearly 21,000 manufacturing firms from 57 countries, of which 28 are in Eastern and Central Europe, 9 in Africa, 5 in Southeast Asia, and 15 in Latin America. Table 1 lists key summary statistics by country. While most are middle and low income countries, there are a few rich countries in the sample, notably South Korea, Portugal, Spain, Germany and Ireland. Thus, the data encompass a broad range of countries at different levels of development.

The sample size variation across countries is related to the variation in the total number of firms in these countries. All but the following four countries - Brazil, Mexico, Thailand and Egypt- contribute less than a thousand firms to the sample. In terms of

[3]See www.enterprisesurveys.org for detailed descriptions of the surveys.

[4]Note that the country-industry dummies in the estimations absorb all year dummies.

[5]This is not to say that such firms do not innovate. However, they are much less likely to take out patents, and so dropping them makes the data more comparable to those used in most other studies of innovation.

the number of surveyed firms, about 39% the sample is from Latin America, 27% from Europe, 18% from Southeast Asia, and 16% from Africa.

Following the convention in the literature, I measure firm size by the value of total annual sales (in million US dollars), and spending on innovation by annual expenditure on research and development (in '000 US dollars).

The surveys categorize firms into two-digit (ISIC) industry groups; there are 16 such categories in the data. Since my main estimation exploits variation in the probability of engaging in R&D within country-industry cells, I do not use cells in which either all firms report strictly positive R&D expenditure, or no firm reports R&D. This amounts to dropping about 4% of the original sample. This leaves me with 654 country-industry cells, each containing about 30 firms on average. After dropping outliers in R&D spending and sales, the data set consists of 19845 firms.

Since not all innovative activity can be classified under an exclusive category, and since some R&D consists of fixed investment in equipment and facilities, it is likely that this current R&D spending is an understatement of a firm's expenditure on innovative activities. It is also possible that different firms report different things under R&D spending. However, there is no reason to believe that this measurement error varies systematically across firm size *and* financial development.

The surveyed firms were asked if their own R&D resulted in a new product, a new process and a significant upgrading of the product. For every firm, I sum up these indicators to construct an index of innovative output that ranges in value from 0 to 3. This index differs from the most commonly used measure of innovative output, which is the number of patents taken out by a firm. Since not all innovative activity results in a new patent, the index is a more exhaustive and direct measure of innovation than patenting activity.[6] But it shares, with patents, the limitation of being a count measure instead of a direct estimate of the monetary value of the new products or processes. Furthermore, a "new product" introduced by a typical small firm in an industry is likely to have less monetary value than a new product introduced by large firms in the same industry. However, it is reasonable to assume that this interindustry reporting bias does not vary across countries.

Table 2 shows that about 26% of the sampled firms spent a positive amount on research and development. As reported in Table 1, there is considerable cross-country variation in this figure. Only 4% of the firms surveyed in Oman report having spent on R&D, while in South Africa this percentage is 52. National income figures in Table 1 also reveal that in general, more firms do R&D in larger economies.

Among firms that do spend on R&D, the average spending on R&D is 3% of total sales. Fewer than a tenth of these firms spend more than 10% of the value of their sales on R&D. The average value of the innovation index for firms engaged in R&D is 2; nearly a quarter of these firms have an innovation index of zero.

2.2 Measures of Financial Development

In keeping with common usage in the literature on finance and growth, my principal measure of a country's financial development is the ratio of private credit to GDP,[7] where private credit is defined as the total credit from deposit-taking institutions to

[6] Although it misses the effect of R&D on technology adoption (Griffith et al. (2004)).

[7] See studies surveyed in Levine (2005).

the private sector. As shown in Table 1, there is considerable variation in private credit/GDP (the variable *PvtCredit*) across the countries in my sample; it ranges from a low of 0.04 in Kyrgyzstan to a high of 1.4 in Portugal, and the median country in the sample has a private credit/GDP value of 0.35.

As alternatives to private credit/GDP, I use two other measures of a country's financial development: deposit accounts (*Deposit*) and the interest rate spread (*Spread*). The variable *Deposit* is the number of bank deposit accounts in a country. These include all checking, savings, and time deposit accounts for businesses, individuals, and others. This variable is taken from the World Development Indicators, where it has been compiled from surveys of banking and regulatory institutions by the World Bank. *Spread* is the difference between the interest rate charged by banks on loans to prime customers and that paid by banks on demand, time, or savings deposits. The source of the private credit and the interest rate data are the IMF International Financial Statistics.[8]

Private Credit/GDP includes credit extended by all banks and non-bank financial institutions. The number of deposit accounts excludes financial intermediaries that do not take deposits, and so is more indicative of just banking sector coverage. The interest rate spread is a measure of the efficiency with which the banking sector intermediates funds; a narrow interest rate spread thus indicates a higher level of financial development. However, it is possible for the banking sector to have limited coverage and a low interest rate spread.[9] So, the three variables pick up closely related but not quite identical aspects of financial intermediation.[10] Table 3 shows that *PvtCredit* and *Deposit* are positively correlated, and as expected, *Spread* has a negative correlation with both variables. Since data on *Deposit* and *Spread* is missing for many countries in the sample, estimations using these measures are best viewed as robustness checks.[11]

I use two alternative measures of a country's stock market development, also derived from the World Development Indicators. The variable *Stock* is the total value of stocks traded in an economy, a measure of the size of stock markets. The second measure is the "turnover ratio" (*TRatio*), the ratio of stocks traded to stock market capitalization, and it measures stock market liquidity. *TRatio* ranges from a low of 0.3 to a high of 255 in the data. The two stock market measures are positively correlated with *PvtCredit*, but the correlation is less than 0.5.

2.3 Financial Dependence

I use the Rajan and Zingales (1998) measure of an industry's dependence on external finance to see if the association between financial development and relative R&D by small firms is stronger in industries that use more external finance. Rajan and Zingales identified an industry's need for external finance, defined as the difference between investments and cash generated from operations, from data on U.S. firms. Under the assumption that capital markets in the United States are relatively frictionless,

[8] The units of these country-level variables were chosen to make magnitudes comparable. For example, *Deposit* is measured in units of 10 millions, while *PvtCredit* is the ratio of private credit to GDP, both measured in the same unit. This makes the magnitude of coefficients comparable across alternative measures of financial development.

[9] Moreover, the interest rate spread measures efficiency under the assumption that interest rates are unregulated.

[10] Also note that being market equilibrium outcomes, they are imperfect measures of the "supply" side of finance.

[11] Results with respect to *PvtCredit* are not sensitive to limiting the sample to countries with full *Deposit* and *Spread* data.

this method allowed them to identify an industry's technological demand for external financing. Under the further assumption that such technological demand carries over to other countries, this measure gave them a ranking of industries by need for external finance that stayed constant across countries.

There are two limitations on the applicability of this industry level variable in the present study. First, the measure does not refer specifically to the financing of innovation. So, in ordering industries by this measure, I assume that firms in industries more reliant on external finance are also those with less internal funds for R&D. Second, since my data set consists of only sixteen two-digit industrial classes, I am unable to exploit the full extent of variation in the Rajan-Zingales measure.[12]

3 Preliminary Analysis

3.1 Comparing Firm Size Distribution Across Countries

The empirical analysis in this paper compares the association between innovation and firm size across different countries by regressing innovation on an interaction of firm size with financial development. Since firm size is measured in absolute terms and in the same unit across countries, the interpretation of the coefficient on the interaction term is less clear if size distribution varies significantly across countries. Figure 1 addresses this concern by comparing the size distribution of firms in the data across countries grouped by financial development. It depicts estimates of the size distribution in each of four randomly picked major industry groups for two sets of countries, those above and below the median value of *PvtCredit*.[13] It is apparent that in all four industries, there is no significant difference in the size distribution across the two sets of countries. The same is true of other industries, lending credence to the interpretation of the interaction term as a measure of the association between finance and relative innovation by small firms.

3.2 Preliminary Evidence

In this section I present four patterns in the data which are suggestive of the hypothesis.

First, firms doing R&D are more intensive users of bank finance. As mentioned in the introduction, prior evidence on the sources of funding for R&D is mixed. Banks are the main source of R&D financing in European countries, and a significant one in the United States. However, small innovative startups are also financed by the venture capital industry, particularly in the US (Hall (2005)). While I lack data on the source of funding for R&D, I can compare financing patterns in firms doing R&D to those not doing R&D. Table 4 looks at the percentage of new firm investment financed according to source. For each source, this percentage is regressed on R&D and country-industry dummies. The regressions show that compared to other firms, those that engage in R&D have significantly higher percentages of new investment financed by domestic banks, foreign banks and by government funds. They have a lower percentage financed

[12]For the most part, there was a one to one correspondence between Rajan and Zingales's industry groups and my 2-digit ISIC categories. In those industries for which this was possible, a finer matching was achieved using my data on the firm's product category.

[13]These are kernel density estimates of the logarithm of firm sales.

by internal funds, while there is no statistically significant difference by R&D status in equity financing. I also find that these patterns hold equally for both small and large firms.[14] Thus, R&D activity certainly seems to be associated with bank funding, while the association with equity is unclear.

Second, there is evidence in the data that small firms report stronger financial obstacles than large firms. Surveyed firms were asked to rate finance as an obstacle to growth, and on average smaller firms' ratings were higher. Being a subjective rating, this is open to the interpretation that small firms simply complain more. Nevertheless, unless this tendency to complain varies differentially by size across countries, it is interesting to note that the higher rating by small firms is less pronounced as we move to countries at higher levels of financial development. Table 5 regresses firm rating of financial obstacles on firm size interacted with private credit/GDP. Controlling for country-industry effects, the tendency of smaller firms to complain more about access to finance falls as *PvtCredit* rises.

Next, figures 2 and 3 give graphical previews of the main finding in this paper. Figure 2 plots R&D spending against firm size separately for countries above and below the median value of the private credit/GDP ratio.[15] A comparison of the two panels makes it evident that in my sample of 19,845 firms, the positive association between R&D spending and firm size is stronger in countries at lower levels of private credit.

Figure 3 graphs the innovation/R&D ratio against firm size for countries above and below the median value of the private credit/GDP ratio. It shows that while the innovation/R&D ratio falls with firm size in both set of countries, the decline is sharper in countries below the median value of private credit. Thus, consistent with an explanation based on financial inefficiency, patterns in R&D returns are the reverse of those seen in R&D spending, and there is greater dispersion in returns in low *PvtCredit* countries. The OLS and probit estimations reported in section 5 confirm these observations.

4 The Empirical Specification

4.1 Financial Development and The Probability of Spending on Innovation

Let r_{ijc} be a dummy variable that equals one if a risk-neutral firm i in industry j and country c engages in R&D. The probability that the firm does R&D can be modeled using a latent variable approach. The size of the R&D project is fixed. Suppose y_{ijc} is the firm's expected profit from the project, defined as the discounted stream of revenue from the R&D output minus the discounted stream of cost of R&D inputs. If the firm needs external financing for R&D, then this cost includes the cost of external funds. Firm i does R&D if the expected profit is higher than a threshold y^*. In line with the observation in Hall (2005) that R&D spending by firms has the characteristics of fixed

[14] In regressions with R&D dummy interacted with firm size as an explanatory variable, the interaction term was insignificant.

[15] The lines, drawn for ease of illustration, are non-parametric locally weighted regression estimates. The graph is drawn for firms reporting non-zero R&D expenditure.

investment, this threshold can be motivated as a fixed cost of investing in research and development.

The expected output of R&D depends on the size of the firm, since there may be economies of scale in R&D or complementarities with other inputs, and since the revenue from an innovation will depend on the total sales of a firm (Cohen et al. (1987)). Now, if financial development has a differential effect by firm size on the cost or availability of external funds for R&D, then y_{ijc} will depend on $Size_{ijc}$ interacted with financial development. Thus,

$$y_{ijc} - y^* = \gamma_{jc} + \mu Size_{ijc} + \alpha Size_{ijc} * FinDev_c + \beta Size_{ijc} * GDP_c + \epsilon_{ijc} \quad (1)$$

where γ_{jc} are country-industry dummies, $FinDev_c$ is a measure of the financial development of country c, and GDP_c measures its income level. Financial development tends to be highly correlated with the total income level of an economy. It is possible that the size of the domestic market matters differentially to small and large firms. So in the above expression, as a control, I also allow national income to have a differential effect on R&D profits. Note also that the country-industry dummies absorb $FinDev_c$ and other country or industry level variables. Now,

$$Pr(r_{ijc} = 1) = Pr(\gamma_{jc} + \mu Size_{ijc} + \alpha Size_{ijc} * FinDev_c + \beta Size_{ijc} * GDP_c + \epsilon_{ijc} >= 0) \quad (2)$$

Assuming that ϵ_{ijc} is normally distributed, the coefficients in the expression for y_{ijc} can be estimated by a probit model.[16]

How does one interpret the coefficient α on the interaction of firm size with financial development? Owing to the non-linearity of the expression (equation 2) for the probability of doing R&D, the interaction coefficient cannot be interpreted the same way as in a linear probability model.[17] It is more straightforward to use equation 1 and interpret α and its estimated standard error in terms of the underlying linear model explaining the latent variable $y_{ijc} - y^*$, the expected profit (net of sunk costs) from entering into R&D. A negative α would indicate that financial development is associated with a higher net profit from R&D to small firms relative to large firms. Assuming that correlates of financial development do not have a *differential* effect by firm size on revenue from R&D, this would suggest that financial development lowers the cost of R&D financing to small firms relative to large firms.

To verify that the coefficient on the interaction of firm size with financial development does indeed reflect the financial channel, I test if the interaction effect is stronger in industries with a higher Rajan-Zingales measure of dependence on external finance ($FinDep$), estimating a Probit in which

$$\begin{aligned} y_{ijc} - y^* &= \gamma_{jc} + \mu Size_{ijc} + \alpha Size_{ijc} * FinDev_c + \beta Size_{ijc} * GDP_c \\ &\quad + \delta Size_{ijc} * FinDev_c * FinDep_j + \tau Size_{ijc} * FinDep_j + \epsilon_{ijc} \quad (3) \end{aligned}$$

If the sign of the coefficient on the $Size_{ijc} * FinDev_c$ term in equation 2 reflects the heterogenous effect of financial development, then I expect the coefficient on $Size_{ijc} *$

[16]Since the data consist of pooled country surveys, the estimation results in the paper report standard errors allowing for the clustering of errors by country.

[17]The parameter of interest, the cross derivative of $Pr(r_{ijc} = 1)$ w.r.t $Size$ and $FinDev$, is not α but a more complicated expression involving all explanatory variables, μ, α and the normal density function. See Ai and Norton (2003) for a discussion on interaction terms in logit and probit models.

$FinDev_c * FinDep_j$ to be of the same sign; that is, I expect a stronger $Size_{ijc} * FinDev_c$ interaction effect in industries with higher $FinDep_j$.[18]

4.2 Spending on Innovation

Let s_{ijt} be the amount spent on R&D (in the previous year) by a firm i, where $r_{ijc} = 1$. To examine how the intensity of innovation spending by small firms relative to large ones varies by financial development, I estimate the following equation by OLS:

$$s_{ijc} = \gamma^s_{jc} + \mu^s Size_{ijc} + \alpha^s Size_{ijc} * FinDev_c + \beta^s Size_{ijc} * GDP_c + \epsilon^s_{ijc} \quad (4)$$

This equation is estimated for the set of firms that report non-zero R&D spending. Thus, it measures how relative spending on innovation varies among firms doing R&D. A negative α^s indicates that in countries at higher levels of financial development, the intensity of R&D has a weaker association with firm size.

Note that if the coefficient α in equation 2 is negative, then relative to the set of large firms doing R&D, the set of small firms doing R&D is likely to be larger in more financially developed countries. It is possible that this higher (relative) incidence of innovation among smaller firms goes with lower (relative) average spending on innovation *per firm*. This is consistent with models in which the main impact of financial development is to enable more entry by small firms into R&D. On the other hand, it is also possible that financial development increases the relative availability of R&D funds to small firms to such an extent that even average R&D intensity among small firms rises. Hence, if the coefficient α in the probit equation is significantly different from zero, a positive α^s does not contradict the hypothesis, although a negative α^s does lend it further support.

4.3 The Productivity of Spending on Innovation

Several studies of R&D and patenting activity find that while small firms spend less on R&D, they take out more patents per dollar R&D (Cohen and Klepper (1996)). This indicates that the productivity of spending on innovation is higher in small firms. Assuming decreasing returns to R&D, it also suggests that with financial development, the reallocation of R&D from large to small firms would be accompanied by an increase in the productivity of R&D in large firms. In other words, it would lead to a more efficient allocation of investment in R&D. To test if there is evidence suggestive of this in cross-country data, I measure innovation produced per dollar R&D, p_{ijt}, by dividing firm i's index of innovation by its R&D spending, and estimate the following equation:

$$p_{ijc} = \gamma^p_{jc} + \mu^p Size_{ijc} + \alpha^p Size_{ijc} * FinDev_c + \beta^p Size_{ijc} * GDP_c + \epsilon^p_{ijc} \quad (5)$$

As suggested by prior patent based evidence, μ^p should be negative: innovation produced per dollar R&D is lower for larger firms. More significantly, if this is caused by "over-investment" in innovation in larger firms, then α^p should be *positive*: as financial markets develop, innovation produced per dollar R&D increases for large firms relative to small firms. Thus, I expect α^p to have the opposite sign from the coefficient α^s in equation 4.

[18] In equation 3, the lower order interaction terms *FinDep* and *Findep*Findev* are absorbed in the γ_{jc}s.

5 Main Results

5.1 The Probability of Spending on Innovation: Probit Results

Table 6 presents the results from probit estimations of the probability of doing R&D on the full sample of 19845 firms. The main specification is the one spelled out in equation 2, and financial development is measured by private credit/GDP. The standard errors presented allow for clustering by country.

Columns (1) and (2) report results when the probit model includes only industry, and not country-industry dummies. In column (1), explanatory variables include firm size (measured by sales), private credit/GDP (*PvtCredit*) and size interacted with *PvtCredit*. The coefficient on firm size is positive and significant, indicating that within industries, larger firms are more likely to do R&D. The coefficient on *PvtCredit* is also positive and significant, indicating a higher incidence of R&D by firms in countries at higher levels of financial development. The concern with interpreting this correlation is that financial development is correlated with the overall level of development, and with other country characteristics that may be relevant to innovation. This problem becomes apparent in column (2), where I add gross national income (GNI) and its interaction with size as a control. The coefficient on *PvtCredit* falls and is no longer significant. The coefficient on the interaction of firm size with *PvtCredit* is negative, although not significant.[19]

A comparison of the association between firm size and R&D across countries should also control for country-industry effects, since otherwise it might pick up cross-country differences in industry shares. Hence, my preferred specification is one that includes country-industry dummies γ_{jc} in the set of independent variables. The result from estimating this specification (equation 2) is shown in column (3). The coefficient on firm size is positive and significant, while that on the interaction of firm size with *PvtCredit* is negative and significant.[20] The negative sign implies that the positive association between size and profits from R&D is weaker in countries at higher levels of financial development. This suggests that in keeping with the hypothesis, financial development lowers the cost of R&D funds to a greater extent for smaller firms.

In order to get an idea of the magnitude of the *Size*PvtCredit* effect from its probit coefficient, one can use the estimates of μ and α from column (3) to measure how the underlying latent variable, the expected profit net of sunk costs of R&D, varies with firm size at different levels of *PvtCredit*. Consider a country at the 20th percentile of *PvtCredit* (0.08) in my sample of countries. The estimates imply that here, a one standard deviation (SD) decrease in firm size is associated with decrease of 0.17 units in expected R&D profits. In contrast, holding everything else constant, if *PvtCredit* is at the 80th percentile of its distribution (0.6), then this decrease is only 0.13 units. Assuming that all non-financial determinants of expected profits from R&D are uncorrelated with *Size*PvtCredit*, this implies that the *increase* in financing cost when firm size falls by 1 SD is 25% lower in the case of higher financial development.

[19] The coefficient that on the interaction of GNI with size is positive and significant. The latter stays positive and significant in nearly all the estimations, indicating that controlling for the differential effect of financial development, the positive association between firm size and the probability of doing R&D is stronger in economies with larger domestic markets.

[20] As mentioned in section 4.1, the interaction coefficient and its standard error can be interpreted in the standard way if one considers the underlying linear latent variable model instead of the predicted probability of R&D.

In column (4) of Table 6, I show evidence to suggest that the interaction effect of firm size and *PvtCredit* is stronger in industries that are inherently more dependent on external finance. I do this by estimating, as expressed in equation 3, the coefficient on the interaction of *Size*PvtCredit* with *FinDep*, the Rajan-Zingales measure of industry reliance on external finance.[21] The coefficient on *Size*PvtCredit* FinDep* is negative, although the standard error puts the precision at 20% level of significance. Since *FinDep* is higher for industries more reliant on external finance, this indicates that the negative coefficient on *Size*PvtCredit* in column (3) was mainly driven by such industries.[22] This pattern, which I will show to be robust to using alternative measures of financial development, increases my confidence in my interpretation of the *Size*PvtCredit* coefficient in column (3).

Table 7 re-estimates equation 2 using two alternative measure of financial development-the number of bank deposits (*Deposit*) and the interest rate spread (*Spread*).[23] To sum up, I find that the patterns seen in columns (3) and (4) of the previous table are verified by both alternative measures. In column (1), the coefficient on *Size* is positive while that on *Size*Deposit* is negative and significant. Thus, controlling for the size of the economy, an increase in the number of bank deposit accounts is disproportionately associated with R&D in smaller firms. Column (2) adds an interaction of *FinDep* with *Size*Deposit* to the specification; as with private credit/GDP, I find that the coefficient on *Size*Deposit* FinDep* is negative.

Columns(3) and (4) of Table 7 use the interest rate spread, a measure of the efficiency of the banking system. Note that unlike the previous measures, a higher *Spread* means *lower* efficiency in financial intermediation. Once again, the signs are consistent with those for *PvtCredit.* The coefficient on the interaction term *Size*Spread* is positive and significant, indicating that controlling for GNI, smaller firms are relatively more likely to do R&D in countries with *lower* interest rate spreads. Moreover, in column (4) we see that this differential effect of *Spread* is significantly stronger in industries that are inherently more dependent on financing: the coefficient on the interaction of *Size*Spread* with *FinDep* is positive and significant at 1% level.

5.2 Spending on Innovation: OLS Results

Table 8 presents OLS estimations of equation 4, examining the relationship between firm size, R&D expenditure and financial development in the subset of firms that do R&D. The results show two robust patterns: first, the relative intensity of R&D by small firms is higher in countries at higher levels of financial development; second, this association is significantly stronger in industries more reliant on external finance. This is evident in columns (1) and (2), which report estimations with *PvtCredit* as the measure of financial development. In column (1), the coefficient on firm size is positive and significant, while that on *Size*PvtCredit* is negative and significant.

What is the magnitude of the *Size*PvtCredit* effect on relative spending on R&D?

[21] Because matching was based on both industry code and product code, there are a few 2-digit industries within which *FinDep* varies. The estimation includes all lower order interaction terms, namely *FinDep*, *Size*FinDep* and *Findep*Deposit* (or *Findep*Spread*), as controls.

[22] As mentioned in section 2, because my data set consists of only sixteen two-digit industrial classes, I am unable to exploit the full extent of variation in this measure. This might explain the low precision of the estimate of the triple interaction.

[23] The estimation uses a subset of the full sample because these variables were not available for all countries.

One can use the estimates of μ^s and α^s from column (1) to calculate the answer. Consider a country at the 20th percentile of *PvtCredit* (0.08). The estimates imply that here, among firms doing R&D, a 1 SD decrease in firm size is associated with a decrease of 0.7 SD in R&D spending. In contrast, holding everything else constant, if *PvtCredit* is at the 80th percentile of its distribution (0.6), then this decrease is only 0.2 SD. Thus, relative R&D spending in smaller firms shows substantial positive cross-country association with financial development.This result indicates that the disproportionate effect of financial development on innovative activities in small firms is stronger than that suggested by looking only at the number of firms that do R&D.

Moreover, in column (2) we see that the disproportionate impact on R&D spending is stronger in industries which we expect to be more affected by financial development: the coefficient on *Size*PvtCredit*FinDep* is negative and significant at 1% level.

Columns (3)-(6) confirm these findings using other measures of financial development. In column (3), the coefficient on *Size*Deposit* is negative and significant at 1% level, while in column (4), the triple interaction shows that this negative sign is stronger in industries with higher values of the Rajan-Zingales measure. Column (5) reports that the association between firm size and R&D spending falls in countries with lower interest rate spreads. Again, this is consistent with the patterns in the probability of engaging in R&D. In column (6), we see that the *Size*Spread* association is stronger in industries with higher *FinDep*.

5.3 The Productivity of Spending on Innovation: OLS Results

As discussed in section 4.3, the hypothesis implies that the association of financial development with relative R&D productivity in small firms is the reverse of that with relative R&D spending. In Table 9, I test for this by seeing how, among firms engaged in R&D, innovation produced per dollar R&D varies with firm size and financial development.

I measure innovation per dollar R&D by dividing the index of firm innovation by the amount spent of R&D. The count index of innovation has the limitation of being an imperfect and truncated measure of what I would ideally like to measure, which is the monetary value of the new products or processes that are developed by R&D. Since it has a maximum possible value of 3, the index is biased towards underreporting higher R&D returns. If a "new product" introduced by a small firm in an industry has less monetary value than that introduced by large firms in the same industry, a productivity measure based on this innovation index will be biased downwards for larger firms. However, it is reasonable to assume that this reporting bias does not vary systematically across countries. So, the coefficients on the *interaction* of size with country characteristics are still informative of the cross-country variation in the relative productivity of R&D by small firms.

Column (1) of Table 9 reports that the coefficient on *Size* is negative, while that on *Size*PvtCredit* is positive and significant. This says that in my sample of firms the gap between small and large firms in innovation per unit R&D is lower in countries with higher private credit/GDP. Thus, the patterns in R&D returns are the reverse of those seen in R&D spending. As columns (3) and (5) show, this correlation is robust to replacing *PvtCredit* with either bank deposit accounts or the interest rate spread.

Taken together, the main findings are that as financial markets improve across countries, large firms do less R&D relative to small firms, but they produce more innovation per dollar R&D. This indicates that financial development lowers the gap in returns to R&D across small and large firms, and thereby increases the overall efficiency of R&D allocation across firms.

The reversal of the interaction sign when looking at R&D productivity also suggests that the sign of the coefficient on *Size*PvtCredit* in the previous R&D spending regressions could not have been driven by correlates of financial development that raise the relative returns to R&D in small firms. Had that been the case, the gap in R&D productivity would have widened with *PvtCredit*.

Unlike the previous correlations, the pattern between innovation per dollar R&D and *Size*PvtCredit* is not significantly stronger in industries with higher values of *FinDep*. This could be because of the small sample size and relatively small number of industry groups. It could also be the case that the innovation count is not comparable across industries, and in a way that varies across countries.

6 Robustness Checks

6.1 Stock Market Development

Table 10 presents probit estimates of the probability of R&D when interactions of stock market indicators with firm size are added to equations 2 and 3. The purpose is two-fold: firstly, equity and bank development tend to go together across countries, and since equity might be an important alternative source of R&D investment, it is useful to control for the differential effect of stock market development. Secondly, prior theoretical and empirical evidence on equity and R&D is mixed, and so the coefficient on the interaction of stock market indicators with firm size is interesting in itself.

The estimations use two alternative stock market indicators. *Stock* (columns (1)-(2)), the total value of stocks traded in an economy, measures the size of stock markets. *TRatio*, or "turnover ratio" (columns (3)-(4)) is the ratio of stocks traded to market capitalization, and it measures stock market liquidity. Both measures give broadly similar results. Compared to the original estimate in column (3) of Table 6, both the point estimate and the precision of the coefficient on *Size*PvtCredit* is largely unchanged in Table 10. Similarly, there are no major changes in the coefficient on *Size*PvtCredit*FinDep*.

As for coefficients on the interaction of size with stock market indicators, Table 10 reports that they are negative but statistically insignificant for both measures. Moreover, there is no consistent pattern in the interaction of firm size with stock markets and *FinDep*. This indicates that there is no significant cross-country correlation between stock market development and R&D by small firms relative to large ones. This result is consistent with the low use of venture capital by small innovative firms in Europe (Herrera and Minetti (2007)) and even in the US (Berger and Udell (1998)).[24]

[24] It is also consistent with the observation in Hall (2005) that the returns to innovation by small farms are high even in sectors where venture capital is concentrated.

6.2 Product Market Competition and Entry Regulation

It is possible that financial development is correlated with other country characteristics which affect innovation by firms. Potential candidates include the supply of scientists, the quality of intellectual property rights institutions, or the general contractual environment. However, unless the effect of such characteristics on innovation differs systematically by firm size, they should not matter to the interpretation of the coefficient on the interaction of firm size with financial development. The wages of scientists and engineers, for instance, vary across countries but are unlikely to vary across firms within the same country and industry.

There is, however, a concern that the interaction term picks up the effect of cross-country variation in the product market competition faced by large firms. This concern arises because of two factors. One, standard IO theory predicts that since competition reduces the monopoly rents that reward successful innovators, innovation should decline with competition.[25] Two, the extent of competition might be related to entry regulation, which is negatively correlated with financial development. This is evident in Table 3, which shows that two cross-country measures of entry regulation, the Doing Business[26] estimates of the time to start a new business (*StartTime*) and the cost of procedures to start a new business (*StartCost*) are negatively correlated with *PvtCredit*. There is also evidence, shown in Table 11, to suggest that larger firms face more competition when entry barriers are lower.

The outcome variable in the regressions shown in Table 11 is a firm-reported measure of the number of its domestic product market competitors. In column (1), this measure of competition faced by a firm is regressed on *StartTime*. There is no significant correlation between the two, but in column (2), where the explanatory variables include *Size* and *Size*StartTime*, the coefficient on *Size*StartTime* is negative, indicating that larger firms face relatively less competitors as entry barriers rise. This correlation is robust to using *StartCost* to measure entry regulations. The coefficients are statistically insignificant, perhaps because the firm-reported measure of competition is available for only 15 countries. However, this negative correlation between entry regulation and competition faced by large firms relative to small firms suggests controlling for the differential effect of entry regulation on innovation.[27]

Table 12 presents probit estimates of the probability of R&D when interactions of entry regulations (*StartTime* or *StartCost*) with firm size are added to equations 2 and 3 as controls. Irrespective of which procedural measure I interact with firm size, the coefficient on *Size*PvtCredit* in Table 12 is close to that in the preferred specification which was reported in column (3) of Table 6. Thus, the association between relative R&D by small firms and financial development is robust to controlling for entry barriers.

[25] However, empirical work such Geroski (1995) , Nickell (1996) and Griffith et al. (1999) has pointed to a positive correlation between product market competition and innovative output. Aghion et al. (2002) develop a model in which competition and innovation have a U-shaped relationship.

[26] See www.doingbusiness.org for details; these measures were first developed in Djankov et al. (2002).

[27] Note that since competition is endogenous to innovation, it should not be included as an explanatory variable in itself.

7 Conclusion

Innovation by firms is a important determinant of productivity and growth. There is evidence in theory that small firms find it relatively costly to finance innovation, and recent empirical work (Benfratello et al. (2006)) suggests that banking development encourages innovation by small firms. This channel could partly explain the growing cross-country evidence on the disproportionate association between financial development and growth in small firms. Looking at innovative activity by firms across 57 countries, I find that patterns in the data do fit this story.

Within industry, and relative to large firms, small firms are more likely to engage in R&D in countries at higher levels of financial development. Among firms engaged in R&D, a similar relationship holds for the amounts spent on R&D. These associations are robust to using different measures of banking development, and they are stronger in industries more reliant on external finance, indicating that they do indeed reflect the working of the financial channel. Moreover, in keeping with the hypothesis that financial underdevelopment leads to an underallocation of investment in small innovative firms, smaller firms report more innovation per unit R&D, and this gap is narrower in countries at higher levels of financial development.

These empirical findings suggest that by encouraging R&D in small firms that have high, untapped returns to innovative activities, the development of banks and other financial institutions can have positive growth and distributional consequences.

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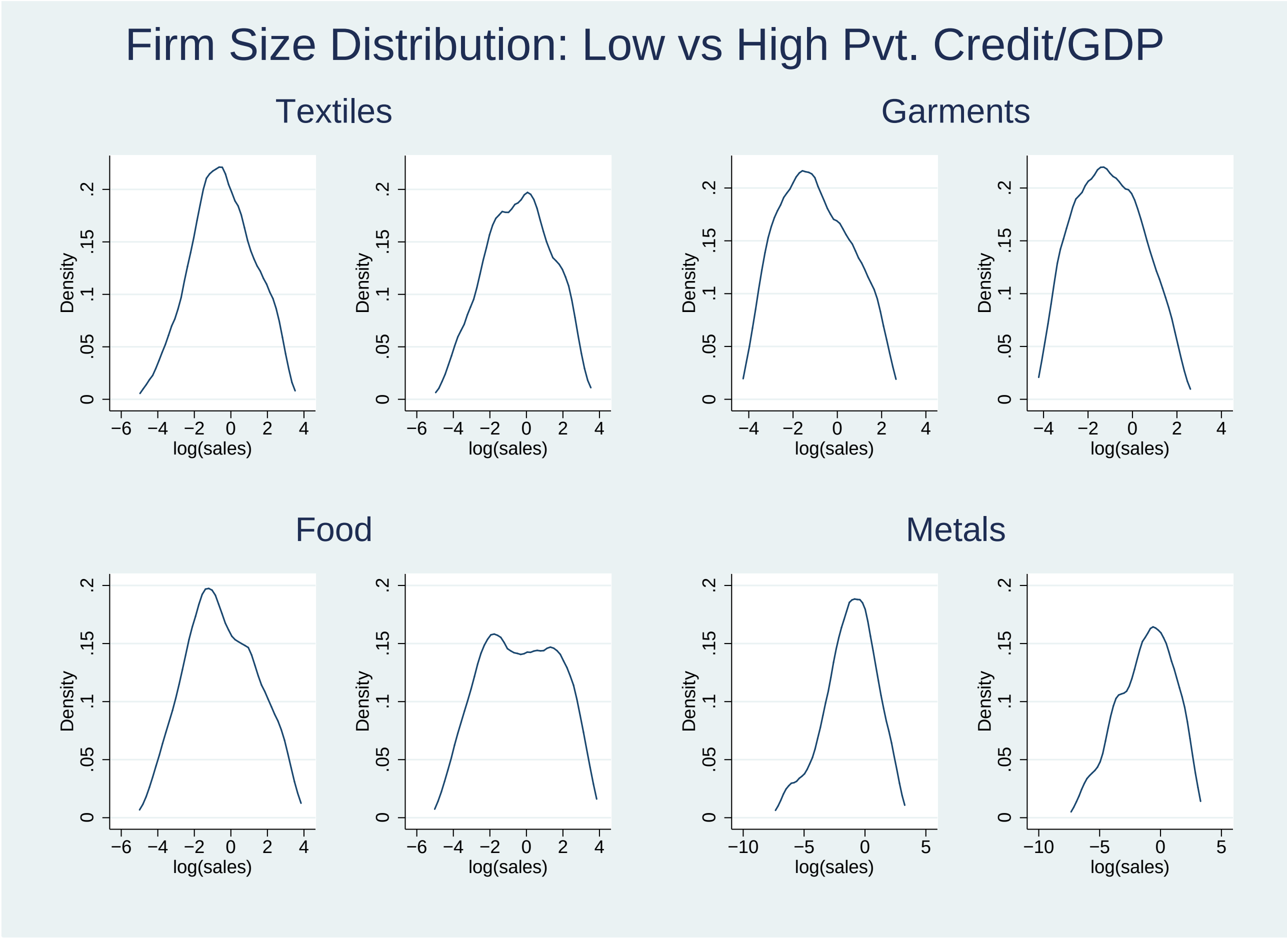

Figure 1: Industry-wise Similarity of Firm Size Distribution in Countries Above and Below Median Private Credit/GDP

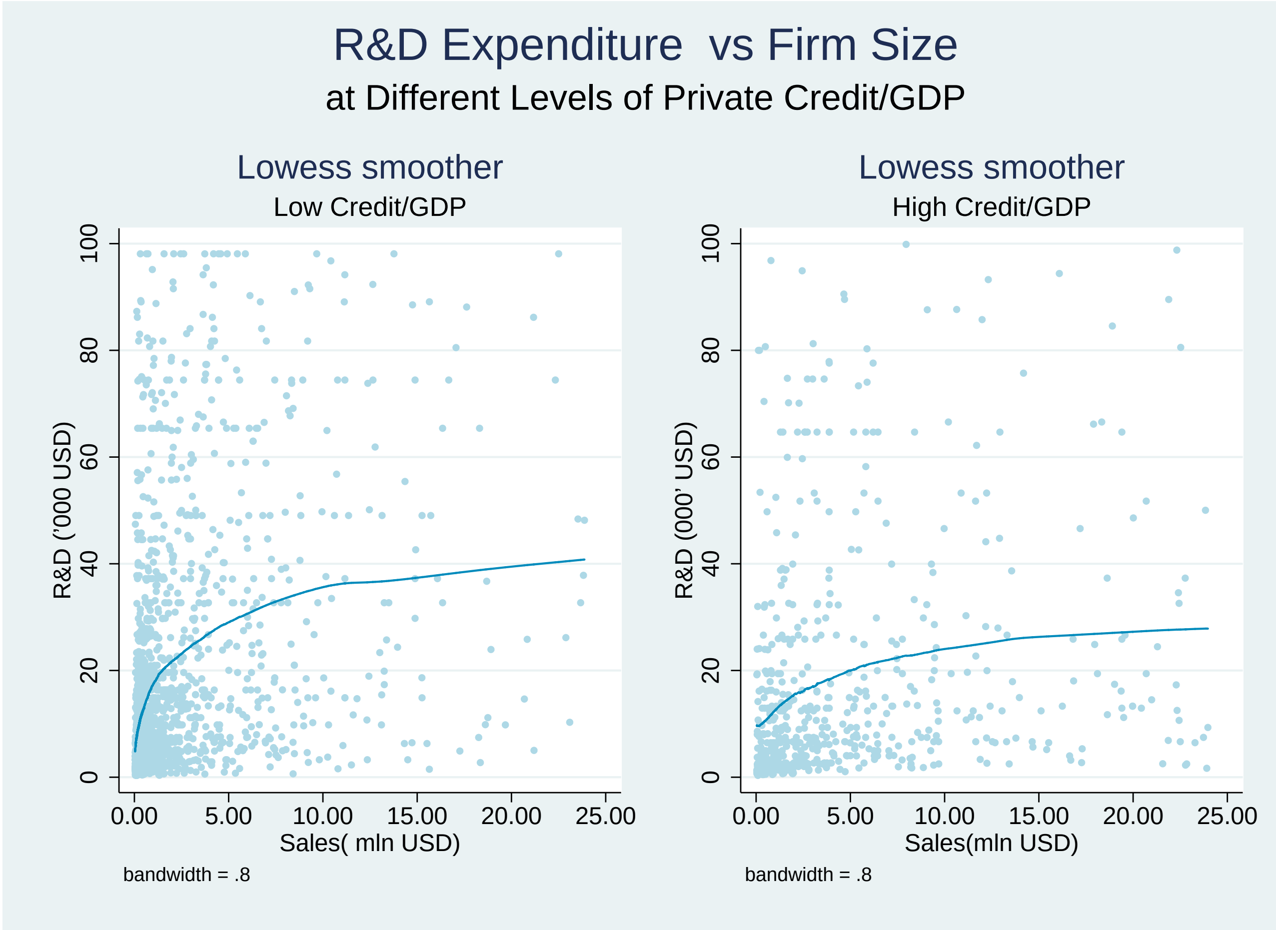
R&D Expenditure vs Firm Size
at Different Levels of Private Credit/GDP
Lowess smoother
Low Credit/GDP
R&D ('000 USD)
0
20
40
60
80
100
0.00
5.00
10.00
15.00
20.00
25.00
Sales(mln USD)
bandwidth = .8
Lowess smoother
High Credit/GDP
R&D (000' USD)
Sales(mln USD)
bandwidth = .8

Figure 2

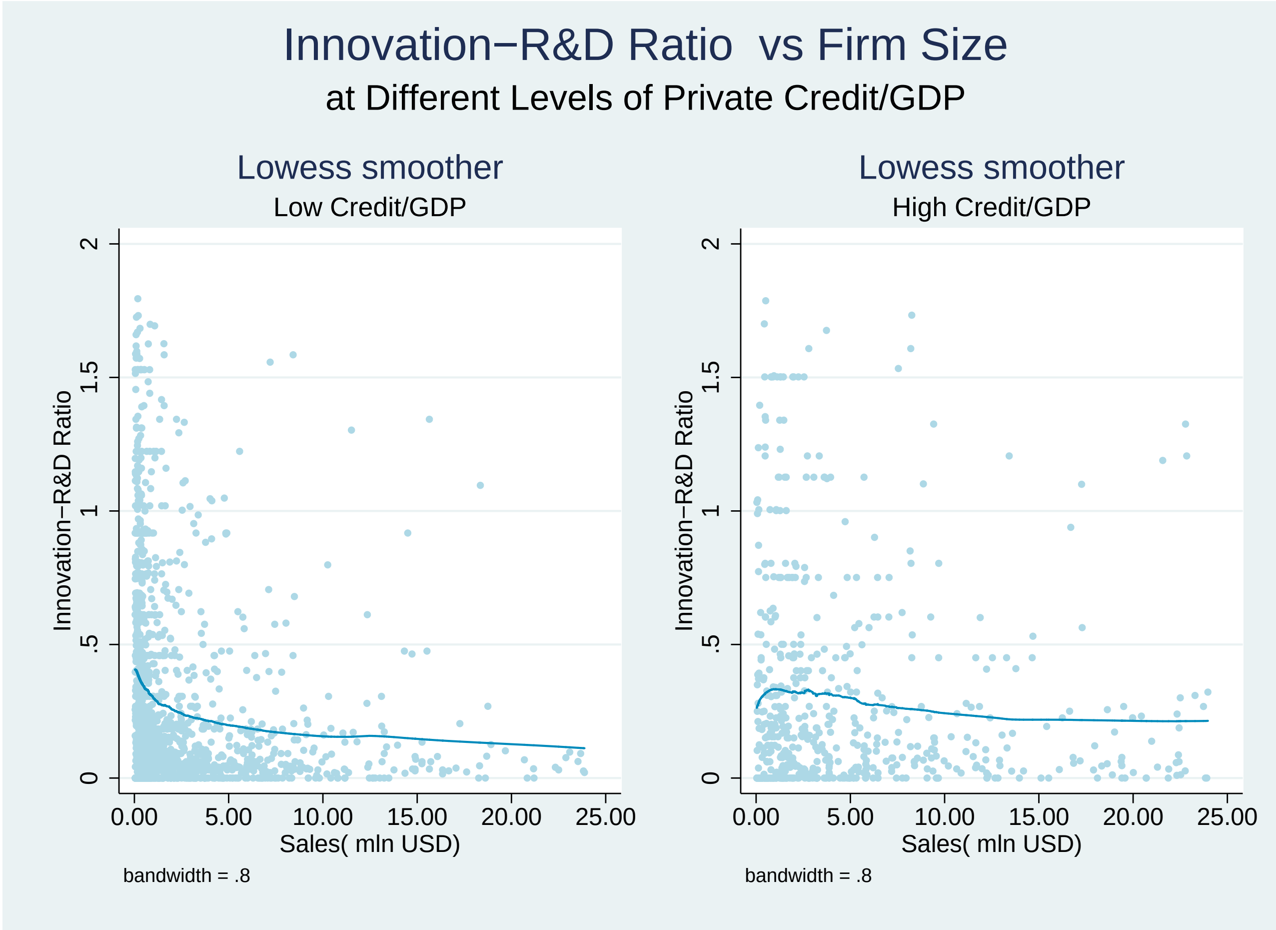
Innovation−R&D Ratio vs Firm Size
at Different Levels of Private Credit/GDP
Lowess smoother
Low Credit/GDP
Innovation−R&D Ratio
0
.5
1
1.5
2
0.00
5.00
10.00
15.00
20.00
25.00
Sales(mln USD)
bandwidth = .8
Lowess smoother
High Credit/GDP
Innovation−R&D Ratio
0
.5
1
1.5
2
0.00
5.00
10.00
15.00
20.00
25.00
Sales(mln USD)
bandwidth = .8

Figure 3

Table 1: Country-wise Data Summary

Country	Private Cdt. /GDP	GNI	% in R&D	Obs.	Country	Private Cdt. /GDP	GNI	% in R&D	Obs.
Albania	0.06	4	14	69	Morocco	0.55	34	3	833
Argentina	0.19	248	29	717	Moldova	0.15	2	17	231
Armenia	0.08	2	13	219	Madagascar	0.08	4	20	225
Bulgaria	0.16	13	20	66	Mexico	0.18	511	17	1057
Bosnia & H.	0.39	5	13	54	Macedonia	0.19	4	22	37
Belarus	0.09	13	13	98	Mali	0.17	3	31	142
Bolivia	0.56	8	30	361	Malawi	0.08	2	7	155
Brazil	0.35	595	47	1552	Nicaragua	0.27	2	13	451
Chile	0.61	69	18	704	Oman	0.4	17	4	56
Colombia	0.27	87	33	667	Panama	0.92	11	18	224
Costa Rica	0.27	14	12	298	Peru	0.25	54	33	393
Czech Rep.	0.42	56	30	120	Philippines	0.41	79	21	624
Germany	1.18	1998	26	408	Poland	0.28	165	20	550
Egypt,	0.61	90	8	947	Portugal	1.4	110	22	151
Spain	1.06	584	18	193	Paraguay	0.24	8	17	366
Georgia	0.08	3	27	37	Romania	0.08	39	13	370
Greece	0.6	123	10	126	Russia	0.16	294	23	161
Guatemala	0.2	20	36	435	El Salvador	0.05	13	17	465
Honduras	0.41	6	13	428	Slovakia	0.43	21	26	46
Croatia	0.44	20	23	82	Slovenia	0.38	19	48	77
Hungary	0.34	49	16	321	Syria	0.09	17	31	168
Ireland	1.1	83	33	198	Thailand	1	121	21	1339
Kazakhstan	0.15	20	7	296	Turkey	0.2	185	26	978
Kyrgyzstan	0.04	1	11	168	Tanzania	0.06	9	20	196
Cambodia	0.07	3	11	110	Ukraine	0.15	38	8	201
Korea, Rep.	0.93	425	29	258	Uruguay	0.53	21	25	334
Lithuania	0.14	11	25	69	Vietnam	0.39	30	11	1400
Latvia	0.23	7	12	43	S. Africa	0.76	123	52	529
					Zambia	0.07	3	18	163

Notes: Private Cdt./GDP is the ratio of private credit to GDP. GNI is gross national income in billion USD. % in R&D is the percentage of surveyed firms that report positive R&D expenditure.

Table 2: Summary Statistics

	Mean	SD	Obs.
R&D Indicator	.264	.440	19845
R&D/Sales (%)	2.979	7.987	4585
Innovation Index	2.01	1.16	4585
Firm Sales (Million USD)	3.81	10.54	19845
PrivateCredit/GDP	.416	.301	19845
Number of Deposit Accounts (10^7)	.71	.52	10123
Interest Rate Spread	0.104	.103	10123
Value of Stocks Traded (Million USD)	0.08	.24	19845
Turnover Ratio	0.43	.57	19845
GNI (10^{12} USD)	.327	.587	19845
Time to Start Business (10^2 days)	.57	.33	19845
Cost of Starting Business/GNI per cap.	.45	.60	19845

Table 3: Correlations in Country Characteristics

	PvtCredit	*Deposit*	*Spread*	*Stock*	*TRatio*	*GNI*	*StartTime*
Deposit	0.689						
Spread	-0.186	-0.169					
Stock	0.387	0.442	0.032				
TRatio	0.789	0.741	-0.039	0.704			
GNI	0.432	0.727	-0.035	0.765	0.584		
StartTime	-0.295	-0.236	0.828	0.240	-0.020	0.071	
StartCost	-0.213	-0.340	-0.127	-0.143	-0.387	-0.097	0.082

Table 4: R&D and Financing Patterns of Firms

DepVar:	Percentage of New Investment Financed by				
	Internal Funds	Domestic Banks	Foreign Banks	Government Funds	Equity
	(1)	(2)	(3)	(4)	(5)
R&D Dummy	-2.084	2.097	.988	.484	-.782
	(1.302)	(.869)**	(.334)***	(.202)**	(.770)
Ind*Cntry FEs	Y	Y	Y	Y	Y
Obs.	19845	19845	19845	19845	19845

1. OLS Results. Robust standard errors adjusted for clustering by country in parenthesis. * indicates significance at 10% level, ** 5%, and *** 1%.
2. *R&D Dummy* is a binary variable equal to one for firms that report positive R&D spending and zero otherwise.

Table 5: Firm Size, Private Credit/GDP and Financial Constraint

Estimation	OLS			
DepVar:	Degree of Financial Constraint			
	(1)	(2)	(3)	(4)
Size	-.016	-.016	-.013	-.017
	(.002)***	(.002)***	(.002)***	(.003)***
Size*PvtCredit	.009	.007		.007
	(.002)***	(.003)***		(.003)**
Size*GNI		.0001		.0001
		(.00008)*		(.00007)*
Size*TRatio			.003	.001
			(.003)	(.002)
Ind*Cntry Dummies	Y	Y	Y	Y
Obs.	19845	19845	19845	19845

1. Robust standard errors adjusted for clustering by country in parenthesis. * indicates significance at 10% level, ** 5%, and *** 1%.
2. The dependent variable is a self-reported index of the degree to which access to finance is an obstacle to the firm. Higher values indicate a more severe constraint.
3. *Size* is firm sales in million USD. *PvtCredit* is the ratio of private credit to GDP. *GNI* is logarithm of gross national income in current USD. *TRatio* is the ratio of stocks traded to stock market capitalization.
4. The country level variables, *GNI*, *PvtCredit* and *TRatio* are absorbed in industry*country dummies.

Table 6: R&D, Firm Size and Private Credit/GDP

Estimation		Probit		
DepVar:		Binary R&D Indicator		
	(1)	(2)	(3)	(4)
Size	.016 (.003)***	.017 (.002)***	.017 (.002)***	.015 (.004)***
PvtCredit	.446 (.140)***	.315 (.238)		
Size*PvtCredit	.003 (.005)	-.003 (.004)	-.006 (.004)*	-.001 (.006)
Size*FinDep				.005 (.007)
Size*PvtCredit*Findep				-.012 (.010)
GNI		.08 (.011)		
Size*GNI		.005 (.002)***	.01 (.002)***	.01 (.002)***
Industry Dummies	Y	Y		
Country*Industry Dummies			Y	Y
Obs.	19845	19845	19845	19845

1. Robust standard errors adjusted for clustering by country in parenthesis. * indicates significance at 10% level, ** 5%, and *** 1%.
2. *Size* is firm sales in million USD. *PvtCredit* is the ratio of private credit to GDP. *FinDep* is the Rajan-Zingales measure of (3-digit) industry dependence on external finance. *GNI* is logarithm of gross national income in current USD.
3. In columns (3) and (4), the country level variables *GNI* and *PvtCredit* are absorbed in industry*country dummies. The estimation in column(4) includes all lower order interaction terms, namely *Findep* and *Findep*PvtCredit*, as controls. *Findep* varies within some industry groups.

Table 7: R&D, Firm Size and Alternative Measures of Financial Development

Estimation:	Probit			
Measure of Fin. Development:	Bank Deposits		Interest Rate Spread	
DepVar:	Binary R&D Indicator			
	(1)	(2)	(3)	(4)
Size	.014	.013	.011	.014
	(.003)***	(.004)***	(.002)***	(.002)***
Size*Deposit	-.004	-.001		
	(.002)**	(.003)		
Size*Deposit*Findep		-.006		
		(.005)		
Size*Spread			.008	-.024
			(.005)*	(.006)***
Size*Spread*FinDep				.124
				(.017)***
Size*GNI	.02	.02	.01	.01
	(.002)***	(.002)***	(.003)***	(.003)***
Country*Industry Dummies	Y	Y	Y	Y
Obs.	10123	10123	10123	10123

1. Robust standard errors adjusted for clustering by country in parenthesis. * indicates significance at 10% level, ** 5%, and *** 1%.
2. *Deposit* is the number of bank deposit accounts. *Spread* is the average interest rate charged by banks on loans minus the interest rate paid by banks for deposits.
3. *FinDep* is the Rajan-Zingales measure of (3-digit) industry dependence on external finance.
4. The estimations include all lower order interaction terms, namely *Findep*, *Size*FinDep* and *Findep*Deposit* (or *Findep*Spread*), as controls.
5. The number of observations is less than 19845 because the sample is restricted to countries with data on *Spread* and *Deposit*.

Table 8: R&D Spending, Firm Size and Financial Development

Estimation:	OLS					
Measure of Fin. Development:	Private Credit		Bank Deposits		Interest Spread	
DepVar:	R&D Spending					
	(1)	(2)	(3)	(4)	(5)	(6)
Size	.022	.004	.018	.003	.002	-.010
	(.001)***	(.004)	(.001)***	(.004)	(.002)	(.007)
Size*PvtCredit	-.027	-.005				
	(.002)***	(.005)				
Size*PvtCredit*FinDep		-.043				
		(.015)***				
Size*Deposit			-.014	-.004		
			(.001)***	(.004)		
Size*Deposit*Findep				-.024		
				(.010)**		
Size*Spread					.115	.156
					(.026)***	(.098)
Size*Spread*Findep						.267
						(.433)
Ind*Ctry FE	Y	Y	Y	Y	Y	Y
Obs.	1977	1977	1977	1977	1977	1977
R^2	.317	.504	.263	.419	.217	.34
F statistic	201.236	46.313	142.904	95.007	98.534	9.931

1. Robust standard errors adjusted for clustering by country in parenthesis. * indicates significance at 10% level, ** 5%, and *** 1%.
2. Sub-sample of firms reporting strictly positive R&D spending, in countries with data on *PvtCredit*, *Spread* and *Deposit*.
3. The estimations include *Size*GNI* and all lower order interaction terms, namely *Findep*, *Size*FinDep* and *Findep*PvtCredit* (or *Findep*Deposits*, or *Findep*Spread*), as controls. Results are not sensitive to the exclusion of *Size*GNI*.

Table 9: Innovation/R&D Spending, Firm Size and Financial Development

Estimation:	OLS					
Measure of Fin. Development:	Private Credit		Bank Deposits		Interest Spread	
DepVar:	Innovation per unit R&D Spending					
	(1)	(2)	(3)	(4)	(5)	(6)
Size	-.042 (.012)***	.020 (.130)	-.080 (.029)***	-.219 (.118)*	.052 (.032)	.156 (.170)
Size*PvtCredit	.031 (.015)**	.136 (.213)				
Size*PvtCredit*FinDep		-.188 (.517)				
Size*Deposit			.050 (.023)**	.153 (.094)		
Size*Deposit*FinDep				-.200 (.157)		
Size*Spread					-1.658 (.583)***	-4.551 (4.002)
Size*Spread*Findep						11.705 (15.922)
Ind*Ctry FE	Y	Y	Y	Y	Y	Y
Obs.	3512	3512	1127	1127	1127	1127
R^2	.353	.353	.259	.263	.259	.263
F statistic	12.49	5.673	8.655	2.4	8.527	14.298

1. Robust standard errors adjusted for clustering by country in parenthesis. * indicates significance at 10% level, ** 5%, and *** 1%.
2. Sub-sample of firms reporting strictly positive R&D spending. The number of observations differs from those in the previous table because firms surveyed in 2006 are excluded owing to lack of comparability of innovation measures with pre-2006 surveys. Columns 1-2 have more observations because *Deposits* and *Spread* are unavailable for several countries. However, results in column 1-2 are not sensitive to restricting the data to the 1127 observations in columns 3-6.
3. *Innovation* is an additive index of product and process innovation ranging in value from 1-3.
4. The estimations include *Size*GNI* and all lower order interaction terms, namely *Findep*, *Size*FinDep* and *Findep*PvtCredit* (or *Findep*Deposits*, or *Findep*Spread*), as controls. Results are not sensitive to the exclusion of *Size*GNI.*

Table 10: R&D, Firm Size and Stock Market Development

Estimation	Probit			
Measure of Stock Markets	Stocks Traded		Turnover Ratio	
DepVar:	Binary R&D Indicator			
	(1)	(2)	(3)	(4)
Size*PvtCredit	-.005	-.0006	-.005	.0005
	(.004)	(.006)	(.003)*	(.006)
Size*PvtCredit*FinDep		-.011		-.017
		(.010)		(.013)*
Size*Stock	-.0004	.005		
	(.007)	(.009)		
Size*Stock*FinDep		-.014		
		(.013)		
Size*TRatio			-.002	-.003
			(.002)	(.002)
Size*TRatio*FinDep				.006
				(.009)
Ind*Cntry Dummies	Y	Y	Y	Y
Obs.	19845	19845	19845	19845

1. Robust standard errors adjusted for clustering by country in parenthesis. * indicates significance at 10% level, ** 5%, and *** 1%.
2. *Stock* is value of stocks traded. *TRatio* is the ratio of stocks traded to stock market capitalization.
3. The estimations include all lower order interaction terms, as well as *Size*GNI* as controls. All country level variables- *PvtCredit*, *Stock*, *TRatio* and *GNI*- are absorbed in Industry*Country dummies.

Table 11: Entry Regulation and Product Market Competition

Estimation	OLS				
Measure of Entry Regulation		Time to Start Business		Cost of Starting Business	
DepVar:	Number of Domestic Product Market Competitors				
	(1)	(2)	(3)	(4)	(5)
Size		1.306 (3.386)	.656 (5.789)	-.992 (.601)*	-1.116 (5.885)
StartTime	154.742 (254.413)				
Size*StartTime		-8.313 (10.754)	-16.359 (11.585)		
Size*StartCost				-4.962 (6.282)	-10.279 (8.953)
Controls	N	N	Y	N	Y
Ind*Cntry Dummies	N	Y	Y	Y	Y
Obs.	4734	4734	4734	4734	4734

1. Robust standard errors adjusted for clustering by country in parenthesis. * indicates significance at 10% level, ** 5%, and *** 1%.
2. *StartTime* is the Doing Business measure of time to start a new business. *StartCost* is the Doing Business measure of the cost of entry procedure.
3. Number of domestic product market competitors is a firm-level variable from Enterprise Survey data.
4. The controls in columns (3) and (5) are *Size*GNI* and *Size*PvtCredit*.

Table 12: R&D, Firm Size and Entry Regulation

Estimation	Probit			
Measure of Entry Regulation	Time to Start Business		Cost of Starting Business	
DepVar:	Binary R&D Indicator			
	(1)	(2)	(3)	(4)
Size*PvtCredit	-.006	-.001	-.005	.002
	(.004)*	(.007)	(.004)	(.007)
Size*PvtCredit*FinDep		-.012		-.014
		(.010)		(.010)
Size*StartTime	-.00006	-.00009		
	(.003)	(.003)		
Size*StartCost			.005	.005
			(.004)	(.004)
Ind*Cntry Dummies	Y	Y	Y	Y
Obs.	19845	19845	19845	19845

1. Robust standard errors adjusted for clustering by country in parenthesis. * indicates significance at 10% level, ** 5%, and *** 1%.
2. *StartTime* is the Doing Business measure of time to start a new business. *StartCost* is the Doing Business measure of the cost of entry procedure.
3. The estimations include all lower order interaction terms, as well as *Size*GNI* as controls. All country level variables- *StartTime*, *StartCost*, *PvtCredit* and *GNI*- are absorbed in Industry*Country dummies.