

# Finance, Property Rights and Creative Destruction

Roberto M. Samaniego\*

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## Abstract

Entry, exit and innovation spending are found to be disproportionately sensitive to the level of financial development in research intensive industries - although these are not industries with especially high turnover rates. Moreover, this result appears linked to differences in the institutions that avoid costly disputes about intellectual property. The results underline the role of institutions in determining rates of entry, exit and innovation at the industry level, and suggest that intellectual property rights encourage growth by enabling innovative entrepreneurs to raise external funds.

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\*Contact: Department of Economics, George Washington University, 2115 G St NW Suite 340, Washington, DC 20052, Tel: (202) 994-6153, Fax: (202) 994-6147, E-mail: roberto@gwu.edu.

*“The banker [...] is essentially a phenomenon of development [...] he makes possible the carrying out of new combinations [of productive means], authorises people, in the name of society as it were, to form them.”*

Joseph A. Schumpeter, *The Theory of Economic Development* (1934).

## 1 Introduction

The introduction of innovations by entrepreneurs is thought to be an important motor of economic growth, as embodied in the widely-used "creative destruction" framework of Aghion and Howitt (1992). Moreover, some argue that financial markets fuel this motor, by reallocating resources towards innovative entrepreneurs.<sup>1</sup> However, an empirical link between finance, entry and innovative activity has proved elusive. Nor is it known which are the empirically relevant frictions that might interfere with the financing of innovative entry, which is critical for correctly modeling this channel of finance-enabled growth, as well as for understanding the determinants of entry, exit and innovation more generally.

This paper exploits *country-industry variation* in rates of entry, exit and innovation spending to understand whether and how financial markets channel funds towards innovative entrants. Country-industry data provide a natural environment in which to search for evidence of a link between financial development and innovative entry. Samaniego (2010) finds that country and industry dummies account for almost half the variation in European rates of entry and exit – whereas time dummies account for about 1%, indicating that industry data provide is a useful source of variation for understanding the determinants of entry and exit. This paper uses data from Eurostat, which provides internationally comparable industry data covering the universe of legal firms in 28 European countries, covering both manufacturing and non-manufacturing industries.<sup>2</sup>

In a large survey of business startups conducted by the European Commission, country

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<sup>1</sup>This view is often traced back to Schumpeter (1934), see Evans and Jovanovic (1989) for a discussion.

<sup>2</sup>Most studies of entry and exit focus on manufacturing; exceptions include Brandt (2004) and Samaniego (2010), who use earlier Eurostat entry and exit data but do not look at R&D nor at startup survey data.

financial development is positively related to the extent to which entrepreneurs draw on external funds, and to the extent to which entrepreneurs are innovators. Furthermore, if financial development enables costly innovation by entrepreneurs, we might expect financial underdevelopment to be related to reductions in entry *primarily in research-intensive industries*. If financial markets improve the allocation of resources across firms by directing capital towards innovative entrepreneurs and away from incumbents, in financially underdeveloped economies we would also expect such industries to display disproportionate reductions in *exit rates* and in *spending on innovation*. Reductions in innovation spending are potentially important as they indicate that financial underdevelopment does not simply reallocate innovation from entrepreneurs to incumbents. Finally, financial development is ultimately thought of as being institutionally determined, and understanding which are the *institutional underpinnings* of any impact of finance on innovative entry helps identify the frictions that are most relevant for modeling the finance-growth interaction in a creative destruction framework. Hence, the financial development variables are replaced with a variety of institutional indicators that relate to the feasibility, enforceability and cost of financial transactions.<sup>3</sup>

The main result is that financial development tends to encourage entry, exit and innovation spending in R&D intensive industries. The institutions most closely linked to this effect are (1) low costs of legal disputes and (2) strong intellectual property rights (IPRs). These are institutions that favor activities where knowledge easily spills over to competitors and may hence be easily appropriated by others in the absence of effective legal protection, leading to disputes – a finding that is reminiscent of Romer’s (1990) comment that "excludability is a function both of the technology and of the legal system." An entrepreneur with a protected idea is less likely to lose the rights to the project through imitation by firms who

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<sup>3</sup>The literature distinguishes between two broad classes of institutions that underpin financial markets: contracting institutions and property rights institutions. Contracting institutions support the effectiveness of private agreements – by encouraging transparency to avoid disputes, or by dealing with disputes efficiently once they emerge. Property rights institutions determine the extent to which entrepreneurs can control the use and transfer of the firm’s physical or intangible assets – defining what can or cannot be used as collateral, and determining whether the firm is open to the threat of competition through imitation or theft. See North (1984) and Acemoglu and Johnson (2005).

do not incur the full R&D cost. Thus, the ability to own (and voluntarily transfer) ideas enables entrepreneurs to raise external funds to create and/or implement ideas in the first place.<sup>4</sup> Furthermore, we find that IPR protection disproportionately increases growth in R&D intensive industries. All this indicates that financial development encourages growth by channeling funds towards innovations introduced by entrepreneurs.

The paper bridges the literature on financial development and the literature on the determinants of entry and exit. Numerous studies including King and Levine (1993) and Rajan and Zingales (1998) examine the impact of financial development on growth. However, in spite of the importance for innovation often attributed to the *financing of entrepreneurs*, direct evidence of this channel of growth is lacking. The sense that there *should* be a link between technical change, entry and exit goes back at least as far as Schumpeter (1934), and Geroski (1989), Audretsch (1991) and others study the link empirically, but none of these papers studies the role of finance in the process of entry and exit, nor the impact of finance on innovative activity. Carlin and Meyer (2003) document a sensitivity of research spending to the financial environment, and the survey of Hall (2005) devotes a section to the financing of innovation at startups, but neither discusses entry and exit rates as such, and neither looks at industry differences. Aghion, Fally and Scarpetta (2007) find that entry in manufacturing industries that draw more on external funds is disproportionately sensitive to financial development, but they do not present evidence linking this result to innovative activity, nor do they look at exit. Claessens and Laeven (2003) find that property rights (including intellectual property rights) are an important institutional underpinning for financial development, enhancing growth through improvements in resource allocation. The present paper finds evidence for one channel through which this might occur: the replacement of incumbents by innovative entrants. Ilyina and Samaniego (forthcoming) links the use of external finance to R&D intensity at the industry level and finds that growth in R&D

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<sup>4</sup>Cohen and Levinthal (1990) argue that a significant function of R&D is to implement innovations developed at other firms, and Branstetter et al (2006) find evidence that multinationals increase technology transfer in response to IPR reform. This suggests that the introduction of both new-to-the-world and pre-existing technologies requires R&D, and could be affected by the intensity of IPR enforcement.

intensive industries is sensitive to financial development, but does not look at entry, exit nor innovation.

Evans and Jovanovic (1989) argue that the debate on the importance of entrepreneurial finance can be traced back to Knight and Schumpeter. Knight (1921) viewed entrepreneurs as being self-financed, implicitly assuming financing constraints. On the other hand, Schumpeter (1934) believed that the banking sector would adequately channel funds from those who had them towards entrepreneurs who might lack them. An interpretation of the empirical results of this paper is that the Schumpeterian view is more appropriate for financially developed environments,<sup>5</sup> whereas the Knightian view is adequate for financially underdeveloped environments. Moreover, variation in financial development appears linked to variation in IPR protection, so that the key friction leading to financial underdevelopment is lack of intellectual property rights enforcement or costly dispute resolution. The idea that property rights encourage entrepreneurship by increasing access to external finance dates back at least to De Soto (1987), but the emphasis on *intellectual* property rights is novel to the author's knowledge.

Section 2 presents the empirical strategy and introduces the data used in the paper. Section 3 provides motivating evidence of a link between financial development and constraints on the activity of entrepreneurs and of innovators, based on European survey data. Section 4 reports empirical results concerning financial development and industry entry, exit and innovation spending, as well as institutions. Section 5 concludes by discussing the link between these findings and theories of innovation and IPR enforcement.

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<sup>5</sup>This is consistent with Hurst and Lusardi (2004) who conclude that "even if some households that want to start small businesses are currently constrained in their borrowing, such constraints are not empirically important in deterring the majority of small business formation in the United States."

## 2 Method and Data

### 2.1 Empirical Approach

First of all, we report some stylized facts regarding the obstacles faced by entrepreneurs and innovators, based on large European surveys of entrepreneurs and innovators. Then we ask whether, in financially underdeveloped, creative destruction is suppressed particularly in industries that, in the absence of constraints, are research-intensive. To test for this pattern, we adopt the differences-in-differences approach pioneered by Rajan and Zingales (1998). Let  $y_{i,c}$  be the dependent variable for industry  $i$  in country  $c$ . Dependent variables include turnover measures and innovation expenditure measures – but, for concreteness, let us assume it is the rate of entry. Let  $\alpha_c$  and  $\delta_i$  denote country and industry indicator variables, respectively.  $RND_i$  measures desired R&D intensity in industry  $i$ , and  $FD_c$  measures financial development in country  $c$ . We estimate the equation:

$$y_{i,c} = \alpha_c + \delta_i + \beta_{RND} RND_i \times FD_c + \varepsilon_{i,c} \quad (1)$$

In specification (1), all country- and industry-specific factors affecting rates of entry are removed. Thus, any policies or regulations that affect entry rates at the country level are accounted for, as are all industry-specific factors leading to entry and exit. Instead, the existence of an impact of financial development on creative destruction through entry is identified by asking whether entry  $y_{i,c}$  is particularly susceptible to financial development in industries with high  $RND_i$ . In other words, we seek evidence that financial development affects entry in innovative industries by asking whether there is a significant interaction between  $RND_i$  and  $FD_c$  – whether  $\beta_{RND} > 0$ . As in Rajan and Zingales (1998), to deal with the common problem of heteroskedasticity in fixed effect panels, we apply a White (1980) heteroskedasticity-consistent estimator, which allows the variance of the residual  $\varepsilon_{i,c}$  to vary by country and by industry (as well as by  $RND_i \times FD_c$ ).

To fully test the creative destruction hypothesis, we also ask whether  $\beta_{RND} > 0$  when the dependent variable  $y_{i,c}$  is the *exit* rate. In addition, we test whether it is specifically spending on innovation that is hampered by financial underdevelopment by asking whether  $\beta_{RND} > 0$  when the dependent variable  $y_{i,c}$  is *innovation spending*, as a share of net sales.

A potential concern is endogeneity of financial development: if there is a lot of entry, it may be that this encourages greater use of external credit, which is our baseline measure of  $FD_c$ . We handle this possibility in several ways. First, we use a variety of measures of financial development  $FD_c$ , most of which are not based on financial deepening. Second, the fact that the dependent variable is defined at the level of the country-industry pair (whereas financial development is a country variable) itself should reduce the possibility of endogeneity. This is precisely the motivation for the Rajan and Zingales (1998) differences-in-differences approach: all country-specific factors affecting entry are captured by the country indicator  $\alpha_c$ , and identification depends only on *industry differences* in rates of entry across countries. Third, we estimate equation (1) using instrumental variables. We use the standard set of instruments for financial development, based on legal origin – English, French, German or Scandinavian – as well as an additional indicator variable for whether the country in question is a post-socialist transition economy. We draw legal origin from the CIA World Factbook: see La Porta et al (1998) for more on the use of the legal origin instruments.<sup>6</sup> The distribution of  $RND_i$  turns out to be quite skewed: as a result, we correct all standard errors for heteroskedasticity and check the robustness of results by bootstrapping, among other methods described later.

The maintained assumption behind (1) is that desired R&D intensity is an industry characteristic, the ranking of which persists across countries.<sup>7</sup> For example, if in the US firms in Chemicals are more R&D intensive than firms in Textiles, our assumption is that

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<sup>6</sup>There is also a question as to whether R&D intensity might be determined by rates of entry (reverse causality). The empirical and theoretical literature surveyed in Geroski (1989), Cohen and Levin (1989) and Ngai and Samaniego (2011) argues against this.

<sup>7</sup>We think of *desired* R&D spending as the optimal R&D spending given the technological parameters of the industry in an environment with few financial or institutional frictions. *Actual* R&D spending is determined by both technological and institutional parameters.

the same would hold true in, say, Spain or Estonia, in the absence of financing constraints. Using the US as a benchmark, Ilyina and Samaniego (forthcoming) compute R&D intensity using US firms in Compustat, and also excluding US-incorporated firms from Compustat Global, finding that the correlation between the two measures is 0.98: this suggests that large firms that face few frictions display similar R&D behavior regardless of location.

Financial development is viewed as being determined by "deeper" institutions that enable assets to be used as collateral or that aid contract enforcement – see North (1984) and Acemoglu and Johnson (2005). Hence, we also estimate equation (1) replacing financial development with a variety of indicators of contracting institutions and property rights institutions. These results serve to narrow down the specific institutions that foster the financing of entry and innovation, either by supporting the operation of financial intermediaries (for example, creditor protection), or by providing entrepreneurs with the kinds of guarantees that they require in order to raise external funds (for example, secure property rights over the firm's assets, to avoid expropriation and to make assets collateralizable). The objective of this exercise is to narrow down the specific frictions that should be elements of *theoretical models* of finance and creative destruction. The literature offers a host of different models of financial frictions, and our exercise is aimed at determining which is the empirically relevant friction that limits the financing of creative destruction.

## 2.2 Data on Industry-country pairs

### 2.2.1 Entry and exit

Rates of entry and exit are drawn from the Eurostat Business Demography database,<sup>8</sup> as are data on industry expenditures on innovation. The data cover 28 countries over the period 1997 – 2006. Eurostat reports data gathered by the national statistical agencies of

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<sup>8</sup>The unit of observation is the "enterprise", which is similar to the US Census Bureau definition of a "firm", except that mergers and changes of legal status are distinguished from "true" entries and exits. Included countries are those that reported to Eurostat at the time of the study: participation in the data collection exercise was not mandatory so some countries report entry data but not innovation data.

the member countries of the European Union concerning the universe of enterprises in the business register, following a common methodology, so that the data are comprehensive and internationally comparable.

Entering the business register is required to legally produce and sell goods and services. If an enterprise ceases operations, by law it must notify the business register within a matter of months. Mergers and changes of legal form are not counted as entry, nor are temporary shut-downs counted as exit. Thus, the data should adequately reflect entry and exit rates in the formal sector of each country. As well as coverage and comparability, an advantage of using European data is that the relatively skilled workforces of European economies, along with the cross-border mobility of labor and goods, imply that bottlenecks experienced by would-be entrepreneurs are not likely to be driven by the lack of existence or availability of certain skills or resources, but rather by the inability to acquire them, for example due to financial constraints. The survey data will support this presumption.

We study the same 41 industries as Samaniego (2010).<sup>9</sup> This includes 15 manufacturing industries and 26 non-manufacturing industries.

For industry  $i$  in country  $c$ , the variable  $Entry_{i,c}$  is the proportion of enterprises active at a given date  $t$  that entered since date  $t - 1$ , and the variable  $Exit_{i,c}$  is the number of enterprises that closed between  $t - 1$  and  $t$ , divided by the number of enterprises active at date  $t$ . The variable  $Turnover_{i,c}$  is the sum of these two variables. All of these are average rates over the sample period for each country-industry pair, to abstract from short term conditions. Since the concept of creative destruction is related to both entry and exit, for much of the paper we will focus on the variable  $Turnover_{i,c}$ , but also check that results are robust to considering  $Entry_{i,c}$  and  $Exit_{i,c}$  separately.

For most of the paper, we use turnover, entry and exit for each industry-country pair. However, for cross-sectional comparisons, the industry index of entry, exit or turnover is based on the industry fixed effect in a regression of country and industry dummy variables.

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<sup>9</sup>Samaniego (2010) contains additional details regarding the construction of the Eurostat entry and exit data, but uses an earlier edition of Eurostat with fewer countries.

For example, if  $y_{i,c}$  is entry in industry  $i$  in country  $c$ , we estimate:

$$y_{i,c} = \alpha_c + \delta_i + \varepsilon_{i,c} \quad (2)$$

where  $\alpha_c$  and  $\delta_i$  are country and industry dummy variables. The index of entry for industry  $i$  is then the coefficient  $\delta_i$ , added to the coefficient  $\alpha_c$  for the median country.

### 2.2.2 Innovation expenditures

Innovation expenditures are based on the European Community Innovation Survey IV, 2002-2005, which was conducted by the European Commission and which is also available through Eurostat.<sup>10</sup> The survey reports innovation expenditure relative to net sales over the period, which has been used as a measure of innovation intensity since at least Carlin and Meyer (2003). The survey defines an innovation as:

"a new or significantly improved product (good or service) introduced to the market or the introduction within an enterprise of a new or significantly improved process. Innovations are based on the results of new technological developments, new combinations of existing technology or the utilization of other knowledge acquired by the enterprise. Innovations may be developed by the innovating enterprise or by another enterprise. However, purely selling innovations wholly produced and developed by other enterprises is not included as an innovation activity. Innovations should be new to the enterprise concerned. For product innovations they do not necessarily have to be new to the market and for process innovations the enterprise does not necessarily have to be the first one to have introduced the process."

Note that, under this definition of innovation, a firm need not create a "new-to-the-world" innovation. This is consistent with the fact that our data cover countries at different stages

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<sup>10</sup>Eurostat indicates the sampling method of earlier surveys may not be uniform across countries.

of development.<sup>11</sup> Cohen and Levinthal (1990) argue that a significant function of R&D is to implement innovations developed at other firms, and the definition of "innovation" in the Eurostat data encompasses this function of R&D.

The sampling population for the innovation data includes all enterprises with 10 or more employees, as well as many smaller enterprises. Responding firms comprised 45 percent of the universe of firms in the business registries, totalling 181,838 firms. Eurostat reports industry innovation expenditures across enterprises that reported some innovation, which is about 40 percent of responding firms, varying somewhat across countries.

From these data we construct two measures of R&D spending. One is the ratio of innovation expenditures to sales reported in Eurostat for industry  $i$  in country  $c$ , called  $Innov_{i,c}^{RAW}$ . As mentioned, this "raw" data only covers innovating firms. The other measure is  $Innov_{i,c}^{RAW}$  multiplied by the share of innovators in each country, which we call  $Innov_{i,c}^{ADJ}$ .

### 2.2.3 Industry growth

Eurostat also reports value-added growth  $g_{j,c}$  for each industry-country pair. This is the measure of growth used in Rajan and Zingales (1998) to study the interaction between external finance dependence and financial development. Again, we measure it using the average over the period 1997 – 2006.

## 2.3 Survey data

We also employ the Eurostat Factors of Business Success survey, to get a sense of the impact of financial factors on entrepreneurship as perceived by entrepreneurs themselves. Survey results are useful for painting an overall picture of the link between finance and innovative activity at startups, to motivate the more detailed analysis. The survey covers entrepreneurs responsible for births registered in 2002 that survived to 2005. Data were gathered in 2005, and cover 338,462 different firms across Europe.

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<sup>11</sup>Eaton and Kortum (2001) argue that most innovations originate in a handful of highly-industrialized countries. Of course, there are well-known exceptions e.g. Skype, which was developed in Estonia.

## 2.4 Data on Industry Characteristics

### 2.4.1 Research intensity

In what follows, desired R&D intensity is viewed as an industry characteristic. Indeed, Cohen et al (1987) find that industry dummies account for over half of the variation in research intensity across firms in their sample, and Ilyina and Samaniego (forthcoming) find that the industry ranking by R&D intensity is stable across decades. We require an indicator of the "technological" degree of research intensity in an industry. In particular, the ideal indicator should not be contaminated by financing constraints. We draw on data on publicly traded US firms. The presumption is that these firms operate in highly liquid capital markets, so any constraints on profitable investment projects should be minimal, except perhaps in times of crisis – see Rajan and Zingales (1998) and Ilyina and Samaniego (forthcoming). As a result, the R&D activity of a typical firm drawn from this environment should adequately reflect the technological tendency of firms to perform R&D in that firm's industry.<sup>12</sup>

R&D intensity at the firm level is defined as R&D expenditures divided by value added (DATA 46 divided by DATA 12 in Compustat). For each firm, we add the numerator and the denominator over the years 1997-2006 before computing the ratio. The industry measure of R&D intensity is the median firm value, which we call  $RND_i$ .<sup>13</sup>

### 2.4.2 External finance dependence

We also adopt a measure of the extent to which different industries draw on external funds. This is for two reasons: (1) it will be useful to establish a link between the use of external funds and R&D spending; (2) given that such a link exists, it is important to establish that financial development interacts with R&D intensity and not just with external finance

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<sup>12</sup>Ilyina and Samaniego (forthcoming) find that R&D spending measures reported by the NSF correlate very highly with this measure of R&D intensity when the two are computed for the same industry grid.

<sup>13</sup>We do not use the CIS IV data to construct measures of "fundamental" industry tendency to perform R&D. The main reason is that (as discussed later) these numbers do not represent a "clean" measure of the technological requirement for research, since financing constraints in different countries may affect their innovation spending. In addition, the innovation measures are not available for some service sector industries.

dependence. External finance dependence is measured as in Rajan and Zingales (1998), using the share of capital expenditures that is not financed by cash flow from operations. Capital expenditures correspond to DATA 128 in Compustat. Cash flow from operations is defined as cash flow from operations plus changes in payables minus changes in receivables plus changes in inventories, and is computed using DATA 110 and DATA 2, 3 and 70, or DATA 302, 303 and 304 if unavailable. Both capital expenditures and cash flow are summed up over the period 1997 – 2006 to compute the firm-level dependence measures. The industry-level measure  $EFD_i$  is the value for the median firm.

## 2.5 Descriptive statistics

The cross country mean rate of turnover (and the mean across country-industry observations) is 17.5 percent. The cross country standard deviation is 4.8 percent, whereas across industries it is 4.4 percent. Thus there is roughly as much variation across countries as there is across industries.

Table 1 reports that entry, exit and turnover are very highly correlated across industries, as known since Dunne, Roberts and Samuelson (1988) reported this finding for US Manufacturing. The fact that industries with high entry rates also have high exit rates is consistent with the basic concept of creative destruction. On the other hand, the correlation between  $RND_i$  and entry/exit is *negligible*. Even at the country level, the correlation between  $RND_i$  and entry varies from only 0.06 to  $-0.27$ . This is puzzling from the perspective of the standard model of creative destruction. It also implies that any interaction between R&D and finance leading to differences in turnover should not be due simply to the fact that R&D is itself a determinant of turnover, but rather due to the impact of financial factors on the ability of firms to conduct business or pursue R&D.

Table 1 shows that  $EFD_i$  is very highly correlated with  $RND_i$  (although not with turnover). This is consistent with the presumption that external finance is particularly important for high-R&D firms. At the same time, to avoid omitted variable bias, we esti-

mate our regressions below with  $EFD_i$  as well as  $RND_i$ . If results are stronger for  $EFD_i$  than for  $RND_i$ , this indicates that it is the need for finance (regardless of the purpose) that interacts with financial development. If results are stronger for  $RND_i$  than for  $EFD_i$ , this indicates that it is specifically (or primarily) problems that arise in the financing of R&D that interact with financial development.<sup>14</sup>

	Industry indicator			
	Entry	Exit	$RND$	$EFD$
Turnover	0.97*** (0.042)	0.90*** (0.071)	-0.15 (0.158)	0.134 (0.160)
Entry	-	0.75*** (0.106)	-0.11 (0.159)	0.160 (0.160)
Exit	-	-	-0.18 (0.158)	0.075 (0.160)
$RND$				0.78*** (0.107)

Table 1 – Cross-industry correlations between turnover measures and industry variables. Rates of turnover, entry and exit are based on industry fixed effects  $\delta_j$  in equation (2). Standard errors are in parentheses. In all tables, one, two and three asterisks represent significance at the 10%, 5% and 1% levels respectively.

## 2.6 Data on Countries

### 2.6.1 Financial Development

According to Levine (2005), *financial development* is defined as an amelioration of the effects of information, enforcement and transactions costs, provided by financial instruments, markets and intermediaries.

Building on this definition, we employ six different **measures of financial develop-**

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<sup>14</sup>Samaniego (2010) finds a strong link between turnover and investment-specific technical change (ISTC). However, the correlation between R&D intensity and ISTC as measured in that paper turns out to be only 0.064, and an interaction of ISTC with financial development is not statistically significant. Thus, omitted variable bias from ISTC is not a concern.

**ment.** Using six different indicators, measured in very different ways, adds considerable robustness to the results. The typical measure of financial development is financial deepening, which is used in King and Levine (1993) and Rajan and Zingales (1998). A second class includes measures of financial development that are based on observed outcomes, but are not directly related to financial deepening. Instead, they indicate other aspects of the productivity or efficiency of financial intermediaries. A third class of measures of financial development is based on surveys of executives, which ask regarding the nature and availability of financial services. As such, these may be the broadest measures of the six. Specifically, the measures are defined as follows, for each country  $c$  (Table 2 shows that all six measures are positively correlated):

		Financial Development				
		CAP	BANK	MARG	ACCS	SOPH
CRE		0.90*** (0.000)	0.57*** (0.001)	.57*** (0.002)	0.42** (.027)	.56*** (.002)
CAP		-	0.49*** (.008)	.54*** (.003)	0.54*** (.003)	.65*** (.000)
BANK		-	-	.75*** (.000)	0.45** (.016)	.57*** (.002)
MARG		-	-	-	0.50*** (.006)	.62*** (.000)
ACCS		-	-	-	-	.91*** (.000)

Table 2 – Cross-country correlations between measures of financial development. P-values are in parentheses.

1.  $CRE_c$ : Our benchmark measure uses the domestic *private credit-to-GDP ratio*. Domestic credit data come from the IMF International Financial Statistics (IFS); domestic credit allocated to the private sector is IFS line 32d. It is measured at the beginning of the period for which we have industry data (1997) or else the earliest year in the period for which it is available.
2.  $CAP_c$ : For robustness we also use the domestic *capitalization-to-GDP ratio*, the sum

of domestic market capitalization and private credit. Market capitalization is reported by Eurostat. It is measured at the beginning of the period for which we have industry data (1997) or else the earliest year in the period for which it is available. Although  $CAP_c$  is broader than  $CRE_c$ , it may not always accurately reflect the amount of funds raised in domestic financial markets for productive activities – due to tax incentives to list on stock exchanges, stock market dynamics being driven by factors other than fundamentals, etc. Such distortions likely to be particularly severe for the case of transition economies. Hence, in what follows we use  $CRE_c$  as our benchmark.

3.  $BANK_c$ : We also use a measure of *bank overhead as a share of assets* in 1997. This is an *inverse* indicator of financial development (see Beck et al (2000)), as high overhead represents inefficiency in the financial sector. Hence, we multiply it by minus one. It is drawn from the 2006 update of the Beck et al (2000) Database on Financial Development and Structure.
4.  $MARG_c$ : The *interest rate margin* between borrowing and lending is also an inverse indicator of financial development. The presumption is that high margins reflect high costs of operation, or an uncompetitive financial sector. We draw it from the same source as  $BANK_c$ , and also multiply it by minus one.
5.  $ACCS_c$ : The World Economic Forum Global Competitiveness Report (GCR) contains a measure of "*loan access*". It is based on the survey question "how easy is it to obtain a bank loan with a good business plan and no collateral?" measured on a scale of 1-7. The question was included in the Executive Opinion Survey, which covers over 12,000 executives in 134 countries. See Browne et al (2007) for more details.
6.  $SOPH_c$ : The GCR also contains a measure of *financial market sophistication*. It grades responses to the question "the level of sophistication of financial markets in your country is (1=lower than international norms, 7=higher than international norms)."

## 2.6.2 Institutional Indicators

Cross-country differences in financial development are ultimately attributable to institutional factors. The literature distinguishes between two broad classes of institutions that underpin the existence and effective functioning of financial markets: contracting institutions and property rights institutions. See North (1984) and Acemoglu and Johnson (2005).

**Contracting institutions** support the effectiveness of private agreements. Countries may differ in terms of the likelihood of contract disputes, differences in efficiency, and the weight they give the principal (e.g. the borrower, the entrepreneur) as opposed to the agent (the lender, or financier) in the event of disputes or default. They may underpin financial development because financial contracts are less likely to be signed if principal-agent problems are severe, transparency is weak or if enforcement is lax or costly.

We use two measures of investor protection, and two measures of the efficiency of dispute-resolution:

1.  $INVP_c$ : Investor protection intensity, from Djankov et al (2008). It aggregates together three measures: the extent of disclosure, the extent of director liability and the ease of shareholder suits. The data come from a survey of corporate lawyers and are based on securities regulations, company laws and court rules of evidence.
2.  $DISC_c$ : Disclosure requirements, also from Djankov et al (2008). It reflects the transparency of contracting relations. We use this alongside  $INVP_c$  because transparency is distinct from the weights given to different players in court once disputes emerge.
3.  $ENFOR_c$ : Contract enforcement costs, from Djankov et a (2003). It is the proportion of a claim, including attorney fees, that must be paid to successfully sue a buyer to pay for delivered goods worth 200% of GDP when the goods are alleged not to be of adequate quality.
4.  $INFOR_c$ : Djankov et a (2003) find that the degree of formalism in the legal system is a strong predictor of delays in dispute resolution, as well as lower consistency/fairness

in outcomes. Following Acemoglu and Johnson (2005), we use the negative of the Djankov et al (2003) formalism index as a measure of efficiency in dispute resolution.  $INFOR_c$  may also relate to investor protection, since the principal (plaintiff) will generally suffer more from delays. Thus it is also an indicator of creditor rights.

**Property rights institutions** determine the extent to which entrepreneurs can control the use and transfer of the firm's physical or intangible assets. They underpin financial development because agents may use productive assets as collateral, provided they can credibly transfer those assets in the event of default (see Claessens and Laeven (2003)). In addition, even though certain intangible assets may be inherently difficult to collateralize, *intellectual* property rights may ensure that the revenues from an intangible investment accrue ultimately to the firm. An investment project is more valuable, and more able to raise external funds, when the intangibles that delimit the project (the business plan, the product, etc.) are less likely to be stolen or copied by competitors.<sup>15</sup>

We use the following property rights indicators:

1.  $PHYS_c$ : a measure of physical property rights protection. It is drawn from the GCR, and is based on the response to a survey question on the clarity of definition of property rights, including over financial assets. The survey asks where the enforcement of IPRs lies on a 1-7 scale of weakness or stringency.
2.  $PTNT_c$ : patent enforcement. This applies to patentable (e.g. scientific) knowledge, such as new products or processes. It is measured as in Ginatre and Park (1997), a *de jure* measure of IPR intensity, as updated in 2000. See Property Rights Alliance (2007).

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<sup>15</sup>Acemoglu and Johnson (2005) define property rights institutions as those that specifically guard against expropriation by the executive. The definition here is slightly different. As far as financial development is concerned, whether an asset can be used as collateral depends on whether it can be voluntarily transferred and on whether it can be expropriated. Both depend on whether property rights are credibly assigned and enforced, independently from the identity of a potential expropriator.

3.  $COPY_c$ : copyright enforcement. It is based on the Office of the United States Trade Representative "Special 301" watch list, reflecting piracy rates in the business software, entertainment software, motion picture, record and music industries. We take it to indicate the protection of organizational and marketing innovations, as well as new products and processes where some aspect of them might require copyright – including branding. See Property Rights Alliance (2007). Thus  $COPY_c$  captures a much broader concept of intellectual property rights protection than just patenting.
4.  $RULE_c$ : Acemoglu and Johnson (2005) interpret property rights protection as protection from expropriation by the government. We capture this aspect of property rights with the Rule of Law indicator (1996) developed by Kaufmann et al (2007) – an overall indicator of the confidence of the populace in governmental institutions, perception of freedom from corruption, etc., and is constructed from a variety of sources.<sup>16</sup>

### 3 Preliminary evidence: Survey results

We begin by examining the results of Europe-wide surveys of startups and of innovators. An indication of the role of different sources of finance in entrepreneurship can be obtained from the Factors of Business Success Survey (FBS). In addition, the Community Innovation Survey IV (CIS) sheds light on the difficulties suffered by innovating firms.

Figure 1 reports the sources of financing tapped by entrepreneurs in the FBS survey. Figure 1 also relates these sources to financial development, as measured by  $CRE_c$ . It is notable that the entrepreneur's own resources are a significant source of funds in all countries. At the same time, *variation* in this dimension is not clearly related to financial deepening

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<sup>16</sup>Acemoglu and Johnson (2005) use the *de jure* Polity IV indicator of constraints on the executive to measure protection from expropriation by the government. There is insufficient variation in this indicator across the countries in Eurostat to be able to use it in the present study. Hence, the results of the present paper may be interpreted in terms of the impact of finance on the process of creative destruction, conditional on a certain level of protection from expropriation by the government. However, it is worth noting that the values of RULE in the countries studied in this paper cover the top half of values among countries in the Kaufmann et al (2007) dataset (as well as matching the range covered by the top 50% of countries), indicating a wide variety of institutional outcomes.

– see Table 3. This suggests that, in all places, entrepreneurs generally exhaust their own resources and have to seek funds from external sources. On the other hand, all the sources of external funding are positively correlated with financial development (except for venture capital, which in general is hardly used).

Sources of finance	Financial Development					
	CRE	CAP	BANK	MARG	ACCS	SOPH
Own funds	.34	.32	.44	.08	-.01	-.00
Family funds	-.55**	-.66***	-.72***	-.54**	-.77***	-.79***
Collateralized loans	.43	.56**	.28	.48*	.56**	.51*
Non-coll loans	.17	.15	.13	.15	.42	.50*
Venture capital	-.33	-.28	-.39	-.00	-.17	-.17
Other Enterprises	.28	.64**	.28	.34	.52*	.346
Public funds	.26	.34	.48*	.42	.36	.42

Table 3 – Correlations between significant sources of financing for startups and financial development measures. P-values are in brackets.

Source – Eurostat Survey on Factors of Business Success, 2007.

Survey question	Financial Development					
	CRE	CAP	BANK	MARG	ACCS	SOPH
Is loan repayment a priority?	0.67***	0.55**	0.77***	0.81***	0.36	0.49*
Was the firm born to implement innov.?	0.29	0.33	0.65**	0.63**	0.49*	0.52*

Table 4 – Highest priority if earnings increase. P-values are in parentheses. Source – authors calculations and the Eurostat survey on Factors of Business Success, 2007.

Two other sources of external funds are quantitatively important, in that they are widespread and in that variation in the importance of these sources is linked to financial development. These sources are "family assistance" and "bank loans with collateral". The two are significantly negatively correlated with each other (–64 percent, P-value 1 percent). Moreover, the extent to which entrepreneurs rely on family for external funds is negatively related to financial development and, while there are several alternatives for them to seek, the main alternative seems to be bank loans with collateral (Table 3). Thus, financial development

allows entrepreneurs to tap new (formal) sources of external finance that would otherwise have been limited.

Limitations on innovation	Financial Development					
	CRE	CAP	BANK	MARG	ACCS	SOPH
Own funds	-.32	-.36*	.04	.08	-.30	-.30
External funds	-.62***	-.53***	-.48**	-.62***	-.77***	-.60***
Innovation costs	-.55***	-.28	-.29	-.41**	-.59***	-.60***
Qualif. personnel	-.26	-.27	-.01	-.08	-.22	-.19
IT adoption	-.20	-.25	-.16	-.08	-.23	-.21
Market info	-.17	-.16	.00	.13	-.10	-.12
Partners	-.49**	-.43**	-.33	-.32	-.50***	-.46**
Dom. incumb.	-.65***	-.56***	-.24	-.38*	-.53***	-.52***

Table 5 – Correlations between reported significant difficulties in financing innovation among firms and financial development measures. Answers include (1) lack of own funds (2) difficulty of raising external funds (3) high costs of innovation (4) difficulty of finding qualified personnel (5) difficulty of adopting information technology (6) lack of information about market conditions (7) difficulty of finding partners for innovation (8) presence of a dominant incumbent. P-values are in parentheses.

Source – Authors calculations and the Eurostat survey on Factors of Business Success, 2007.

Two further questions on the survey are useful for determining whether financial development is critical for entrants and, in particular, whether it is critical for *innovation* by entrants. One is the answer to the question "Is the highest priority if earnings increase to pay off loans or credit?" The share of startups responding "yes" to this question ranges from 3.1% in Romania to 47.7% in Portugal, and is positively related to the level of financial development – indicating that in financially underdeveloped environments startups may often simply not have access to loans, or that firms tend to enter industries that depend less of external finance (i.e. less R&D intensive industries). Another is the answer to the question "Was the motivation for the start-up to realize an idea for a new product or service?" The share of startups responding "yes" to this question ranges from 15.7% in Romania to 88.2%

in Sweden, and is positively related to financial development. See Table 4.

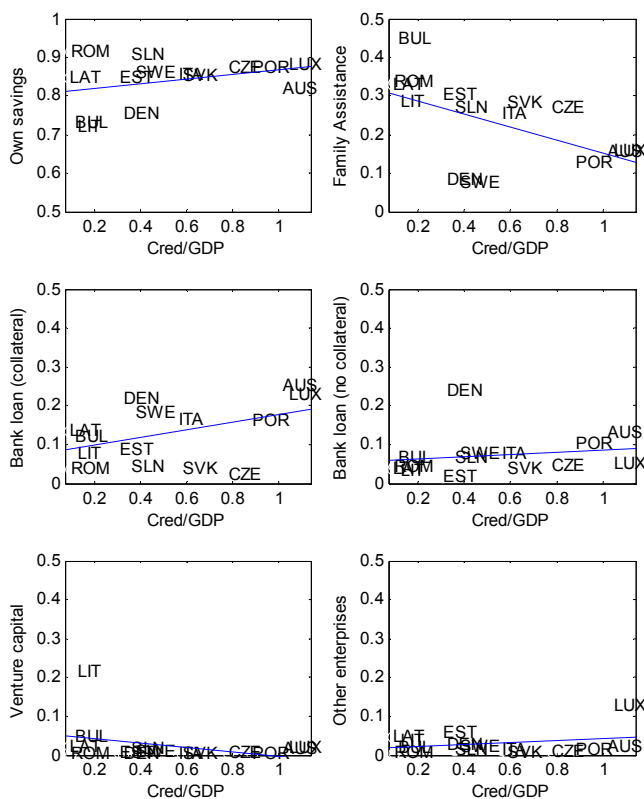


Figure 1 – Significant sources of finance for startups. The y-axis reports the share of startups reporting each factor as a significant source of finance. Responses include (1) own funds (2) family members (3) bank loan with collateral (4) bank loan without collateral (5) venture capital (6) other enterprises. Source – Eurostat survey on Factors of Business Success, 2007.

The CIS Survey asks firms what kind of factors severely hamper innovation. Firms in financially developed economies are much less likely to report the lack of external financing as a difficulty – see Table 5. Tellingly, they also appear less likely to report dominance by "established enterprises" as a factor discouraging innovation, consistent with the idea that financial development stimulates competition by facilitating innovation by entrepreneurs. They also report difficulty finding partners for innovation, suggesting either the unwillingness

of established enterprises to cooperate with competitors or, perhaps, that in underdeveloped financial markets property rights enforcement is weak or disputes are costly, making it hard for firms to trust each other with joint control of an intangible asset – see Gans et al (2002).

This discussion suggests that financial development is important for starting new enterprises, but also for facilitating innovation by new firms. In what follows, we exploit cross-industry variation in observed entry and exit rates, as well as innovation spending, to further substantiate this link.

## 4 Country-industry regressions

### 4.1 Entry, exit and financial development

Table 6 reports our baseline estimates of equation (1). The coefficient on the interaction term between  $RND_i$  and financial development is positive and significant. This is regardless of whether turnover, entry or exit is the dependent variable in the regression. The fact that  $RND_i$  interacts with financial development to generate differences in *both entry and exit rates* indicates that financial development supports entrepreneurial activity, but also that it allocates resources *away* from incumbents – as per the creative destruction hypothesis. The results are also robust to a variety of indicators of financial development.

To get a sense of the magnitude of these coefficients, consider the following example. The country with the lowest financial development (according to the measure  $CRE_c$ ) is Latvia (9.1 percent of GDP), and the highest is Switzerland (177 percent). The coefficients imply that the difference in entry rates between the industries with the highest and lowest R&D intensity in Latvia is about 3.6 percentage points smaller than in Switzerland. Since industry rates of entry vary from 2.6 percent to 16.8 percent, this represents a substantial difference.

Table 6 also reports the results of estimating equation (1) where the dependent variable  $y_{i,c}$  equals innovation spending in industry  $i$ , country  $c$ . Financial development is related not only to increased entry, but also to the increased replacement of incumbents and to

increased spending on innovation. Recalling that the country with the lowest value of  $CRE_c$  is Latvia and that the highest is Switzerland, the coefficients imply that the difference in innovation spending (using  $INNOV_{i,c}^{ADJ}$ ) between the industries with the highest and lowest R&D intensity in Latvia is about 6.1 percentage points smaller than in Switzerland. Since industry R&D intensity varies from 0 to 32.2 percent, this too represents a substantial difference.

$FD_c$	Dependent variable $y_{j,c}$									
	Turnover		Entry		Exit		$Innov^{ADJ}$		$Innov^{RAW}$	
	$\beta_{RND}$	$R^2$	$\beta_{RND}$	$R^2$	$\beta_{RND}$	$R^2$	$\beta_{RND}$	$R^2$	$\beta_{RND}$	$R^2$
CRE	0.33***	.652	0.19**	.640	0.13**	.538	.56***	.602	1.58***	.658
	(.115)		(.095)		(.056)		(0.150)		(.578)	
CAP	0.29**	.652	0.17*	.640	0.12*	.538	.83***	.608	2.13**	.654
	(.125)		(.100)		(.057)		(0.219)		(.760)	
BANK	0.51**	.649	0.31*	.638	0.18*	.535	.52***	.586	1.34**	.636
	(.232)		(.160)		(.103)		(.179)		(.525)	
MARG	0.45***	.651	0.27**	.640	0.17*	.536	.57**	.580	1.31**	.634
	(0.180)		(0.119)		(0.100)		(.248)		(.579)	
ACCS	0.46***	.654	0.30***	.642	0.16***	.539	.63***	.588	1.33***	.639
	(0.129)		(0.091)		(0.061)		(.183)		(.439)	
SOPH	0.44***	.653	0.27***	.641	0.16**	.538	.70***	.603	1.63***	.648
	(0.137)		(0.099)		(0.066)		(.164)		(.492)	

Table 6 – Effect on turnover, entry and exit of the interaction between R&D intensity and financial development, based on estimating equation (1). Country and industry fixed effects are omitted for brevity. Heteroskedasticity-corrected standard errors are reported in brackets. R&D intensity is measured as the ratio of research spending to net sales at the median firm in Compustat ( $RND$ ). Financial development is instrumented using legal origin. Observations for turnover, entry and exit are 869, 916 and 875 respectively.

	Contract enforcement				Property rights		
	INVP	DISC	INFOR		PTNT	COPY	PHYS
ENFOR	0.12 (0.560)	0.08 (0.691)	0.04 (.870)	RULE	0.29 (0.162)	0.65*** (0.000)	0.80*** (0.000)
INVP	-	0.82*** (.000)	0.34 (.104)	PTNT	-	.41** (0.049)	0.24 (0.241)
DISC	-	-	0.15 (.477)	COPY	-	-	0.77*** (0.000)

Table 7 – Cross-country correlations between institutional measures.

P-values are in parentheses. In all tables, one, two and three asterisks represent significance at the 10%, 5% and 1% levels respectively.

## 4.2 Institutional Underpinnings

Correlations among different forms of contract enforcement institutions are all positive but mostly low, suggesting that they capture very different provisions. Only the investor protection and disclosure variables are strongly related to each other. By contrast, property rights measures are mostly very closely related to each other. See Table 7. Among contracting institutions, correlations between contract enforcement measures and financial development suggest the (in)formality of the legal system as a likely suspect behind the effects of financial development, whereas property rights measures are significantly positively related to financial development with the exception of  $PTNT_c$ . See Table 8. Thus, any significant estimates of the interaction term  $\beta_{RND}$  when financial development  $FD_c$  is measured using  $ENFOR_c$ ,  $INVP_c$ ,  $DISC_c$  or  $PTNT_c$  must be through channels other than financial development.

	Contract enforcement				Property rights			
$FD_c$	ENFOR	INVP	DISC	INFOR	RULE	PTNT	COPY	PHYS
CRE	-0.01	-0.13	-0.22	0.45**	0.47**	-0.16	0.62***	0.44**
CAP	-0.03	-0.13	-0.21	0.49***	0.58***	-0.04	0.70***	0.58***
BANK	-0.06	-0.04	-0.30	0.42**	0.35*	0.01	0.60***	0.40**
MARG	-0.07	-0.06	-0.27	0.48**	0.26	-0.12	0.62***	0.58***
ACCS	-0.13	0.33	0.09	0.68***	0.46**	0.05	0.71***	0.88***
SOP	-0.12	0.34*	0.11	0.74***	0.54***	0.12	0.81***	0.87***

Table 8 – Cross-country correlations between institutional indicators and financial development. In all tables, one, two and three asterisks represent significance at the 10%, 5% and 1% levels respectively.

Contracting institutions appear weakly related to either turnover or innovation – with the exception of  $INFOR_c$ , the extent to which the legal system avoids excessive formalism. See Table 9. By contrast, property rights institutions are generally linked to both turnover and innovation – see Table 10. The fact that the only institutional measures that interact significantly with R&D intensity are those that correlate strongly with financial development suggests that a key channel through which these institutions encourage entrepreneurship and innovation is precisely by laying the foundations for financial development.

To see which are the "dominant" institutional measures, we include several interaction terms in the same regression. Suppose that we are interested in comparing the interactions of a set  $K$  of institutional measures. Let  $FD_c^k$  equal the value of institutional measure  $k \in K$ . We estimate

$$y_{i,c} = \alpha_c + \delta_i + \sum_{k \in K} \beta_{RND} RND_i \times FD_c^k + \varepsilon_{i,c}. \quad (3)$$

In this case, a potential concern is that the institutions are measured with different amounts of error, so the winner of a "horse race" among institutions might simply be the variable with the least error. Thus, we report results instrumenting the interaction terms using Legal Origin indicators, following Acemoglu and Johnson (2005). Results are similar without instrumenting, however.

Contract enforcement						
Dependent variable $y_{j,c}$						
$FD_c$	Turnover			$Innov^{ADJ}$		
	$\beta_{RND}$	Obs	$R^2$	$\beta_{RND}$	Obs	$R^2$
ENFOR	.015 (.113)	869	.650	-.105 (.086)	483	.622
INVP	.113 (.147)	831	.655	.241* (.131)	476	.624
DISC	.072 (.119)	831	.655	.113 (.091)	476	.622
INFOR	.351*** (.107)	828	.660	.351*** (.132)	494	.628

Table 9 – Effect on turnover and innovation of the interaction between R&D intensity and indicators of contract enforcement, based on estimating equation (1).

Property rights						
Dependent variable $y_{j,c}$						
$FD_c$	Turnover			$Innov^{ADJ}$		
	$\beta_{RND}$	Obs	$R^2$	$\beta_{RND}$	Obs	$R^2$
RULE	.417*** (.112)	869	.654	.442*** (.118)	519	.614
PTNT	.308* (.160)	746	.674	.086* (.144)	495	.597
COPY	.462*** (.105)	869	.655	.521*** (.111)	519	.618
PHYS	.486*** (.107)	869	.654	.291*** (.097)	519	.603

Table 10 – Effect on turnover and innovation of the interaction between R&D intensity and indicators of property rights, based on estimating equation (1).

	Contract enforcement			Property rights	
	Dependent variable $y_{j,c}$			Dependent variable $y_{j,c}$	
	Turnover	$Innov^{ADJ}$		Turnover	$Innov^{ADJ}$
$FD_c$	$\beta_{RND}$	$\beta_{RND}$	$FD_c$	$\beta_{RND}$	$\beta_{RND}$
ENFOR	.295 (.929)	.723 (.643)	RULE	-.040 (1.69)	.389 (.632)
INVP	-.893 (.598)	-.477 (1.35)	PTNT	.988 (.272)	-.511*** (.178)
DISC	.722 (.594)	-.707 (1.91)	COPY	-.028 (1.90)	.431*** (.128)
INFOR	.817*** (.214)	1.03** (.462)	PHYS	.334 (1.094)	-.064 (.737)
Obs	808	470	Obs	763	517
$R^2$	.660	.443	$R^2$	.676	.611

Table 11 – Effect on turnover and innovation of the interaction between R&D intensity and institutional indicators, based on estimating equation (3). Interactions of R&D intensity with all four measures of contract enforcement (or all four measures of property rights) are included together in the corresponding regression. Interaction variables are instrumented using legal origin dummies.

$FD_c$	Dependent variable $y_{j,c}$				
	Turnover	Entry	Exit	$Innov^{RAW}$	$Innov^{ADJ}$
INFOR	.290 (.194)	.190 (.137)	.108 (.088)	2.02** (.931)	.486*** (.180)
COPY	.362*** (.131)	.222** (.092)	.126** (.052)	-.152 (.684)	.258 (.172)
Obs	828	875	834	516	516
$R^2$	.662	.648	.543	.656	.629

Table 12 – Effect on turnover and innovation of the interaction between R&D intensity and the dominant institutional variables from each category. Results are based on estimating (3), including interactions of INFOR and COPY with R&D intensity. Interaction variables are instrumented using legal origin.

We find that the "dominant" property rights measure is copyright enforcement. When all four property rights interaction variables are included simultaneously in regression (3),  $COPY_c$  is the only one with a significant coefficient – see Table 11. Thus, the strongest factor leading to the expansion of financial markets appears to be the definition and protection of

intangible assets, and the degree of formalism of court proceedings. When we put interactions of R&D intensity with  $COPY_c$  and with  $INFOR_c$  in the same equation (Table 12),  $INFOR_c$  dominates when we look at innovation spending as a dependent variable, whereas  $COPY_c$  dominates when we focus on enterprise turnover.<sup>17</sup> We interpret these results as indicating that the most important factor leading financial development to encourage entrepreneurship and innovation – the creation of new firms and of new products or methods – is the sharp delineation of the intangible assets that define the boundaries of the firm and of its products or methods, and the efficient resolution of disputes about the ownership of these assets when they do occur.

To sum up, entry, exit and innovation are all stimulated by financial development disproportionately in R&D intensive industries. This result appears to be due to country differences in the protection of intellectual property rights, and the efficiency with which disputes are resolved.

### 4.3 Industry growth

A significant motivation behind interest in the link between finance and entrepreneurship/innovation is the possibility that the provision of financial resources to entrepreneurs and innovators may be an important source of economic growth. Thus, it is interesting to see whether any of our results can also be linked to industry growth. This would indicate that it is not merely the *allocation* of resources that are affected by the financial channels explored in this paper, but that these channels may also affect aggregate outcomes.

For this purpose, we estimate:

$$g_{j,c} = \alpha_c + \delta_j + \beta_{RND} RND_j \times FD_c + \varepsilon_{j,c} \quad (4)$$

where  $g_{j,c}$  is the growth rate of industry  $j$  in country  $c$  over the period, as reported in

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<sup>17</sup>These results also hold if we insert an additional interaction of  $RND_j$  and  $CRE_c$  or any other measure of financial development. It is worth noting that  $COPY_c$  unambiguously dominates  $INFOR_c$  if we do not use instrumental variables.

Eurostat. The variable  $g_{j,c}$  is measured as the growth rate of value added in industry  $j$  in country  $c$  over the period of interest.

Out of all measures of financial development, and all institutional measures, we find that only  $COPY_c$  interacts significantly with R&D intensity – the coefficient is 1.05\*\* (s.e. 0.528). Thus, there is evidence that financial development disproportionately encourages growth in R&D intensive industries, and that the main institutional feature underlying this interaction is the protection of property rights concerning intangibles. That growth, entry, exit and innovation spending all behave in the same way, together with the survey evidence, provides strong support for several of the main mechanisms underlying the Schumpeterian view of development and growth.<sup>18</sup>

#### 4.4 Robustness

We have already established that the results are robust to different measures of financial development, different indicators of firm turnover and different indicators of innovation. We perform several other robustness checks. Details are available upon request.

One feature of the data is that research activity is not smoothly distributed across industries. For example, the most research-intensive industry (Chemicals) has a ratio of R&D spending to net sales of 32.2 percent, and the next highest (Computers and Electronic Products) is 13.7 percent. Also, several industries have zero R&D intensity. To ensure that the results are not driven solely by outliers and that the standard errors are robust to skewness, we estimate several variations of the original specification. First, we eliminate Chemicals from the list of industries. Second, we check whether the results hold only for manufacturing, as many of the industries with zero R&D intensity are service sector industries. Third, we estimate the original specification, with bootstrapped standard errors. Fourth, we es-

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<sup>18</sup>I also estimated (4) replacing  $RND$  with  $EFD$ , as in Rajan and Zingales (1998). The interaction of  $EFD$  with the financial development measures in Table 4 was not significant in any case: however, coefficients significant at the 5 percent level were obtained by interacting  $EFD$  with  $INVP$ ,  $INFOR$  and  $COPY$ . I view this as independent confirmation of the Rajan and Zingales (1998) result, using a totally different data set, for a different time period, and extended to look at non-manufacturing industries, but focusing on the institutional determinants of financial development rather than on financial development measures per se.

estimate a "median regression," where *absolute deviations* (rather than squared deviations) are minimized by the estimation procedure, again with bootstrapped standard errors. This approach weights outliers less than "least squares" methods. The results are robust to all of these variations of the original specification.

Aghion, Fally and Scarpetta (2007) find that entry is disproportionately sensitive to financial development in manufacturing industries that are more dependent on external finance, using a different data set. We ask whether their results extend to our data set, and whether the behavior of  $RND_i$  is due to bias stemming from the omission of  $EFD_i$ . It is worth noting that Rajan and Zingales (1998) developed the  $EFD_i$  measure assuming that it was a technologically determined characteristic, but without investigating what the underlying determinants might be. Using the production function as a concept of technology, Ilyina and Samaniego (forthcoming) explore a number of measures of input intensity and find that  $RND_i$  is both highly correlated with  $EFD_i$  and outperforms  $EFD_i$  in industry growth regressions, indicating that R&D intensity is a likely technological characteristic that underpins  $EFD_i$ . Thus, we would expect  $EFD_i$  to behave qualitatively the same as  $RND_i$ , albeit more weakly. Indeed, we find that replacing  $RND_i$  with  $EFD_i$  in (1) yields a statistically significant coefficient, but only if we restrict ourselves to manufacturing industries. This is also true when the dependent variable is innovation spending. When we included interactions of financial development with each of  $EFD_i$  and  $RND_i$  in the regressions, only  $RND_i$  was ever statistically significant and again  $EFD_i$  had the wrong sign. We conclude that financial need alone is not sufficient for entrepreneurs to have problems raising funds: *the need to finance R&D-intensive projects* is critical. This is consistent with Ilyina and Samaniego (2010), who find that R&D intensity and  $EFD_i$  are strongly related at the firm level, and also that R&D intensity is related to measures of the *inability to raise funds* (particularly asymmetric information and asset intangibility indicators, which may affect the firm's ability to raise funds by exacerbating principal-agent problems and by reducing its

ability to use its assets as collateral, respectively).<sup>19</sup>

A possibility is that financial development proxies for an unrelated (but correlated) policy. In particular, Klapper et al (2006) find that the regulation of entry hampers firm creation. For the case of investment-specific technical change, Samaniego (2010) suggests that policies that make entry costly may lead innovations to be introduced by incumbents instead of entrants. If so, an interaction of  $RND_j$  with entry costs might carry a negative coefficient and, if entry costs are negatively correlated with financial development, the significance of  $\beta_{RND}$  may be due to omitted variable bias. Indeed, startup costs as measured by Djankov et al (2002) and updated in World Bank (2006) are negatively related to financial development (although the relationship is only statistically significant for  $ACCS_c$  and  $SOPH_c$ ), indicating that financial development could potentially be proxying for entry costs. To check for bias due to the omission of entry costs, we estimate (1) including interactions of  $RND_j$  with entry costs  $EC_c$  as well as with financial development or institutional variables:

$$y_{j,c} = \alpha_c + \delta_j + \beta_{RND}^{EC} RND_j \times EC_c + \beta_{RND} RND_j \times FD_c + \varepsilon_{j,c} \quad (5)$$

The results in Table 6 are generally robust to the inclusion of the interaction of  $RND_j$  with entry costs. The interaction term  $\beta_{RND}^{EC}$  is negative and often significant as conjectured. However, when we include either of the preferred institutional variables  $INFOR_c$  or  $COPY_c$ ,  $\beta_{RND}^{EC}$  is not statistically significant (this is true with and without instrumental variables). We conclude that our results do not reflect the impact of entry costs as an omitted variable. See Table 13.

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<sup>19</sup>There is a presumption that human capital is required for R&D, and one might wonder if results reflect the impact of low human capital in financially underdeveloped economies. Ilyina and Samaniego (forthcoming) find that industry human capital intensity is not statistically significantly related to R&D intensity and, in fact, the correlation between financial development (as measured by  $CRE_i$ ) and average years of schooling (as reported in Botero et al (2004)) is  $-0.06$  in our sample.

	Dependent variable $y_{j,c}$			
	Turnover		$Innov^{ADJ}$	
$FD_c$	$\beta_{RND}^{EC}$	$\beta_{RND}$	$\beta_{RND}^{EC}$	$\beta_{RND}$
CRE	-.85*** (.292)	.34*** (.133)	-.76** (.346)	.65*** (.199)
INFOR	.20 (.502)	.71** (.287)	.25 (.296)	.78*** (.169)
COPY	-.29 (.299)	.44*** (.121)	-.32 (.288)	.57*** (.135)

Table 13 – Effect on turnover and innovation of the interaction between R&D intensity and entry costs, based on estimating equation (5).

Results from the earlier tables are robust to the inclusion of the interaction of entry costs and R&D intensity. Interaction variables are instrumented using legal origin.

## 5 Concluding Remarks

This paper asks whether there is an impact of financial development upon entry, exit and innovation spending, by asking whether this impact might be different across industries depending on their R&D intensity. Combined with survey data on the difficulties experienced by entrepreneurs attempting to innovate, the results provide direct evidence tying financial markets to entrepreneurial and innovative activity. Moreover, intellectual property rights enforcement seem to play a key role in supporting this function of financial development, possibly by enabling trust between entrepreneurs and their partners – including financiers themselves. The results of this paper suggest that the general equilibrium modeling of the interaction of R&D and finance through IPR enforcement remains a fruitful direction for future research.

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