Financing Creative Destruction

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Abstract

This paper uncovers evidence of a potentially important channel linking financial development to growth: the financing of innovations introduced by entrepreneurs. Using internationally comparable data on European countries, entry and exit in research-intensive industries are found to be disproportionately sensitive to the level of financial development. Furthermore, financial development is related to increased R&D spending. The results are robust to several different measures of financial development, and are supported by surveys of the sources of finance used by entrepreneurs. The evidence suggests that intellectual property rights provide the institutional underpinning for financial markets to direct funds towards innovative entrepreneurs.

JEL Codes: G18, L26, O14, O16, O31, O33, O34.

Keywords : Entry, exit, financial development, creative destruction, R&D intensity, entrepreneurship, intellectual property rights.

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"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

An important motor of economic growth is thought to be the introduction of innovations (new or improved products or processes) by entrepreneurs, fuelled by resources provided to them by financial markets.[1] However, an empirical link between finance, entry and innovative activity has proved elusive. Since the institutions that underpin financial development vary significantly across countries, but only gradually over time, uncovering this link requires internationally comparable data. This paper aims to link financial development to entry and innovation using comprehensive, internationally-comparable data on entry, exit and innovation expenditures, gathered by the European Union.

Key to the empirical strategy in this paper is industry variation. Industry data provide a natural environment in which to search for evidence of a link between financial development and innovative entry. Cohen, Levin and Mowery (1987) and Ilyina and Samaniego (2008) find persistent differences across industries in R&D intensity,[2] and Aghion, Fally and Scarpetta (2007) demonstrate the sensitivity of industry entry rates to measures of financial development. If financial development enables costly innovation by entrepreneurs, we would expect financial *under*development to be related to reductions in entry *primarily in research-intensive industries*. Moreover, if financial markets improve the allocation of resources across firms by directing capital towards innovative entrepreneurs, we would expect to see disproportionate reductions in *exit rates* in such industries as well.

[1] This view is often traced back to Schumpeter (1934) as in the epigraph of this paper. Morales (2003) and Aghion, Howitt and Mayer-Foulkes (2005) develop models of growth through "creative destruction" fuelled by financial markets.

[2] This is not to say that R&D activity does not also vary significantly *within* industries: see Klette and Kortum (2004) for an extensive analysis.

The paper measures research intensity using data on publicly traded firms in the United States. In normal times, a typical such firm arguably does not experience significant financial constraints on its ability to finance profitable projects, so its propensity to conduct research should be representative of the technological opportunities for research open to firms in the industry. Industry variation in rates of entry and exit across European countries can then be exploited to identify whether financial development stimulates entrepreneurship and innovative activity particularly in industries that have a greater propensity to conduct research. Also, using comprehensive survey data from the European Union, I examine whether financial development is related to difficulty in raising external funds for entry and innovation. The data are based on the universe of legal firms and (unlike most previous studies of firm demographics[3]) cover both manufacturing and non-manufacturing industries.

I find that, in countries with greater financial development, rates of entry are higher in industries with greater research-intensity, supporting the hypothesis of a link between finance, innovation and entrepreneurship. Moreover, the rate of *exit* is also disproportionately higher in such industries. Thus, the availability of finance increases competitive pressure on incumbents, and this occurs *mainly in research-intensive industries*. These findings are consistent with the notion that the entry of new firms and the displacement of incumbents together form part of a process of "creative destruction," and that the availability of finance plays a critical role in enabling that process. The results are robust to different measures of financial development, including measures of financial deepening, measures of the efficiency of financial markets, and survey-based measures of the availability and sophistication of financial markets.

The paper also finds that financial development disproportionately affects *spending on innovation* in research-intensive industries, so that innovative (as well as entrepreneurial) activity is hampered by financial underdevelopment. Thus, financial development does not merely *reallocate* innovative activity between entrants and incumbents. Indeed, in a com-

[3]Exceptions include Brandt (2004) and Samaniego (2010), who also use Eurostat entry and exit data but do not look at innovation nor startup survey data.

prehensive survey of startups across Europe, I find that financial development is negatively related to the share of firms that report difficulty in raising external funds as a significant obstacle to innovation.

The importance of financing constraints for research activity raises questions about the role of intellectual property rights (IPRs) in supporting financial development. The output of R&D is generally thought of as being non-rival and (in the absence of IPRs) non-excludable – see Romer (1990). As a result IPRs are thought to be among the institutions that underpin financial development, since an entrepreneur with a protected idea is less likely to lose the rights to the project through imitation by firms who do not incur the full R&D cost. See Claessens and Laeven (2003) and Biasi and Perotti (2008). Thus, the ability to own (and voluntarily transfer) ideas may make it easier for entrepreneurs to raise external funds in the first place. We explore whether IPRs underpin financial development by using measures of IPR protection, including interactions of IPRs with R&D intensity in the industry regressions. We find that an interaction of R&D intensity and IPR protection outperforms the interaction of R&D intensity and financial development. This could explain why R&D intensive industries are not necessarily industries with high rates of entry and exit in financially developed economies: to the extent that these are also economies with strong IPRs, the inventor and the developer need not be the same person as the idea could be easily transferred to whoever is most capable (financially or otherwise) of realizing the idea, as suggested by Cagetti and De Nardi (2006). 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.

An early debate on the economic role of entrepreneurs can be traced back to Knight and Schumpeter – see Evans and Jovanovic (1989) for a discussion. Knight (1921) viewed entrepreneurs as being self-financed, perhaps assuming committment or asymmetric information problems inherent to financial transactions. On the other hand, Schumpeter believed that the banking sector would adequately channel funds from those who had them towards

entrepreneurs who might lack them. An interpretation of the results of this paper is that the Schumpeterian view is more appropriate for financially developed environments,[4] whereas the Knightian view is adequate for financially underdeveloped environments. Moreover, variation in financial development appears linked to variation in IPR protection.

The paper fits between an extensive literature on financial development and the literature on the determinants of entry and exit. Numerous studies including King and Levine (1993), Rajan and Zingales (1998) and Bekaert, Harvey and Lundblad (2005) 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. However, 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) on the financing of innovation devotes a section to innovation at startups, but neither discusses entry and exit rates themselves, and neither looks at industry differences.

Brown, Fazzari and Petersen (2009) study the 1990s R&D boom for evidence of a causal link from finance to R&D spending, finding a significant influence of the availability of equity finance and cash flow on R&D at young (but not at mature) firms. In the current paper, the use of a country-industry panel (instead of a time-firm panel) provides strong confirmation of their results, as well as allowing us to focus specifically on the entry (and exit) of firms. Claessens and Laeven (2003) find that property rights (including intellectual property rights) appear to be an important institutional underpinning for financial development, enhancing growth through improvements in resource allocation. The present paper finds evidence for

[4]Hurst and Lusardi (2004) also 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."

one channel through which this might occur: the replacement of incumbents by innovative entrants.

A closely related paper is Aghion, Fally and Scarpetta (2007), who ask whether entry is especially sensitive to financial development in industries where firms are more dependent on external finance. We find that external finance dependence and research intensity are positively linked, and show that similar results for finance dependence can be derived as for R&D intensity: however, the results concerning R&D intensity are more robust in a variety of ways, consistent with the proposition in Hall (2005) and Ilyina and Samaniego (2008, 2009) that finance dependence results in part from the need to raise funds for research, and that R&D intensive industries not only have a greater need for external finance but also a lower ability to raise it in a financially underdeveloped environment.

Klapper et al (2006) argue that the regulation of entry suppresses entry. I also show that these results are not simply due to a negative correlation between financial development and institutional entry costs – although, interestingly, entry costs have similar impact as financial underdevelopment. This could be because, for a given level of financial development (ability to raise funds), high entry costs raise the *need* for entrepreneurs to raise funds initially. Nonetheless, the impact of entry costs disappears once we condition for intellectual property rights.

Section 2 discusses the data to be 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 the results concerning financial development and industry entry, exit and innovation spending. Section 5 concludes by discussing the link between these findings and theories of innovation and IPR enforcement.

2 Data

2.1 Data on Industry-country pairs

2.1.1 Entry and exit

Rates of entry, exit and turnover are drawn from the Eurostat Business Demography database, 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 the member countries of the European Union concerning the universe of "enterprises" in the business register, following a common methodology.[5] Thus, 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.

We study the same 41 industries as Samaniego (2010).[6] This includes 15 manufacturing industries and 26 non-manufacturing industries. Thus, the results of this paper provide a comprehensive view of the impact of financial institutions on entrepreneurship and innovation across the economy. Most other studies of entry or innovation focus on manufacturing (e.g.

[5] An "enterprise" 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. The included countries are all those that reported to Eurostat at the time of the study: participation in the data collection exercise was not mandatory so that, for example, some countries report entry data but not innovation data.

[6] 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 does not look at financing nor innovation data.

Dunne, Roberts and Samuelson (1988) and Aghion, Fally and Scarpetta (2007)), which accounts for less than half of employment and GDP in most countries.

For industry j in country c, the variable $Entry_{j,c}$ is the proportion of enterprises active at a given date t that entered since date $t-1$, and the variable $Exit_{j,c}$ is the number of enterprises that closed between $t-1$ and t, divided by the number of establishments active at date t. The variable $Turnover_{j,c}$ 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 and from possible delays in the reporting of entry and exit.[7] Since the concept of creative destruction is related to both entry and exit, for much of the paper we will focus on the variable $Turnover_{j,c}$, but also check that results are robust to considering $Entry_{j,c}$ and $Exit_{j,c}$ 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. For example, if $y_{j,c}$ is entry in industry j in country c, we estimate:

$$y_{j,c} = \alpha_c + \delta_j + \varepsilon_{j,c} \tag{1}$$

where α_c and δ_j are country and industry dummy variables. The index of entry for industry j is then the coefficient δ_j, added to the coefficient α_c for the median country. See Tables 1 and 2 for summary statistics at the country and industry level.

2.1.2 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

[7] In practice these are likely to be short: for example, in the UK enterprises are removed from the business register three months after the register is notified of their closure.) Individual country registration rules may be found at: http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/Annexes/sbs_base_an2.htm

Eurostat.[8] The survey reports expenditure on innovation as a share of net sales over the period. 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."

The sampling population included 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. The survey covers a sample of 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.

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

[8] Eurostat suggests that the sampling methodology of earlier surveys may not have been uniform across countries.

2.1.3 Industry growth

Eurostat also reports value-added growth $g_{j,c}$ for each industry-country pair. This is the meaure 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 $1997 - 2006$.

2.2 Survey data

I 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. While survey results are not available at the industry level, they are useful for painting an overall picture of the link between finance and innovative activity at startups. 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.

2.3 Data on Industry Characteristics

2.3.1 Research intensity

In what follows, R&D intensity will be regarded as an industry characteristic. This is in line with Cohen et al (1987), who find that industry dummies account for over half of the variation in research intensity across firms in their sample, and Ilyina and Samaniego (2008) who find that the industry ranking by R&D intensity is stable across decades.

We require an indicator of the "technological" aspect of research intensity in an industry. The ideal indicator should not be contaminated by, in particular, 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 (2008). 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.

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). This is as in Carlin and Meyer (2003). For each firm, I add the numerator and the denominator over the years 1997-2006. The industry measure is the median firm value, which we call RND_j.[9]

Table 2 reports that the distribution of RND_j is quite skewed. As a result, in the multivariate regressions that follow we correct all standard errors for heteroskedasticity by industry (and country), and later check the robustness of results by bootstrapping, among other methods.

2.3.2 External finance dependence

External finance dependence (EFD_j) 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 EFD_j measures. The industry-level measure is the EFD of the median firm.

Tables 1 and 2 report the overall pattern of entry and exit rates across countries and industries. 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 industry averages observations it is 4.4 percent. Thus there is roughly as much variation across countries as there is across industries.

[9] 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.

Table 3 reports that entry, exit and turnover are very highly correlated across industries, as known since Dunne, Roberts and Samuelson (1988) reported this finding for Manufacturing. On the other hand, the correlation between RND_j and turnover is negligible. Thus, R&D intensity does not appear related to entry and exit rates per se. This 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 3 shows that EFD_j is very highly correlated with RND_j (although not with turnover). Thus, to avoid omitted variable bias, we estimate our regressions below replacing RND_j with EFD_j. If results are stronger for EFD_j than for RND_j, this indicates that it is the need for finance (regardless of the purpose) that interacts with financial development. If results are stronger for RND_j than for EFD_j, this indicates that it is specifically (or primarily) problems that arise in the financing of R&D that interact with financial development.[10]

TABLES $1-4$ ABOUT HERE

2.4 Data on Countries

2.4.1 Financial Development

According to Levine (2005), financial institutions arise to ameliorate market frictions, lowering transaction costs and generating or distributing information. The functions of financial institutions are to produce information, allocate capital, monitor investments, allocate risk, pool savings and ease the exchange of goods and services. As a result, financial institutions naturally affect the allocation of resources across activities and macroeconomic outcomes. *Financial development* is defined as an amelioration (although not necessarily elimination) of the effects of information, enforcement and transactions costs, provided by financial in-

[10] 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. Thus, omitted variable bias from ISTC should not be a concern.

struments, markets and intermediaries.

Building on this definition, I employ six different **measures of financial development**. Using six different measures of financial development, measured in very different ways, adds considerable robustness to the results. All of the measures are positively correlated with each other – see Table 4.

The prototypical measure of financial development is financial deepening, which is used in King and Levine (1993) and Rajan and Zingales (1998), among others. Deepening is thought of as indicating development because a larger financial sector indicates a larger number of transactions that are more efficiently dealt with by financial institutions than by dealing directly with the "untreated" transaction costs (or simply avoided).

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 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.

1. CRE_c: Our benchmark measure uses the domestic *private credit-to-GDP ratio*. The presumption is that financial deepening is the outcome of financial development, as in King and Levine (1993). 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 I also use the domestic *capitalization-to-GDP ratio*, the sum of domestic market capitalization and private credit. Although CAP is broader than CRE, 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. Market capitalization is reported in 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.

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* is also an inverse indicator of financial development. The presumption is that high margins reflect high costs of operation, or an uncompetitive banking sector. We draw it from the same source as $BANK_c$, and also multiply it by minus one.

5. $ACCS_c$: We also use some survey-based measures. 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?" 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)."

3 Preliminary evidence: Survey results

To motivate the more detailed industry-level analysis in Section 4, we begin by examining the results of Europe-wide surveys of startups and of innovators. This is to examine broad evidence of financing constraints facing entrepreneurs and 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 some 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 the private credit/GDP ratio (CRE), a conventional measure of financial development. 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. This suggests that, in all places, entrepreneurs generally exhaust their own resources and have to seek funds from external sources. Interestingly, while some authors ascribe a central role to venture capital in entrepreneurial activity in certain industries (for example Hellmann and Puri (2000)), according to the FBS survey venture capital is not in general a significant source of funds for new firms.

Two sources of external funds are quantitatively important, both because they are widespread and because 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 5). Thus, financial development allows entrepreneurs to tap new (formal) sources of external finance that would otherwise be limited.

TABLES $5-7$, FIGURES $1-2$ ABOUT HERE

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 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 (such as less R&D intensive industries). Another is the answer to the question "Was the motivation for the start-up to realize an idea for an new product or service?" The share of startups responding "yes" to this question is positively related to financial development – in spite of the possibility of selection effects. See Table 6.

The CIS Survey asks firms what kind of factors severely hamper innovation. Financially developed economies appear much less likely to report the lack of external financing as a difficulty – see Figure 2 and Table 7. 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, making it hard for firms to trust each other with joint control of an intangible asset – see Gans et al (2002). Biais and Perotti (2008) develop a theory whereby successful entepreneurship requires evaulation of the entrepreneur's "idea" by several other agents (including financiers), each of whom may try to steal the idea, and their model is consistent with this finding.

This discussion suggests that financial development is important for financing new enterprises, but also for facilitating innovation, particularly at 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 results

4.1 Entry, exit and financial development

We wish to ask whether, in financially underdeveloped economies, creative destruction is suppressed particularly in industries that are research-intensive. To test for this pattern, I adopt the differences-in-differences approach pioneered by Rajan and Zingales (1998). Let $y_{j,c}$ be the dependent variable for industry j 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 α_c and δ_j denote country and industry indicator variables, respectively. RND_j measures R&D intensity in industry j, and FD_c measures financial development in country c. I estimate the equation:

$$y_{j,c} = \alpha_c + \delta_j + \beta_{RND} RND_j \times FD_c + \varepsilon_{j,c} \tag{2}$$

In specification (2), 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. The impact of financial development on entry (or more broadly on any country-industry outcome variable $y_{j,c}$) is then identified by asking whether entry $y_{j,c}$ is particularly susceptible to financial development in industries depending on their value of RND_j. In other words, we seek evidence that financial development affects entry, exit or innovation by asking whether there is a significant interaction between RND_j and FD_c.

Suppose that $y_{j,c}$ is the rate of entry in industry j, country c. If financial development encourages entrepreneurial activity primarily in industries where RND_j is high, then we would expect the coefficient β_{RND} on the interaction term between RND_j and FD_c to be *positive*. By controlling for industry and country fixed effects, this should be the case regardless of other country- or industry-specific factors that might affect rates of entry. 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 $\varepsilon_{j,c}$ to vary by country and by industry (as well as by $RND_j \times FD_c$).

A potential concern is endogeneity: if there is a lot of entry, it may be that this encourages greater use of external credit, which is how we measure FD_c. We handle this possibility in several ways. First, we use a variety of measures of financial development FD_c, including several that 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 advantage of the Rajan and Zingales (1998) differences-in-differences approach: all country-specific factors affecting entry are captured by the country indicator α_c, and identification depends only on *industry differences* in rates of entry across countries. Third, we estimate equation (2) using instrumental variables. We use the standard set of instruments for financial development, which is 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.[11] 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.[12]

The maintained assumption for regression (2) is that R&D intensity is an industry char-

[11] We use the standard two-stage procedure, where in the first stage, we regress all exogenous variables (including the instruments) on the interaction of R&D intensity and financial development, and then use the predicted values from the first stage to estimate regression equation specification (2) in the second stage. The first stage requires using the interactions of legal origin with industry measures as instruments to predict the interaction term. Using the instruments to predict values of financial development, and then interacting the predicted values of financial development with the industry variables in the second stage, does not yield a consistent estimator. See Wooldridge (2002) p236 for a related discussion. It is worth noting that results are similar without instrumental variables, except that coefficients tend to be smaller.

[12] There is also a question as to whether R&D intensity might be determined by rates of entry (reverse causality). The literature surveyed in Geroski (1989), Cohen and Levin (1989) and Ngai and Samaniego (2009) argues against this, in that industry differences in R&D intensity appear largely driven by technological differences that are exogenous to the process of entry and exit. For example, Nelson and Winter (1977) coin the term "natural trajectories" to describe the phenomenon that "advances seem to follow advances in a way that appears somewhat 'inevitable' and certainly not fine tuned to the changing demand and cost conditions." Consistent with this literature, the correlation between entry and R&D intensity is essentially zero.

acteristic the ranking of which persists across countries. For example, if in the United States firms in Chemicals are more R&D intensive than firms in Textiles, our assumption is that the same holds true in, say, Spain or Estonia. Cohen et al (1987) find that industry dummies account for about half of the variation in R&D intensity across firms in their sample, and Ilyina and Samaniego (2008) find that R&D intensity in manufacturing is stable across countries when comparing different decades, suggesting that this is a reasonable assumption.

The coefficient on the interaction term between RND_j and financial development is positive and significant – see Table 8. This is regardless of whether turnover, entry or exit is the dependent variable in the regression. The fact that RND_j 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. The weakest results are those concerning the dependent variable $Exit_{j,c}$.

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 8 also reports the results of estimating equation (2) where the dependent variable $y_{j,c}$ equals innovation spending in industry j, country c. These results are strong, particularly for the indicator that is adjusted by the share of innovating enterprises. Thus, financial development is related not only to increased entry, but also to the increased replacement of incumbents and to increased spending on innovation. Revalling that the country with the lowest financial development is Latvia and that the highest is Switzerland, the coefficients imply that the difference in innovation spending (using $INNOV_{j,c}^{ADJ}$) between the indus-

tries 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 represents a substantial difference.

TABLE 8 ABOUT HERE

4.2 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.

As mentioned earlier, Aghion, Fally and Scarpetta (2007) find that entry is disproportionately sensitive to financial development in industries that are more dependent on external finance. They use a different data set, that only covers manufacturing and which does not have data for exit nor innovation. We ask whether their results extend to our data set, and whether the behavior of RND_j is due to bias due to the omission of EFD_c. Since EFD_j and RND_j are positively related, we estimate

$$y_{j,c} = \alpha_c + \delta_j + \beta_{EFD} EFD_j \times FD_c + \varepsilon_{j,c} \tag{3}$$

and check whether the results can be replicated using EFD_j instead of RND_j.

Results are as follows – see Table 9. First, when we use the full sample that includes both manufacturing and non-manufacturing, the coefficient β_{EFD} in equation (3) is not significant. Second, if we restrict ourselves to only look at manufacturing industries as in Aghion, Fally and Scarpetta (2007), we confirm their finding that entry in highly finance-dependent manufacturing industries appears sensitive to financial development. Financial development also has a significant impact on innovation spending in high-EFD industries. However, coefficients are all smaller than those for RND_j reported in Table 8 and, as noted, results are not significant in the full sample of industries. We interpret these results as

indicating that financial need alone is not sufficient for entrepreneurs to have problems raising funds: *financial need to finance R&D-intensive projects* is critical. This is consistent with Ilyina and Samaniego (2009), who find that R&D intensity and EFD_j 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 their ability to use their assets as collateral, respectively).

One feature of research intensity at the industry level 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, I estimate several variations of the original specification. First, I eliminate Chemicals from the list of industries. Second, I check whether the results hold only for manufacturing, as many of the industries with zero R&D intensity are service sector industries. Third, I estimate the original specification, with bootstrapped standard errors. Fourth, I 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. Table 10 shows that the results are generally robust to all of these variations of the original specification. To conclude, a number of standard indicators of financial development interact positively with industry research intensity, leading to disproportionate increases in entry, exit and innovative activity in such industries.

TABLES 9 – 11 ABOUT HERE

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 β_{RND} may be misleading. Indeed, startup costs as measured 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 the following:

$$y_{j,c} = \alpha_c + \delta_j + \beta^{EC}_{RND} RND_j \times EC_c + \beta_{RND} RND_j \times FD_c + \varepsilon_{j,c} \tag{4}$$

Here, as before, $y_{j,c}$ is a measure of turnover or innovative activity in industry j in country c. EC_c is a measure of entry costs, and FD_c is a measure of financial development. There is a concern regarding measurement error in the policy variables FD_c and EC_c, so that the variable with the strongest interaction might simply be the one that is better measured: we account for this by instrumenting for both policy variables using legal origin, as described earlier.

Results are reported in Table 11. Interestingly, the interaction with entry costs is indeed negative (as expected)[13] and significant at the 10 percent level or better. This suggests that entry costs can have an independent impact on turnover in R&D intensive industries, which would be interesting to explore further in future work. Still, the interaction of financial development retains its significance, most clearly when innovation spending is the dependent variable. Thus, both financial development and entry costs affect the turnover dimension of creative destruction. This suggests that the interaction of financial development with R&D intensity is robust to several checks, but that it is best to condition on entry costs. Indeed,

[13]Results are not due to collinearity, as we would expect β^{EC}_{RND} and β_{RND} to have opposite signs: if results were solely due to collinearity then they would have the same sign.

the two could be related, since higher entry costs (in the form of direct costs or delays) could increase the startup cost and hence the financial need of the entrepreneur.

4.3 Property rights and creative destruction

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). In particular, the importance of financial development for R&D intensive industries raises the question of whether *intellectual property rights* might be important for the creative destruction effects identified above.

Property rights institutions determine the extent to which entrepreneurs can control the use and transfer of the firm's physical or intangible assets. They may underpin financial development because agents may use productive assets as collateral, provided they can credibly transfer those assets in the event of default. See Kiyotaki and Moore (1997) and Claessens and Laeven (2003) for further discussion. 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 investor. An investment project is more valuable, and more able to raise external funds towards its realization, when the intangibles that delimit the project (the business plan, the product, the brand name, etc.) are less likely to be stolen or copied by competitors. Also, they might enable the voluntary transfer of the intangible asset so it too might be used as collateral. As a result, indicators of IPR protection might be expected to behave similarly to financial development measures in equation 2

We study the following IPR protection indicators:

1. $PTNT_c$: 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).

2. $COPY_c$: 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).

Table 12 displays the correlations between the IPR protection indicators and measures of financial development. $COPY_c$ and $PTNT_c$ are significantly positively correlated. However, $COPY_c$ is also strongly correlated with the financial development measures, whereas $PTNT_c$ is much less so. This suggests that "soft" IPR protection is more likely to underpin financial development than is the protection of more scientific IPRs. This may be intuitive, considering that patents are much more likely to protect intellectual property in some industries (e.g. Chemicals) than in others (e.g. Restaurants), whereas copyright enforcement protects intangibles across the board.

We estimate the following equation:

$$y_{j,c} = \alpha_c + \delta_j + \beta_{RND}^{IPR} RND_j \times IPR_c + \beta_{RND} RND_j \times FD_c + \varepsilon_{j,c} \tag{5}$$

Here, as before, $y_{j,c}$ is a measure of turnover or innovative activity in industry j in country c. IPR_c is a measure of IPR protection, and FD_c is the credit-to-GDP ratio. We first ask whether there is evidence that IPRs might in fact underpin financial development. We estimate (5) using instrumental variables, which is important since IPR_c and FD_c are possibly subject to measurement error. The instrumental variables procedure guarantees consistency provided the legal origin variables are an adequate instrument for these instututions. We use the credit-to-GDP ratio as a measure of FD_c: however, results are similar using other measures of FD_c.

Results are reported in Table 13, assuming that the coefficient on the financial develop-

ment interaction β_{RND} is zero. Results allowing $\beta_{RND} \neq 0$ are also reported in Table 13. We find that an interaction of R&D intensity and IPR strength behaves much the same as the interaction of R&D intensity and financial development, although this depends on the measure of IPRs used. We find that both $PTNT_c$ and $COPY_c$ behave much the same way as financial development when $\beta_{RND} = 0$ and the dependent variable is firm turnover. Moreover, when we allow $\beta_{RND} \neq 0$, the estimate for β_{RND} is not statistically significant. This supports the hypothesis that property rights underpin financial development – in particular, that they help to direct financing towards entrepreneurs in research-intensive industries.

However, when the dependent variable in (5) is innovation spending, we find that the same holds only for $COPY_c$. In other words it appears that, when it comes to encouraging innovation spending, "soft" intellectual property rights are more important than IPRs related to patenting. This could reflect the fact that patenting activity is typically concentrated in certain industries, whereas the IPRs covered by copyright law affect all types of products and services. Alternatively, it could simply be that there is not as much cross-country variation in patent enforcement as in "soft" IPR enforcement.[14] Notably, when we include an interaction of R&D intensity with entry costs along with the interaction $RND_j \times IPR_c$, the entry cost interaction is no longer significant even when the dependent variable $y_{j,c}$ is industry turnover when we use $COPY_c$ as an indicator of IPR protection.

TABLES 12 – 14 ABOUT HERE

As a matter of robustness, we check whether this relationship survives the inclusion of an interaction between RND_j and entry costs. Table 14 reports that the significance of the IPR interactions is maintained and, moreover, that entry cost interactions are no longer significant in any of the regressions in which they are matched up against an interaction of

[14] This finding could explain why R&D intensive industries are not necessarily industries with high rates of entry and exit in financially developed economies: to the extent that these are also economies with strong IPRs, the inventor and the developer need not be the same person, as suggested by Cagetti and De Nardi (2006).

RND_j and $COPY_c$ (again, results are instrumented using legal origin variables, to correct for possible measurement error).

Finally, we have seen that financial development, and IPR protection, appear to encourage both more turnover and more innovation spending particularly in R&D intensive industries. However, it is worth asking whether there are any signs that this has an impact on "real" outcomes. Rajan and Zingales (1998) find that high-EFD manufacturing industries grow disproportionately faster in financially developed economies, and Ilyina and Samaniego (2008) find that the same is the case for R&D-intensive industries. This suggests that the considerations in this paper may have an impact on economic growth. Eurostat also reports the growth in value added for each country-industry pair, and we ask whether this is the case by estimating equation (2) with *industry growth* as the dependent variable $y_{j,c}$ (as in Rajan and Zingales (1998) and Ilyina and Samaniego (2008)). We did not find a significant interaction for the measures of financial development, nor for $PTNT_c$, although all interaction coefficients were positive. However, when $COPY_c$ was used as a measure of financial development, there was a statistically significant interaction of 1.01^{**} (s.d. 0.143).

Thus, to sum up the results of the paper, the data indicate that IPR protection promotes growth by enabling entrepreneurs to raise the funds necessary to implement innovations.

5 Concluding Remarks

This paper asks whether there is an impact of financial development upon entry, exit and innovation spending, and whether this impact might be different across industries depending on their intrinsic 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, they suggest that intellectual property rights enforcement plays a key role in supporting this function of financial development, possibly by enabling trust between entrepreneurs and their partners – including

financiers themselves.

Note that it need not be that entrepreneurs in the least financially developed economies are creating new-to-the-world innovations.[15] 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. Thus, the results indicate that IPR protection encourages the financing of R&D to implement innovations regardless of whether they are new-to-the-world or whether they are developed elsewhere.

We conclude with a brief discussion of these results in light of theoretical work on intellectual property rights (IPRs).

Anton and Yao (1994, 2005) present several papers on the subject of appropriating rents in environments with weak IPRs. Anton and Yao (1994) discuss a model in which the developer of an innovation knows more about its quality than potential buyers: this asymmetric information problem could be surmounted by revealing the idea to the buyer, but in the absence of IPRs the buyer could then implement the idea without paying: information revelation leads to expropriation. They find that even in the absence of IPRs the seller can appropriate some of the rents from the innovation by credibly threatening to create a duopoly, e.g. by threatening to sell the idea to another potential buyer. Anton and Yao (2005) extend this model by allowing the seller to separately reveal a "portion" β of their idea, over which they have tightly defined intellectual property rights. They show that a sequential game in which portion β is revealed first and the remainder is then auctioned is better for the developer than the strategy of selling the entire idea at once. Moreover – although the authors did not emphasize this – the payoff to the developer is increasing in β. If we interpret β as being determined by IPR protection, and if we view the seller as an entrant who might sell the rights to the idea as a way of raising funds to implement it,[16]

[15] 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.

[16] This is especially relevant if we interpret the "sale" as the terms of a partnership.

then we see that more funds can be raised (and appropriated) by an innovative entrant in the presence of strong IPR protection. One way to think of the interaction of R&D and finance in the Anton and Yao (2005) context is to consider that R&D intensive industries produce (and disproportionately rely on) intangible assets,[17] which are more easily expropriated than tangible assets. Thus, a larger β might disproportionately help technology transfer in research intensive industries.

Another useful model for understanding our results is proposed by Biasi and Perotti (2008). In their model, entrepreneurs require the evaluation of different dimensions of their projects by "experts".[18] Evaluation requires revealing the idea to the expert, which raises a risk of intellectual property theft as in Anton and Yao (1994). While the identity of the experts is not important for their model, at least two dimensions along which many projects need to be evaluated are (a) the scientific or engineering soundness of the underlying innovation and (b) the financial viability of the project. Nanda (2008) finds evidence that externally financed projects tend to be more profitable than internally financed projects, indicating that financiers could themselves be considered a type of "expert" whose financial know-how is critical to evaluating the viability of an innovation. Thus, for simplicity we can think of two dimensions along which the entrepreneur requires signals as "science" and "finance."

The key is that projects may not be realized in equilibrium because the experts face a strong temptation to steal the idea – something we could think of as "weak IPR protection." If R&D intensive industries are those in which expert evaluation is the most critical (for example, they are those in which projects depend critically on a "science" signal), then a prediction of the Biasi and Perotti (2008) model is that entry would be suppressed by weak IPR protection – as found in this paper. A consequence of weak IPR protection would be a lack of externally financed projects, and hence less measured credit, leading standard

[17] See Hall (2005) and Ilyina and Samaniego (2008, 2009).

[18] This is consistent with the evidence in Lazear (2004, 2005) that entrepreneurs are mostly generalists rather than specialists.

measures of financial development such as the credit-to-GDP ratio or market capitalization dividied by GDP to ultimately proxy for IPR protection.

Ueda (2004) has a similar model in which the entrepreneur's problem is whether to finance through a venture capitalist or a bank. Only the entrepreneur knows the quality of the project, and the venture capitalist has a better ability to evaluate the project than the bank. Thus, contracting with venture capitalists is more efficient. The problem is that the venture capitalist may expropriate the idea and implement it herself (or at another firm managed by the venture capitalist). Ueda (2004) shows that this becomes harder if IPR enforcement is better, so that more projects are handled by the venture capitalist. If it is easier to expropriate the idea in more R&D-intensive industries, and if this ability is sensitive to IPR enforcement, then IPRs may enable the more efficient handling of ideas (and, in a general equilibrium world, may encourage their creation).

Finally, Frantzeskakis and Ueda (2007) develop a model which distinguishes explicitly between incumbents and entrants. They develop a model with a transaction cost for transferring knowlege, which we could think of as costs imposed by an inefficient IPR protection regime. Entrants develop ideas and then find out whether they can successfully implement them or not – which also becomes a signal about their future prospects. Thus, entry is a form of experimentation, whereas established firms already know which ideas they are capable of implementing, and they can thus buy the ideas of entrants who are less suited for implementation. They find that with low transaction costs in the market for intellectual property, incumbents innovate less relative to entrants but introduce (i.e. purchase) more innovations relative to entrants – because the cost of passing the idea from an unsuccessful entrant to an incumbent is lower (as suggested by Cagetti and De Nardi (2005)). In an environment of strong IPRs, in which it is less costly to transact intellectual property, entrants are both more able to introduce innovations themselves, and also more able to enter and sell innovations to pre-existing firms. This is consistent with the finding in Section 3 that in less financially developed economies entrepreneurs are more likely to report the dominance of an

incumbent as an obstacle to innovation – the same applies to the ease of finding partners for innovation. Again, to the extent that IPR protection encourages entry (and the R&D required for entry), we would expect greater financial deepening in such an economy.

The surveyed papers are developed in partial equilibrium. In particular, they are generally models of entry which abstract from exit – which is both essential to general equilibrium and to the creative destruction concept. Aghion and Howitt (1992) develop a model of growth through entry by innovators, and Aghion et al (2005) extend the model to incorporate credit constraints. In turn, Ilyina and Samaniego (2009) extend their framework to a multi-industry context. However, these two models are geared towards generating predictions for growth, and have no predictions for entry and exit – nor do they have an explicit notion of intellectual property rights. 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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Country	Turnover	Entry	Exit	Innov^{RAW}	Innov^{ADJ}
Belgium	14.5	7.0	7.5	2.7	1.4
Bulgaria	19.8	10.4	9.4	2.1	0.3
Czech Rep.	18.1	9.3	8.8	3.5	1.3
Denmark	15.0	7.7	7.3	3.5	1.8
Germany	-	-	-	3.3	2.1
Estonia	19.1	10.5	8.6	2.4	1.2
Ireland	-	-	-	2.4	1.5
Greece	-	-	-	6.2	2.2
Spain	14.6	8.6	6.0	1.5	0.5
France	12.8	7.2	5.6	3.3	1.1
Italy	14.0	7.6	6.4	2.8	1.0
Cyprus	-	4.1	-	4.0	1.8
Latvia	21.6	13.6	8.0	-	-
Lithuania	20.0	11.9	8.1	2.5	0.7
Luxembourg	16.4	9.6	6.8	2.2	1.1
Hungary	18.2	10.0	8.2	2.3	0.5
Malta	-	-	-	1.7	0.4
Netherl.	16.2	8.4	8.2	2.0	0.7
Poland	-	-	-	2.6	0.7
Portugal	15.3	8.8	6.5	2.1	0.9
Romania	25.3	16.9	8.4	3.4	0.7
Slovenia	13.5	8.0	5.5	-	-
Slovakia	17.4	9.5	7.9	3.2	0.7
Finland	13.1	7.0	6.1	-	-
Sweden	10.9	6.0	4.9	4.7	2.4
UK	21.6	11.1	9.5	-	-
Norway	18.4	10.6	7.8	1.8	0.7
Switzerland	7.3	3.5	3.8	-	-

Table 1 – Summary statistics: Average annual rates of turnover across countries. Source – Eurostat.

Industry	RND	Turnover	Entry	Exit
Oil and gas extraction	0.18	13.65	6.65	6.99
Other mining	0.82	11.26	5.89	5.37
Utilities	0.38	11.19	6.95	4.24
Construction	0.22	17.94	10.40	7.53
Wood products	0.00	13.91	6.59	7.32
Nonmetal products	0.73	12.89	6.38	6.50
Primary and fabricated metal prod.	0.77	13.83	7.39	6.43
General Machinery	2.77	11.55	5.96	5.58
Computers and electronic prod.	13.68	12.65	6.19	6.46
Electrical machinery	10.79	5.51	2.65	2.86
Transport Equip.	2.28	13.96	7.50	6.45
Manuf n.e.c.	11.91	14.97	7.62	7.35
Food products	0.56	12.31	5.15	7.16
Textiles	1.38	17.00	7.63	9.36
Leather	0.00	14.24	5.66	8.57
Paper, printing, software	0.84	14.71	7.57	7.15
Petroleum and coal products	0.47	13.54	7.85	5.68
Chemicals	32.18	11.18	5.48	5.71
Plastics	1.30	11.00	5.47	5.53
Wholesale Trade	0.00	18.95	9.59	9.36
Retail Trade	0.00	17.88	8.38	9.50
Air transport	0.00	17.45	9.20	8.26
Water transport	0.00	18.26	9.33	8.93
Land transport	0.00	15.14	7.43	7.71
Transport support	0.00	16.95	9.43	7.52
Broadcasting	1.58	27.81	16.80	11.01
Information and data processing	3.84	25.60	14.50	11.11
Finance (not insurance, trusts)	0.51	19.87	11.05	8.82
Insurance, trusts	3.68	12.67	6.85	5.82
Real estate	0.00	20.12	12.25	7.87
Rental services	0.00	20.58	11.39	9.19
Legal services	0.00	19.93	12.40	7.52
Systems design	13.64	24.87	15.37	9.49
Technical Services	12.60	21.06	12.41	8.65
Waste disposal	2.33	14.91	8.28	6.63
Education	0.00	19.09	11.17	7.92
Healthcare	0.00	12.61	7.85	4.76
Arts, sports, amusement	0.00	22.53	13.22	9.31
Hotels	0.00	14.22	7.83	6.39
Restaurants	0.00	18.74	9.28	9.46
Other services	0.00	18.76	10.68	8.08
Median	0.47	14.97	7.85	7.52

Table 2 – Summary statistics: annual industry rates of R&D intensity and turnover. R&D intensity is the median ratio of R&D spending to sales. Entry, exit and turnover are industry fixed effects plus the median country fixed effect. All variables are measured over the period 1997-2006.

Sources – Eurostat, Compustat.

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

Table 3 – Cross-industry correlations between turnover measures and industry variables. Rates of turnover, entry and exit are based on industry fixed effects δ_j in equation (1). Standard errors are in parentheses. In all tables, one, two and three asterisks represent significance at the 10%, 5% and 1% levels respectively.

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

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 5 – 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 6 – Highest priority if earnings increase.
dominant incumbent. P-values are in parentheses.
Source – Authors calculations and the Eurostat survey on Factors of Business Success, 2007.

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 7 – 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.

	Dependent variable $y_{j,c}$									
	Turnover		Entry		Exit		$Innov^{ADJ}$		$Innov^{RAW}$	
FD_c	β_{RND}	R^2	β_{RND}	R^2	β_{RND}	R^2	β_{RND}	R^2	β_{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 8 – Effect on turnover, entry and exit of the interaction between R&D intensity and financial development, based on estimating equation (2). 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). The measure of financial development is the private credit-to-GDP ratio (CRE). Financial development is instrumented using legal origin. Observations for turnover, entry and exit are 869, 916 and 875 respectively.

Dependent variable $y_{j,c}$										
Turnover		Entry		Exit		$Innov^{ADJ}$		$Innov^{RAW}$	
β_{EFD}	R^2	β_{EFD}	R^2	β_{EFD}	R^2	β_{EFD}	R^2	β_{EFD}	R^2
0.24**	.604	0.15	.571	0.09	.498	.41***	.403	1.48**	.304
(.121)		(.114)		(.060)		(0.136)		(.679)	

Table 9 – Effect on turnover, entry and exit of the interaction between EFD and financial development, based on estimating equation (3). Country and industry fixed effects are omitted for brevity. Heteroskedasticity-corrected standard errors are reported in parentheses. Results are for manufacturing only. The measure of financial development is the private credit-to-GDP ratio (CRE). Financial development is instrumented using legal origin. Observations for turnover, entry and exit are 869, 916 and 875 respectively.

	Dependent variable $y_{j,c}$				
Specification	Turnover	Entry	Exit	$Innov^{RAW}$	$Innov^{ADJ}$
Without chemicals	.62*** (.224)	.28* (.163)	.31*** (.103)	2.03** (.833)	1.00*** (.340)
Manuf only	.24** (.112)	.17* (.098)	.06 (.057)	1.24** (.592)	.358*** (.119)
Bootstrapped standard errors	.33*** (.094)	.19* (.102)	.13** (.059)	1.58*** (.461)	.563*** (.172)
Median regression (bootstrapped)	.270*** (.104)	.160** (.081)	.073** (.037)	.404*** (.113)	.142* (.086)

Table 10 – Effect on turnover of the interaction between financial development, based on estimating equation (2). Robustness exercises. The results use the credit-to GDP ratio as a measure of financial development. In the first two specifications financial development is instrumented using legal origin.

	Dependent variable $y_{j,c}$			
	Turnover		$Innov^{ADJ}$	
FD_c	β^{EC}_{RND}	β_{RND}	β^{EC}_{RND}	β_{RND}
CRE	-.85***	.34***	-.76**	.65***
	(.292)	(.133)	(.346)	(.199)
CAP	-.74***	.25*	-.49*	.81***
	(.284)	(.129)	(.279)	(.245)
BANK	-.73**	.45**	-.88***	.67***
	(.289)	(.213)	(.320)	(.225)
MARG	-.65**	.37**	-.59*	.59**
	(.281)	(.156)	(.341)	(.240)
ACCS	.13	.51	.59	.88***
	(.670)	(.317)	(.442)	(.259)
SOPH	-.31	.33	.057	.71***
	(.461)	(.225)	(.311)	(.180)

Table 11 – Effect on turnover and innovation of the interaction between R&D intensity and entry costs, based on estimating equation (4).

Measures of	Financial Development						
IPR protection	CRE	CAP	BANK	MARG	ACCS	SOPH	COPY
PTNT	-.11	.02	.06	.16	.10	.16	.45**
COPY	.63***	.71***	.61***	.63***	.71***	.81***	-

Table 12 – Cross country correlations between measures of financial development and IPR protection.

	Dependent variable $y_{j,c}$							
	Turnover				$Innov^{ADJ}$			
IPR_c	β_{RND}^{IPR}	β_{RND}	Obs	R^2	β_{RND}^{IPR}	β_{RND}	Obs	R^2
PTNT	1.27***	-	746	.666	-0.21	-	495	.597
	(.397)				(.144)			
	1.24***	0.28	746	.667	-0.41	0.58***	495	.603
	(.370)	(.198)			(.149)	(.152)		
COPY	.500***	-	869	.655	.601***	-	519	.618
	(.115)				(.135)			
	.455***	.127	869	.655	.449**	.236	519	.616
	(.117)	(.130)			(.205)	(.253)		

Table 13 – Effect on turnover and innovation of the interaction between R&D intensity and indicators of IPRs, based on estimating equation (5). Results are reported both imposing and relaxing the assumption that β_{RND} is zero. The measure of financial development is CRE; results are similar using other measures of financial development.

	Dependent variable $y_{j,c}$			
	Turnover		$Innov^{ADJ}$	
IPR_c	β^{EC}_{RND}	β^{IPR}_{RND}	β^{EC}_{RND}	β^{IPR}_{RND}
PTNT	-.44	1.10***	-.58**	.07
	(.342)	(.373)	(.257)	(.330)
COPY	-.29	.44***	-.32	.57***
	(.299)	(.122)	(.288)	(.135)

Table 14 – Effect on turnover and innovation of the interaction between R&D intensity and indicators of IPRs, based on estimating equation (5) but including an interaction of R&D intensity with entry costs instead of FD_c and entry costs.

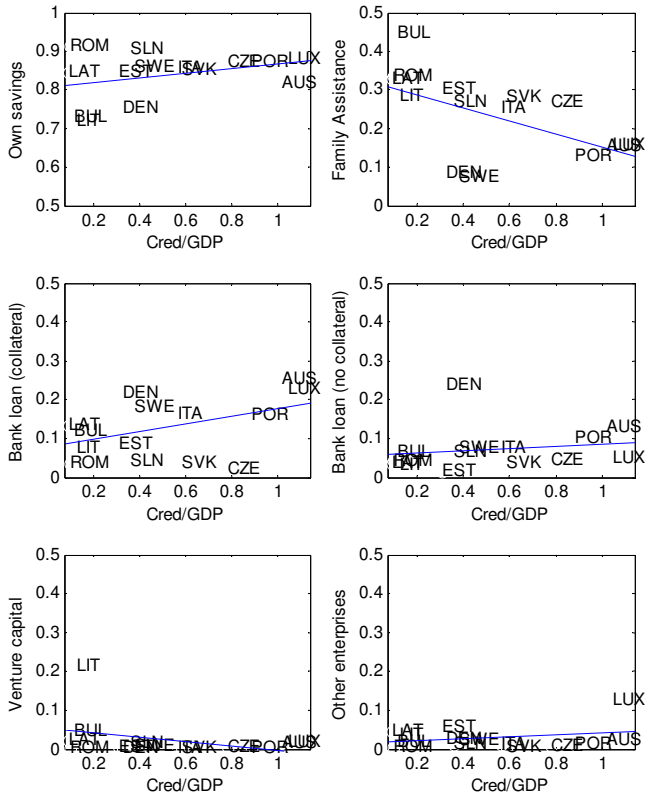

Figure 1 – Significant sources of finance for startups. The y-axis reports the share of startups reporting each factor as a significant source of finance. Responses include (1) own funds (2) family members (3) bank loan with collateral (4) bank loan without collateral (5) venture capital (6) other enterprises.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

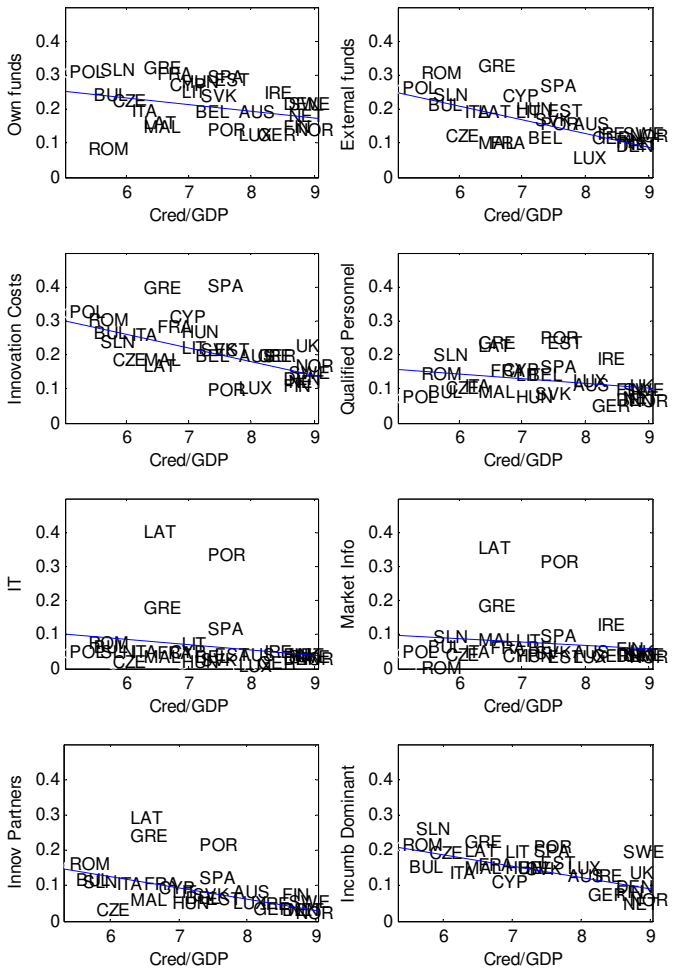

Figure 2 – Factors hampering innovation. Answers include: lack of own funds; difficulty of raising external funds; high costs of innovation; difficulty of finding qualified personnel; difficulty of adopting information technology; lack of information about the market; difficulty of finding partners for innovation; presence of established enterprises. Source – Author's calculations and the Eurostat survey on Factors of Business Success, 2007.