Financing Creative Destruction

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October 16, 2009

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.

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

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

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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 and exit 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

[1] This view is often traced back to Schumpeter (1934) as in the epigraph of this paper: see Evans and Jovanovic (1989) for a discussion. Aghion and Howitt (1992) develop a model of growth through innovation by entrepreneurs, and Morales (2003) and Aghion, Howitt and Mayer-Foulkes (2005) introduce a role for financial development in related models.

[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.

to see disproportionate reductions in *exit rates* in such industries as well.

I begin by defining 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. I then exploit industry variation in rates of entry and exit across European countries, to ask 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 innovation. The data are based on the universe of legal firms and (unlike most previous studies of firm demographics) 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 encouraging 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 spending on innovation is disproportionately affected by financial development 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 comprehensive survey of firms across Europe, financial development is negatively related to the share of firms that report difficulty in raising external finance as a significant obstacle to innovation. Moreover, Ilyina and Samaniego (2008) find that R&D-intensive industries are found to grow most rapidly in financially developed economies. All this indicates that financial development encourages growth through R&D activity and, in particular, that it channels funding 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 viewed entrepreneurs as capitalists, so that entrepreneurs were likely to be wealthy people. Using US data, Evans and Jovanovic (1989) argued that this was the case, possibly because informational frictions implied that that external funding was difficult to raise. On the other hand, Schumpeter believed that the banking sector would adequately channel funds from those who had funds towards entrepreneurs. An interpretation of the results of this paper is that the Schumpeterian view is more appropriate for financially developed environments,[3] whereas the Knightian view is adequate for financially underdeveloped environments. Furthermore, the evidence indicates that the protection of intellectual property is key in determining whether the Schumpeterian or Knightian view is the more appropriate one in a given economy. This suggests that IPRs are key to overcoming informational frictions that would otherwise limit the financing of innovative entrepreneurs.[4]

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 often attributed

[3] 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."

[4] Cagetti and De Nardi (2006) suggest that the existence of a market for intellectual property would make financing constraints less important, since ideas could be transferred to and realized by unconstrained parties (instead of the entrepreneur, if he/she is constrained). This would imply the opposite sign for the interaction between property rights and entry rates. Our results point to a different mechanism: the ability to transfer ideas makes it easier for entrepreneurs to raise external funds in the first place.

to the financing of innovation by 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 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 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 (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.

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.

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 sectors of the included countries. 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

[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.

them, for example due to financial constraints.

We study the same 41 industries as Samaniego (2009).[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. Dunne, Roberts and Samuelson (1988) and Aghion, Fally and Scarpetta (2007)), which accounts for less than half of employment and GDP in most countries.

The variable Entry is the proportion of enterprises active at a given date t that entered since date $t-1$, and the variable Exit 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 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, but also check that results are robust to considering Entry and Exit separately.

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.

[6] Samaniego (2009) uses an earlier edition of Eurostat, and contains additional details regarding the construction of the Eurostat entry and exit data.

[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

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 Eurostat.[8] The survey reports expenditure on innovation as a share of total 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 used two measures of R&D spending: the industry ratio of innovation expenditures to sales reported in Eurostat $\left(\mathsf{Innov}^{RAW}\right)$, and these numbers multiplied by the share of innovators in each country $\left(\mathsf{Innov}^{ADJ}\right)$.[9]

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

[9] We do not use the Survey 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.

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 these data are not available at the industry level, they provide a useful window into . 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 appears 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. 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.

Since the distribution of RND is quite skewed, in the multivariate regressions that follow we correct all standard errors for heteroskedasticity by industry (and country), and check the robustness of results by bootstrapping.

2.3.2 External finance dependence

External finance dependence (EFD) 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 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%. The cross country standard deviation is 4.8%, whereas across industry averages observations it is 4.4%. Thus there is roughly as much variation across countries as there is across industries.

Table 3 reports that entry, exit and turnover are very highly correlated across industries, as known since Dunne, Roberts and Samuelson (1988). On the other hand, the correlation between RND and turnover is negligible. Thus, R&D intensity does not appear related to entry and exit rates per se. This is not surprising: in a financially developed environment in which firms are *able* to raise any needed funds, the factors that lead firms to *require* funds (such as research spending) need not have any effect on economic outcomes such as industry turnover. 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 financial factors on the ability of firms to conduct

business or pursue R&D.

Table 3 shows that EFD is very highly correlated with RND (although not with turnover). Thus, we will replicate some of our results below replacing RND with EFD. If results are stronger for EFD than for RND, this indicates that it is the need for finance (regardless of the purpose) that interacts with financial development. If results are stronger for RND than for EFD, this indicates that it is specifically (or primarily) problems that arise in the financing of R&D that interacts 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 both 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 instruments, 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.

One class measures financial deepening, and are typical measures of financial development

[10] Samaniego (2009) 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.

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.

A second class uses are also measures of financial development that are based on observed outcomes, but are not directly related to financial deepening. Instead, they indicate the productivity or efficiency of financial intermediaries.

A third class of measures of financial development are based on surveys of executives. to 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: Our benchmark measure uses the domestic private credit-to-GDP ratio (CRE). 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 (1997) or the earliest year in the period for which it is available.

2. CAP: For robustness I also use the domestic capitalization-to-GDP ratio (CAP), 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.). This is likely to be particularly severe for the case of transition economies. Hence, in what follows we use CRE as our benchmark. Market capitalization is reported in Eurostat. It is measured at the beginning of the period (1997) or the earliest year in the period for which it is available.

3. BANK: We also use a measure of the bank overhead as a share of assets in 1997 (BANK). 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 to obtain a measure of financial development. It is drawn from the 2006 update of the Beck et al (2000) Database on Financial Development and Structure.

4. MARG: The interest rate margin (MARG) 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, and also multiply it by minus one.

5. ACCS: We also use some survey-based measures. The World Economic Forum Global Competitiveness Report (GCR) contains a measure of "loan access" (ACCS). 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: The GCR also contains a measure of Financial Market Sophistication (SOPH). SOPH 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 our more detailed industry-level analysis, 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 (FBS) Survey. 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 it 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%, P-value 1%). 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 ABOUT HERE, 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

in 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 selection effects just mentioned. 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 find 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).

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 entry costs 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 variable $y_{j,c}$ is then identified by asking whether outcome $y_{j,c}$ is particularly susceptible to financial development in industries depending on their value of RND_j. In other words, we seek evidence that finance affects entry and exit by asking whether there is a significant interaction term 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 $RND_j \times FD_c$). For robustness, we also report bootstrapped standard errors. As for the concern that both the policy indicator FD_c might be endogenously affected by rates of entry, the advantage of the Rajan and Zingales (1998) differences-in-differences approach is that 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.[11]

[11] There is 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 (2008) argues against this, in that industry differences in R&D intensity appear largely driven by technological differences

A potential concern is endogeneity: if there is a lot of entry, it may be that this encourages greater use of external finance. We handle this possibility in several ways. First, the fact that the dependent variable is defined at the level of the country-industry pair (whereas financial development is a country variable) itself helps. Second, 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.[12] See La Porta et al (1998). We draw legal origin from the CIA World Factbook.

The maintained assumption for this regression is that R&D intensity is an industry characteristic 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.

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 entry costs 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

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.

[12] 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 somewhat smaller.

indicators of financial development – see Table 9. The weakest results are those concerning the dependent variable Exit.

To get a sense of the magnitude of these coefficients, consider the following. The country with the lowest financial development (according to the measure CRE) 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% to 16.8%, this represents a substantial difference.

Table 10 reports the results of estimating equation (2), where $y_{j,c}$ equals R&D 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.

TABLES 8-10 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. I now perform some further robustness checks.

As mentioned earlier, Aghion, Fally and Scarpetta (2007) find (in a different data set) that entry is disproportionately sensitive to financial development in industries that are more dependent on external finance. Since EFD and RND 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 instead of RND.

We find the following. First, when we use the full sample that includes both manufacturing and non-manufacturing, the coefficient β_{EFD} in equation (3) is never 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. Results are only significant for the survey-based measures of financial development but, by restricting ourselves to manufacturing, we have relatively little cross-industry variation. Interestingly, as well as entry, we find some evidence that overall turnover (entry plus exit) in highly finance-dependent manufacturing industries is sensitive to financial development, something that they cannot show in their data – see Table 11. Financial development also has a significant impact on R&D spending in high-EFD industries (Table 12). 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 are strongly related at the firm level, but 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).[13]

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%, and the next highest (Computers and Electronic Products) is 13.7%. Also, several industries have zero R&D intensity: given the potential for skewness in this variable, it may be worth checking whether the usual asymptotic results are appropriate by checking whether results are robust to different approaches to estimation. To ensure that the results are not driven solely by outliers and that

[13]We also estimated equation (2) replacing RND with a measure of investment specific technical change (ISTC, technical progress in upstream capital goods). Results were not significant, perhaps because delayed replacement or the possibility of purchasing second-hand capital goods lessens the impact of financial constraints in high-ISTC industries.

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, to correct for the fact that variables (and errors) may be skewed. 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 13 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 11-13 ABOUT HERE

A possibility is that financial development proxies for an unrelated (but correlated) policy. In particular, Samaniego (2009) suggests that policies that make entry costly may lead innovations to be introduced by incumbents instead of entrants. If so, an interaction of RND 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 significant for ACCS and SOPH), indicating that financial development could potentially be proxying for entry costs. However, including an interaction between RND and entry costs in equation (2) (as well as the interaction with financial development) does not change the results concerning β_{RND}. Interestingly, the interaction with entry costs is indeed negative (as expected) and significant at the 10 percent level or better in all cases when the dependent variable is industry turnover, but never significant when the dependent variable is R&D spending, suggesting that entry costs themselves do not

affect the presence of innovation but rather whether it occurs at entrants or at incumbents. All these results are omitted for brevity but are available upon request.

4.3 Concluding Remarks

This paper asks whether there is an impact of financial development upon entry, exit and R&D spending, and whether this impact might be different across industries depending on their R&D intensity as measured in the United States. 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.

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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		
RND_j	β_{RND}	R^2	Obs	β_{RND}	R^2	Obs	β_{RND}	R^2	
RND	0.33***	.652	869	0.19**	.640	916	0.13**	.538	875
	(.115)			(.095)			(.056)		

Table 8 – Effect on turnover of the interaction between research 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 parentheses. 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).

	Dependent variable $y_{j,c}$							
	Turnover			Entry			Exit	
FD_c	β_{RND}	R^2		β_{RND}	R^2		β_{RND}	R^2
CRE	0.33***	.652	869	0.19**	.640	916	0.13**	.538
	(.115)			(.095)			(.056)	
CAP	0.29**	.652		0.17*	.640		0.12*	.538
	(.125)			(.100)			(.057)	
BANK	0.51**	.649		0.31*	.638		0.18*	.535
	(.232)			(.160)			(.103)	
MARG	0.45***	.651		0.27**	.640		0.17*	.536
	(0.180)			(0.119)			(0.100)	
ACCS	0.46***	.654		0.30***	.642		0.16***	.539
	(0.129)			(0.091)			(0.061)	
SOPH	0.44***	.653		0.27***	.641		0.16**	.538
	(0.137)			(0.099)			(0.066)	

Table 9 – Effect on turnover, entry and exit of the interaction between RND 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.

	Dependent variable $y_{j,c}$			
	$Innov^{ADJ}$		$Innov^{RAW}$	
FD_c	β_{RND}	R^2	β_{RND}	R^2
CRE	.56***	.602	1.58***	.658
	(0.150)		(.578)	
CAP	.83***	.608	2.13**	.654
	(0.219)		(.760)	
BANK	.52***	.586	1.34**	.636
	(.179)		(.525)	
MARG	.57**	.580	1.31**	.634
	(.248)		(.579)	
ACCS	.63***	.588	1.33***	.639
	(.183)		(.439)	
SOPH	.70***	.603	1.63***	.648
	(.164)		(.492)	

Table 10 – Effect on innovation of the interaction between RND and financial development, based on estimating equation (2) with $y_{j,c}$ equal to a measure of innovation. Country and industry fixed effects are omitted for brevity. Heteroskedasticity-corrected standard errors are reported in parentheses.

	Dependent variable $y_{j,c}$					
	Turnover		Entry		Exit	
FD_c	β_{EFD}	R^2	β_{EFD}	R^2	β_{EFD}	R^2
CRE	0.24**	.604	0.15	.571	0.09	.498
	(.121)		(.114)		(.060)	

Table 11 – 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.

	Dependent variable $y_{j,c}$			
	$Innov^{ADJ}$		$Innov^{RAW}$	
FD_c	β_{EFD}	R^2	β_{EFD}	R^2
CRE	.41***	.403	1.48**	.304
	(0.136)		(.679)	

Table 12 – Effect on innovation 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.

	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 13 – 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.

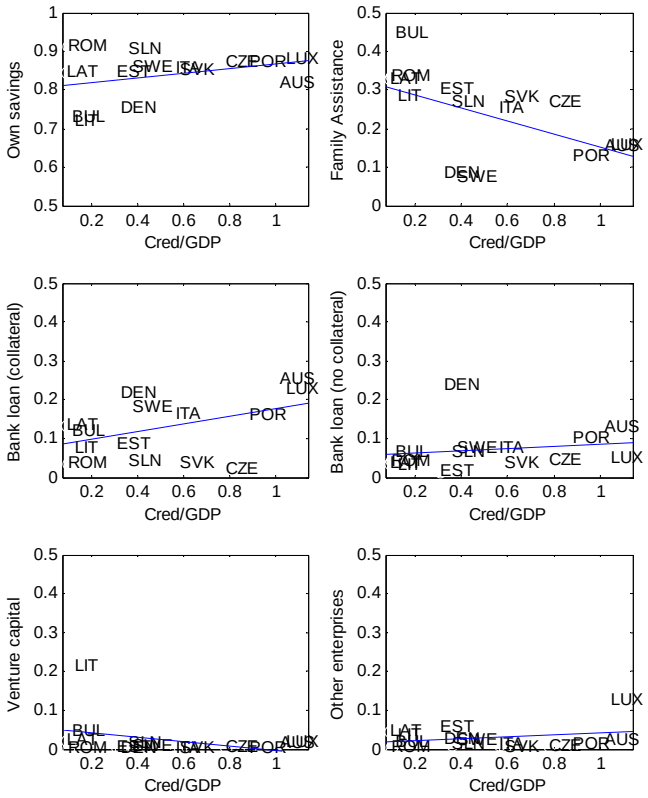

Figure 1 – Significant sources of finance for startups. The y-axis reports the share of startups reporting each factor as a significant source of finance. Responses include (1) own funds (2) family members (3) bank loan with collateral (4) bank loan without collateral (5) venture capital (6) other enterprises.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

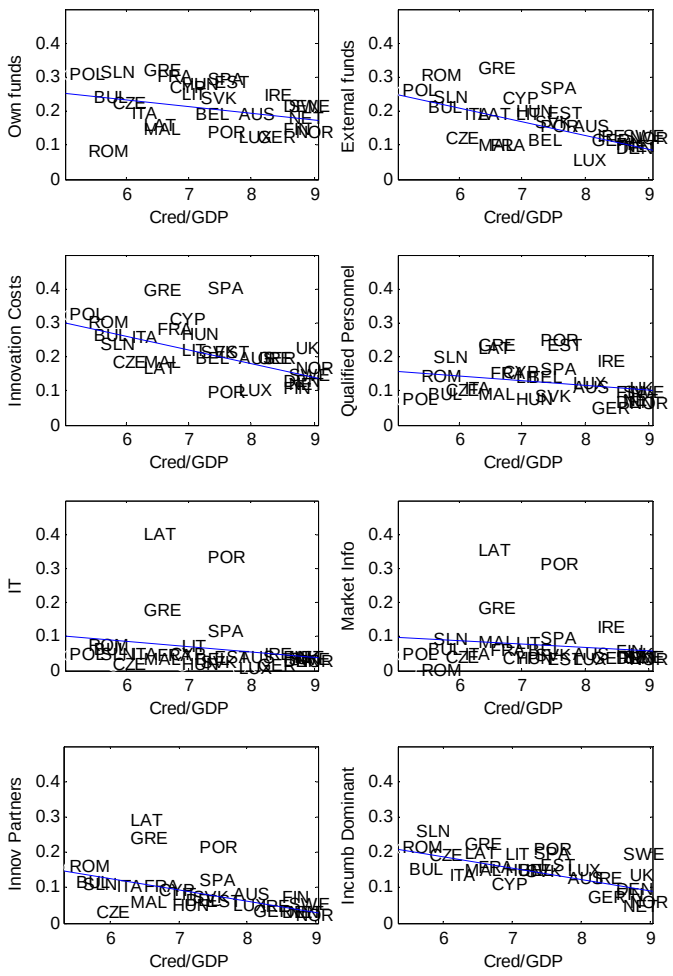

Figure 2 – Factors hampering innovation. Answers include: lack of own funds; difficulty of raising external funds; high costs of innovation; difficulty of finding qualified personnel; difficulty of adopting information technology; lack of information about the market; difficulty of finding partners for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