Technology and Financial Development*

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Abstract

The growth benefits from financial development are known to vary across industries. However, no systematic effort has been made to determine the technological characteristics shared by industries that grow relatively faster in more financially developed economies. Using the standard growth-theoretic definition of technology in terms of the *production function*, we explore a range of technological characteristics that theory suggests might underpin differences across industries in the *need* or the *ability* to raise external finance. We find that industries that grow faster in more financially developed countries display greater *R&D intensity* and *investment lumpiness*, indicating that well-functioning financial markets direct resources towards industries where growth is driven by R&D.

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I. INTRODUCTION

Any theory that aims to explain how financial development affects growth relies on specific assumptions about the reasons why producers may *need* to draw on external funds, and why they may be *unable* to do so. The search for factors that might determine the *need* or *ability* to raise external funds has led many researchers to believe that such factors are likely to be industry specific and technological in nature.[1] However, no systematic effort has been made to identify the *strictly technological* factors that are related to this need and ability. Knowing which factors are empirically important has implications for financial and development economics as well as growth theory – shedding light on the interaction between real and financial variables, and pointing towards the class of growth models most appropriate for analyzing the impact of financial development.

A systematic effort to identify these such factors does not require sorting through all industry variables identified in the literature, as not all of them are strictly "technological". Instead, the approach used in this paper is to start with a standard definition of "technology", using it as a guide for choosing variables that measure "technological" differences across industries.

This paper contributes to the literature by: (i) investigating which technological characteristics might underlie cross-industry differences in the *need* or the *ability* to raise external funds; (ii) developing empirical measures of these characteristics; and (iii) identifying the technological characteristics that are shared by industries that grow relatively faster in more financially developed economies.

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[1] Recent surveys of the literature include Demetriades and Andrianova (2004), Levine (2005) and Beck (2008).

As is standard in growth theory, we define "technology" in terms of the production function. Hence, we *measure* industry differences in technology using factor intensities, or using the qualitative attributes of factors of production – an approach dating back at least to Cobb and Douglas (1928). Under this approach, inherent differences between the production of Textiles and the production of Machinery (for example) can be described in terms of the former being more labor-intensive and less research-intensive than the latter.

Economic theory highlights several channels through which the technology of production might influence the producer's *ability* to access external finance – ranging from collateral constraints to informational frictions. For example, collateralized borrowing is more prevalent in less developed financial systems because of the absence of alternative mechanisms to overcome financial frictions. However, firms with a larger share of durable fixed assets may be better able to raise external funds in underdeveloped financial systems, because such assets are more likely to be eligible to serve as collateral – see Kiyotaki and Moore (1997). Another strand of literature, pioneered by Rajan and Zingales (1998, henceforth RZ), explores the impact of financial development on growth under the premise that industry variation in the *need* for external finance is due to technological differences. However, there has been no systematic effort to identify the underlying technological determinants of the need to draw on external funds and pin down the ones that are empirically relevant.[2]

[2] The only such study that we are aware of is by Furstenberg and Kalckreuth (2006), who find at best weak links between a measure of need and certain variables they regard as "technological".

We follow the differences-in-differences methodology of RZ for determining whether a given industry characteristic interacts with financial development, regressing industry growth rates in several countries on an interaction of our industry-level technological variables with country-level measures of financial development.[3] We find that *R&D-intensive* industries and industries characterized by greater *investment lumpiness* tend to be the main beneficiaries of financial development. Our cross-country industry growth regressions suggest that investment lumpiness plays an important role during the 1970s, while R&D intensity remains important throughout the 1970s, 80s and 90s. We also find that industry rankings based on these variables are stable over time, and are positively correlated with the ranking based on RZ's *external finance dependence* (EFD) measure. Moreover, our finding regarding the role of R&D intensity is more robust than that regarding either investment lumpiness or EFD. Hence, our main finding is that financial development stimulates growth by relieving financing constraints on industries that grow by performing R&D.

An extensive theoretical literature[4] considers how the availability of external financing affects economic outcomes. Although several models link finance to growth through R&D, the empirical literature often describes ways in which financial markets might improve resource reallocation without linking this to a theory of *growth*. Our results indicate that understanding how financial under-development slows growth requires focusing on the

[3] Demetriades and Hussein (1996) and others argue that cross country studies may suffer from endogeneity and omitted-variable problems: however, these problems are much less severe in the case of country-industry differences-in-differences studies such as ours, an argument known as the RZ "smoking gun".

[4] In De la Fuente and Marin (1996), Morales (2003) and Aghion et al (2005), firms use external funds to fund specifically research projects. In Greenwood and Jovanovic (1990) and Blackburn et al (2005) agents fund risky investment projects, whereas in Bencivenga and Smith (1991) finance is needed to invest in illiquid capital.

frictions that matter most for the financing of R&D, pointing to R&D-based growth models as the relevant framework for studying the finance-growth link. In particular, we explore several measures of the institutional infrastructure underlying financial development, finding that *intellectual property rights* may encourage growth by facilitating the financing of R&D.

Section II outlines the factors that distinguish technology in one industry from another, and that might be tied to financing need or ability. Section III describes the data, and Section IV analyzes whether industry growth rates are influenced by the interaction between any of the technological measures and financial development. Section V assesses the robustness of the results, and explores some of the underlying channels. Section VI concludes.

II. Technology and External Finance

What specific characteristics of the production technology might relate to the need and/or the ability to raise external funds? A common approach to identifying the properties of a production technology – using measures of input use – dates back at least to Cobb and Douglas (1928). We consider a number of *factor intensities* and *factor attributes*, and relate them either to the *need* for external funds (if they exacerbate the mismatch in cash inflows and outflows) or to the *ability* to raise external funding (if they increase the collateral value of productive assets, or reduce the severity of informational frictions). The discussion below is summarized in Table 1, and expanded upon in Ilyina and Samaniego (2008).

Why would some industries inherently need more external finance than others? RZ suggest that cross-industry differences in EFD may be due to “technological” factors specific to each industry. In particular, these could include the initial project scale, the gestation period, the cash harvest period, and the requirement for continuing investment.[5] More generally, firms that use a production technology characterized by significant mismatches in the magnitude or timing of inputs and outputs are more likely to experience shortfalls in cash revenues relative to cash outlays than firms in other industries. If so, it should be possible to establish a link between the *need* for external funding and specific parameters of the production technology, such as factor intensities and attributes.

Capital vs. Labor

***Need**:* Capital-intensive industries may be more finance-dependent, to the extent that a higher need for continuing investment implies greater need for external finance.

Ability: On the other hand, capital-intensive industries may be better *able* to raise funds in less developed financial systems where only durable fixed assets can serve as collateral.

Physical Capital: Fixity

Need: Fixed capital may be more rapidly installed than intangible capital, with the latter requiring time and firm-specific investments to generate (e.g., through R&D or advertising). Fixed capital may thus require lower startup costs or shorter gestation lags.

[5] As commonly defined, "initial project scale" is required investment before a project generates revenue; "gestation period" is the time period from the first investment outlay until cash revenues start to flow; "harvest period" is the period during which cash revenues are generated; and "continuing investment" is investment maintained continuously across periods. For example, a project may require "continuing investment" during both gestation and harvest periods.

Ability: Fixed assets serve well as collateral due to their ease of transferability (in contrast, intangible assets are often inalienable: e.g., brand name recognition is inherently difficult to transfer, see Myers and Rajan (1998)). Thus, industries that use more fixed assets may be better *able* to raise external finance in less developed financial systems.

Physical Capital: Durability

Need: If the capital used by industry *i* depreciates faster than the capital used in industry *j* – e.g., if *i* uses relatively more equipment (as opposed to structures) than does *j* – then the cash harvest period in *i* may be shorter, or the requirement for continuing investment may be higher. This implies that industries that experience higher rates of capital depreciation are likely to have a greater need for external finance. This may be true whether depreciation is physical or *economic* (due to embodied technical change or obsolescence).

Ability: More durable physical assets are more easily collateralizable. Thus, industries that use capital with higher rates of depreciation should have lower ability to raise external finance in less developed financial systems. See Hart and Moore (1994).

Physical capital: Lumpiness

Need: Firm-level investment tends to occur in "spikes", often associated with large, non-convex adjustment costs – see Doms and Dunne (1998). Greater "lumpiness" of investment should exacerbate the mismatch between the firms' cash inflows and outflows and may compel the firm to seek external funding. Hence, industries with more frequent investment spikes are likely to be relatively more dependent on external funding.

Ability: Lumpy investment may indicate that some of the firms' assets cannot be transferred (alienated) without being destroyed, and hence, are less suitable to serve as collateral. Ramey and Shapiro (2001) find that equipment cannot be moved between firms without destroying value, and Sakellaris (2004) and Samaniego (2010) link investment lumpiness to the destruction of knowledge pertaining to the capital that is being replaced.

Research & Development (R&D)

Need: R&D activity can lead to either product or process innovations (i.e., increases in the efficiency with which other inputs are used in production). One might expect more R&D-intensive industries to a have greater need for external finance for several reasons. R&D does not yield immediate results, and thus may be associated with longer gestation periods. R&D may require large startup investments for new firms and also for new projects – in which case it may be associated with investment lumpiness. R&D investments are also inherently risky and likely to be sunk.[6] In R&D intensive industries, a firm's market niche may be constantly under threat from innovative competitors, so that expected harvest periods may be relatively short. See Kamien and Schwartz (1982).

Ability: R&D is an intangible asset, which is difficult to collateralize. Success in R&D is highly uncertain, and an R&D-intensive project may be difficult to monitor and assess, exacerbating agency problems (asymmetric information). Thus, R&D intensive industries may have a low ability to raise finance in less developed financial systems.

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[6] According to Burley and Stevens (1997), the ratio of new product ideas to new products is 1:1000.

Human Capital

Need: Human-capital intensive industries may require up-front investment to assemble an appropriately-skilled workforce. Moreover, if financial or labor markets are such that *individuals* find it difficult to finance investments in human capital, or if human capital has an important firm-specific component, then firms may choose to finance such investments themselves. This would raise their initial need for external funds – particularly since these are likely to be long-term investments that take time to pay off.

Ability: Human capital is inalienable and generally cannot serve as collateral, so human-capital intensive industries may find it hard to raise funds in less financially developed countries – see Hart and Moore (1994).[7]

To recap, we conjecture that industries that have both a high *need* for external finance and/or a low *ability* to raise it are the main beneficiaries of financial development. This conjecture can be recast in terms of the technological characteristics discussed above, i.e., industries with greater *investment lumpiness*, higher rates of *capital depreciation* or *obsolescence*, lower share of *fixed* assets, higher *R&D intensity* and higher *human capital intensity* are likely to benefit from financial development. Industries with higher *R&D intensity* and *investment lumpiness* may be at a particular disadvantage in less financially developed economies given their high share of irreversible investments of a firm- or project-specific

[7] There are exceptions e.g. David Bowie, Iron Maiden and several American songwriters have borrowed millions of dollars backed by future royalties from their albums.

nature, which imply large or frequent expenditures on assets that are inalienable from the firm.

III. Data

A. Technological Measures

Technological measures are constructed for 28 manufacturing industries using U.S. data on publicly traded firms where possible.[8] The rationale is that these firms operate in deep financial markets so that their input use is not distorted by financial constraints. We do, however, check that the measures are similar using data for other countries where possible.

The time period under consideration is 1970-1999. We study each decade separately. This allows us to examine whether the behavior of these technological measures is stable over sufficiently long period of time.[9] Following RZ's procedure for constructing industry

[8] Our 28 industries are the finest classification for which we could construct all the desired data. UNIDO replaced the dataset used by RZ with INDSTAT3 in 1993, which has a slightly coarser industry classification. The advantage is that it also covers the 1990s. INDSTAT4 is more disaggregated, but coverage is less complete and many technological measures could not be developed for such a fine partition. The data are incomplete or non-existent after 2000. We use the US as a benchmark as we follow tightly the methodology of RZ, inheriting the well-known plusses and minuses of their approach. See Levine (2005).

[9] Following RZ, we average over each decade rather than using a time panel. As is standard, we measure financial development using financial deepening measures, which proxy for underlying contracting and property rights institutions (Acemoglu and Johnson (2006)). Since we do not believe that most year-on-year changes in financial deepening represent changes in the institutions of financial development, low-frequency

(continued)

measures, firm-level measures are computed over each decade and industry-level measures are taken to be the median firm values (unless described otherwise). The data come from several sources: industry growth data come from the INDSTAT3 database from the United Nations Industrial Development Organization (UNIDO).

Technological measures (reported in Table 2) are constructed as follows:

- *Fixity of assets* (FIX) is measured as the ratio of fixed assets to total assets (DATA 8 divided by DATA 6 in Compustat), as in Braun and Larraín (2005).
- *R&D intensity* (RND) is defined as R&D expenditures divided by capital expenditures (DATA 46 divided by DATA 128 in Compustat).[10]
- *Depreciation* (DEP) is the industry rate of capital depreciation, computed from the BEA capital flow tables and averaged over the decade in question (see Table 2).
- *Obsolescence* or *Embodied technical change* (ETC): We measure ETC using the methodology and data of Cummins and Violante (2002), whereby a long-term decline in the (quality adjusted) price of the capital goods used by industry *i* relative to industry *j*

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data is most appropriate for our purposes. Higher frequency data is, of course, useful for the study of financial *reform*, as in Bekaert et al (2005) and Baltagi et al (2009), for example.

[10] One might be concerned that firms in R&D-intensive industries located in developing countries do not perform as much R&D as, say, firms from the same industries in the US. However, Cohen and Levinthal (1990) show that R&D is required not just to develop innovations but also to absorb innovations. Thus, the premise is that industry variation in the need to absorb innovations is similar across countries (e.g. as a result of competing in international markets).

reflects a faster rate of technical progress in the production of the capital goods used by *i* as compared to *j* (see Table 2).

- *Labor intensity* (LAB) is defined as total wages and salaries divided by valued added, as reported by UNIDO.
- *Human capital intensity* (HC) is defined as total wages and salaries divided by total employees, as reported by UNIDO. This follows Mulligan and Sala-i-Martin (1997).
- *Investment lumpiness* (LMP) is the average number of investment spikes experienced by Compustat firms in a given industry over the decade. As in Doms and Dunne (1998), a *spike* is an annual capital expenditure in excess of 30% of the firm's stock of fixed assets.

Consistent with our interpretation that these measures are inherent characteristics of the production technology in each industry, we find that industry rankings based on all measures are highly *auto-correlated* across decades (Table 3). Relationships *across* different technological measures are mostly stable over time, and generally consistent with theory, such as capital-skill complementarity – see Ilyina and Samaniego (2008) for details. We also find that LMP and RND are highly positively correlated, indicating that R&D intensive industries also tend to have more investment spikes.

Given that financial underdevelopment may cause difficulties in raising funds to purchase certain inputs, it may distort patterns of input use, so that there is no a priori reason why these measures might be stable across countries. Nonetheless, we find some evidence that they are. Each of the LMP, RND and FIX measures computed using Compustat Global data for the 1990s is highly correlated (over 90%) with the same measure computed using the US data. Excluding US-incorporated firms from Compustat Global, the correlations with US measures for the available industries remain high, at 98% for RND, 67% for LMP and 85% for FIX. In the case of LAB and HC, we compared the US values for these measures with values computed using UNIDO data on India for the 1980s, finding correlations of 40% for LAB (significant at the 5% level) and 78% for HC. It was not possible to repeat this comparison for DEP and ETC, because of the lack of comparable data for other countries.[11]

B. Finance Dependence

To measure financing need, we adopt the RZ definition of external financial dependence (EFD): the share of capital expenditures that is not financed by cash flow from operations.. As in RZ, both capital expenditures and cash flow are summed up over the relevant decade (1970s, 1980s or 1990s) to compute firm-level EFD measures. The industry-level measure is the EFD of the median firm. See Rajan and Zingales (1998) for details.

Since EFD has been identified as an important channel of interaction between finance and growth, we check the relationship between the technological measures introduced in the previous section and EFD. Out of all the measures considered in this paper, only two – *lumpiness* and *R&D intensity* – are closely related to EFD (Table 4). The correlations between industry rankings based on LMP and on EFD are positive and statistically significant in all three decades. The correlations between industry rankings based on RND and on EFD are very high for the 1980s and the 1990s – over 80% – but not statistically

[11] One might ask to what extent the industry (median firm) measures are representative of each industry. One way to determine this is via a quantile regression of the firm level technological measures on industry dummies. For RND and FIX, coefficients on industry dummies are statistically significant at the 5 percent level in all cases except one. For EFD, there were 6 exceptions, suggesting that it might indeed be a noisy proxy for some industry specific intrinsic technological characteristic.

significant in the 1970s. Nonetheless, we do find that EFD and RND are significantly related at the *firm* level in each decade, including the 1970s (Table 5).

C. Financial Development Measures

For the sample of 41 countries in RZ we construct the following standard measures of financial development, based on financial deepening (e.g. King and Levine (1993)):

- the *domestic private credit-to-GDP* ratio (CRE). Domestic credit data come from the IMF International Financial Statistics (IFS) (domestic credit allocated to the private sector is IFS line 32d). [12] In what follows we use CRE as our benchmark.
- the *domestic capitalization-to-GDP* ratio (CAP), the sum of domestic market capitalization and private credit. Market capitalization is based on the World Stock Exchange Factbook of the International Finance Corporation (IFC).

For each country, we average each financial development measure over the decade of interest in order to reduce the effects of short-term fluctuations in economic or financial market conditions. A potential concern with using the average levels of financial development measured over the same period as the industry growth rates is endogeneity, whereby economic growth that emerges for reasons outside the model might affect the level of financial development. This, however, is unlikely to be a serious problem as growth data are at the industry level whereas financial development is measured at the country level – the

[12] GDP is measured in constant prices multiplied by the PPI (or CPI, if the PPI is unavailable), where the base year is five years before the year of interest as in RZ.

"smoking gun" argument of Rajan and Zingales (1998). Nonetheless, we check the robustness of our results using instrumental variables, among other methods.

IV. Technology, Financial Development and Industry Growth

What technological characteristics are shared by industries that tend to grow relatively faster in countries with higher levels of financial development? Because the need and the ability to raise external funds may be driven by independent factors, the correlation between EFD and R&D intensity on its own does not imply that, for example, financial development necessarily relieves financial constraints on firms in R&D intensive industries. In the same vein, the *lack* of any statistically significant relationship between EFD and the other technological measures does not necessarily imply that financial development might not disproportionately affect, say, human capital-intensive industries, through other channels. Hence, we proceed as follows. In a given decade, for each technological measure X_k, we run a cross-country industry growth regression with the interaction variable for X_k and financial development. The estimated country-industry panel regression equation is:

$$g_{i,c} = \alpha_i + \beta_c + \gamma \times SHARE_{i,c} + \delta X_{ki} \times FD_c + \varepsilon_{i,c} \qquad (1)$$

where $g_{i,c}$ is growth in real value added in industry i and country c, α_i is an industry fixed-effect, β_c is a country fixed-effect, $SHARE_{i,c}$ is the share of industry i in the manufacturing sector of country c, X_{ik} is the value of technological measure k in industry i and FD_c is a measure of financial development in country c. The objective is to determine whether the interaction between any of the technological measures and financial development may be a significant factor of industry growth *differences* (in what follows, we use the circumflex $\widehat{X_k}$ to refer to the interaction term between a technological variable X_k and any measure of financial development). The inclusion of country and industry dummy variables implies that we do not need to specify any industry- nor country-specific variables that might affect growth, as in RZ. We also run (1) with EFD in place of X_k, to verify that the RZ result holds in our data and to compare the behavior of our technological measures with that of EFD.

Focusing on the ***1980s*** and using ***CRE*** as a measure of financial development, we obtain the following results (Table 6):

- The results of RZ hold for our coarser industry classification: the interaction of EFD with financial development ($\widehat{\text{EFD}}$) carries a positive and statistically significant coefficient.
- The technological variables that interact significantly with financial development in the 1980s are RND, LMP, DEP and HC. Of note is that the coefficients on $\widehat{\text{RND}}$ and $\widehat{\text{LMP}}$ are positive, with a higher level of significance than that of $\widehat{\text{EFD}}$. In addition, some technological variables that are not correlated with EFD also interact with financial development, consistent with the idea that financial need and ability may not be linked to the same technological factors. In particular, the sign of the coefficient on $\widehat{\text{DEP}}$ is positive, which means that industries that used less-durable capital tended to benefit more from financial development in the 1980s. The coefficient on $\widehat{\text{HC}}$ is also positive.

How should one interpret the economic significance of the coefficients on the interaction terms $\widehat{X_k}$? Since fixed effects account for much of the variation in the data, the R^2 values alone do not give much indication of the economic significance of the interaction variables. The following example, however, might give a sense of economic significance of the interaction term. The country at the 75th percentile of financial development is France, and that at the 25th percentile is Egypt. The industry at the 75th percentile of RND is Industrial Chemicals, and Food Products is at the 25th percentile of RND. If financial development in an average country were to improve from the level of Egypt to the level of France, Industrial Chemicals would grow 1.1% faster annually than Food Products. The average growth rate across industries and countries is 0.57% and the standard deviation is 0.65%, so the impact of financial development on industry growth differences is economically significant.

The interaction terms $\widehat{\text{RND}}$ and $\widehat{\text{LMP}}$ carry larger coefficients and greater statistical significance than $\widehat{\text{EFD}}$ (Table 6). At the same time, this could simply represent omitted variable bias, as the three variables RND, LMP and EFD are correlated amongst themselves. Another way to see which of these interactions is strongest is to include all three variables in the same cross-country, cross-industry regression, i.e. to run a "***horse race***". Table 7 presents the results of estimating equation (1) with all three interaction terms: $\widehat{\text{EFD}}$, $\widehat{\text{RND}}$ and $\widehat{\text{LMP}}$. We find that $\widehat{\text{EFD}}$ and $\widehat{\text{LMP}}$ lose statistical significance, whereas $\widehat{\text{RND}}$ does not.

V. PERSISTENCE AND ROBUSTNESS

The robustness of the results is checked with respect to (A) different time periods; (B) other measures of financial development, as well as the potential endogeneity of financial development; (C) policy collinearity. We also explore some specific institutional factors that might drive our results.

A. 1970s and 1990s

Are the results specific to the 1980's? In any given decade, industry growth patterns, as well as patterns of financial development, may have been affected by both secular and transitory factors which may be difficult to disentangle. Thus, cross-decade robustness is important for ensuring that our results reflect an impact of finance on long run growth rather than the impact of transitory factors.

- In the ***1970s*** (Table 6), we find that $\widehat{\text{EFD}}$, $\widehat{\text{RND}}$ and $\widehat{\text{LMP}}$ carry significant, positive coefficients, as in the 1980s. However, $\widehat{\text{FIX}}$ is statistically significant as well (unlike in the 1980s). Focusing on the ***1990s*** (Table 6), we find that $\widehat{\text{EFD}}$ and $\widehat{\text{LMP}}$ are no longer statistically significant, while $\widehat{\text{RND}}$ remains significant. Also, while the "horse race" in the 1970s has no clear winner, R&D stands out in both the 1980s and 1990s (Table 7).

To sum up, we find that:

- $\widehat{\text{RND}}$ is the only variable that remains statistically significant in all three decades;
- the interactions of LMP and of EFD with financial development are similar across decades, but the $\widehat{\text{LMP}}$ coefficients are larger in magnitude and significance;
- certain other technological interaction variables appear significant in the 1970s or in the 1980s, but none of them persist across decades.

How should one interpret these results? ***First***, the interactions of RND and LMP with financial development are robust. ***Second***, some cross-industry differences in technology that are unrelated to financial *need* interact with financial development – but only in a single decade. They may reflect the impact of certain kinds of shocks – such as the oil price shocks

– which are better weathered by firms with a greater ability to raise external funds.[13] ***Third***, the results confirm that EFD can indeed be viewed as a proxy for some technological industry characteristics, with LMP and RND being the leading candidates – although it appears that EFD does not capture the full interaction between finance and technology.

B. Robustness

We perform a variety of robustness checks. In the interests of brevity we report only certain results: further details may be found in Ilyina and Samaniego (2008).

Are the results robust to different measures of financial development? Table 8 presents the findings of the same exercise performed for the 1980s, but with CAP as a measure of financial development. The results are essentially the same. We also used CAP minus CRE as a financial development indicator (STOCK), to see whether debt and equity might have differential effects (see Arestis et al (2001) and Levine (2005) for discussions in a cross-country context). We obtained essentially the same results as in Table 7.

It is worth noting that our results do not hinge on using financial deepening measures to proxy for financial development. In Ilyina and Samaniego (2009) we estimate equation (1) with RND as a technological variable and several measures of financial development including bank overhead costs, borrowing-lending spreads, and survey-based measures of loan accessibility for businesses and financial market sophistication, finding similar results.

[13] The role of financial development in aiding firms to adjust to shocks is studied in Fisman and Love (2004a).

Furthermore, the fact that financial deepening measures employed in the regression analysis represent the ten-year averages reduces concerns that these measures might suffer from distortions caused by credit or asset price bubbles.

Is there a risk that we may be capturing feedback effects between growth and financial development? Because we focus on the impact of financial development on differences in growth rates across industries (not on aggregate growth), endogeneity is unlikely to be a problem. Nonetheless, we use several approaches to address this concern. ***First***, we run cross-country industry growth regressions for the 1980s using financial development measured earlier, in the 1970s. The coefficients on $\widehat{\mathrm{RND}}$ and $\widehat{\mathrm{LMP}}$ remain robust but, interestingly, the coefficient on $\widehat{\mathrm{EFD}}$ does not. ***Second***, we examine whether the statistical significance of $\widehat{\mathrm{EFD}}$ (and of $\widehat{\mathrm{RND}}$) in the 1980s is robust to instrumenting financial development with the country's *legal origin*, following La Porta et al (1996). We find, as do RZ, that instrumenting in this way in fact increases the coefficient on $\widehat{\mathrm{EFD}}$. Moreover, the same is true of the interaction term $\widehat{\mathrm{RND}}$, as well as $\widehat{\mathrm{LMP}}$.

One might wonder whether some other policy that is perhaps correlated with financial development could be responsible for our results. For example, it could be that the costs imposed by the regulation of entry disproportionately harm innovative firms, or that in more innovative industries employment protection is more costly (see Samaniego (2006, 2010)). Hence, we check whether our results concerning $\widehat{\mathrm{RND}}$ are robust to including interactions of RND with the entry cost measure of Djankov et al (2002), and the employment regulation intensity measure of Botero et al (2004). Neither of these interactions turns out to be significant, nor do they affect the significance of $\widehat{\text{RND}}$ when it is also present in the specification.

C. Further results: institutions and other channels

Fisman and Love (2004b, henceforth FL) argue that the RZ measure is related to growth opportunities. Could our results hold simply because R&D intensive industries happen to have had better growth opportunities? We compute the FL measure of industry growth opportunities (the median sales growth rate among US firms in Compustat) and find that it is indeed positively correlated with EFD, LMP and RND in each decade. Statistical significance at the 5% level or better only occurs in the 80s and 90s – see Table 9. However, between the 70s and 80s the Spearman rank correlation is among "growth opportunities" themselves *across* decades is 42% (significant at the 5% level) and between the 80s and 90s it is 74%. This suggests that the "growth opportunities" captured by the FL measure are unlikely to be transitory: rather, it would appear that certain industries grow (while others shrink) as a matter of long-term structural change, and that this is what the FL measure captures when measured over a decade. See Ilyina and Samaniego (2009) for a model of structural change in which productivity-enhancing R&D leads to precisely such a pattern of structural change.

Claessens and Laeven (2003), Acemoglu and Johnson (2005), Gupta and Yuan (2009) and others find that institutional quality is an important factor of financial development. We also ask what kind of institutions appear most closely linked to the observed effects of financial development upon industry growth, replacing our financial development variables with a variety of institutional indicators. First, we adopt the Law and Order indicator (LAW) developed by the Political Risk Services group and reported in their International Country Risk Guide (ICRG). This is an overall indicator of the confidence of the populace in governmental institutions, perception of freedom from corruption, etc, as perceived by PRS group experts. We take the value from 1984, the earliest year reported.

Second, the literature distinguishes between two broad classes of institutions that underpin the development of well-functioning financial markets: contracting and property rights. *Contracting institutions* support the effectiveness of private agreements – by avoiding disputes, or by dealing with disputes efficiently once they emerge. *Property rights institutions* determine the extent to which entrepreneurs can control the use and transfer of the firm's physical or intangible assets – defining what can or cannot be used as collateral, and determining whether the firm is open to the threat of imitation or theft. See North (1984) and Acemoglu and Johnson (2005).

Djankov et al (2003) find that ineffective contract enforcement is linked to the formalism of the legal system. We follow Acemoglu and Johnson (2005) in measuring the strength of contract enforcement using the Djankov et al (2003) formalism index times -1 (ENFOR).

Acemoglu and Johnson (2005) define property rights institutions as those that specifically guard against expropriation by the executive. They use the *de jure* Polity IV indicator of constraints on the executive to measure protection from expropriation by the government (EXEC). We used as an additional measure of property rights, the Democratic Accountability indicator (DEMO) reported in the ICRG, for 1984. This measure ranges from 1 (autocracy) to 6 (alternating democracy), as assessed by PRS group experts.

An investment project is more valuable, and more able to raise external funds, when the intangibles that delimit the project (business plan, product idea, brand, etc.) are less likely to be stolen or copied by competitors. Given our focus on R&D, we are particularly interested in the impact of *intellectual* property rights (IPRs). We use two IPR indicators. Ginatre and Park (1997) develop a measure of patent enforcement for 1980 (PTNT), which applies to patentable (e.g. scientific) knowledge, such as new products or processes. Property Rights Alliance (2007) reports a measure of copyright enforcement (COPY). 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. The fact that industry growth and R&D intensity are measured over the 1980s, whereas ENFOR and COPY are measured later, means that there is no perfect temporal match between these variables .It is worth noting, however, that institutions are typically highly persistent. For example, the correlation between the Political Risk Services group's International Country Risk Guide (ICRG) composite of political, financial and economic risk indicators in January 1984 and January 2003 measured across countries is 0.80*** (standard error 0.066).

We find that many of the institutional variables are in fact significantly correlated with financial deepening (Table 10), suggesting the existence of an institutional basis underlying financial development. As expected, LAW, which can be thought of as a broad measure of institutional quality, does indeed interact with R&D (Table 11). When we examine more granular institutional indicators, the only indicator that interacts significantly with R&D is copyright protection[14] (Table 11). Thus, it appears that a key institution that enables R&D-intensive ventures to raise external funds is the enforcement of property rights over the intangibles that define the firm.

VI. Concluding Remarks

After reviewing a range of technological factors that might underlie cross-industry differences in the *need* or the *ability* to raise external finance, we conjecture that industries that have greater *need* for external finance, but also lower *ability* to use their productive assets as collateral, are likely to be the main beneficiaries of financial development. Indeed, we find that industries characterized by greater investment lumpiness and higher R&D intensity tend to grow faster in more financially developed economies. While later research may identify other empirically relevant technological characteristics, we believe that this paper provides a benchmark set of results using the broadest measures.

We see several avenues for future work. It would be interesting, though challenging, to assess the extent to which financial development encourages growth in R&D intensive industries via improvements in total factor productivity, factor-saving technical change, or

[14] In European data, Samaniego (2009) finds that rates of entry, exit and spending on innovation in R&D intensive industries are disproportionately sensitive to copyright enforcement.

factor accumulation. Tadesse (2005) takes a step in this direction, finding that financial development may encourage total factor productivity growth in industries in which young firms are financially dependent. Based on our findings, it would not be surprising to see that more R&D-intensive industries realize faster rates of technological progress in more financially developed countries.

Several theories link financial development to aggregate growth rates in general equilibrium models. However, to our knowledge, there are no general equilibrium models relating financial development to *industry* growth rates – in spite of the frequent use of industry data in empirical work. Our results suggest that R&D could be an important building block of such theories. A companion paper (Ilyina and Samaniego (2009)) presents a multi-industry growth model with financing constraints and differences in R&D intensity across industries.

Table 1. Production Technology: *Need* for External Finance vs. *Ability* to Raise External Funds.

Technological measure (X_i)	Defined as	How does X_i affect the *ability* to access external finance (A_i)?		How does X_i affect the *need* for external finance (N_i)?	
CAPITAL					
Fixed capital (FIX)	- a fraction of total assets	↑	- higher tangibility	↓	- lower startup costs, shorter gestation.
Depreciation (DEP)	- a fraction of capital stock	↓	- lower durability	↑	- greater need for follow-up investment
Obsolescence (ETC)	- the rate of decline in the quality-adjusted price of capital	↓	- lower durability	↑	- greater need for follow-up investment
R&D (RND)	- R&D spending as a fraction of capital expenditures	↓	- lower alienability, lower tangibility	↑	- longer gestation period, high startup costs, shorter harvest periods
Investment lumpiness (LMP)	- average number of investment spikes.	↓	- lower alienability	↑	- higher adjustment costs
LABOR					
Labor intensity (LAB)	- a fraction of value added	↓	- lower alienability, lower tangibility	↓	- lower need for follow-up investment
Human capital (HC)	- average wage	↓	- lower alienability, lower tangibility	↑	- longer gestation period, shorter harvest periods

Notes: See Section III for a detailed description of the construction of technological variables and data sources.

Table 2: Industry Classification and Technological Measures

Industry	ISIC code	EFD	DEP	ETC	RND	HC	LAB	FIX	LMP
Food products	311	-0.090	7.110	3.487	0.061	1.870	0.271	0.379	1.326
Beverages	313	-0.234	7.110	3.511	0.014	2.469	0.245	0.353	1.333
Tobacco	314	-0.686	5.293	3.511	0.347	2.716	0.116	0.207	0.546
Textiles	321	0.092	7.568	3.623	0.111	1.497	0.457	0.328	1.451
Apparel	322	-0.055	6.288	4.053	0.000	1.093	0.444	0.127	1.459
Leather	323	-0.415	9.238	3.718	0.317	1.409	0.443	0.148	1.909
Footwear	324	-0.839	8.253	3.763	0.067	1.139	0.434	0.153	2.156
Wood products	331	0.218	9.588	3.797	0.000	1.687	0.491	0.296	1.650
Furniture, except metal	332	-0.098	8.125	3.938	0.165	1.539	0.485	0.289	1.266
Paper and products	341	-0.102	8.557	3.035	0.059	2.495	0.355	0.464	1.114
Printing and publishing	342	-0.178	9.636	4.084	0.000	2.067	0.394	0.282	1.984
Industrial chemicals	351	0.011	9.225	3.720	0.326	3.001	0.250	0.402	1.537
Other chemicals	352	1.670	6.628	3.792	1.369	2.556	0.214	0.207	2.366
Petroleum refineries	353	-0.115	6.649	3.623	0.048	3.493	0.177	0.590	0.569
Misc. pet. and coal products	354	-0.052	6.649	3.691	0.209	2.530	0.300	0.322	1.625
Rubber products	355	-0.034	9.826	3.038	0.317	2.263	0.426	0.294	0.821
Plastic products	356	0.048	9.826	3.097	0.188	1.854	0.405	0.368	1.727
Pottery, china, earthenware	361	-0.010	8.508	4.547	0.203	1.831	0.478	0.418	1.125
Glass and products	362	0.339	7.850	4.325	0.178	2.285	0.415	0.418	1.571
Other non-metallic mineral prod.	369	0.073	8.508	4.696	0.049	2.134	0.389	0.512	0.970
Iron and steel	371	-0.023	6.620	3.109	0.068	2.769	0.504	0.421	0.936
Non-ferrous metals	372	0.035	5.485	3.099	0.107	2.530	0.463	0.345	1.358
Fabricated metal products	381	-0.087	7.000	3.282	0.155	2.065	0.456	0.275	1.500
Machinery, except electrical	382	0.622	8.832	4.970	0.924	2.466	0.443	0.204	2.817
Machinery, electric	383	0.658	9.117	4.467	0.753	2.310	0.423	0.227	2.770
Transport equipment	384	0.038	10.790	4.237	0.398	2.966	0.454	0.268	1.716
Prof. & sci. equip.	385	1.090	9.110	4.137	1.176	2.606	0.382	0.185	2.961
Other manufactured prod.	390	0.431	9.967	2.782	0.353	1.654	0.404	0.179	1.986

Notes: EFD, LMP and RND are constructed using the Compustat database. Compustat reports a 4-digit SIC code for each firm, which can be easily aggregated to the 3-digit ISIC level. HC and LAB are constructed using UNIDO data. ETC and DEP are constructed using capital flow tables from the United States Bureau of Economic Analysis (BEA), which report investment expenditures, current cost stock and current cost depreciation in each industry by type of capital good. The industry classification in the capital flow tables is slightly coarser than that used by UNIDO. For example, Food, Beverages and Tobacco constitute one category under the former system. To measure ETC differences among sub-industries, we proceed as follows. First, we construct ETC measures for the sub-industries using the 1987 benchmark input-output tables, which are more disaggregated than the capital flow tables. We then multiply them by a common factor so that their average equals the average for the full Food, Beverages and Tobacco category as computed from the BEA capital flow tables As for DEP, the equipment share of investment in the capital flow tables (EQ) is highly correlated with DEP, suggesting that this share is the primary determinant of depreciation rate differences. We impute values of DEP for subcategories using relative differences in equipment and structures intensity, and the differences in the depreciation rates of equipment and structures across sub-industries reported by the BEA. In fact, in terms of correlations and industry growth regressions, we found that EQ and DEP behave very similarly. DEP and ETC are reported as percentages.

Table 3: Correlations Across Decades

	80s - 90s	*70s - 80s*	*70s - 90s*
EFD	**0.89***** (0.088)	**0.48***** (0.172)	0.32* (0.186)
FIX	**0.96***** (0.054)	**0.97***** (0.049)	**0.96***** (0.058)
DEP	**0.96***** (0.057)	**0.98***** (0.035)	**0.95***** (0.064)
ETC	**0.63***** (0.152)	**0.74***** (0.131)	**0.62***** (0.154)
RND	**0.92***** (0.078)	**0.91***** (0.080)	**0.77***** (0.124)
LMP	**0.82***** (0.113)	**0.63***** (0.153)	**0.50***** (0.169)
LAB	**0.97***** (0.047)	**0.97***** (0.051)	**0.93***** (0.070)
HC	**0.98***** (0.036)	**0.96***** (0.058)	**0.90***** (0.084)

Notes: This table shows the autocorrelations across decades (the 1970s, 1980s and 1990s) for each of the technological measures - Fixed capital (FIX), Depreciation (DEP), Obsolescence (ETC), R&D (RND), Investment lumpiness (LMP), Labor intensity (LAB) , Human capital (HC) - and of external finance dependence (EFD). Standard errors are reported in parentheses. One, two and three asterisks indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 4: Correlations of Technological Measures with EFD

	EFD		
	1970s	***1980s***	***1990s***
FIX	0.22 (0.191)	-0.14 (0.194)	-0.25 (0.190)
DEP	0.04 (0.196)	0.13 (0.194)	0.06 (0.196)
LMP	**0.32*** (0.186)	**0.59***** (0.159)	**0.47**** (0.173)
ETC	0.09 (0.195)	0.25 (0.190)	0.30 (0.187)
RND	0.28 (0.189)	**0.80***** (0.117)	**0.85***** (0.102)
LAB	-0.01 (0.196)	0.00 (0.196)	-0.09 (0.195)
HC	0.31 (0.187)	0.23 (0.191)	0.15 (0.194)

Notes: This table shows correlations between industry rankings based on different technological measures - Fixed capital (FIX), Depreciation (DEP), Obsolescence (ETC), R&D (RND), Investment lumpiness (LMP), Labor intensity (LAB) , Human capital (HC) - and external finance dependence (EFD), computed for three time periods: the 1970s, 1980s and 1990s. Standard errors are reported in parentheses. One, two and three asterisks indicate statistical significance at the 10%, 5% and 1% levels respectively.

Table 5: Correlations between R&D intensity and EFD at the firm level

		1970s	*1980s*	*1990s*
All Firms	Correlaton	**0.103*****	**0.481*****	**0.591*****
	StDeviation	(0.014)	(0.011)	(0.009)
	Obs	4869	6209	7748
Manufacturing Only	Correlation	**0.112*****	**0.511*****	**0.614*****
	StDeviation	(0.013)	(0.013)	(0.011)
	Obs	2794	3520	4073
Manufacturing with industry fixed effects	Correlation	**0.081*****	**0.503*****	**0.605*****
	StDeviation	(0.031)	(0.030)	(0.034)
	Obs	2794	3520	4073

Notes: This table shows the firm-level correlations between R&D intensity (RND) and external finance dependence (EFD), computed for three time periods: the 1970s, 1980s and 1990s. Standard errors are reported in parentheses. One, two and three asterisks indicate statistical significance at the 10%, 5% and 1% levels respectively.

Table 6: Cross-country Industry Growth Regressions with CRE as a Measure of Financial Development

Interaction Variables $\hat{X}$	**Regression Specification**					
	CRE/1970s		*CRE/1980s*		*CRE/1990s*	
	Coefficients	R^2	Coefficients	R^2	Coefficients	R^2
$\widehat{EFD}$	**0.030*** (0.018)	0.42	**0.033**** (0.015)	0.38	0.022 (0.017)	0.30
$\widehat{FIX}$	**-0.031*** (0.018)	0.42	-0.009 (0.032)	0.38	-0.242 (0.019)	0.30
$\widehat{DEP}$	0.024 (0.018)	0.42	**0.036*** (0.019)	0.38	0.033 (0.023)	0.30
$\widehat{LMP}$	**0.054***** (0.020)	0.42	**0.037**** (0.017)	0.38	0.028 (0.020)	0.30
$\widehat{ETC}$	-0.009 (0.013)	0.42	0.014 (0.022)	0.38	0.005 (0.017)	0.30
$\widehat{RND}$	**0.035*** (0.020)	0.42	**0.049***** (0.017)	0.39	**0.038**** (0.018)	0.30
$\widehat{LAB}$	0.027 (0.017)	0.42	-0.015 (0.028)	0.38	0.029 (0.023)	0.30
$\widehat{HC}$	0.001 (0.016)	0.42	**0.055**** (0.026)	0.39	0.005 (0.018)	0.30

Notes: This table presents the results of the panel regression estimation of equation (1), with industry shares, industry and country fixed effects, and the interaction term(s) of EFD or of technological measure X with financial development (denoted $\hat{X}$). Equation (1) is $g_{i,c} = \alpha_i + \beta_c + \gamma \times SHARE_{i,c} + \delta X_{ki} \times FD_c + \varepsilon_{i,c}$, where the dependent variable $g_{i,c}$ is industry growth. The technological measures are Fixed capital (FIX), Depreciation (DEP), Obsolescence (ETC), R&D (RND), Investment lumpiness (LMP), Labor intensity (LAB), Human capital (HC). Only regression coefficients and standard errors for $\hat{X}$'s are reported. Each cell represents a regression. In this table, the financial development indicator is CRE = Private Credit/GDP and the sample period covers the 1970s, the 1980s and the 1990s. Results are corrected for heteroskedasticity using the Huber-White procedure. Standard errors are reported in parentheses. One, two and three asterisks indicate statistical significance at the 10%, 5% and 1% levels respectively.

The number of observations is 1034 in the 1970s, 1084 in the 1980s and 968 in the 1990s.

Table 7: The "Horse Race" between $\widehat{\mathrm{EFD}}$, $\widehat{\mathrm{LMP}}$ and $\widehat{\mathrm{RND}}$

Interaction Variables $\hat{X}$	**Regression Specification**					
	CRE/1970s		*CRE/1980s*		*CRE/1990s*	
	Coefficients	R^2	Coefficients	R^2	Coefficients	R^2
$\widehat{\mathrm{EFD}}$	0.014 (0.016)	0.42	-0.024 (0.026)	0.38	-0.045 (0.040)	0.30
$\widehat{\mathrm{RND}}$	0.008 (0.022)		**0.065**** (0.031)		**0.072*** (0.040)	
$\widehat{\mathrm{LMP}}$	**0.045**** (0.023)		0.005 (0.024)		0.010 (0.022)	

Notes: This table presents the results of the panel regression equation (1) with industry shares, industry and country fixed effects, and the interaction term(s) of EFD and RND with financial development (denoted $\hat{X}$). Equation (1) is $g_{i,c} = \alpha_i + \beta_c + \gamma \times SHARE_{i,c} + \delta X_{ki} \times FD_c + \varepsilon_{i,c}$, where the dependent variable $g_{i,c}$ is industry growth.

In this case, a column represents a regression. Only regression coefficients and standard errors for $\hat{X}$'s are reported. Results are corrected for heteroskedasticity using the Huber-White procedure. One, two and three asterisks indicate statistical significance at the 10%, 5% and 1% levels respectively.

Table 8: Cross-country Industry Growth Regressions with CAP as a Measure of Financial Development

Interaction Variables $\hat{X}$	Regression Specification					
	CAP/1980s		*CAP/1990s*		*STOCK/1980s*	
	Coefficients	R^2	Coefficients	R^2	Coefficients	R^2
$\widehat{EFD}$	**0.038**** (0.015)	0.39	0.014 (0.016)	0.30	**0.035**** (0.015)	0.38
$\widehat{FIX}$	-0.004 (0.022)	0.38	-0.020 (0.019)	0.30	-0.002 (0.019)	0.38
$\widehat{DEP}$	**0.037*** (0.019)	0.39	0.036 (0.022)	0.30	**0.029*** (0.017)	0.38
$\widehat{LMP}$	**0.039**** (0.017)	0.39	0.021 (0.019)	0.30	**0.031*** (0.017)	0.38
$\widehat{ETC}$	0.020 (0.015)	0.38	-0.006 (0.017)	0.30	0.021 (0.015)	0.38
$\widehat{RND}$	**0.048***** (0.017)	0.39	**0.032*** (0.017)	0.30	**0.037**** (0.015)	0.39
$\widehat{LAB}$	-0.009 (0.020)	0.38	0.033 (0.021)	0.30	-0.002 (0.018)	0.38
$\widehat{HC}$	**0.055**** (0.025)	0.39	0.009 (0.018)	0.30	**0.043**** (0.021)	0.39

Notes: This table presents the results of the panel regression estimation of equation (1), with industry shares, industry and country fixed effects, and the interaction term(s) of EFD or of technological measure X with financial development (denoted $\hat{X}$). Equation (1) is $g_{i,c} = \alpha_i + \beta_c + \gamma \times SHARE_{i,c} + \delta X_{ki} \times FD_c + \varepsilon_{i,c}$, where the dependent variable $g_{i,c}$ is industry growth. The technological measures are Fixed capital (FIX), Depreciation (DEP), Obsolescence (ETC), R&D (RND), Investment lumpiness (LMP), Labor intensity (LAB), Human capital (HC).. Only regression coefficients and standard errors for $\hat{X}$'s are reported. Each cell represents a regression. In this table, the financial development indicator is CAP = (Domestic Private Credit + Domestic Market Capitalization)/GDP and the sample period is the 1980s and the 1990s. STOCK is CAP-CRE. Results are corrected for heteroskedasticity using the Huber-White procedure. One, two and three asterisks indicate statistical significance at the 10%, 5% and 1% levels respectively.

Table 9: Correlations of Technological Measures with FL

	FL		
	1970s	***1980s***	***1990s***
EFD	0.31 (0.19)	**0.74***** (0.013)	**0.85***** (0.010)
LMP	0.24 (0.19)	**0.62***** (0.15)	**0.50***** (0.17)
RND	0.19 (0.19)	**0.72***** (0.14)	**0.84***** (0.11)

Notes: This table shows correlations between industry rankings based on different technological measures – growth opportunities (FL), R&D (RND), Investment lumpiness (LMP), and external finance dependence (EFD), computed for three time periods: the 1970s, 1980s and 1990s. Standard errors are reported in parentheses. One, two and three asterisks indicate statistical significance at the 10%, 5% and 1% levels respectively.

Table 10: Correlations of Institutional Measures with CRE

	LAW	ENFOR	EXEC	DEMO	PTNT	COPY
CRE/80	**0.53***** (0.14)	**0.32**** (0.15)	**0.28*** (0.15)	**0.46***** (0.15)	**0.56***** (0.14)	**0.65***** (0.12)
CAP/80	**0.46***** (0.15)	**0.49***** (0.14)	**0.26*** (0.15)	**0.41***** (0.15)	**0.51***** (0.14)	**0.62***** (0.13)

Notes: This table shows correlations between country rankings based on different financial development and institutional measures – credit-to-GDP ratio (CRE/80), capitalization-to-GDP ratio (CAP/80), law and order (LAW), contract enforcement (ENFOR), constraints on the executive (EXEC), democratic accountability (DEMO), patent enforcement (PTNT) and copyright enforcement (COPY). Standard errors are reported in parentheses. One, two and three asterisks indicate statistical significance at the 10%, 5% and 1% levels respectively.

Table 11: Institutional Underpinnings of Financial Development

Interaction Variables $\hat{X}$	Regression Specification					
	LAW/1980s		*DEMO/1980s*		*EXEC/1980s*	
	Coefficients	R^2	Coefficients	R^2	Coefficients	R^2
$\widehat{EFD}$	**0.034**** (0.016)	0.38	0.028 (0.018)	0.38	0.014 (0.017)	0.38
$\widehat{LMP}$	-0.003 (0.018)	0.38	-0.002 (0.018)	0.38	-0.010 (0.017)	0.38
$\widehat{RND}$	**0.035**** (0.017)	0.39	0.028 (0.020)	0.38	0.007 (0.018)	0.38

Interaction Variables $\hat{X}$	Regression Specification					
	ENFOR		*PTNT/1980s*		*COPY*	
	Coefficients	R^2	Coefficients	R^2	Coefficients	R^2
$\widehat{EFD}$	0.020 (0.014)	0.38	0.014 (0.017)	0.38	**0.039**** (0.016)	0.39
$\widehat{LMP}$	0.015 (0.015)	0.38	-0.010 (0.017)	0.38	0.014 (0.018)	0.38
$\widehat{RND}$	0.017 (0.014)	0.38	0.007 (0.018)	0.38	**0.047***** (0.018)	0.39

Notes: This table presents the results of the panel regression estimation of equation (1), with industry shares, industry and country fixed effects, and the interaction term(s) of EFD or of technological measure X with institutional measures (denoted $\hat{X}$). Equation (1) is $g_{i,c} = \alpha_i + \beta_c + \gamma \times SHARE_{i,c} + \delta X_{ki} \times FD_c + \varepsilon_{i,c}$, where the dependent variable $g_{i,c}$ is industry growth. The technological measures are R&D (RND) and Investment lumpiness (LMP). Only regression coefficients and standard errors for $\hat{X}$'s are reported. Each cell represents a regression. In this table, institutional development indicators are LAW= law and order, DEMO= democratic accountability, EXEC= constraints on the executive, ENFOR=contract enforcement, PTNT=patent enforcement and COPY=copyright enforcement. Results are corrected for heteroskedasticity using the Huber-White procedure. Standard errors are reported in parentheses. One, two and three asterisks indicate statistical significance at the 10%, 5% and 1% levels respectively.

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