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# Law, Stock Markets, and Innovation

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**Abstract:** We study a broad sample of firms across 32 countries and find that strong shareholder protections and better access to stock market financing lead to substantially higher long-run rates of R&D investment, particularly in small firms, but are unimportant for fixed capital investment. Credit market development has a modest impact on fixed investment but no impact on R&D. These findings connect law and stock markets with innovative activities key to economic growth, and show that legal rules and financial developments affecting the availability of external equity financing are particularly important for risky, intangible investments not easily financed with debt.

**Keywords:** Financial development; Investor protection; Stock markets; R&D; Innovation; Economic growth
**JEL Classification:** O16; O30; G32; K20

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An extensive literature shows that countries with legal systems providing strong protections for outside investors have larger, more accessible, and more developed stock markets (e.g., La Porta, Lopez-de-Silanes, and Shleifer (LLS; 2006, 2008)). Furthermore, a number of studies find evidence of a positive connection between stock market development and broad measures of economic growth (e.g., Levine and Zervos (1998) and Bekaert, Harvey, and Lundblad (2005)). The literature provides much less evidence, however, directly linking law and finance with firm-level activities that promote economic growth. The evidence that does exist indicates that the causal connections work principally through productivity growth rather than physical capital accumulation (see the Levine (2005) survey). For example, Acemoglu and Johnson (2005) find that legal "contracting institutions" promote stock market development but have no effect on aggregate investment in fixed capital, and Bekaert, Harvey, and Lundblad (2011) show that stock market liberalizations have a substantial impact on aggregate productivity but a relatively limited impact on fixed investment.

In this study we identify a causal mechanism directly linking law and stock markets with a firm-level investment critical for innovation and productivity growth. Our main idea is that access to stock market financing is particularly important for investment in research and development (R&D) because the nature of R&D sharply limits firms' ability to use debt finance. In particular, R&D investments are intangible and offer little or no collateral value. In addition, since creditors share only in downside returns, the design of standard debt contracts does not work well for financing innovative investments characterized by a high probability of failure but some chance of extremely large upside returns. Supporting the idea that debt is poorly suited for funding R&D, a large empirical literature finds a strong negative association between R&D and leverage across firms (see the Hall and Lerner (2010) survey). In contrast to R&D, fixed capital investments have collateral value and are typically less risky (e.g., often not investment in new technologies), making them easier to finance with debt if access to external equity is limited. Thus, legal rules and financial developments that increase long-

run access to stock market financing are potentially much more important for innovation and R&D-led productivity growth than for physical capital accumulation.

We test these ideas by exploring how the type and amount of funding available from domestic financial markets affects long-run levels of firm investment in both R&D and fixed capital. Using multiple measures of the access that firms in a given country have to both equity and debt financing, we focus on four main empirical predictions that, to our knowledge, have not been evaluated previously. First, we expect better access to stock market financing at the country level to have a positive effect on firm-level rates of R&D investment. Second, we expect the availability of stock market financing to have the strongest effect on R&D investment in smaller and younger firms, as these firms are most likely to require external finance to fully fund investment demand. Third, credit market access should be much less important than stock market access for R&D investment, given the shortcomings of debt for funding R&D. Finally, stock markets should matter less for fixed capital investment than R&D, since firms can more readily substitute debt for equity.

To evaluate these predictions, we adopt the difference-in-difference methodology that Rajan and Zingales (RZ; 1998) use to identify the causal connection between financial development and industry-level growth. The key insight in RZ is that if finance matters for growth, it should have a relatively stronger effect on the growth of industries that are more technologically dependent on external funds. This insight should extend to the firm level: if access to external finance matters for firm-level investment, it should matter most for firms located in industries with a relatively high technological demand for external funds.

We analyze approximately 5,300 firms across 32 countries over the period 1990 to 2007 and find strong support for our main predictions. In particular, access to stock market funding is especially important for R&D investment in smaller and younger firms, but has little or no impact on R&D investment in larger, more mature companies. Specifically, our preferred estimates indicate that small-firm R&D (scaled by assets) in an industry highly dependent on external finance like

Instruments (75th percentile in dependence) will be 0.022 higher than in a low-dependence industry like Textiles (25th percentile), in a country with high stock market access like the Netherlands (75th percentile in stock market access) compared to a country with limited stock market access like South Africa (25th percentile). This *differential* effect of stock market access on small-firm R&D is approximately one-third of the average small-firm R&D intensity, and thus establishes an economically important connection between access to stock market financing and innovative investment at the firm level. In sharp contrast, we find no evidence of a connection between access to stock market financing and fixed investment. Finally, while we find some evidence that access to credit matters for fixed investment, we find no evidence that access to credit matters for R&D.

We also estimate the RZ regressions using legal rules and institutions as instruments for the country-level measures of stock market access. A large literature treats legal rules as exogenous determinants of financial market development, and of particular importance for our study, legal rules offering protection for minority investors and enforcement of private contracts appear to be especially important determinates of access to *stock market* financing (e.g., La Porta et al. (LLSV; 1997, 1998) and LLS (2006)). Estimates from this instrumental variables approach indicate that exogenous variation in access to external equity, caused by differences in legal rules across countries, has an economically large and statistically significant effect on firm-level investment in R&D. These results are of interest not only because they provide strong support for a causal connection between stock market access and R&D investment, but also because, despite considerable evidence that law affects financial development, it has generally been difficult to connect law to real activities that drive economic growth (see the discussion in LLS (2008)). Our findings suggest that the financing of firm-level innovative activity is one such channel.

If law and stock markets matter for innovative investment in the way we have argued, there are three additional implications. First, access to external equity should also be important for broader measures of intangible assets that, like R&D, may be difficult to finance with debt; indeed, we find a

strong positive connection between stock market access and intangible assets-to-fixed assets ratios for small firms but not large firms. Second, R&D is an important input for growth, suggesting that better access to stock market financing should have a positive impact on firm growth rates, particularly among the firms most dependent on external sources to fund growth-enhancing investments. We find a positive and significant relation between stock market access and rates of small-firm growth in both value-added and productivity. Finally, our findings suggest that legal rules affecting the availability of stock market financing will have an important influence on how R&D is actually financed at the firm level. Consistent with this expectation, we find that firms in countries with strong legal investor protections use significantly more external equity and have long-run R&D levels that are less tied to internally generated cash flows.

Overall, our findings provide robust evidence that legal rules and financial market developments that increase access to stock market financing have a substantial positive impact on innovative investment at the firm level, but are much less important for firm investment in fixed capital. We are aware of no other studies that establish these connections between law, stock markets, and innovative investment, or show that legal rules and the structure of financial markets have very different effects across R&D and fixed investment. Given the importance of firm-level R&D investment for productivity and technological change (e.g., Griliches (1998) and Aghion and Howitt (1992)), these findings establish a previously unexplored channel connecting law and stock markets with economic growth.

Our results are especially relevant for a set of related literatures that study how legal and financial institutions affect real activity. First, our evidence showing that productivity-enhancing R&D investments are particularly dependent on the *funding* supplied by stock markets can explain why stock market developments and liberalizations – which presumably lead to permanent increases in the supply of external equity finance – have long-lasting effects on productivity and economic growth (e.g., Bekaert, Harvey, and Lundblad (2011)). Second, an influential branch of modern

growth theory emphasizes innovation and creative destruction by new entrants (e.g., Aghion and Howitt (1992)) and our findings are useful for understanding the role of stock markets in funding this process. Third, our findings contribute to the debate about the relative merits of market- and bank-based financial systems (e.g., Levine (2005)) by identifying a channel through which market-based systems should have an advantage in funding growth-enhancing real activities. Fourth, while there is strong evidence that legal rules governing private contracting affect *how* investment is financed, there is little evidence that such rules affect the type or amount of investment that is undertaken. Legal rules may not matter much for investment when firms can use debt to contract around weak legal investor protections (e.g., Acemoglu and Johnson (2005)); our findings, however, suggest that strong contracting institutions can matter a great deal for investments such as R&D that are not readily financed with debt. Finally, our study contributes to the debate concerning whether financial development disproportionately helps small or large firms (e.g., Beck et al. (2008)).

Our insights on the causal mechanisms linking law, finance, innovative investment, and growth differ substantially from other studies that examine related issues. Comparatively few empirical studies in the finance and growth literature focus specifically on R&D and innovation, and the studies that do (e.g., Aghion et al. (2012) and Pienknagura (2010)) do not emphasize the special importance of stock markets and legal investor protections for R&D.[1] Similarly, related studies argue that the *overall* level of financial development and the quality of legal rules protecting private property can affect the mix of tangible and intangible assets at the industry level (e.g., Braun (2003) and Claessens and Laeven (2003)), but provide no intuition or evidence that the *type* of financial development and the quality of legal *investor* protections matter for R&D investment and the accumulation of intangible assets. Finally, several studies document a connection between credit market development and growth, and others discuss the potential for finance to foster growth via the influence it has on fixed investment.[2] Our conclusions are in no way inconsistent with this literature, and though we emphasize the importance of a stock market-R&D connection for understanding the

finance-growth nexus, our findings do not rule out alternative channels through which finance (including credit markets) can affect growth. Our results do, however, suggest that credit market development promotes growth through channels other than the "financing innovation" channel we emphasize, and that stock market access may be particularly important in situations in which growth is driven primarily by intangible inputs rather than physical capital accumulation.

Section I describes data, variables, and sample characteristics. Section II reports the difference-in-difference results based on the RZ approach. Section III presents evidence on how the legal environment influences the financing of R&D. We summarize the key findings and discuss the most important implications in Section IV.

## I. Data, Measurement, and Sample Characteristics

### *A. Sample Construction*

To construct the sample we start with standardized financial statement information for firms with coverage in Compustat Global and Compustat North America over the period 1990 to 2007. We focus on firm-level evidence because: i) there is extensive heterogeneity in the need for external finance across firms, which we exploit in our empirical tests, ii) country-level data include R&D by universities and other organizations not relevant for our hypothesis, and iii) there is little evidence on the real impact that law and finance has at the firm level.[3] We focus on firms that report fully consolidated financial statements and we exclude all firms with a primary industry classification in financials (SIC 6000-6999) and utilities (SIC 4900-4999). We also drop firms without at least three nonmissing R&D observations and firms with no information on employment, which we use to identify small and large firms.[4] Finally, we exclude all U.S. firms from the sample because in the RZ approach the U.S. is the benchmark for constructing measures of industry-level technological dependence on external funds.

To construct the firm-level variables we start by scaling all variables by total assets and Winsorizing the ratios at the 1% level. (All of our findings are robust to normalizing by sales rather

than total assets or using alternative approaches to deal with potential outliers.) We then calculate average values for each firm based on all nonmissing ratios over the sample period. We focus on average values across firms, rather than yearly variation within firms, because we are interested in the *long-run* connection between stock market access and investment at the firm level. It is especially problematic to use yearly variation to measure how access to external equity finance affects R&D because high adjustment costs likely cause firms to keep the path of R&D spending far smoother than stock issues, which are lumpy by nature and fluctuate sharply year-to-year (Brown and Petersen (2011)).

We next merge the firm-level data with country-level economic, legal, and financial statistics collected from several different sources. Table I contains definitions and data sources for each of the key variables in our study. The final sample consists of approximately 5,300 firms across 32 countries.[5] Table AI in the Appendix lists the 32 countries in the sample and presents key statistics on country income, legal rules, and financial market development. As in other studies relying on international firm-level data (e.g., McLean, Zhang, and Zhao (2012)), firm counts differ substantially across the countries we sample. Japan contributes a large share of the observations, partially because it is the largest economy in the study. We report results for a sample that excludes the countries contributing the largest share of firms in the robustness section.

**[Insert Table I here]**

*B. Measuring Access to External Finance*

Our focus is on the type of external finance that is available for firm investment, rather than simply the overall level of financial development. Our primary measure of access to stock market financing is based on actual use of external equity finance by firms in a given country. To construct this variable, we find the average ratio of net equity issues to total assets for all firms in our sample and then compute the country average across firms (*Country equity issues*). We also report results using the country's average ratio of equity issued by newly public firms to GDP over the period 1996

to 2000 (*IPOs/GDP*). This proxy is used by LLSV (1997) and LLS (2006) and should also be a good measure of the access that younger and smaller firms have to public equity markets. Both *Country equity issues* and *IPOs/GDP* fit with Wachtel's (2011) suggestion that measures of financial development should capture the degree to which new enterprises are able to access external financing. Also supporting the use of these equity funding measures, RZ note that dollars raised on country stock markets is potentially the most appropriate way to measure financial market development, but they do not use such a measure because of lack of data. Instead, their primary measure of financial development is a country's accounting standards (*Accounting standards*), which we also use to link our results to those in RZ. Of particular importance to our study, RZ (p. 571) argue that "the higher the standards of financial disclosure in a country, the easier it will be for firms to raise funds from a wider circle of investors." The "wider circle of investors" suggests that *Accounting standards* should be a particularly good proxy for ease of access to external *equity* finance, since unlike a bank loan, external equity is typically raised from large numbers of individual investors, each of whom may find that the fixed costs of information acquisition are prohibitive unless the accounting information released by the firm is of high quality.[6] Consistent with this idea, *Accounting standards* is strongly correlated with both *Country equity issues* and *IPOs/GDP* across the countries in our sample.

All three of the above measures return very similar results, as do a number of alternative measures that should also be good proxies for firm access to stock market financing (discussed in the next section). We also examine the stock market capitalization-to-GDP ratio (*MCAP/GDP*), a broad measure of stock market development used in a number of other studies. We get somewhat weaker results with the market capitalization ratio than with the other stock market measures, likely because market capitalization can be a relatively poor measure of the actual funding available from domestic equity markets.[7] These weaker findings are consistent with a number of studies reporting that stock market capitalization is not strongly associated with either increased use of stock market financing

(e.g., McLean, Zhang, and Zhao (2012)) or faster growth (e.g., Levine and Zervos (1998), Demirgüç-Kunt and Maksimovic (1998), and Beck and Levine (2004)).[8]

We use two proxies to measure firm access to credit markets. The first is private domestic credit-to-GDP (*Credit/GDP*), the standard measure of credit market development used in numerous prior studies, including RZ. However, like *MCAP/GDP*, while *Credit/GDP* may capture some cross-country differences in the overall stage of development, it appears to be a relatively weak proxy for the access listed firms have to external debt funding. For example, LLSV (1997) find similar use of debt among publicly traded firms regardless of country legal origin or credit market depth, and McLean, Zhang, and Zhao (2012) find no evidence that private credit-to-GDP is associated with reduced financing difficulties for listed firms. We therefore also examine the value-weighted average debt-to-assets ratio across all sampled firms in a given country (*Country-weighted leverage*), which should be a better and more direct proxy for the ability of listed firms in a country to borrow.[9]

*C. Firm-Level Characteristics*

A key argument in our study is that access to external equity should be relatively more important for smaller and younger firms, since they are more likely to depend, ex ante, on costly external finance from domestic capital markets to fund investment demand. Size and age are widely used criteria for identifying the firms most likely (a priori) to rely on costly external finance. For example, Beck, Demirgüç-Kunt, and Maksimovic (2005) show that financial underdevelopment constrains growth in small firms much more than large firms, and Figure 1 in RZ shows that publicly traded U.S. firms issue stock primarily in the early part of their life cycle, suggesting that the technological demand for external funding is particularly pronounced in younger firms.

We use the number of employees to measure firm size, which is readily comparable across countries and is a standard way to sort firms into different size categories (e.g., Beck, Demirgüç-Kunt, and Maksimovic (2005)). We consider firms "small" if their average level of employment over the sample period is in the bottom 70% of all sampled firms, and we show in an Internet Appendix that

the results are similar if we base the splits on the median value across firms or the relative size of firms within a given country.[10] We proxy for relative age based on the years since the firm first appears in Compustat. We consider firms that first appear in Compustat by 1990 as "mature," and those appearing after 1990 as "young."

Table II reports summary statistics for both the full sample of firms as well as the small and large subsamples (statistics for the young/mature subsamples are similar to those for the small/large subsamples). Four facts are worth noting. First, R&D is a large share of total investment (e.g., in the full sample, average R&D and fixed investment ratios are similar). Second, small firms are more R&D intensive than large firms, consistent with a Schumpeterian view of creative destruction whereby new entrants use innovation to challenge established incumbents (e.g., Aghion and Howitt (1992)). Third, on average, small-firm R&D is large relative to cash flow, suggesting that small firms are likely dependent on external finance. Finally, external equity issues are a key source of external finance for small firms, but not for large firms. These statistics suggest that access to stock market financing may be most important for small firms, as the typical large firm appears much less dependent on external finance to fund investment demand.

**[Insert Table II here]**

## II. Financial Development and Innovative Investment

### *A. Rajan and Zingales Difference-in-Difference Approach*

To evaluate how cross-country differences in access to external equity affect investment at the firm level, we adopt the widely used identification strategy developed by Rajan and Zingales (1998) in their seminal study on finance and economic growth. RZ argue that industries that are technologically more dependent on external finance should gain more from financial development than industries that require relatively little external finance. Extending the RZ tests to the firm level, we examine how the *interaction* between an industry's technological dependence on external finance ($ExternalDepend_j$) and the country's overall level of financial development ($FinDevelop_k$) affects

firm-level investment, after controlling for firm characteristics, industry fixed effects, and country fixed effects.[11]

The main regression is:

$$R\&D_{ijk} = \gamma_0 + \gamma_1 ExternalDepend_j * FinDevelop_k + \boldsymbol{\gamma_2 X}_{ijk} + \lambda_k + \omega_j + \varepsilon_{ijk,} \quad (1)$$

where $R\&D_{ijk}$ is R&D investment by firm *i* in industry *j* and country *k*. As in RZ, $ExternalDepend_j$ is industry *j*'s dependence on external finance, computed as the difference between investment spending and cash generated from operations for the median firm in each two-digit SIC industry in the U.S. over the period 1990 to 2007.[12] This approach assumes that publicly traded U.S. firms face relatively frictionless capital markets and their use of external finance is therefore driven primarily by technological demand. The second component of the interaction term, $FinDevelop_k$, is the access firms in country *k* have to external finance using the various measures of financial development discussed in Section I. In addition, $\boldsymbol{X}_{ijk}$ is a vector of firm-specific control variables: age, internally generated cash flow, sales, and sales growth. All firm-level variables except age and sales growth are scaled by the book value of total assets. The specification includes both country fixed effects ($\lambda_k$) and industry fixed effects ($\omega_j$). Notably, the country fixed effects control for any time-invariant country-specific factors that affect firm-level R&D investment through nonfinancial channels, such as the extent of intellectual property protection or the appetite for risk taking.

If access to external equity finance matters for R&D investment, as we have argued, then the logic of RZ suggests that better access to stock market financing will have the strongest effect on R&D investment in firms located in industries with a relatively high technological demand for external finance. Thus, our main empirical prediction is a positive and economically substantial estimate of $\gamma_1$ in equation (1) when $FinDevelop_k$ reflects the access that firms in a given country have to stock market funding. In contrast, we expect $\gamma_1 \approx 0$ when the financial development measures

reflect access to debt finance, given the theoretical arguments and empirical evidence suggesting that debt is poorly suited to financing risky, intangible investments like R&D.[13]

*B. Baseline Results for R&D*

Table III reports OLS estimates of $\gamma_1$ in equation (1) using the five alternative measures of financial development discussed above. Standard errors robust to clustering at the country level are reported in parentheses. We start in the first column with our preferred measure of stock market access based on actual stock issues in each country (*Country equity issues*). The coefficient estimate on the interaction between industry dependence on external finance and country equity issues is positive and statistically significant at the 1% level, indicating that better access to stock market financing has a relatively stronger positive effect on R&D intensity in firms located in industries that are relatively more dependent on external finance.

To evaluate the quantitative magnitude of the coefficient estimate, we follow RZ and compute a "differential in R&D intensity" by comparing the difference in predicted R&D intensity in high- and low-financially dependent industries across countries with high and low financial development measures. We report this value in the final row of Table III. The industry at the 75$^{th}$ percentile of financial dependence is Instruments and the industry at the 25$^{th}$ percentile is Textiles. The country at the 75$^{th}$ percentile of financial development (based on *Country equity issues*) is the Netherlands and at the 25$^{th}$ percentile is South Africa. The estimate in column (1) of Table III predicts that, on average, long-run R&D intensity for firms in the Instruments industry should be 0.015 higher than R&D intensity for firms in the Textiles industry in a high stock issue country such as the Netherlands, as compared to a low stock issue country such as South Africa. This predicted *differential* effect is approximately 30% of the average R&D intensity in the overall sample, suggesting a quantitatively important impact.

In the next two columns of Table III we examine alternative measures of stock market development and access. The results for *Accounting standards* are reported in column (2): the interaction coefficient is positive and significant at the 1% level and the differential in R&D intensity (0.014) is very similar to the results using *Country equity issues*. In column (3) we report results for *IPOs/GDP* and again find a positive, significant, and economically substantial coefficient on the key interaction term. Finally, columns (4) and (5) report results using the proxies for access to credit markets (*Country-weighted leverage* and *Credit/GDP*). As expected, the findings differ markedly from the results using measures of stock market access. In particular, the coefficient estimates on the key interaction term are negative (though statistically insignificant), indicating that credit market access has no impact on R&D intensity across high- and low-financially dependent industries.

**[Insert Table III here]**

Given the importance of the connection between access to stock market financing and R&D for our study, we also estimate equation (1) using a number of alternative measures of stock market access and development. These results are presented in the Internet Appendix. Notably, we obtain very similar results to those reported in Table III if we use: i) a measure of *Country equity issues* constructed from stock issues by small firms only, ii) the number of domestic listed firms relative to the overall population (used by LLSV (1997) and LLS (2006)), iii) the "access to equity" index developed by Schwab et al. (1999), or iv) the ratio of total market capitalization held by small investors scaled by GDP (used by LLS (2006)). As mentioned above, we get weaker results using the overall stock market capitalization-to-GDP ratio (*MCAP/GDP*), likely because it is a relatively poor measure of the access listed firms have to the actual funding available from domestic stock markets.

*C. Legal Rules and Institutions as Instruments*

In Table IV we follow an extensive literature and rely on predetermined legal variables as instruments for the stock market development measures. The legal system is an important determinant of cross-country differences in access to external finance (e.g., Demirgüç-Kunt and

Maksimovic (2002), Beck and Levine (2005), and LLS (2008)) and, of particular relevance for our study, the evidence in LLSV (1997) suggests that legal investor protections matter much more for access to external equity finance than for access to debt finance (e.g., see Tables IV to VI compared to Table VII in LLSV (1997)). In column (1) we report two-stage least squares (IV) estimates of equation (1) using a dummy variable equal to one if a country is of common law legal origin (*Legal origin*) to instrument for *Country equity issues*. Legal origin is widely used to instrument for financial development because it is arguably exogenous to contemporary economic and financial development.[14] The IV estimate on the key interaction term is statistically significant at the 5% level and the magnitude (0.359) is only slightly smaller than the corresponding OLS estimate in Table III. In column (2) we replace *Legal origin* with an index from Djankov et al. (DLLS, 2008) measuring the extent to which contracts are enforced (*Enforcement*) and find an even stronger effect of stock market access on firm-level R&D. In column (3) we use both *Legal origin* and *Enforcement* as instruments, similar to the IV approach in RZ; the point estimate of 0.444 is statistically significant at the 1% level and very similar in both magnitude and precision to the corresponding OLS estimate in Table III. In column (4), we replace *Legal origin* with the shareholder protection measure that DLLS (2008) develop to measure the legal protection of minority investors against self-dealing and expropriation by corporate insiders (*ASD*). Using *ASD* and *Enforcement* as instruments also returns a point estimate similar to the corresponding OLS estimate in Table III. Finally, in columns (5) and (6) we use *Legal origin* and *Enforcement* to instrument for *Accounting standards* and *IPOs/GDP*, respectively. The estimated coefficients are statistically significant at the 5% level or better and are somewhat larger than the corresponding point estimates in Table III.

Overall, the IV results in Table IV support the baseline results in Table III indicating that access to stock market financing has an economically important effect on innovative investment at the firm level. In addition to dealing with the potential endogeneity of the stock market measures, these

results highlight a causal mechanism through which legal institutions can affect important real economic activities, a point we return to in Sections III and IV.

**[Insert Table IV here]**

*D. R&D Results across Firm Types*

We expect access to stock market financing to matter most for R&D investment in firms that depend most on external finance to fund investment demand. We test this by estimating $\gamma_I$ in equation (1) separately for groups of firms sorted based on both size and age. We report separate results for subsamples of small and large firms in Panel A of Table V, and separate results for young and mature firms in Panel B. In the first six columns we report OLS results for our three main measures of stock market access (*Country equity issues*, *Accounting standards*, and *IPOs/GDP*), and in the final two columns we report IV results where *Legal origin* and *Enforcement* are used to instrument for *Country equity issues*. In each case, the key interaction term is positive and statistically significant in the small- and young-firm subsamples. Furthermore, the predicted R&D differentials are substantial: for example, using the OLS estimate for *Country equity issues* in column (1), the predicted R&D intensity for small firms in the Instruments industry is 0.022 higher than small-firm R&D intensity in Textiles in the Netherlands as compared to South Africa. In contrast, for the large- and mature-firm subsamples, the estimates of $\gamma_I$ are quantitatively small and generally statistically insignificant (the lone exception being the IV estimate for mature firms in the final column). Furthermore, in all cases the estimates of $\gamma_I$ are statistically different across the small/young and large/mature subsamples. These results increase confidence in our empirical approach because we find significant financial effects in the groups of firms that *should* be especially sensitive to stock market access.

**[Insert Table V here]**

*E. Alternative Samples and Approaches*

We find similar results using a number of alternative sampling and estimation approaches. We report the most important robustness checks in Table VI. For all of these checks we report OLS estimates using the *Country equity issues* measure of stock market access. First, column (1) reports results using an alternative measure of industry-level dependence on external finance: we compute financial dependence using only U.S. firms that are within 10 years since they first appear in Compustat. As the estimates show, we continue to find a positive and significant coefficient on the key interaction term, and the predicted R&D differential is quantitatively large and consistent with our baseline estimates in Table III. Similarly, in the Internet Appendix we show that our findings are also robust to computing the industry dependence measures using U.S. data from the 1980s, the decade preceding the start of our sample. Second, in column (2) we drop the restriction that firms must report R&D investment to be included in the sample by setting R&D to zero for any firm that never reports information on R&D expenditures (which sharply increases the number of observations). The estimates show a positive and significant coefficient on the key interaction term. Notice that although the absolute size of the R&D differential (0.005) in column (2) is considerably smaller than the figures reported above, the magnitude of this predicted differential remains substantial when evaluated *relative* to the new sample average, which falls by almost 60% (to 0.022) when we set missing R&D to zero. In columns (3) and (4) we exclude countries that contribute fewer than 50 firms (roughly the median number across countries in our sample) and continue to find positive, significant, and economically substantial results for small firms only. The main reason for this robustness test is to ensure that we have sufficient within-country variation across high- and low-dependence industries to obtain relatively precise coefficient estimates in both the small- and large-firm subsamples. Similarly, dropping the countries that contribute the largest number of firms to the sample – Canada, Japan, and the UK – reduces the sample size considerably but has no impact on our key findings for small and large firms (columns (5) and (6)).

**[Insert Table VI here]**

*F. Fixed Investment, Intangible Assets, and Firm Growth*

We now turn to three extensions of our main results. First, we expect the availability of stock market financing to have a much smaller quantitative impact on fixed investment than on R&D since firms should be better able to substitute debt for equity when it comes to funding investment in tangible fixed assets. In Table VII we report estimates of equation (1) with fixed investment replacing R&D as the dependent variable. Consistent with our priors, the interaction between industry external finance dependence and stock market access is quantitatively small (and actually slightly negative) for all three stock market measures (columns (1) to (3)). In contrast, the key interaction term is positive for both credit market measures (columns (4) and (5)), although only the *Country-weighted leverage* measure in column (4) is statistically significant. The results using *Country-weighted leverage* indicate that fixed capital investment for firms in the Instruments industry should be approximately 0.002 higher than fixed investment for firms in the Textiles industry in a high-leverage country such as Japan compared to a low-leverage country such as Israel. This predicted differential is around 4% of the sample average fixed investment intensity, suggesting that credit market access has a positive but relatively modest effect on fixed investment levels.[15]

**[Insert Table VII here]**

Second, our insights on the particular importance of stock market access for R&D investment should apply to other intangible assets within the firm that lack collateral value and therefore are likely difficult to finance with debt. We thus reestimate equation (1) with the firm-level ratio of intangible assets-to-net fixed assets replacing R&D as the dependent variable. Using the *Country equity issues* measure of stock market access, we report separate results for subsamples of small and large firms in the first two columns of Table VIII. The estimates show a positive and statistically significant coefficient on the key interaction term in the small-firm subsample, but a small and statistically insignificant estimate for large firms. Furthermore, the predicted small-firm intangible intensity differential is around 0.279, or roughly 20% of the sample average. We obtain similar

results with the other measures of stock market access (see the Internet Appendix). Thus, the overall results for intangible asset intensity are very similar to the results for R&D.[16]

Finally, since R&D is a key input for growth, our findings connecting R&D and access to stock market financing suggest that better access to stock markets should be associated with faster rates of firm growth, particularly in smaller and younger firms. We report direct evidence of such a connection in the final four columns of Table VIII. In columns (3) and (4) we examine the relation between *Country equity issues* and firm-level value-added growth (*Value-added growth*); in columns (5) and (6) we replace value-added growth with a proxy for growth in firm-level productivity (*Productivity growth*).[17] We again report separate results for small and large firms. In each case, *Country equity issues* shares a strong positive connection with value-added and productivity growth, but only among small firms. In the Internet Appendix we show that the results are similar if we measure stock market access with *Accounting standards* or *IPOs/GDP* instead of *Country equity issues*. Thus, we find direct evidence that access to stock market financing is associated with small-firm growth, consistent with the evidence we present linking stock markets with R&D investment and the accumulation of intangible assets.

There are reasons to expect that our results understate the full effect of stock markets on firm growth. For one, the spillovers associated with innovative investment can be substantial (e.g., Jones and Williams (1998)), in which case the relatively higher rates of R&D investment by firms in financially dependent industries can foster growth in firms located in other sectors of the economy. If so, our evidence above on the *differential* effects on firm growth across high- and low-dependence sectors will understate the importance of stock market access for firm-level growth. In addition, our sample is (necessarily) comprised entirely of listed firms, and better access to external finance may have even stronger effects on investment and growth in unlisted firms. Thus, our findings suggest a substantial connection between stock market access and firm growth rates, consistent with the strong

connection between finance and growth at the industry- and economy-wide levels documented in RZ and many other studies (e.g., Levine (2005)).

**[Insert Table VIII here]**

Together with the findings for R&D, the results in Tables VII and VIII yield several new insights on the effects financial development has on real economic activity and the causal channels through which finance fosters growth. In particular, our estimates indicate that innovative and intangible investments are much more sensitive to financial development than is firm investment in fixed capital. These results are consistent with the idea that firms have multiple options for financing fixed investment, making it less dependent on financial market development in general and stock market development in particular.[18] Furthermore, since access to stock market financing is positively associated with R&D, intangible assets, and firm growth rates, but not with fixed capital investment, these results suggest that access to stock market financing is especially important in situations in which growth is driven primarily by innovative and other intangible investments.

## III. Additional Tests: Legal Rules and Financing R&D at the Firm Level

Our findings support the idea that legal rules and financial developments affecting the long-run supply of external equity finance have a substantial impact on firm R&D investment. To further evaluate this 'financing R&D' channel, we now turn to some additional evidence connecting law and the financing of R&D at the firm level.[19]

### *A. Law and Firm Stock Issues*

If the causal channel we have emphasized is truly operational, we should observe more firm-level *use* of external equity finance when investor protections are strong and stock market funding is widely available. Further, this reliance on stock markets for funding should be most pronounced in smaller and younger firms that cannot fully fund investment demand with internal cash flow. As discussed above, many studies present evidence connecting legal rules with broad measures of stock

market development (e.g., LLS (2006)), but there is much less evidence directly connecting legal investor protections with the use of external equity at the firm level. To test this potential connection, we estimate the following specification:

$$Stock\ issues_{ijk} = \alpha_0 + \alpha_1 InvestorProtection_k + \boldsymbol{\alpha_2 X}_{ijk} + \boldsymbol{\alpha_3 Y}_k + \omega_j + \varepsilon_{ijk}. \quad (2)$$

Here, $Stock\ issues_{ijk}$ is the net issues of new external equity for firm *i* in industry *j* and country *k*. To measure $InvestorProtection_k$ we focus on both a country's legal origin (*Legal origin*) and the anti-self dealing index (*ASD*). In addition, $\boldsymbol{X}_{ijk}$ is the set of firm-level controls (age, sales, sales growth, and cash flow) used in equation (1) and $\boldsymbol{Y}_k$ is a vector of country-level controls used in a number of other studies on financial development and growth (e.g., Bekaert, Harvey, and Lundblad (2005)).[20] Finally, $\omega_j$ is an industry-specific fixed effect (defined at the two-digit SIC level) and $\varepsilon_{ijk}$ is a random error term.

Panel A in Table IX contains OLS estimates of equation (2). The results in the first column show that the use of external equity across all firms in our sample is significantly higher in countries with higher anti-self dealing measures (*ASD*), after controlling for the firm, country, and industry characteristics noted above. Further, estimating equation (2) separately for small and large firms shows that the quality of investor protections is a particularly important determinant of stock issues by small firms. For example, the coefficient estimate on *ASD* in the small-firm regression (column (2)) is 0.129, which indicates that, all else equal, moving from a country with an *ASD* value at the 25$^{th}$ percentile (Spain) to a country at the 75$^{th}$ percentile (Israel) increases the small-firm stock issues ratio by 0.044 (0.129*0.34). This effect is economically substantial (approximately 50% of the sample average for small firms). Furthermore, it suggests that stronger legal investor protections lead to greater reliance on stock markets for *funding*, which is a different benefit of stock market access than is typically emphasized in the literature. In columns (4) to (6) we measure investor protections with *Legal origin* rather than *ASD* and get very similar results.

**[Insert Table IX here]**

*B. Law, Internal and External Finance, and R&D*

The channel we emphasize requires that firms use the new equity issues examined in Panel A of Table IX to fund R&D. We directly test this idea by exploring the association between R&D investment and actual use of external equity financing across firms. Specifically, we regress firm R&D on the *firm-level* equity issues measure examined in equation (2). We include the same firm and country controls noted above and we use the country measures of legal investor protection to instrument for firm stock issues, which are clearly endogenous (thus, the regressions reported in Panel A are the "first stage" results in this two-stage (2SLS) regression). The results, which are reported in the Internet Appendix, show a very strong connection between R&D and firm-level equity issues in subsamples of small and young firms, but not large and mature firms. These findings indicate that cross-firm differences in external equity issues, caused by differences in legal investor protections across countries, have a substantial impact on long-run levels of small-firm R&D investment. These results support our emphasis on the importance of external equity for *funding* innovative investment and complement our main findings (from the RZ approach) linking country-level measures of stock market access with firm-level R&D.[21]

Given the importance of legal rules for firm access to stock market financing, and the difficulties firms should have financing R&D with debt, the evidence presented thus far suggests that financing constraints on R&D should be particularly tight whenever investor protections are weak and access to external equity is limited. If so, we expect firm R&D investment to be more dependent on *internally* generated funds whenever shareholder protections are weak. To test this implication, we compute the average (long-run) ratio of R&D to cash flow (*R&D/cash flow*) for all firms in our sample, and regress this ratio against investor protections and the country and firm controls used above (except, of course, we no longer control for internal cash flow). The results are reported in Panel B of Table IX. The first three columns show that the firm-level R&D-to-cash flow ratio is

significantly higher in countries with higher anti-self dealing measures, countries with common law legal origins, and countries with higher levels of *Country equity issues*, indicating that R&D investment is less closely tied to internal funds for firms located in countries with strong investor protections and better availability of stock market financing. The results in column (4) show that when both investor protections and *Country equity issues* are included in the specification, only *Country equity issues* shares a positive relation with *R&D/cash flow*. This finding suggests that legal investor protections matter for R&D via the impact they have on the availability of external equity financing. Columns (5) and (6) show that the positive connection between investor protections and *R&D/cash flow* is driven entirely by small firms, as large firms tend to have slightly lower *R&D/cash flow* ratios when investor protections are strong. These very different results for small and large firms suggest that strong investor protections can be valuable not only because, as we have emphasized, they allow otherwise constrained firms to increase R&D investment, but also because they constrain overinvestment by larger firms with ample free cash flow, thereby enhancing the *efficiency* of firm-level innovative investment.[22] Finally, we show in the Internet Appendix that the long-run ratio of fixed investment to cash flow is unrelated to the strength of legal investor protections, supporting our earlier evidence showing that fixed investment levels are much less sensitive to the availability of external equity finance.

## IV. Conclusions and Implications

We examine the causal connections between a country's legal system, the access firms have to stock market financing, and innovative investment at the firm level. We find that better access to stock market financing has a substantial positive effect on long-run levels of firm investment in R&D but no effect on firm investment in fixed capital. The availability of external equity is particularly important for R&D investment in smaller and younger firms. In contrast, credit market access is unimportant for firm rates of R&D investment. Further, our evidence indicates that the legal rules and

institutions driving cross-country differences in stock market access matter a great deal for innovative activity and have an important impact on the way that R&D investment is financed at the firm level. The underlying logic for this full set of findings is that debt is poorly suited to finance risky, intangible investments. Thus, when it comes to funding R&D, firms cannot easily substitute debt for any lack of external equity caused by weak shareholder protections and underdeveloped stock markets. Our study has implications for a number of important literatures, and highlights several areas for further research.

*A. What Connects Finance and Growth?*

In his review of the finance and growth literature, Levine (2005) emphasizes that physical investment does not appear to be important for understanding the finance-growth nexus, but rather what is required are "theories that describe how financial development influences resource allocation decisions in ways that foster productivity growth…." Of particular relevance to our study, there is strong evidence that the causal connections between stock markets and growth work through productivity growth rather than physical capital accumulation (e.g., Levine (2005) and Bekaert, Harvey, and Lundblad (2011)). Our study contributes to this literature by documenting a micro-level channel through which stock market developments can cause growth by supplying critical funds for productivity-enhancing R&D investments. In addition, these findings can help explain why stock market liberalization appears to have a long-lasting impact on growth rates (e.g., Bekaert, Harvey, and Lundblad (2005, 2011)): since liberalizations should lead to a permanent increase in the availability of external finance, our estimates suggest that liberalizations can bring about a long-lasting increase in firm-level rates of R&D, innovation, and productivity.

Our findings are also relevant for endogenous growth theory, particularly the Schumpeterian growth literature that emphasizes the entry of innovators with better products and technologies (e.g., see Aghion and Howitt (1992, 2006)). It is natural to think of the small (and young) firms in our study as innovative entrants. Our findings for these firms suggest that stock market financing should

be an important determinant of their ability to produce the superior technologies and products key to the Schumpeterian paradigm.

*B. Legal Systems and Real Activity*

Extensive evidence shows that a country's legal rules and the strength of its "contracting institutions" affect the nature and extent of its financial market development (e.g., LLSV (1997, 1998) and LLS (2006)). However, as LLS (2008) note, it has been difficult to "take the next step" and link law with aggregate economic performance. Our study highlights a potential next step by linking legal institutions with real activities that drive innovation and economic growth. In doing so, our results provide an important counterexample to Acemoglu and Johnson's (2005) argument that contracting institutions "may have limited effects on real activity because agents can use debt to contract around poor legal rules." While their argument may hold for fixed investment (the investment that they and most other studies focus on), our findings suggest that contracting institutions matter a great deal when it comes to funding innovation, as firms seeking to fund R&D likely have considerable difficulty substituting debt for equity.

*C. Does Financial Development Matter More for Small Firms?*

Beck et al. (2008) describe the debate surrounding whether financial development disproportionately helps small or large firms. They find that industries with a larger share of small firms (for technological reasons) grow faster in economies with well-developed financial systems. Our study contributes to this debate by showing that access to stock market financing matters much more for the R&D investment of small firms compared to large firms. Given our results, together with the findings in Beck et al. (2008) and related studies (e.g., Demirgüç-Kunt and Maksimovic (1998), Beck, Demirgüç-Kunt, and Maksimovic (2005)), it appears that the preponderance of evidence points to financial development disproportionately impacting small firms.

*D. Does Financial Architecture Matter?*

Holding constant the overall level of financial development, the prevailing view appears to be that whether a country is bank- or market-based does not have a substantial impact on the real side of the economy (e.g., see the review in Levine (2005)). Our research identifies an unexplored channel through which the structure of financial markets can matter: market-based financial systems should have a clear advantage in funding innovative activity, particularly for smaller and younger firms most dependent on external finance. Small firms in countries like the U.S. contribute a large share of total R&D and there is evidence that their R&D is much more productive than the R&D of larger firms. For example, Acs and Audretsch (1988) show that small firms have rates of innovation per employee that are far greater (i.e., 6.64 times) than those of large firms in the innovative industries in their sample. Furthermore, small firms, relying heavily on external equity finance, appear to be particularly important for creative destruction (e.g., Brown and Petersen (2010) and Liang, McLean, and Zhao (2011)). Thus, our evidence linking stock markets and R&D across countries suggests that market-based systems may have a significant advantage in generating growth through a process of creative destruction driven by the innovation of young and small firms. This advantage should be most pronounced in the stage of economic development where growth is driven primarily by creating and adopting new knowledge rather than investing in physical capital. More research is required to determine whether in fact financial architecture affects growth in such an environment.

## Appendix: Country Characteristics
## Table AI

This table reports firm counts and investor protection and financial development measures for all sampled countries. All variables and data sources are listed in Table I.

| Country | Firm count | Legal origin | Anti-self dealing index (ASD) | Enforcement | Country equity issues | Accounting standards | IPOs/GDP | Country-weighted leverage | Credit/GDP |
|---|---|---|---|---|---|---|---|---|---|
| Australia | 188 | Common | 0.79 | 9.36 | 0.197 | 75 | 0.087 | 0.280 | 0.793 |
| Austria | 29 | Civil | 0.21 | 9.80 | 0.037 | 54 | 0.012 | 0.287 | 0.979 |
| Belgium | 39 | Civil | 0.54 | 9.74 | 0.088 | 61 | 0.024 | 0.276 | 0.693 |
| Brazil | 24 | Civil | 0.29 | 6.31 | 0.007 | 54 | 0.001 | 0.199 | 0.327 |
| Canada | 484 | Common | 0.65 | 9.48 | 0.175 | 74 | 0.086 | 0.272 | 0.933 |
| Chile | 12 | Civil | 0.63 | 6.91 | 0.013 | 52 | 0.005 | 0.235 | 0.534 |
| Denmark | 41 | Civil | 0.47 | 9.66 | 0.117 | 62 | 0.012 | 0.240 | 0.864 |
| Finland | 83 | Civil | 0.46 | 9.58 | 0.029 | 77 | 0.038 | 0.282 | 0.673 |
| France | 169 | Civil | 0.38 | 9.09 | 0.045 | 69 | 0.023 | 0.257 | 0.885 |
| Germany | 250 | Civil | 0.28 | 9.50 | 0.075 | 62 | 0.028 | 0.263 | 1.072 |
| Greece | 51 | Civil | 0.23 | 6.40 | 0.014 | 55 | 0.088 | 0.274 | 0.454 |
| Hong Kong | 53 | Common | 0.96 | n/a | 0.105 | 69 | 0.091 | 0.190 | 1.457 |
| India | 243 | Common | 0.55 | 5.14 | 0.026 | 57 | 0.006 | 0.217 | 0.275 |
| Indonesia | 17 | Civil | 0.68 | n/a | 0.031 | n/a | 0.017 | 0.304 | 0.344 |
| Ireland | 36 | Common | 0.79 | 8.38 | 0.112 | n/a | 0.061 | 0.287 | 0.896 |
| Israel | 130 | Common | 0.71 | 6.18 | 0.132 | 64 | 0.004 | 0.222 | 0.703 |
| Italy | 32 | Civil | 0.39 | 8.75 | 0.045 | 62 | 0.059 | 0.338 | 0.680 |
| Japan | 2167 | Civil | 0.48 | 9.34 | 0.013 | 65 | 0.024 | 0.284 | 1.540 |
| Korea | 19 | Civil | 0.46 | 6.97 | 0.063 | 62 | 0.053 | 0.317 | 0.680 |
| Malaysia | 83 | Common | 0.95 | 7.11 | 0.050 | 76 | 0.062 | 0.268 | 1.112 |
| Netherlands | 70 | Civil | 0.21 | 9.68 | 0.096 | 64 | 0.026 | 0.209 | 1.179 |
| New Zealand | 13 | Common | 0.95 | 9.65 | 0.054 | 70 | 0.001 | 0.335 | 1.019 |
| Norway | 43 | Civil | 0.44 | 9.86 | 0.096 | 74 | 0.022 | 0.232 | 0.641 |
| Pakistan | 13 | Common | 0.41 | 3.95 | 0.000 | n/a | 0.004 | 0.185 | 0.233 |
| Philippines | 17 | Civil | 0.24 | 3.77 | 0.015 | 65 | 0.022 | 0.166 | 0.306 |
| Singapore | 73 | Common | 1.00 | n/a | 0.051 | 78 | 0.059 | 0.278 | 0.935 |
| South Africa | 45 | Common | 0.81 | 5.85 | 0.019 | 70 | 0.007 | 0.168 | 0.618 |
| Spain | 11 | Civil | 0.37 | 8.10 | 0.008 | 64 | 0.024 | 0.362 | 0.956 |
| Sweden | 133 | Civil | 0.34 | 9.79 | 0.108 | 83 | 0.063 | 0.231 | 0.640 |
| Switzerland | 107 | Civil | 0.27 | 9.99 | 0.048 | 68 | 0.071 | 0.237 | 1.592 |
| Turkey | 43 | Civil | 0.43 | n/a | 0.009 | 51 | 0.015 | 0.251 | 0.155 |
| United Kingdom | 643 | Common | 0.93 | 9.10 | 0.133 | 78 | 0.113 | 0.206 | 1.254 |
| **Mean** | | | **0.54** | **8.12** | **0.063** | **66** | **0.038** | **0.255** | **0.795** |
| **Median** | | | **0.47** | **9.09** | **0.049** | **65** | **0.024** | **0.260** | **0.748** |

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**Table I**
**Description of the Variables**

| Variable | Description |
|---|---|
| | Firm and industry variables |
| R&D | R&D is the firm average of R&D scaled by the book value of total assets over the period 1990 to 2007. Firm-year observations are Winsorized at the 1% level prior to computing the average. Data are from Compustat Global and North America. |
| Fixed investment | Fixed investment is the firm average of fixed investment scaled by the book value of total assets over the period 1990 to 2007. Firm-year observations are Winsorized at the 1% level prior to computing the average. Data are from Compustat Global and North America. |
| Intangible assets | Intangible assets is the firm average of the stock of intangible assets scaled by the book value of net fixed assets over the period 1990 to 2007. Firm-year observations are Winsorized at the 1% level prior to computing the average. Data are from Compustat Global and North America. |
| Value-added growth | Valued-added growth is the firm average of the annual log change in the sum of operating income plus labor expenses over the period 1990 to 2007. Firm-year observations are Winsorized at the 1% level prior to computing the average. Data are from Compustat Global and North America. |
| Productivity growth | Productivity growth is the firm average of revenue growth minus 0.3*growth in fixed assets minus 0.7*growth in employment over the period 1990 to 2007. Firm-year observations are Winsorized at the 1% level prior to computing the average. Data are from Compustat Global and North America. |
| Cash flow | Cash flow is the firm average of cash flow scaled by the book value of total assets over the period 1990 to 2007. Cash flow is measured as after-tax income before extraordinary items plus depreciation and amortization plus research and development expense. Firm-year observations are Winsorized at the 1% level prior to computing the average. Data are from Compustat Global and North America. |
| Stock issues | Stock issues is the firm average of net equity issues scaled by the book value of total assets over the period 1990 to 2007. Net equity issues is equal to the sale of common and preferred stock minus the purchase of common and preferred stock. Firm-year observations are Winsorized at the 1% level prior to computing the average. Data are from Compustat Global and North America. |
| Sales | Sales is the firm average of net sales scaled by the book value of total assets over the period 1990 to 2007. Firm-year observations are Winsorized at the 1% level prior to computing the average. Data are from Compustat Global and North America. |

**Table I (Continued)**

| Variable | Description |
|---|---|
| Sales growth | Sales growth is the firm average of the annual log change in net sales over the period 1990 to 2007. Firm-year observations are Winsorized at the 1% level prior to computing the average. Data are from Compustat Global and North America. |
| Employment | Employment is the firm average number of employees over the period 1990 to 2007. Data are from Compustat Global and North America. |
| ExternalDepend | Industry-level dependence on external finance is fixed investment minus cash from operations divided by fixed investment plus R&D for the median U.S. firm in each two-digit SIC industry. Both reliance on external finance (fixed investment minus cash from operations) and total investment (fixed investment plus R&D) are summed over 1990 to 2007 for each firm before dividing. Data are from Compustat North America. |
| | Law and finance variables |
| Legal origin | A dummy variable equal to one if the country is of common law legal origin. From La Porta et al. (1997). |
| Anti-self dealing index (ASD) | A measure of legal protection of minority shareholders against expropriation by corporate insiders in 2003, scaled between zero and one (Djankov et al. (2008)). From La Porta's webpage: http://mba.tuck.dartmouth.edu/pages/faculty/rafael.laporta/publications.html. |
| Enforcement | Enforceability of contracts. The relative degree to which contractual agreements are honored. Scaled from zero to 10 with higher scores indicating higher enforceability (Djankov et al. (2003)). From La Porta's webpage (see above). |
| Country equity issues | The country average of the firm-level variable *Stock issues*. See above. |
| Accounting standards | Index of the comprehensiveness of corporate annual reports in 1990 developed by the Center for International Financial Analysis and Research, scaled between zero and 90, with higher values indicating stronger standards. From Levine (1999). |
| IPOs/GDP | Value of IPOs over GDP. Averaged over 1996 to 2000. From La Porta's webpage (see above). |
| Country-weighted leverage | Value-weighted average debt-to-assets ratio across all sampled firms in a given country. Data are from Compustat Global and North America. |
| Credit/GDP | Private credit by deposit money banks to GDP. Averaged over the period 1990 to 2007. Data are from the World Bank's Financial Development and Structure Database (Beck, Demirgüç-Kunt, and Levine (2000) and Beck and Demirgüç-Kunt (2009)). |

**Table II**
**Sample Characteristics**

The firm-level data are from Compustat Global and North America and consist of R&D reporting firms with at least three nonmissing R&D observations during 1990 to 2007. Firms with a primary industry classification in financials (SIC 6000-6999) and utilities (SIC 4900-4999) are excluded. All firm-level variables are averages over the full sample period. Firms are classified as small if their average employment during the sample period is in the bottom 70$^{th}$ percentile of all sampled firms and large otherwise. All variables except *Employment* are scaled by the book value of total assets.

| | R&D | Fixed investment | Cash flow | Equity issues | Employment |
|---|---|---|---|---|---|
| | | | All firms | | |
| Mean | 0.053 | 0.048 | 0.064 | 0.065 | 5933 |
| Median | 0.018 | 0.038 | 0.080 | 0.005 | 871 |
| Std dev | 0.089 | 0.038 | 0.140 | 0.145 | 20443 |
| | | | Small firms | | |
| Mean | 0.066 | 0.044 | 0.048 | 0.088 | 640 |
| Median | 0.022 | 0.033 | 0.067 | 0.010 | 451 |
| Std dev | 0.101 | 0.038 | 0.159 | 0.167 | 586 |
| | | | Large firms | | |
| Mean | 0.024 | 0.056 | 0.104 | 0.012 | 18145 |
| Median | 0.013 | 0.050 | 0.097 | 0.001 | 6993 |
| Std dev | 0.036 | 0.035 | 0.066 | 0.032 | 34176 |
| Tests of difference in means (*p*-value) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

**Table III**
**Firm-Level R&D Investment and Access to External Finance**

Table III reports OLS regressions with firm-level R&D to assets as the dependent variable. The firm-level data are from Compustat Global and North America and consist of R&D reporting firms with at least three nonmissing R&D observations during 1990 to 2007. All firm-level variables are averages over the full sample period. Firms with a primary industry classification in financials (SIC 6000-6999) and utilities (SIC 4900-4999) are excluded. The key independent variable is the interaction between industry-level dependence on external funds (*ExternalDepend*) and country-level measures of access to external finance. All regressions include firm-level control variables (age, cash flow, sales, and sales growth) as well as country and industry fixed effects. Detailed variable definitions are provided in Table I. The differential in R&D intensity measures the difference in R&D/assets in an industry at the 75$^{th}$ percentile of external dependence relative to an industry at the 25$^{th}$ percentile in a country at the 75$^{th}$ percentile of development versus a county at the 25$^{th}$ percentile. Standard errors calculated with clustering at the country level are in parentheses.

| | Financial development measured as | | | | |
|---|---|---|---|---|---|
| | Country equity issues | Accounting standards | IPOs/GDP | Country-weighted leverage | Credit/GDP |
| | (1) | (2) | (3) | (4) | (5) |
| ExternalDepend× Country equity issues | 0.413 | – | – | – | – |
| | (0.097) | | | | |
| ExternalDepend × Accounting standards | – | 0.253 | – | – | – |
| | | (0.081) | | | |
| ExternalDepend × IPOs/GDP | – | – | 0.454 | – | – |
| | | | (0.181) | | |
| ExternalDepend × Country weighted leverage | – | – | – | -0.063 | – |
| | | | | (0.201) | |
| ExternalDepend × Credit/GDP | – | – | – | – | -0.011 |
| | | | | | (0.024) |
| $R^2$ | 0.359 | 0.352 | 0.353 | 0.348 | 0.348 |
| Observations | 5,310 | 5,244 | 5,310 | 5,310 | 5,310 |
| Differential in R&D | 0.015 | 0.014 | 0.010 | -0.002 | -0.002 |

**Table IV**
**R&D Regressions: Instrument with Legal Rules and Institutions**

Table IV reports 2SLS regressions with firm-level R&D to assets as the dependent variable. The key independent variable is the interaction between industry-level dependence on external funds (*ExternalDepend*) and various measures of country-level access to external finance. The instruments for country-level access to external equity finance are: a dummy variable indicating common law legal origin (*Legal origin*), an index measuring the enforcement of contracts (*Enforcement*), and the anti-self dealing index (*ASD*). All regressions include firm-level control variables (age, cash flow, sales, and sales growth) as well as country and industry fixed effects. The sample is described in Table II. Detailed variable definitions are provided in Table I. The differential in R&D intensity measure is explained in Table III. Standard errors calculated with clustering at the country level are in parentheses.

| | Financial development measured as | | | | | |
|---|---|---|---|---|---|---|
| | Country equity issues | | | | Accounting standards | IPOs/GDP |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Instruments: | Legal origin | Enforcement | Legal origin and Enforcement | ASD and Enforcement | Legal origin and Enforcement | Legal origin and Enforcement |
| ExternalDepend × Country equity issues | 0.359 (0.162) | 0.689 (0.275) | 0.444 (0.123) | 0.445 (0.177) | – | – |
| ExternalDepend × Accounting standards | – | – | – | – | 0.388 (0.161) | – |
| ExternalDepend × IPOs/GDP | – | – | – | – | – | 0.814 (0.386) |
| $R^2$ | 0.359 | 0.356 | 0.361 | 0.361 | 0.354 | 0.352 |
| Observations | 5,310 | 5,125 | 5,125 | 5,125 | 5,076 | 5,125 |
| Differential in R&D | 0.013 | 0.024 | 0.016 | 0.016 | 0.021 | 0.018 |

**Table V**
**R&D Regressions: Size and Age Splits**

Table V reports OLS and 2SLS regressions for separate samples of small and large firms (Panel A) and young and mature firms (Panel B). Firm-level R&D to assets is the dependent variable. The key independent variable is the interaction between industry-level dependence on external funds (*ExternalDepend*) and country-level measures of access to external finance (*FinDevelop*). All regressions include firm-level control variables (age, cash flow, sales, and sales growth) as well as country and industry fixed effects. In columns (7) and (8) *Legal origin* and *Enforcement* are used as instruments for *Country equity issues*. The sample is described in Table II. Detailed variable definitions are provided in Table I. Firms are classified as small if their average employment during the sample period is in the bottom 70$^{th}$ percentile of all sampled firms and large otherwise. Firms that first appear in Compustat before 1990 are considered "mature", and those appearing after 1990 as "young". The differential in R&D intensity measure is explained in Table III. Standard errors calculated with clustering at the country level are in parentheses. Superscripts $^{a}$, $^{b}$, and $^{c}$ indicate that the coefficient estimate for the small (young) firms is statistically different from the coefficient estimate for the large (mature) firms at the 1%, 5%, and 10% level, respectively.

| | Financial development measured as | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Country equity issues | | Accounting standards | | IPOs/GDP | | Country equity issues (IV) | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| | Panel A: Size split | | | | | | | |
| Firms: | Small | Large | Small | Large | Small | Large | Small | Large |
| ExternalDepend × FinDevelop | 0.630$^{a}$ (0.119) | 0.053 (0.044) | 0.339$^{b}$ (0.150) | 0.021 (0.030) | 0.794$^{b}$ (0.369) | 0.073 (0.057) | 0.547$^{a}$ (0.154) | 0.036 (0.059) |
| $R^2$ | 0.398 | 0.433 | 0.389 | 0.432 | 0.391 | 0.433 | 0.399 | 0.437 |
| Observations | 3,689 | 1,621 | 3,646 | 1,598 | 3,689 | 1,621 | 3,583 | 1,542 |
| Differential in R&D | 0.022 | 0.002 | 0.019 | 0.001 | 0.018 | 0.002 | 0.019 | 0.001 |
| | Panel B: Age split | | | | | | | |
| Firms: | Young | Mature | Young | Mature | Young | Mature | Young | Mature |
| ExternalDepend × FinDevelop | 0.668$^{a}$ (0.124) | 0.091 (0.056) | 0.287$^{a}$ (0.092) | 0.047 (0.047) | 0.698$^{b}$ (0.295) | 0.116 (0.073) | 0.629$^{a}$ (0.162) | 0.108 (0.049) |
| $R^2$ | 0.389 | 0.300 | 0.379 | 0.297 | 0.380 | 0.299 | 0.390 | 0.299 |
| Observations | 3,650 | 1,660 | 3,599 | 1,645 | 3,650 | 1,660 | 3,473 | 1,652 |
| Differential in R&D | 0.024 | 0.003 | 0.016 | 0.003 | 0.016 | 0.003 | 0.022 | 0.004 |

**Table VI**
**R&D Regressions: Robustness Checks**

Table VI reports OLS regressions with firm-level R&D to assets as the dependent variable. The key independent variable is the interaction between industry-level dependence on external funds (*ExternalDepend*) and *Country equity issues*. All regressions include firm-level control variables (age, cash flow, sales, and sales growth) as well as country and industry fixed effects. The sample is described in Table II. Detailed variable definitions are provided in Table I. Firms are classified as small if their average employment during the sample period is in the bottom 70$^{th}$ percentile of all sampled firms and large otherwise. In column (1), *ExternalDepend* measures industry external financial dependence over 1990 to 2007 using only U.S. firms that are within 10 years since they first appear in Compustat. In column (2) we set R&D to zero for any firm that reports information on fixed investment but not R&D. In columns (3) and (4) we exclude all countries with less than 50 firms in the original sample (roughly the median firm count). In columns (5) and (6) we drop the three largest contributor countries in terms of firms: Japan, the UK, and Canada. The differential in R&D intensity measure is explained in Table III. Standard errors are calculated with clustering at the country level and presented in parentheses. Superscripts [a], [b], and [c] indicate that the coefficient estimate for the small firms is statistically different from the coefficient estimate for the large firms at the 1%, 5%, and 10% level, respectively.

| | Robustness check | | | | | |
|---|---|---|---|---|---|---|
| | Dependence young U.S. firms | Set missing R&D = 0 | Excl. countries with less than 50 firms | | Excl. Japan, UK, & Canada | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Firms: | All | All | Small | Large | Small | Large |
| ExternalDepend × Country equity issues | 0.367 | 0.145 | 0.612[a] | 0.069 | 0.614[b] | 0.106 |
| | (0.086) | (0.045) | (0.122) | (0.058) | (0.265) | (0.081) |
| $R^2$ | 0.358 | 0.281 | 0.394 | 0.431 | 0.337 | 0.450 |
| Observations | 5,307 | 13,557 | 3,444 | 1,436 | 1,315 | 734 |
| Differential in R&D | 0.013 | 0.005 | 0.022 | 0.002 | 0.022 | 0.004 |

**Table VII**
**Firm-Level Fixed Investment and Access to External Finance**

Table VII reports OLS regressions with firm-level fixed investment to assets as the dependent variable. The key independent variable is the interaction between industry-level dependence on external funds (*ExternalDepend*) and country-level measures of access to external finance. All regressions include firm-level control variables (age, cash flow, sales, and sales growth) as well as country and industry fixed effects. The sample is described in Table II. Detailed variable definitions are provided in Table I. The differential in fixed investment intensity measures the difference in fixed investment/assets in an industry at the 75$^{th}$ percentile of external dependence relative to an industry at the 25$^{th}$ percentile in a country at the 75$^{th}$ percentile of development versus a country at the 25$^{th}$ percentile. Standard errors are calculated with clustering at the country level and presented in parentheses.

| | Financial development measured as | | | | |
|---|---|---|---|---|---|
| | Country equity issues | Accounting standards | IPOs/GDP | Country-weighted leverage | Credit/GDP |
| | (1) | (2) | (3) | (4) | (5) |
| ExternalDepend × Country equity issues | -0.019 (0.021) | – | – | – | – |
| External depend × Accounting standards | – | -0.027 (0.013) | – | – | – |
| External depend × IPOs/GDP | – | – | -0.037 (0.028) | – | – |
| External depend × Country weighted leverage | – | – | – | 0.056 (0.019) | – |
| External depend × Credit/GDP | – | – | – | – | 0.003 (0.003) |
| $R^2$ | 0.272 | 0.274 | 0.272 | 0.272 | 0.272 |
| Observations | 5,292 | 5,226 | 5,292 | 5,292 | 5,292 |
| Differential in fixed inv. | -0.001 | -0.001 | -0.001 | 0.002 | 0.001 |

**Table VIII**
**Intangible Assets, Firm Growth, and Access to External Finance**

Table VIII reports OLS regressions where the dependent variable is firm-level intangible assets/net fixed assets in columns (1) and (2), firm-level value-added growth in columns (3) and (4), and firm-level productivity growth in columns (5) and (6). The key independent variable is the interaction between industry-level dependence on external funds (*ExternalDepend*) and *Country equity issues*. The sample is described in Table II. Detailed variable definitions are provided in Table I. The firm size split is described in Table V. The differential in dependent variable measures the difference in the dependent variable in an industry at the 75$^{th}$ percentile of external dependence relative to an industry at the 25$^{th}$ percentile in a country at the 75$^{th}$ percentile of development versus a country at the 25$^{th}$ percentile. The sample average is the average value of the dependent variable in a particular regression sample. The regressions in columns (1) and (2) include firm-level control variables (age, cash flow, sales, and sales growth) and the regressions in columns (3) to (6) include firm-level control variables age and initial size (number of employees the year the firm first enters the sample). All regressions include country and industry fixed effects. Standard errors are calculated with clustering at the country level and presented in parentheses. Superscripts [a], [b], and [c] indicate that the coefficient estimate for the small firms is statistically different from the coefficient estimate for the large firms at the 1%, 5%, and 10% level, respectively.

| | Dependent variable | | | | | |
|---|---|---|---|---|---|---|
| | Intangible assets | | Value-added growth | | Productivity growth | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Firms: | Small | Large | Small | Large | Small | Large |
| ExternalDepend × Country equity issues | 7.897[b] | -0.850 | 1.441[a] | -0.159 | 0.252[c] | -0.030 |
| | (3.943) | (1.244) | (0.284) | (0.250) | (0.124) | (0.191) |
| $R^2$ | 0.224 | 0.241 | 0.090 | 0.218 | 0.068 | 0.161 |
| Observations | 3665 | 1616 | 3189 | 1615 | 3451 | 1591 |
| Differential in dependent variable | 0.279 | -0.030 | 0.051 | -0.006 | 0.009 | -0.001 |
| Sample average | 1.368 | 0.410 | 0.130 | 0.099 | 0.023 | 0.018 |

**Table IX**
**Legal Rules and Financing R&D**

Panel A in Table IX reports OLS regressions with firm-level stock issues to assets as the dependent variable. In Panel B firm-level R&D to internal cash flow is the dependent variable. The sample is described in Table II. Detailed variable definitions are provided in Table I. The firm size split is described in Table V. All regressions in Table IX include the following country control variables: log (GDP/Pop), GDP growth, secondary school enrollment, creditor rights, private property rights protection, global growth opportunities, government expenditure/GDP, and inflation rate. Regressions in Panel A also include firm-level control variables (age, cash flow, sales, and sales growth) as well as industry fixed effects; regressions in Panel B include the same controls less firm cash flow. Standard errors are calculated with clustering at the country level and presented in parentheses. Superscripts [a], [b], and [c] indicate that the coefficient estimate for the small firms is statistically different from the coefficient estimate for the large firms at the 1%, 5%, and 10% level, respectively.

Panel A: Law and External Equity Issues

| | Dependent variable: Stock issues/assets | | | | | |
|---|---|---|---|---|---|---|
| Firms: | All | Small | Large | All | Small | Large |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| ASD | 0.119 | 0.129[a] | 0.012 | – | – | – |
| | (0.029) | (0.031) | (0.004) | | | |
| Legal origin | – | – | – | 0.071 | 0.079[a] | 0.005 |
| | | | | (0.009) | (0.008) | (0.002) |
| $R^2$ | 0.365 | 0.392 | 0.203 | 0.374 | 0.401 | 0.202 |
| Observations | 5,185 | 3,616 | 1,569 | 5,185 | 3,616 | 1,569 |

Panel B: Law and R&D Relative to Cash Flow

| | Dependent variable: R&D/cash flow | | | | | |
|---|---|---|---|---|---|---|
| Firms: | All | All | All | All | Small | Large |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| ASD | 0.310 | – | – | 0.019 | 0.340[a] | -0.147 |
| | (0.111) | | | (0.099) | (0.146) | (0.045) |
| Legal origin | – | 0.204 | – | – | – | – |
| | | (0.054) | | | | |
| Country equity issues | – | – | 2.449 | 2.420 | – | – |
| | | | (0.356) | (0.501) | | |
| $R^2$ | 0.211 | 0.213 | 0.215 | 0.215 | 0.254 | 0.261 |
| Observations | 4,887 | 4,887 | 4,887 | 4,887 | 3,323 | 1,564 |

[1] The few studies that document a connection between stock market funding and R&D are much more limited in scope. For example, Kim and Weisbach (2008) examine how firms around the world spend the proceeds from new stock issues. They use descriptive regressions to show that a large fraction of the proceeds from both IPOs and SEOs are eventually invested in R&D. They do not, however, examine the causal connections between financial market development and long-run levels of firm investment. Brown, Fazzari, and Petersen (2009) document a strong connection between external equity issues and the late 1990s boom and bust in U.S. R&D, but their findings to not speak to the importance of legal rules and the nature of financial development for understanding long-run levels of firm investment across countries.

[2] For example, financial development can foster growth by increasing the efficiency of capital allocation across sectors, making fixed capital investments more responsive to growth opportunities, reducing the sensitivity of (short-run) capital spending to cash flow shocks, and reducing the volatility of fixed investment over the business cycle (see, for example, Wurgler (2000), Love (2003), Khurana, Martin, and Pereira (2006), Bekaert et al. (2007), Aghion et al. (2010), and McLean, Zhang, and Zhao (2012)).

[3] One notable exception is Demirgüç-Kunt and Maksimovic (1998), who show that more efficient legal systems and more developed financial systems (active stock markets and a large banking sector) facilitate growth at the firm level. Also see Demirgüç-Kunt and Maksimovic (2002), Beck, Demirgüç-Kunt, and Maksimovic (2005), and McLean, Zhang, and Zhao (2012).

[4] We expect that setting missing R&D to zero in a sample like the one we study introduces substantial measurement error, as R&D is often missing even among firms in high-tech industries. For this reason we focus only on firms that report some nonmissing values for R&D (note that we do not require firms to report *positive* R&D expenses). Later in the paper we report results for a sample in which missing R&D values are set equal to zero.

[5] We attempt to include as many of the 49 countries in LLSV (1997, 1998) as possible. We lose 15 countries due to insufficient firm-level data: Kenya, Nigeria, Sri Lanka, Thailand, Zimbabwe, Argentina, Colombia, Ecuador, Egypt, Jordan, Mexico, Peru, Portugal, Uruguay, and Venezuela. We drop Taiwan due to lack of information on private credit to GDP. As discussed, we exclude the U.S. since it provides the benchmark for external finance dependence in the RZ regressions. Based on figures for 2007, the countries in our sample account for roughly 75% of global (non-U.S.) R&D (OECD, Main Science Technology Indicators (2009/1).

China and Russia are the major countries excluded from our sample (and most other studies in the finance and growth literature). Excluding the U.S., Russia, and China, our sample covers 91% of remaining global R&D.

[6] Following RZ, the measure of accounting standards we use is based on how comprehensive annual reports actually are, rather than how comprehensive they are required to be. As such, accounting standards, like other measures of financial development, is potentially endogenous.

[7] We report regressions with *MCAP/GDP* in the Internet Appendix. We find a positive connection between *MCAP/GDP* and firm-level R&D, but only in the IV regressions for small and young firms is the estimate statistically significant at conventional levels. In our sample, unlike *IPOs/GDP* and *Accounting standards*, *MCAP/GDP* is only weakly correlated with *Country equity issues*. One reason why *MCAP/GDP* may be a poor proxy for access to stock market financing is that a country's publicly traded firms can have rather high stock market capitalization (e.g., ownership of valuable deposits of natural resources) yet at the same time these firms rarely use their stock markets as a *source* of funds. Indeed, stock market capitalization ratios are surprisingly large values for several countries that arguably do not have highly developed stock markets. For example, in the pioneering study by LLSV (1997), a number of relatively undeveloped countries (e.g., South Africa (1.45)) had much larger stock market capitalization ratios than the U.S. (0.58).

[8] RZ report a positive connection between industry growth rates and both total market capitalization (which includes stock market capitalization) and domestic credit in their initial table of regressions. However, neither of these measures is quantitatively important or statistically significant once accounting standards is also included in the specification (see their Table 4). Because of this, RZ use accounting standards as the primary measure of financial development in the remainder of their paper.

[9] We thank the associate editor for suggesting that we examine this alternative measure of credit market access.

[10] The Internet Appendix is available in the online version of this article on the *Journal of Finance* website.

[11] In the initial version of the paper our empirical tests were based on the cross-sectional connection between firm-level investment and firm-level stock issues, using legal origins and the strength of investor protections at the country level to instrument for firm-level use of external equity finance. We briefly discuss the results from this approach in Section III. We thank an anonymous referee for suggesting that we use the RZ approach. In a contemporaneous working paper, Pienknagura (2010) uses an approach similar to equation (1) to examine the connection between financial development and firm growth and R&D, but his focus and key conclusions are much different than ours.

[12] All of our findings are unchanged (and our most important results are even stronger) if we use U.S. data from the 1980s to compute $ExternalDepend_j$. Our measure follows RZ in all details except that we scale firm-level dependence on external finance by total investment (R&D plus fixed investment) rather than just fixed investment. Our measure is arguably an improvement on the standard RZ measure, at least in studies that examine industries in which R&D comprises a substantial share of total investment. The numerator of the RZ measure of financial dependence is fixed investment less cash from operations. But since R&D is expensed (and thus reduces cash from operations dollar for dollar), the numerator is effectively fixed investment plus R&D less cash from operations gross of R&D investment. For our purposes, it thus makes sense to scale by fixed investment plus R&D, as this reflects the true total investment that must be financed. To not do so would overstate the degree of external dependence in precisely the industries that are most R&D intensive.

[13] Alternative measures of financial development tend to be positively correlated across countries, particularly broad measures of stock market capitalization and credit market depth. As a consequence, it is possible that some studies using broad measures of credit market depth will find $\gamma_1 > 0$, even if our insights on the difficulty of using debt to fund R&D are correct. It is thus potentially difficult to use broad development measures to make inferences about the importance of access to a particular *type* of finance for investment and growth.

[14] Studies using legal origin to instrument for financial development include Rajan and Zingales (1998), Levine (1998, 1999), Levine, Loayza, and Beck (2000), Beck and Levine (2002), Carlin and Mayer (2003), Rossi and Volpin (2004), Acemoglu and Johnson (2005), Aghion, Howitt, and Mayer-Foulkes (2005), and Larraín (2010).

[15] We examine the results for fixed investment using broader samples of firms and obtain similar results. These results are reported in the Internet Appendix. If we expand the sample to include Compustat firms that do not report R&D, we get positive and statistically significant coefficients using some measures of financial development (e.g., *Country equity issues*, *Country weighted leverage*, and *Credit/GDP*), but the economic significance of the estimates is always very small. For example, the predicted differentials in fixed investment intensity are between 2% and 6% of the sample average, whereas the differentials for R&D are in the 25% to 30% range.

[16] We thank an anonymous referee for suggesting that we examine both intangible asset intensity and firm growth rates. In contrast to R&D, which is a flow of new intangible investment spending, the stock of intangible assets is taken from the balance sheet and includes things like blueprints, patents, copyrights, client lists, and goodwill. Our measure of intangible asset intensity follows Claessens and Laeven (2003). We get similar

results if we subtract goodwill from intangible assets before scaling by net fixed assets (see the Internet Appendix).

[17] *Value-added growth* is measured as the log change in the sum of operating income plus labor expense and necessarily excludes observations (and some firms) with negative value-added totals. *Productivity growth* is computed as revenue growth - 0.3*growth in fixed assets - 0.7*growth in labor inputs (employees). In the Internet Appendix we show that we get similar results if we measure *Productivity growth* as either revenue growth - 0.2*growth in fixed assets - 0.8*growth in labor inputs, or revenue growth - 0.4*growth in fixed assets - 0.6*growth in labor inputs. As with the other firm-level variables, the growth measures are firm averages over the full sample period. The growth regressions include firm-level controls for age (number of years in Compustat) and initial size (log of total employment from the first year the firm appears in the sample), as well as industry and country fixed effects.

[18] These findings are also consistent with the findings on aggregate capital spending in Acemoglu and Johnson (2005), as well as existing evidence on the impact that financial development has on economy-wide physical capital accumulation (see the discussion in Levine (2005)).

[19] We thank the associate editor for encouraging us to explore these additional implications.

[20] Specifically, the controls include the natural log of GDP per capita, the average rate of GDP growth during the sample period, a measure of country-specific global growth opportunities from Bekaert et al. (2007), the ratio of government expenditures to GDP, the share of the population enrolled in secondary education, an index of creditor rights following LLSV (1998), the inflation rate, and a rating of private property protections from Claessens and Laeven (2003).

[21] When we repeat this exercise for fixed investment the IV estimates on firm-level stock issues are negative but statistically insignificant. The results are reported in the Internet Appendix.

[22] Xiao (2011) examines this potential in more detail and finds strong evidence that shareholder protections improve the efficiency of R&D investment.