How Does the Financial Environment Affect the Stock Market Valuation of R&D Spending?

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How Does the Financial Environment Affect the Stock Market Valuation of R&D spending?

Abstract: This paper investigates the role of the financial environment in the stock market valuation of research and development (R&D) spending by firms. We examine the importance of equity financing relative to bank financing and the importance of both relative to the size of the economy on the stock market valuation of R&D expenditures. Empirical analysis of the Compustat Global Vantage firm-level data indicates that, the more market-based a financial system is, the more R&D expenditures are valued by the stock market. The degree of financial development does not appear to be important. Our results remain materially unchanged after controlling for numerous firm and country differences.

JEL Classification: G15, M40

Keywords: R&D, stock market, valuation, financial system

1. Introduction

Schumpeter's (1934) seminal work on economic development stresses the importance of innovation. Because a wellspring of innovation is the research and development (hereafter R&D) process, it is only natural that economists, economic policy makers and others are interested in understanding its nature and providing an environment that enables R&D activities to be successful. Success, however, requires more than new ideas. It also requires that these ideas need to be implemented and financed. The latter typically means that the firm is incorporated and has access to various forms of equity and debt capital via the financial environment that it faces. Wide-ranging discussions concerning the role of financial infrastructure and its impact on the firm appear in the academic and popular business presses (e.g., Beck and Levine, 2002, and *The Economist*, 2003, respectively). Some discussions argue that the ease with which investments are financed depends on whether the financial system in which the firm operates is primarily market-based or bank-based, while others suggest that it is not the type of financial system that matters but is whether the system is cost effective. Encompassing these views is the notion that effective financing cannot exist unless there is a viable legal system.

In the last 30 years or so, there have been numerous studies that quantify the effect of R&D expenditures on the financial performance of the firm. Some studies (e.g., Jaffe, 1986; Megna and Klock, 1993; Hall, 2000) develop models that indicate that market value is a function of, among other things, a firm's technological capital stock. Others (e.g., Lev and Sougiannis, 1996; Chan et al., 2001; Eberhart, Maxwell and Siddique, 2004) address the question of how various R&D based measures can explain and predict long-run stock returns and operating performance of the firm. Still others (e.g., Chan et al., 1990; Woolridge and Snow, 1990; Doukas and Switzer, 1994) investigate the short-run reaction of stock prices to announcements concerning R&D efforts. With few published exceptions, these studies use U. S. data. Exceptions include Johnson and Pazderka (1993), Xu and Zhang (2004), and Hall and Oriani (2004). Johnson and Pazderka (1993) document that R&D spending by Canadian firms is reflected in their market value, and Xu and Zhang (2004) report that the average market returns of Japanese firms are positively affected by R&D expenditures. Hall and Oriani (2004) examine the relationship between market value and R&D expenditures in France Germany, Italy, the U. K. and the U. S. They motivate their research by noting that the continental European capital markets and corporate governance systems differ from those found in the Anglo-Saxon hegemony. Their empirical results, which are obtained by examining each country independently, support the notion that the market value of a firm is a positive function of its investment in knowledge. This relationship holds for Italy, however, only after controlling for stock ownership concentration. Moreover, in the case of France, adding ownership concentration to the mix strengthens the observed relationship between R&D and market value. The general finding of all these empirical studies is that R&D expenditures increase a firm's future cash flows and current market value but that the strength of the effect varies across countries and samples.

In addition, there are several theoretical papers that provide insights into understanding the role of equity and debt capital in financing R&D spending and into explaining why R&D spending is reflected in market values differently in different countries. More specifically, these papers address the importance of a financial system's degree of development as well as its architecture in explaining a technology-intensive firm's choice between different forms of financing. For example, Yosha (1995) compares bilateral and multilateral (public information) financing arrangements, assuming that a firm's private information may leak to competitors in multilateral financing; and Bhattacharya and Chiesa (1995) investigate the choice of financing source in knowledge-intensive environments. Both these papers suggest that financial arrangements matter in R&D spending because of the potential for information leakage may lead to differences in the stock market's response to R&D expenditures. In a similar vein, Boot and Thakor (1997) explore the structure of a well-designed financial system and suggest, among other things, that financial system design may affect what types of firms go to the capital market for funds. They posit that firms that rely on more complex technologies have more to gain from the feedback role of market prices and, therefore, should prefer financial markets, implying that stock market reaction to R&D spending should be influenced by the characteristics of the financial system. Despite these theoretical insights, empirical research investigating whether the differences in financial development and financial design affect the strength of the impact of R&D expenditures on market values in different countries is very limited. To our knowledge, the only exception is Hall and Oriani (2004) and their comparison is qualitative and not quantitative.

The above mentioned theoretical and empirical studies raise the question: how does the relationship between a firm's market value and its R&D spending vary across countries that exhibit differences in financial development and architecture? The purpose of this paper is to address this question by investigating the impact of R&D activities on the market value of stocks in 10 countries. Following Lev and Zarowin (1999) and others, we argue that equity investors do not treat R&D expenditures as costs. Rather, investors consider these expenditures to be value-increasing investments because they are expected to increase the firm's future cash flows. Relying on findings reported by Boot and Thakor (1997), Beck and Levine (2002) and Demirgüc-Kunt and Maksimovic (2002), we conjecture that the way that equity investors value R&D expenditures depends not only on the extent to which the financial system in which the firm operates is developed but also on the relative importance of bank and public equity financing within the system. The former relies on the notion that the degree of financial development reflects the ability and willingness of investors to finance business endeavors. The latter, however, focuses on the role of information asymmetry between the firm and its investors. In this respect, according to Allen and Gale (1999), the core "primary" investors are less knowledgeable about the firm's activities in a bank-based financial system than they are in a market-based one, and consequently, are uncertain about the future benefits implicit in the firm's published R&D figures, resulting in a low market value for the firm. Both conjectures, however, presuppose the existence of an effective legal system.

To explore these issues, we extend the Edwards-Bell-Ohlson (EBO) stock valuation model, which relies on the notion of residual income, to explicitly recognize the investment nature of R&D expenditures. We use this extended model to analyze the relationship between the market value of an individual firm's stock and its R&D expenditures conditioned on its financial system's degree of development and relative strength of public equity financing. The analysis covers firms in Australia, Canada, Finland, France, Germany, Japan, Sweden, Switzerland, the U. K., and the U. S. for an 11-year period beginning in 1991. During this period, these countries exhibited diverse financial environments. Using panel regression methods, we find international evidence that a firm's R&D expenditures are positively related to its market value. In addition, this relationship is positively and significantly related to the importance of its home country's public equity financing expressed as a portion of total financing. The value-relevance relationship, however, is not significantly related to the degree of financial development, when measured as the ratio of total financing to Gross Domestic Product. These results are robust after controlling for a number of firm-specific (e.g., industry, size, and risk) and country-specific (e.g., accounting disclosure, legal enforcement, and ownership concentration) influences.

We divide the remainder of the body of this paper into four sections. In Section 2, we develop our extended version of the EBO model and convert it to an empirical model, with the tedious algebraic details being relegated to the Appendix. We describe the data in Section 3 and discuss their economic purposes. In Section 4 we report the results of the panel regressions including the corresponding robustness tests and provide concluding remarks in Section 5.

2. A Stock Valuation Model with R&D Expenditures

A common stock's fundamental value is often defined to be the present value of its expected future dividends where expectations are formed using all currently available information. As pointed out by Penman and

Sougiannis (1998), among others, if clean surplus accounting assumptions hold, expected future dividends may be rewritten as the reported book value plus the infinite sum of expected future residual income. This version of the relationship expresses share value in terms of accounting variables and is referred to as the EBO model, a term first alluded to by Bernard (1995).

According to the EBO model,

$$v_t = b_t + \sum_{j=1}^{\infty} E_t\left[\left(ROE_{t+j} - k\right) b_{t+j-1}\right] / (1+k)^j, \qquad (1)$$

where t is a time subscript and v_t and b_t represent the firm's market and book values, respectively, at the end of year t. ROE_t represents the return to book equity capital, while k is the cost of equity. $E_t[.]$ denotes expected residual income, with E being the expectations operator.

To accomplish our purpose, we extend the EBO model to include the impact of R&D expenditures on expected residual income and then convert the resulting theoretical model into one that can be empirically estimated. We begin our extension by expressing the market and book values in terms of the previous period's book value. Dividing Eq. (1) by b_{t-1} and rearranging yields:

$$V_t = \sum_{j=1}^{\infty} E_t\left[\left(ROE_t - k\right) B_{t+j-1}\right] \ / \ \left(1+k\right)^j, \qquad (2)$$

where $V_t = \left(v_t - b_t\right) / b_{t-1}$ and $B_{t+j} = b_{t+j} / b_{t-1}$ for $j = 0, 1, 2, \ldots$. These operations "deflate" the original book and market values in order to allow inter-firm comparisons and create a dependent variable that reflects the firm's market-to-book premium. In the spirit of Myers (1984), hereafter we refer to this variable as the growth opportunity premium since it measures profit opportunities that have yet to be realized.

We argue that a firm's technological edge, which results in positive residual income, will slowly dissipate if sufficient investments in innovative activities are not made. Consequently, the residual income will also decay to a target level, where this level varies by firm and may be either zero or even slightly positive or negative. To reflect this behavior, we model expected residual income as a first-order Markovian process with the current residual being a function of immediately previous residual income plus all past R&D expenditures. We define R&D expenditures (*RD*) relative to the previous period's book value and posit that investors believe that these expenditures will remain at about the present level (in book value deflated terms) and that their impact will geometrically decay over time.

Using these assumptions, we are able to rewrite Eq. (2) to express the growth opportunity premium as a finite function of return on equity and R&D expenditures such that:

$$V_t = \beta_0 + \psi V_{t-1} + \beta_1\ ROE_t - \psi\beta_1\ ROE_{t-1} + \beta_2 RD_t, \qquad (3)$$

where β_0 and β_1 reflect the cost of equity capital and the time series behavior of expected residual income. β_2 depicts the link between residual income and R&D expenditures. The magnitude of this link depends on the firm's efficiency in allocating capital and its stockholders' ability to reap the long-term benefits from competing, innovative projects. The details of obtaining Eq. (3) from Eq. (2) are given in the appendix.

To convert Eq. (3) into an empirical model that is capable of explaining the average behavior of many firms, we add subscript i to denote an individual firm such that:

$$V_{i,t} = \beta_0 + u_i + \psi V_{i,t-1} + \beta_1 ROE_{i,t} - \psi\beta_1 ROE_{i,t-1} + \beta_2 RD_{i,t} + \varepsilon_{i,t}, \qquad (4)$$

where $u_i = \beta_{0,i} - \beta_0$ with the expectation of $\beta_{0,i}$ being β_0 and the expectation of u_i being 0. As explained in the appendix, treating the intercept term as a random variable with an unspecified distribution permits the cost of equity capital and the target level of residual income to vary by firm. The error terms, $\varepsilon_{i,t}$, are assumed to be independent of each other and need not have equal variances. They are also assumed to be independent of the random intercept, u_i, and of the explanatory variables, which are assumed to be weakly exogenous. Unlike the values of $\beta_{0,i}$, the value of β_1 is assumed to be "relatively stable" across firms despite the varying costs of equity capital.

Recall that our purpose is to examine whether the availability of capital and its sources affect the manner in which R&D expenditures are valued by equity investors. Four not entirely unrelated perspectives concerning the economics of the valuation process have been offered. The first two views are concerned with financial structure and involve the potential advantages and disadvantages of market-based versus bank-based financing. For instance, Stulz (2002) suggests that banks are more effective than equity markets when financing innovative initiatives because they can commit to provide any required subsequent funding. Moreover, according to Boot et al. (1993) bank financing enables firms to keep sensitive competitive information from the general market. Helwig (1991) and Rajan (1992) counter these points by arguing that it is in the best interest of powerful banks to limit innovation to protect established firms. In a similar vein, Allen and Gale (1999) suggest that, because in a market-based financial system a large number of investors participate directly in a firm's financing decisions, innovative projects are more easily financed in this environment. The next two views focus on the finance system as a whole. In the financial services view, the real issue, according to Levine (1997), is the ability of the financial system to minimize transaction costs regardless of whether this is accomplished by banks or by equity markets. Some, e.g., Boyd and Smith (1998) and Huybens and Smith (1999), note that banks and markets may actually complement one another in providing financial services. The fourth view, often referred to as law and finance, overarches the first three. In this view, as exemplified by La Porta et al. (2000), the legal system and its ability to protect investors by enforcing contracts is the crucial determinant of the degree of financial development. It is this ability that facilitates external financing and the establishment of new firms as well as new economic initiatives.

We incorporate these ideas in our empirical model by adding two metrics to reflect the firm's home economic environment. *STR* and *DEV* measure home country *n*'s financial structure and degree of financial development, respectively. We model the effect of the differences in the financial environment on the stock market valuation of the i^{th} firm's R&D expenditures by letting β_2 be a linear function of *STR* and *DEV*. Thus:

$$\beta_{2,i,t} = \delta_0 + \delta_1 STR_{n(i),t} + \delta_2 DEV_{n(i),t}\,, \tag{5}$$

and the subscript *n(i)* denotes the home country of firm *i*. *STR* is the ratio of the stock market value of equity of the firm's home country to the sum of this value and bank loans to the private sector. *DEV* is the denominator of *STR*, i.e., equity and bank loans, divided by the Gross Domestic Product (GDP). To complete our analysis, we extend Eq. (5) to include other proxy measures of the financial environment. We do this by rewriting Eq. (5) to include selected country-specific and firm-specific variables such that:

$$\beta_{2,i,t} = \delta_0 + \delta_1 STR_{n(i),t} + \delta_2 DEV_{n(i),t} + \omega_p PRX_{p,q}\,, \tag{6}$$

where *q* equals *n(i),t* if *PRX* is a country-specific variable, *q* equals *i,t* if *PRX* is a firm-specific variable or set of these variables, and *p* denotes the particular variable.

With respect to county-specific influences, numerous studies document that the information content of financial reports across countries is affected by several institutional and cultural factors, with the nature of the legal system perhaps being the most important. For instance, in their survey of legal systems, David and Brierley (1985) conclude that in common law countries accounting rules are primarily determined by the disclosure needs of the stockholders while in code law countries the other stakeholders' needs are more important. Ball et al. (2000) document that the demand for the timely incorporation of information in reported accounting income is higher in common law countries than in code law countries. Alford et al. (1993) find that firms located in countries in which financial and tax accounting are closely related have incentives to reduce reported income. Finally, Leuz et al. (2003) report that countries with relatively strong investor protection laws, dispersed ownership, and developed stock markets exhibit a lower level of earnings management than countries with weak investor protection laws, relatively concentrated ownership, and less developed markets. As a result of these examples, we sequentially augment Eq. (6) by country-specific variables representing accounting disclosure, legal enforcement, concentration of ownership, and investor rights.

In addition to the above institutional differences, several firm-specific factors may influence the financial environment. For instance, as Collins and Kothari (1989) point out firm size, is often used as a measure of the firm's information environment. Large firms are widely investigated and followed by financial analysts, investors and the media, whereas public interest in small firms is much more limited. Consequently, the information set regarding the future prospects of large firms is likely to be richer than that of small firms. The effect of R&D spending is not always obvious from this figure alone, and it is often necessary to be analyzed using supplementary material. Thus, it is likely that the stock market response of large firms to R&D spending will be stronger that for small firms. Along similar lines, it may be that the market response also depends on the branch of industry that the firm represents. Because some industries are more closely associated with innovation, innovations may seem routine and thereby discounted. Finally, the ability of a firm to find the resources to fund its R&D initiatives may have an impact. For instance, Bhagat and Welch (1995) find that the magnitude of a firm's R&D spending is related to how it is financed and Hayn (1995) shows that earnings response coefficients, which measure the impact of earnings on stock returns, are influenced by losses. To proxy these notions in our empirical analysis, we consider the impact on Eq. (6) of industry type, firm size, operating cash flow, debt ratio, payout ratio, beta (systematic risk) and earnings losses in the same manner that we handle the country-specific auxiliary variables.

Similar to Beck and Levine (2003), we estimate our models using an iterative GMM-method. We choose this approach to avoid making specific assumptions regarding the shape of the distribution of the model intercepts and to recognize the likely possibility of heteroskedastic error terms. In all cases our list of instrumental variables includes one- and two-period lagged changes in our dependent variable, V. We use the Newey-West estimator with three lags (see, e.g., Hamilton, 1994, p. 281), which is robust to autocorrelation, to calculate the asymptotic covariance matrix of the orthogonality functions, which, in turn, is used to define the iterative GMM-method's distance measure. Baltagi (2001) provides a basic description of panel data models, while more recent developments are discussed by Blundell, Bond and Windmeijer (2000) and Bond (2002).

3. Data Description

The sample consists of all the listed firms from 10 industrial countries (Australia, Canada, Finland, France, Germany, Japan, Sweden, Switzerland, the U. K. and the U. S.) for which the required stock market and accounting data are available. We obtain annual firm-level data from the most recent Compustat Global Vantage database for 1991 to 2001 inclusive. The R&D expenditure represents all direct and indirect costs related to the creation and development of new processes, techniques, applications and products. It includes basic and applied research as well as all customer and government sponsored research. There are only very few observations for which R&D expenditures are equal to zero in our sample (Canada – 6 and the U. S. – 183). Excluding these observations from our analysis does not materially affect any of the statistical results that we subsequently report for the entire sample. Our sources for the country stock market value of equity and financial structure and development data and bank loans to the private sector are the World Federation of Exchanges and the World Bank database, whereas the GDP data are from the Bank of Finland.

Table 1 reports selected summary statistics for these primary firm-level variables by country. These data indicate that the values of these variables vary greatly across country and over time for a given country. For instance, the 11-year mean for R&D expenditures deflated by book value (*RD*) ranges from 0.06 for Australia and Japan to 0.20 for Canada, Germany and the U. S. For an individual country, the largest inter-quartile range for *RD* values is 0.27 for the Canada while the smallest is 0.03 for Australia. The corresponding values for the growth opportunity premium (*V*) is a low of 0.74 for Japan and a high of 3.72 for the U. S. For *V* the smallest and largest inter-quartile ranges are associated with Finland (1.22) and the U. S. (3.73), respectively.

(Insert Table 1 about here.)

The data for the firm-specific control variables also come from Compustat Global Vantage. For the industry categories we use the database's Economic Sector (CES) codes: 1000 - Basic Materials, 3500 – Health Care, 6000 – Capital Goods, 8000 – Technology, and 8600 – Communications Services. The industry dummy variables (*I1000*, *I3500*, *I6000*, *I8000*) equal one if the firm is in that industry and zero otherwise. *I8600* is the numeraire industry code. We define firm size to be the average market value of equity calculated over the sample period. Firms are classified into four size categories each associated with a dummy variable. With the exception of *SIZE1*, the dummy variable associated with the smallest firms, the dummy variables equal one if the firm is in that size category and zero otherwise. *SIZE1* is the numeraire. Cash flow (*CF*) is the sum of earnings, depreciation and amortizations deflated by book value. The debt ratio (*DR*) is the ratio of total debt to equity, and the payout ratio (*PR*) is the ratio of dividends to equity. *BETA* is the year-end beta calculated using the previous 36 months of returns. Finally, *LOSS*, a dummy variable indicating that a firm experiences a earnings loss in a particular year, equals one if there is a loss and zero otherwise.

We gather country-specific control variable data from La Porta et al. (1997 and 1998) and Leuz et al. (2003). The disclosure index (*DI*) measures the inclusion or omission of certain items in firm annual reports. Legal enforcement (*LE*) is the mean of indexes measuring the efficiency of the judicial system, an assessment of the rule of law, and corruption. Each of the three components have values ranging from one to 10 with higher scores indicating a stricter level of legal enforcement in a country. Ownership concentration (*OC*) is the median percentage of common shares owned by the largest three stockholders in the 10 largest privately owned non-financial firms. The importance of equity markets (*IE*) is the mean rank of the ratio of aggregate stock market capitalization held by minority stockholders to GNP, the number of listed domestic firms per capita, and the number of initial public offerings per capita. These three components are ranked so that higher scores indicate a greater importance for the stock market. Outside investor rights (*OI*) is an aggregate measure of minority stockholder rights and ranges from zero to five, with higher scores being associated with more rights. Finally, legal tradition (*LT*) is a dummy variable with a value of one if the country has a common law system and zero if it has a code law system. Australia, Canada, the U. K. and the U. S. are common law countries while Switzerland, Germany, Finland, France, Japan and Sweden legal systems fall into the code law category.

4. Empirical Results

We begin our formal analysis by investigating the effect of the differences in the importance of bank- and market-based financing on the valuation impact of R&D spending. The data are formatted so that cross-sectional and time series data are pooled together. The GMM panel data regressions for Eq. (4) with (β_2 defined by Eq. (5)) and without the financial structure (*STR*) and financial development (*DEV*) variables are displayed in Table 2. In both cases the parameter for the lagged value of *ROE* is determined by the parameters of the current *ROE* and lagged *V*, the growth opportunity premium. All of the estimated parameters are highly statistically significant and are associated with the theoretically expected sign. Thus, similar to other studies, we find that the stock market investors do value R&D expenditures. Our results point to the proposition that the value-relevance of these expenditures is an international phenomenon. Moreover, as indicated by the significant coefficient for our lagged valuation variable, the valuation process is dynamic.

(Insert Table 2 about here.)

Adding the financial structure and development variables to the mix does not materially change the results with respect to the positive relationship between *ROE* and the growth opportunity premium, nor does it change the dynamic nature of the model. What does change is the way in which the market values R&D expenditures. According to the regression results, only Eq. (5)'s parameter for *STR* is statistically significant. This means that the channel that the stock market uses to value R&D expenditures is determined by the financial structure of the firm's home country and not by the overall level of the country's financial development. More specifically, our results show that the more a firm's financial environment leans toward equity financing as opposed to bank financing, the stronger the market response to changes in R&D spending. Evaluating the elasticity of *STR* using the means of the relevant variables indicates that a 1.00% increase in a country's stock market value of equity expressed as a portion of the sum of itself plus the amount of bank loans to the private sector results in a 0.48% increase in *V*, our measure of a firm's growth opportunity premium, even though the firm's R&D expenditures do not change.

Are our empirical results robust to the inclusion of other firm-specific and country-specific variables? In other words, is it possible that our measure of financial structure is a proxy for some other important economic factor? We address this issue, by re-estimating Eq. (4) using Eq. (6) to define β_2. Table 3 provides the regression results when we sequentially consider a variety of firm-specific variables. The parameters for firm size, operating cash flow, the payout ratio, and earning losses are statistically significant, but the corresponding parameters for industry, debt ratio, and systematic risk (beta) variables are not. More important, however, is that the financial structure parameter remains statistically significant while the financial development parameter continues to be insignificant in all but one case. In this case, the parameter's statistical significance is marginal (p-value = 0.049), and because of the relatively large sample size, its economic significance is nil. This pattern holds even if we include all of the significant firm-specific variables in the model together (estimation results not shown).

(Insert Table 3 about here.)

Table 4 gives the GMM regression results for the country-specific variables. These results, which are displayed in columns (1) through (5), are similar to those reported in Table 2. The parameters associated with accounting disclosure, legal enforcement, ownership concentration, importance of equity markets, and outside investor rights are statistically insignificant. Moreover, the financial structure parameter in each of these regressions is statistically significant while the financial development parameter is not. We handle the home country's legal tradition in a different fashion. This is because this variable and financial structure are highly correlated (0.81), which occurs because common law countries historically tend to be more equity oriented than code law countries. It is unclear, however, whether a country's financing preferences are the result of its type of legal system or whether a country's legal system evolved to its current status because of its financial structure orientation. To handle this issue, we modify our GMM regression setup by defining our legal tradition variable (*LT*), which is specified as an interaction variable with *RD* (i.e., *RD*x*LT*), to be an instrument rather than an exogenous variable, thereby mitigating the effect of the legal system. We choose *LT* rather than *STR* to create our instrumental variable because the latter variable is a finer grained measure. The results of this regression are given in column (6). Similar to the other country-specific variable regressions, the financial structure parameter is statistically significant and the one for financial development is not.

(Insert Table 4 about here.)

In addition to the above, there may be several unobserved factors causing cross-country differences. Examples of such factors include differences in accounting conventions, discount rates and capital productivity. Moreover, the observations from different firms might be slightly correlated because of temporal fluctuations or changes in the general economic environment. Thus, as a final robustness check, we add country-specific dummy variables to the list of instruments and include exogenous temporal dummy variables in our model defined by Eq.s (4) and (5). The results of this regression (details not reported) confirm our previous findings; i.e., the financial structure coefficient is positive and highly significant (p = 0.000) while the coefficient for financial development is not (p = 0.344).

5. Conclusions

Many studies have investigated the role of the financial system regarding the economic growth of firms and countries. Some of these studies examine the role of a firm's investment in R&D. In addition, recently the stock market evaluation by investors of R&D spending activities has received intensive interest. As documented by Lev (1999) and many others, stock markets consider firms' investments in R&D activities as a significant value-increasing activity rather than a simple cost. We extend the extant work by investigating whether the nature of the financial environment affects R&D-valuation linkage.

To accomplish our task we extend the residual income stock valuation model, which is typically referred to as the Edwards-Bell-Ohlson (EBO) model, to incorporate R&D spending. The intuition underlying our approach is that innovative investments are necessary for firms to maintain positive residual incomes. After analyzing firm-level panel data from 10 countries with developed financial systems over an 11-year period, we confirm the findings of other empirical studies that document the value-relevance of R&D expenditures. We also find support for the notion that the relative size of the equity and private loan markets influences the way that R&D is valued. In particular, our results show that as the portion of equity financing in a country increases relative to bank loan financing, the stronger the R&D link. We do not, however, support the notion that the overall level of a country's financial resources is also a determinant. In all cases, the level of a country's financial resources nearly equal or exceed its GDP. Thus, our latter finding may be due to all of the countries exceeding a critical level of financial development. These empirical results are robust after controlling for a wide range of country- and firm-specific factors.

Our findings partially confirm those of Beck and Levine (2002, p. 175) who state that their "…findings show that the overall level of financial development along with effective contract enforcement mechanisms foster new establishment formation and more efficient capital allocation." They conclude by accepting the financial services and law and finance theories and by rejecting the notion that the distinction between market- and bank-based financing is important. In contrast, in the context of the stock market valuing R&D expenditures, we cannot reject the law and finance theory but support the contention that the institutional source of financing matters. In any case, we are not making a value judgment concerning which system is the better one. We are simply reporting that a market-based system does what it is supposed to do; it values.

Appendix

In this appendix we derive Eq. (3) from Eq. (2). Recall that:

$$V_t = \sum_{j=1}^{\infty} E_t\left[\left(ROE_t - k\right)B_{t+j-1}\right] \,/\, \left(1+k\right)^j , \qquad (2)$$

where t is an end-of-period time subscript. V_t is the growth opportunity premium, which is the difference between the equity market and book values deflated by the previous period's book value. $E_t\left[.\right]$ denotes the expected residual earnings and k represents the cost of equity capital.

For notational convenience, we specify:

$$z^*_{t+j|t} = E_t\left[\left(ROE_{t+j} - k\right)B_{t+j-1}\right] = E_t\left[z_{t+j}\right],$$

where ROE_t is the return on equity capital, and B_t and z_t are the book value and residual earnings, respectively, after being deflated by the previous period's book value. We assume that $z^*_{t+j|t}$ obeys a first-order Markovian structure such that:

$$z^*_{t+j|t} = \alpha z^*_{t+j-1|t} + \left(\gamma_0 RD^*_{t+j|t} + \gamma_1 RD^*_{t+j-1|t} + \ldots + \gamma_r RD^*_{t+j-r|t}\right) + \mu$$

$$= \alpha z^*_{t+j-1|t} + \gamma(L) RD^*_{t+j|t} + \mu, \text{ for } j = 1,2,3,\ldots, \qquad (A1)$$

$$z^*_{t+j|t} = z_{t+j} \text{ and } RD^*_{t+j} = RD_{t+j} \text{ when } j \le 0,$$

where $RD^*_{t+j|t}$ represents the expected R&D expenditures relative to b_{t-1} and L is the lag operator. Assume further that investors predict these expenditures to remain at about the present level, i.e.:

$$RD^*_{t+j|t} = a_0 RD_t + a_1 RD_{t-1} + \ldots + a_s RD_{t-s} = \tilde{RD}_t, \text{ for } j = 1,2,\ldots, \qquad (A2)$$

where $a_0 + a_1 + \ldots + a_s = 1$.

Combining Eq. (A1) and (A2) results in

$$z^*_{t+j|t} = \alpha^j z_t + \mu\left(1+\alpha+\ldots+\alpha^{j-1}\right) + \gamma\left(1\right)\tilde{RD}_t\left(1+\alpha+\ldots+\alpha^{j-r-1}\right)\phi\left(\text{j}-\text{r}-1,0\right) +$$

$$\alpha^{j-r}\left(\gamma_0 \tilde{RD}_t + \gamma_1 \tilde{RD}_t + \ldots + \gamma_{r-1}\tilde{RD}_t + \gamma_r RD_t\right)\phi\left(\text{j}-\text{r},0\right) + \ldots + \qquad (A3)$$

$$\alpha^{j-1}\left(\gamma_0 \tilde{RD}_t + \gamma_1 RD_t + \ldots + \gamma_r RD_{t-r+1}\right)\phi\left(\text{j}-1,0\right)\phi\left(\text{r}-1,0\right) \text{ for j} = 1,2,3,\ldots,$$

where $\phi(x,y)$ stands for the 0/1 function such that it equals one if $\times \geq y$ and zero otherwise.

Joining Eq. (2) and (A3) yields:

$$V_t = \sum_{j=1}^{\infty}\left(\frac{\alpha}{1+k}\right)^j z_t + \mu\sum_{j=1}^{\infty}\frac{1-\alpha^j}{(1-\alpha)} \cdot \frac{1}{(1+\text{k})^j} + \sum_{j-r+1}^{\infty}\frac{1-\alpha^{j-r}}{(1-\alpha)} \cdot \frac{1}{(1+k)^j} \cdot \gamma(1).RD_{i,t} + \sum_{j=1}^{\infty}\left(\frac{\alpha}{1+k}\right)^j \sum_{j'=1}^{r}\alpha^{-j'}\phi(j-j',0)\gamma(L)RD^*_{t+j'|t}, \quad \text{(A4)}$$

which when simplified becomes:

$$V_t = \frac{\mu}{k(1-\alpha)} + \frac{\alpha}{1+k-\alpha} z_t + a_0^* RD_t + a_1^* RD_{t-1} + ... + a_{s^*}^* RD_{t-s^*}, \quad \text{(A5)}$$

where s* = max (r,s) and $a_0^*,...,a_{s^*}^*$ are constants determined by $\gamma_0,...,\gamma_t$ and $a_0,...,a_s$.

Because s* is probably very large in comparison to our time series data, we must impose some structure on the impulse responses, a_j^*. A sensible approach is to approximate the lag structure with geometrically decaying impulse response coefficients:

$$a^*(L) = a_0^* + a_1^* L + ... + a_{s^*}^* L \approx \beta_2 /(1-\psi L).$$

Recasting Eq. (A5) to reflect the structured impulse response coefficients and realizing that under our definitions $z_t = ROE_t - k$ we obtain:

$$V_t = \frac{\mu}{k(1-\alpha)} + \frac{\alpha(ROE_t - k)}{1+k-\alpha} + \frac{\beta_2}{1-\psi L} RD_t. \quad \text{(A6)}$$

Finally, after multiplying Eq. (A6) by $(1-\psi L)$ and rearranging terms, we obtain

$$V_t = \beta_0 + \psi V_{t-1} + \beta_1 ROE_t - \psi\beta_1 ROE_{t-1} + \beta_2 RD_t, \quad \text{(3)}$$

where $\beta_0 = (1-\psi)\left[\frac{\mu}{k(1-\alpha)} - \frac{\alpha k}{1+k-\alpha}\right]$

and

$$\beta_1 = \frac{\alpha}{1+k-\alpha}.$$

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Table 1
Descriptive statistics of the primary variables for the sample period (1991 – 2001).

Variable	Statistics	Country										
		Australia	Canada	Finland	France	Germany	Japan	Sweden	Switzerland	U. K.	U. S.	All 10
$V_{i,t}$	Mean	1.75	3.45	1.55	3.57	2.28	0.74	2.50	2.33	3.57	3.72	2.60
	IQR	1.35	3.44	1.22	3.48	1.80	1.28	2.57	2.45	3.50	3.73	2.62
$ROE_{i,t}$	Mean	0.01	-0.08	0.13	0.06	0.06	0.01	0.03	0.11	0.08	-0.01	0.01
	IQR	0.15	0.41	0.14	0.12	0.12	0.06	0.24	0.16	0.25	0.33	0.20
$RD_{i,t}$	Mean	0.06	0.20	0.10	0.19	0.20	0.07	0.17	0.14	0.14	0.21	0.15
	IQR	0.03	0.27	0.08	0.21	0.22	0.07	0.17	0.13	0.14	0.22	0.17
$STR_{\mathrm{n(i),t}}$	Mean	0.52	0.56	0.57	0.43	0.28	0.37	0.73	0.54	0.55	0.63	0.53
	IQR	0.03	0.10	0.45	0.23	0.13	0.06	0.05	0.19	0.07	0.08	0.27
$DEV_{\mathrm{n(i),t}}$	Mean	1.67	1.50	1.81	1.54	1.59	1.81	1.68	3.81	2.70	1.87	1.90
	IQR	0.54	0.55	1.68	0.58	0.46	0.20	0.48	1.65	0.81	0.71	0.47
Number of Observations		197	551	138	120	239	4657	109	193	876	6812	13892

NOTES: For each variable, the mean, inter-quartile range (IQR) and the number of observations for the whole period of 1991 - 2001 are given for each country. The last column combines all countries. The subscripts *i* , *n* and *t* denote firm, country and time, respectively. *V*, the growth opportunity premium, is the difference between the market and book values of firm *i* in year *t* divided by the previous year's book value. *ROE* is the earnings of firm *i* divided by the previous year's book value of equity. *RD* refers to R&D expenditures by firm *i* divided by the previous year's book value. *STR* denotes financial market structure and is the ratio of the stock market value of equity of country *n* to the sum of itself and bank loans to the private sector. *DEV* measures the degree of financial development and is the ratio of the denominator of *STR* to the GDP of country *n*.

Table 2
Dynamic GMM-estimation results.

Variable	Parameters	Eq. (4)	Eq. (4) and Eq. (5)
Constant	β_0	0.324	0.409
		(0.000)	(0.000)
$V_{i,t-1}$	ψ	0.257	0.251
		(0.000)	(0.000)
$ROE_{i,t}$	β_1	2.263	2.427
		(0.000)	(0.000)
$ROE_{i,t-1}$	$-\psi\beta_1$	-0.582	-0.609
$RD_{i,t}$	β_2 or δ_0	10.097	-1.360
		(0.000)	(0.516)
$RD_{i,t}$ x $STR_{n(i),t}$	δ_1	-	15.921
			(0.000)
$RD_{i,t}$ x $DEV_{n(i),t}$	δ_2	-	0.800
			(0.355)
N		8946	8946
$\bar{R}^2$		0.400	0.407
RMSE		3.675	3.653

NOTES: The subscripts *i*, *n* and *t* denote firm, country and time, respectively. $V_{i,t}$, the growth opportunity premium, is the dependent variable and is the difference between the market and book values of firm *i* divided by the previous year's book value. *ROE* is the earnings of firm *i* divided by the previous year's book value of equity. *RD* refers to R&D expenditures of firm *i* in year *t* divided by the previous year's book value. *STR* denotes financial structure and is the ratio of the stock market value of equity of country *n* to the sum of itself and bank loans to the private sector. *DEV* measures the degree of financial development and is the ratio of the denominator of *STR* to the GDP of country *n*. As required by Eq. (4), we have imposed a non-linear parameter restriction on the coefficient of lagged *ROE*. In addition, we use one and two periods lagged changes of *V* as GMM instruments. P-values are reported in parentheses with 0.000 denoting a p-value of less than 0.0005; N is the number of usable observations; and $\bar{R}^2$ and RMSE are the adjusted coefficient of determination and the root mean squared error of estimation, respectively.

Table 3
Dynamic GMM-estimation results when controlling for the firm-specific factors.

Variable	Eq. (4) and Eq. (5) parameters	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	β_0	0.544	0.345	0.458	0.382	0.326	0.375	0.396
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$V_{i,t-1}$	ψ	0.245	0.236	0.246	0.258	0.259	0.243	0.268
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$ROE_{i,t}$	β_1	2.622	1.757	2.659	2.628	2.079	2.687	1.984
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$ROE_{i,t-1}$	$-\psi\beta_1$	-0.642	-0.420	-0.654	-0.678	-0.539	-0.629	-0.532
$RD_{i,t}$	δ_0	3.024	-7.760	0.298	-2.176	-1.361	-2.011	-0.962
		(0.686)	(0.000)	(0.908)	(0.334)	(0.542)	(0.384)	(0.638)
$RD_{i,t} \times STR_{n(i),t}$	δ_1	13.127	19.124	13.279	18.570	16.962	17.215	17.252
		(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)
$RD_{i,t} \times DEV_{n(i),t}$	δ_2	0.828	1.245	1.762	0.465	0.264	0.649	0.477
		(0.329)	(0.112)	(0.049)	(0.606)	(0.776)	(0.481)	(0.579)
$RD_{i,t}$ x $I1000_{i,t}$	$\omega_{1,1000}$	-4.846	-	-	-	-	-	-
		(0.511)						
$RD_{i,t}$ x $I3500_{i,t}$	$\omega_{1,3500}$	-1.454	-	-	-	-	-	-
		(0.842)						
$RD_{i,t}$ x $I6000_{i,t}$	$\omega_{1,6000}$	-6.311	-	-	-	-	-	-
		(0.385)						
$RD_{i,t}$ x $I8000_{i,t}$	$\omega_{1,8000}$	-3.380	-	-	-	-	-	-
		(0.642)						
$RD_{i,t}$ x $SIZE2_{i,t}$	$\omega_{2,2}$	-	0.894	-	-	-	-	-
			(0.060)					
$RD_{i,t}$ x $SIZE3_{i,t}$	$\omega_{2,3}$	-	1.540	-	-	-	-	-
			(0.000)					
$RD_{i,t}$ x $SIZE4_{i,t}$	$\omega_{2,3}$	-	2.424	-	-	-	-	-
			(0.000)					
$RD_{i,t}$ x $CF_{i,t}$	ω_3	-	-	-7.834	-	-	-	-
				(0.000)				
$RD_{i,t}$ x $DR_{i,t}$	ω_4	-	-	-	-0.255	-	-	-
					(0.504)			
$RD_{i,t}$ x $PR_{i,t}$	ω_5	-	-	-	-	45.378	-	-
						(0.000)		
$RD_{i,t}$ x $BETA_{i,t}$	ω_6	-	-	-	-	-	0.602	-
							(0.216)	
$RD_{i,t}$ x $LOSS_{i,t}$	ω_7	-	-	-	-	-	-	4.100E-5
								(0.000)
N		8946	8946	6486	8834	8736	8477	8884
$\bar{R}^2$		0.412	0.432	0.359	0.412	0.406	0.412	0.419
RMSE		3.638	3.576	4.562	3.572	3.568	3.609	3.596

NOTES: The subscripts *i*, *n*, and *t* denote firm, country and time, respectively. The growth opportunity premium (*V*), return on equity (*ROE*), R&D expenditures (*RD*), financial structure (*STR*) and financial development (*DEV*) are defined in Table 2. The industry dummies *I1000 – I8000* obtain the value of one for the firm's industry and zero otherwise. The industry classification is based on the Compustat Economic Sector (CES) codes, with 1000 referring to Basic Materials, 3500 to Health Care, 6000 to Capital Goods, 8000 to Technology, and 8600 to Communication Services. The *SIZE* variables obtain the value of one, if the firm *i* belongs to the corresponding the group of smallest, second or third smallest, or largest firms, according to the market value, respectively, and zero otherwise. *I8600* and *SIZE1* are defined to be numeraire variables. These variables are omitted from the regressions but their impact is included in *RD*'s coefficient. The other firm-specific factors are the operating cash flow deflated by book value (*CF)*, debt ratio (*DR*), payout ratio (*PR)*, riskiness of the firm (*BETA*) and losses (*LOSS*). If a loss occurs, *LOSS* equals one; otherwise it equals zero. The set of instruments is the same as reported in Table 2. P-values are reported in parentheses with 0.000 denoting a p-value of less than 0.0005; N is the number of usable observations; and $\bar{R}^2$ and RMSE are the adjusted coefficient of determination and the root mean squared error of estimation, respectively.

Table 4
Dynamic GMM-estimation results when controlling for the country-specific factors.

Variable	Eq. (4) and Eq. (6) parameters	(1)	(2)	(3)	(4)	(5)	(6)
Constant	β_0	0.412	0.410	0.412	0.408	0.406	0.399
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$V_{i,t-1}$	ψ	0.252	0.251	0.251	0.251	0.251	0.264
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$ROE_{i,t}$	β_1	2.428	2.431	2.427	2.431	2.435	2.481
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$ROE_{i,t-1}$	$-\psi\beta_1$	-0.612	-0.610	-0.609	-0.610	-0.611	-0.655
$RD_{i,t}$	δ_0	-14.367	16.923	-1.912	-2.254	-2.364	-1.883
		(0.095)	(0.365)	(0.425)	(0.353)	(0.390)	(0.363)
$RD_{i,t} \times STR_{n(i),t}$	δ_1	12.456	18.173	16.606	13.630	13.695	17.411
		(0.004)	(0.000)	(0.000)	(0.005)	(0.004)	(0.000)
$RD_{i,t} \times DEV_{n(i),t}$	δ_2	0.912	0.500	0.724	0.904	1.011	0.561
		(0.285)	(0.558)	(0.418)	(0.295)	(0.284)	(0.511)
$RD_{i,t} \times DI_{n(i),t}$	ω_8	0.210	-	-	-	-	-
		(0.129)					
$RD_{i,t} \times LE_{n(i),t}$	ω_9	-	-2.011	-	-	-	-
			(0.331)				
$RD_{i,t} \times OC_{n(i),t}$	ω_{10}	-	-	1.901	-	-	-
				(0.706)			
$RD_{i,t} \times IE_{n(i),t}$	ω_{11}	-	-	-	0.094	-	-
					(0.500)		
$RD_{i,t} \times OI_{n(i),t}$	ω_{12}	-	-	-	-	0.409	-
						(0.524)	
$RD_{i,t} \times LT_{n(i),t}$	n.a.	-	-	-	-	-	n.a.
N		8946	8946	8946	8946	8946	8946
$\bar{R}^2$		0.408	0.407	0.407	0.407	0.407	0.411
RMSE		3.651	3.653	3.653	3.653	3.653	3.641

NOTES: The subscripts *i*, *n*, and *t* denote firm, country and time, respectively. The growth opportunity premium (*V*), return on equity (*ROE*), R&D expenditures (*RD*), financial structure (*STR*) and financial development (*DEV*) are defined in Table 2. The disclosure index (*DI*) measures the inclusion or omission of 90 items in the 1990 annual reports (La Porta et al., 1998). Legal enforcement (*LE*) is the mean score across three legal variables (1) the efficiency of the judicial system, (2) an assessment of rule of law, and (3) the corruption index (La Porta et al., 1998). The variables range from zero to 10 with the higher number indicating stricter enforcement. Ownership concentration (*OC*) is measured as the median percentage of common shares owned by the largest three shareholders in the 10 largest privately owned non-financial firms. The importance of equity markets (*IE*) is measured by the mean rank across (1) the ratio of the aggregate stock market capitalization held by minorities to GNP, (2) the number of listed domestic firms relative to the population, and (3) the number of initial public offerings (IPOs) per capita (La Porta et al., 1997). Higher scores indicate a greater importance. Outside investor rights (*OI*) is the "anti director rights" index created by La Porta et al. (1998). It is an aggregate measure of minority shareholder rights and ranges from zero to five, with higher scores being associated with more rights. Legal tradition (*LT*) is a dummy variable obtaining a value of one, if country *n* uses a common law system and zero if it uses a code law system. Because of the strong correlation between *LT* and *STR*, the financial structure variable, in column (6) we define *RD*x*LT* to be an instrumental rather than exogenous variable. (Column (6) results are qualitatively the same for *STR* and *DEV* if *LT* is used as an instrument instead of *RD*x*LT*). In all the other cases the set of instruments is the same as reported in Table 2. P-values are reported in parentheses with 0.000 denoting a p-value of less than 0.0005; n.a. denotes “not applicable”; N is the number of usable observations; and $\bar{R}^2$ and RMSE are the adjusted coefficient of determination and the root mean squared error of estimation, respectively.