Multinational corporations versus domestic corporations: a comparative study of R&D investment activities

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Abstract

This paper empirically examines the effect of the degree of a firm’s multinationality on the firm’s R&D activities. In particular, based on the Internalization (and the Eclectic) approach to the development of multinational corporations this paper examines whether R&D investment influences the market value of firms differently between domestic corporations (DCs) and multinational corporations (MNCs). This paper further investigates how differently firm-related factors based on the Tobin’s Q theory affect a firm’s R&D investment between DCs and MNCs. The results show that R&D expenditures as a percentage of sales are, on average, significantly greater for MNCs than for DCs, indicating that MNCs are on average more R&D intensive. After controlling for firm and market-related factors, R&D expenditures are found to have a persistently positive effect on the market value of both DCs and MNCs, with a more pronounced effect for MNCs. These findings are consistent with the predictions by the Internalization theory. The results further show that there exist notable differences in R&D determinants between DCs and MNCs. While prior-year R&D expenditures and cash flows are significantly positively related to current-year R&D expenditures for both DCs and MNCs, prior-year debt ratio has a significant negative impact on DCs’ current-year R&D expenditures, but has little impact on MNCs’ R&D expenditures. These results suggest that a firm’s degree of multinationality plays an important role in determining the firm’s R&D expenditures. © 2001 Elsevier Science B.V. All rights reserved.

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1. Introduction

Corporate research and development (R&D) investment plays a pivotal role in a firm’s future growth. Finance and economics literature has documented that a firm’s R&D investment has a positive and consistent influence on the market value of the firm (see Chan et al., 1990; Doukas and Switzer, 1992; Chauvin and Hirschey, 1993; Szewczyk et al., 1996). For example, Chauvin and Hirschey report a significant and positive relationship between market values and R&D expenditures of roughly 1500 US firms over a 3-year period from 1988 through 1990. While the evidence on the effectiveness of R&D investments is abundant, little attention has been given to the R&D activities between multinational corporations (MNCs) and domestic corporations (DCs). This study intends to fill this gap.

MNCs may have different R&D activities than DCs for several reasons. According to the Internalization theory and the Eclectic theory (e.g. Buckley and Casson, 1976; Dunning, 1977; Rugman, 1981; Buckley, 1989), an MNC is created whenever markets are internalized across national boundaries; a firm’s location strategy is determined mainly by the interplay of comparative advantage, barriers to trade, and regional incentives to internalize, and the firm will be multinational whenever these factors make it optimal to locate different stages of production in different nations. Hence, MNCs operate an international intelligence system for the acquisition and collection of basic proprietary knowledge relevant to R&D, and for the exploitation of the commercially applicable knowledge generated by R&D. Therefore, the possession of proprietary information is the key reason why MNCs can survive the competition of DCs in host countries. The theory predicts that the more research-intensive firms will be more multinational than the average, or vise versa. It is also conceivable that MNCs have a broad market environment and have affiliates located in multiple economies, compared to DCs which operate in one economy, hence providing better diversification opportunities for MNCs. These characteristics of MNCs could lead to higher R&D investments for MNCs than for DCs.

On the other hand, MNCs are exposed to additional risk including political risk and foreign exchange risk, which would not exist in a domestic market. These characteristics of MNCs may limit the amount of R&D that MNCs can invest. Whether and how corporate R&D investment is related with the extent to which a firm’s operations are internationalized is an empirical matter.

This paper first develops a testing hypothesis regarding the linkage between a firm’s degree of multinationality and its R&D activities based on the Internalization approach to the development of MNCs, and then examines how R&D investment influences the market value of firms between DCs and MNCs. This paper further investigates how differently firm-related factors based on the Tobin’s Q theory
influence a firm’s R&D investment between DCs and MNCs. Two alternative classification criteria of foreign sales ratio and foreign tax ratio are used to distinguish between MNCs and DCs.

The results of this paper show that, consistent with the Internalization theory, the average R&D expenditures as a percentage of sales are significantly greater for MNCs than for DCs. Regression analysis shows that after controlling for firm and market-related factors, R&D investment has a persistently positive effect on the market value of both DCs and MNCs, with a more pronounced effect for MNCs. These results indicate that while capital markets value long-term investment of both domestic and multinational firms highly, the association between a firm’s R&D investment and value is stronger for MNCs than for DCs. The results further show that there are notable differences in R&D determinants between DCs and MNCs. For both DCs and MNCs current-year R&D expenditures are significantly positively related to prior-year R&D expenditures and cash flows. On the contrary, prior-year debt ratio has a significant negative impact on DCs’ current-year R&D expenditures, but has little impact on MNCs’ current-year R&D expenditures. These results suggest that a domestic firm with a relatively high debt ratio in the prior year is less likely to invest in R&D in the current year than an MNC with a similar debt ratio.

Section 2 reviews related studies and develops testing hypotheses on R&D activities of MNCs vs. DCs. Section 3 discusses the data, and Section 4 presents the research methodology and empirical results, with conclusions in Section 5.

2. Related studies and development of testing hypothesis

A number of previous studies have examined the effect of a firm’s R&D investment on its market value. Chan et al. (1990) find that share-price responses to 95 announcements of increased R&D spending are significantly positive even when the announcement occurs in the face of an earning’s decline. These results suggest that investors look beyond the short term earning’s impact of major strategic investment when valuing a firm’s stock. Chauvin and Hirschey (1993) also find a significant and positive relationship between R&D expenditures and market value of approximately 1500 US firms over a 3-year period from 1988 through 1990. Their results suggest that investors evaluate the R&D effort of firms with a long-term perspective. Szewczyk et al. (1996) document significant positive announcement effects associated with increases in firms’ R&D and investment opportunities. They also report a significant relationship of the market’s response to R&D announcements to the firm’s debt ratio and the level of institutional ownership.

The general consensus of the previous studies is that R&D investment increases the market value of firms. A firm’s R&D activities may work as intangible capital stocks, barriers to entry for other firms, or market demand factors that bring positive values to a firm’s market value.
The second set of studies examines different characteristics between MNCs and DCs. Lee and Kwok (1988) question whether US-based MNCs have different capital structures than US-based DCs, and, if so, what causes the differences. Their study uses the foreign tax ratio (foreign income taxes divided by total income taxes) as a measure of a firm's multinationality. Considering several international environmental variables, they examine two capital structure determinants — agency costs and bankruptcy costs. Their results show that while MNCs tend to have lower bankruptcy risk, are less leveraged, and have higher agency costs of debt than DCs, the difference in these factors largely disappears when the size effect is controlled.

Michel and Shaked (1986) evaluate the differences in financial characteristics and performance between MNCs and DCs. Their results show that while DCs have superior risk-adjusted, market-based performance to MNCs, MNCs are more capitalized and less risky than DCs; the average S.D. of stock returns and the average systematic risk (beta) of DCs are significantly higher than those of MNCs. Horst (1972) shows that among US-based firms, firm size distinguishes MNCs from DCs. Blomstrom and Lipsey (1991), however, provide contrasting evidence on firm size; they find that once a firm has overcome initial barriers to foreign production, size has no effect on the fraction of the firm's resources devoted to foreign activity.

Given the different characteristics between MNCs and DCs in many aspects documented in previous studies, MNCs may have different R&D activities than DCs. The Internalization theory and the Eclectic theory of the international business literature provide theoretical bases for the development of MNCs that a firm's internalization of markets leads to the internationalization of the firm (see Buckley and Casson, 1976; Dunning, 1977; Rugman, 1981; Buckley, 1989). According to the theory, an MNC is created whenever markets are internalized across national boundaries, providing a firm with firm specific advantages in knowledge and proprietary information. This firm specific know-how has both a stock and a flow component; the stock, a result of past intra-firm investment in R&D, is added to by a flow of new proprietary information and continuing R&D expenditures. This know-how advantage would enable MNCs to transform the output of R&D into a new form of production at a lower cost than DCs (mainly owing to economies of scale) and to reduce communication costs between R&D, production

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1 In the study of Lee and Kwok (1988), the DC sample consists of companies with a foreign tax ratio of less than 1%, and the MNC sample includes companies with a foreign tax ratio greater than 25%.
2 Their sample consists of 58 MNCs and 43 DCs, which are all publicly held manufacturing companies selected from Fortune 500 companies. The MNC sample includes firms with both foreign sales being at least 20% of total revenues and direct investments in at least six countries outside the US.
3 The Internalization approach to modern theory of the MNC rests on two general axioms: (1) firms choose the least cost location for each activity they perform; and (2) firms grow by internalizing markets up to the point where the benefits of further internalization are outweighed by the costs (see Buckley, 1989). Some analysts (e.g. Dunning in his Eclectic theory) add a third factor, the necessity for 'ownership advantages'. These ownership advantages are either derived from the possession of specific intangible assets such as superior technology, efficient production process, marketing systems, or from the common governance of a set of interrelated activities at home or abroad (Dunning and Bansal, 1997).
and marketing. Moreover, this know-how constitutes a barrier to entry to the industry because potential entrants have to incur costs in order to compete with know-how possessing firms (Porter, 1980).

As Buckley and Casson (1976) argue, the theory postulates that a firm’s location strategy is determined mainly by the interplay of comparative advantage, barriers to trade, and regional incentives to internalize, and hence the firm will be multinational whenever these factors make it optimal to locate different stages of production in different nations. Indeed, there are certain markets in which the incentive to internalize is particularly strong. For example, the production of knowledge through R&D, and its implementation in new processes or products, are lengthy projects which require detailed long-term appraisal and careful short-term synchronization; hence, effective planning requires internalization of the market. MNCs operate an international intelligence system for the acquisition and collection of basic proprietary knowledge relevant to R&D, and for the exploitation of the commercially applicable knowledge generated by R&D.

In sum, the internalization paradigm predicts that because both a firm’s multinationality and growth are linked to the firm’s R&D through the internalization of knowledge, the more research-intensive firms will exhibit higher rates of growth and profitability and will be more multinational than the average, and the value of the firm will vary directly with the scale of R&D. It is also conceivable that unlike DCs, MNCs have a broad market environment and have affiliates located in multiple economies. The performance of these multiple economies gives rise to diversification opportunities for MNCs, which would in turn generate more stable cash flows for MNCs (Lee and Kwok, 1988). In addition, since cash flows of MNCs are internationally diversified, MNCs are in a better position than DCs to support higher debt (Michel and Shaked, 1986). Owing to these characteristics of MNCs, MNCs would be able to support higher R&D investment than DCs would.

On the other hand, MNCs are exposed to additional risk such as political risk and foreign exchange risk, which would not exist in a domestic market (Michel and Shaked, 1986). Furthermore, in view of international market imperfections and the complexity of international operations and corporate governance systems, agency costs would be higher to monitor a firm’s activities for MNCs (Lee and Kwok, 1988) than for DCs. Therefore, these additional risk and costs associated with the operations of MNCs would limit the amount that MNCs can invest on their R&D projects. Whether and how corporate R&D investment is related with the extent to which a firm’s operations are internationalized is an empirical matter and is explored in this paper.

3. Data

The preliminary sample of this study consists of 3,324 U.S. companies, identified through the Worldscope/Disclosure CD-ROM database for the years 1991 through 1995. The data on corporate R&D expenditures and other variables were collected from the Worldscope/Disclosure database. The information on sample firms’
foreign tax ratios was obtained from Standard and Poor’s Compustat Industrial tapes.

In classifying the sample firms into the MNC and DC subsamples, two criteria were used for each firm: foreign sales ratio (foreign sales divided by total sales) and foreign tax ratio (foreign income taxes divided by total income taxes). As a domestic firm foresees growth potential in international operations, the firm needs to take a full advantage of its overseas markets and, hence, needs to produce abroad as well as sell abroad. Thus, as the firm expands its operations across borders, it could be classified as a MNC (Eiteman et al., 1995, p. 4). This classification is, however, vague since a very small sized company can be a MNC if it has overseas operations. Previous studies have used size (Horst, 1972), foreign sales (Michel and Shaked, 1986), foreign tax (Lee and Kwok, 1988), and outward direct foreign investment (Koechlin, 1995) to distinguish between MNCs and DCs. In particular, a firm’s foreign sales ratio has been widely used as a measure of MNCs because other data are less easily available. Foreign sales, however, include both sales by foreign subsidiaries and sales related to exports from the parent company. Using this measure may lead to mixing international trade with international investment. To avoid this potential problem and as a way to ensure the robustness of empirical evidence, this paper employs both foreign sales ratio and foreign tax ratio as classification criteria.

In this paper, the DC sample consists of companies which have a foreign tax ratio of less than 1% (Lee and Kwok, 1988) or which have a foreign sales ratio of less than 10 percent over the period examined. The MNC sample includes companies with a foreign tax ratio greater than 25% (Lee and Kwok, 1988) or with a foreign sales ratio greater than 20% (Michel and Shaked, 1986).

The final sample for this study consists of either 563 or 498 manufacturing firms depending on the classification criteria of foreign sales ratio and foreign tax ratio, respectively. Of the total 563 firms based on foreign sales ratio, 250 belong to the DC sample and 313 to the MNC sample. Of the total 498 firms based on foreign tax ratio, 294 belong to the DC sample and 204 to the MNC sample.

4. Research methodology and results

4.1. Measuring effects of R&D investment on market value of MNCs and DCs

This section examines the influence of R&D activities on market values of firms between MNCs and DCs. The market value of a firm may also be affected by factors other than R&D such as cash flows, growth, and risk (Chauvin and Hirschey, 1993). Given below are discussions on these three factors which are used as control variables in cross-sectional regression analysis.

Since R&D investments are heavily concentrated in manufacturing firms, non-manufacturing firms were excluded from the sample. For example, of the total 681 firms based on foreign sales ratio which have complete data available, 118 (62 DCs and 56 MNCs) were non-manufacturing firms, hence leaving 563 manufacturing firms for the final sample.
1. Cash flow: a firm’s current cash flow is used as an indicator of the firm’s ability to generate future cash flows. Cash flow is measured as operating income before depreciation minus interest expenses, taxes, preferred dividends and common dividends and is expressed as a percentage of total assets.

2. Growth: a firm’s future growth may affect positively the firm’s market value if investments are expected to make above-normal rates of return. Growth is measured as the least-squares estimate of the 5-year rate of growth in sales for each firm.

3. Risk: a firm’s valuation influence may be associated with the degree of stability that the firm’s stock returns exhibit. Risk is measured as the S.D. of a firm’s monthly stock returns over a 2-year period.\(^5\)

Based on these considerations, the following cross-sectional regression model is estimated separately for MNC and DC samples to examine the influence of R&D investment on the market value of firm \(i\):

\[
MVBV_i = \beta_0 + \beta_1(Cash \ Flow)_i + \beta_2(Growth)_i + \beta_3(Risk)_i + \beta_4(R&D)_i + \epsilon_i
\]  

where MVBV, market to book value of equity, is measured as the product of common stock price and common shares outstanding plus book value of preferred stock, divided by book value of equity, and R&D is measured as R&D expenditures divided by sales.\(^6\)

Table 1 presents summary statistics for sample firms. Regardless of the classification employed, the average size of MNCs proxied by market value, net sales, and total assets is significantly greater than that of DCs. It is also shown that MNCs, on average, have higher sales growth, greater cash flow to total assets, lower risk (measured by S.D. of monthly stock returns over a 2-year period), and lower debt to total assets than DCs. The statistics on median values of these variables show similar evidence. These findings are in general consistent with those documented in previous studies (e.g. Michel and Shaked, 1986; Lee and Kwok, 1988).

Regardless of the classification used, R&D expenditures as a percentage of sales (often known as R&D intensity) are greater for MNCs than for DCs, and the difference is statistically significant at least at the 0.05 level in both the standard \(t\)-test and the non-parametric Wilcoxon two-sample test. These results indicate that MNCs are on average more R&D intensive than DCs, consistent with the prediction by the Internalization theory of the international business literature.

Table 2 shows regression results of market value of MNCs and DCs classified by foreign sales ratio and foreign tax ratio. The results show that after controlling for

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\(^5\) In order to check for robustness of regression results, a firm’s risk was also measured by two other alternatives: the earnings volatility over a 5-year period and a firm’s beta representing its systematic risk. The regression analyses using these alternative risk measures provided results qualitatively similar to those using stock return volatility.

\(^6\) While a firm’s absolute market value was used in previous studies (e.g. Chauvin and Hirschey, 1993), a firm’s relative market value such as market to book value of equity ratio would be more meaningful given firms’ different sizes and different share prices.
### Table 1
Summary statistics of domestic corporations (DCs) and multinational corporations (MNCs)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>DCs mean (median)</th>
<th>MNCs mean (median)</th>
<th>T statistics for differences in means</th>
<th>z statistics for differences in medians</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Classified By foreign sales to total sales</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market value (Shillions)</td>
<td>0.658 (0.102)</td>
<td>3.543 (0.720)</td>
<td>6.24***</td>
<td>9.44***</td>
</tr>
<tr>
<td>Net sales (Shillions)</td>
<td>0.899 (0.121)</td>
<td>4.371 (0.666)</td>
<td>3.96***</td>
<td>10.26***</td>
</tr>
<tr>
<td>Total assets (Shillions)</td>
<td>0.849 (0.098)</td>
<td>4.879 (0.644)</td>
<td>3.50***</td>
<td>10.34***</td>
</tr>
<tr>
<td>Net sales growth (%)</td>
<td>4.783 (2.750)</td>
<td>6.967 (5.430)</td>
<td>1.86*</td>
<td>3.14***</td>
</tr>
<tr>
<td>Cash flow to sales (%)</td>
<td>5.444 (7.330)</td>
<td>7.921 (8.900)</td>
<td>1.93*</td>
<td>3.04***</td>
</tr>
<tr>
<td>SD of stock returns</td>
<td>0.221 (0.242)</td>
<td>0.154 (0.166)</td>
<td>2.37**</td>
<td>3.62***</td>
</tr>
<tr>
<td>Debt to total assets</td>
<td>0.289 (0.246)</td>
<td>0.233 (0.207)</td>
<td>2.14**</td>
<td>2.52**</td>
</tr>
<tr>
<td>MVBV</td>
<td>1.338 (1.014)</td>
<td>1.569 (1.219)</td>
<td>2.24**</td>
<td>2.94***</td>
</tr>
<tr>
<td>R&amp;D to sales (%)</td>
<td>5.416 (3.960)</td>
<td>6.309 (4.780)</td>
<td>2.18**</td>
<td>2.85***</td>
</tr>
<tr>
<td><strong>No. firms</strong></td>
<td>250</td>
<td>313</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **B. Classified by foreign taxes to total taxes** | | | | |
| Market value (Shillions) | 0.912 (0.091) | 4.264 (1.017) | 4.75*** | 10.20*** |
| Net sales (Shillions) | 1.139 (0.137) | 4.619 (0.973) | 3.29*** | 10.82*** |
| Total assets (Shillions) | 1.173 (0.109) | 5.796 (0.897) | 2.66*** | 10.90*** |
| Net sales growth (%) | 4.216 (2.250) | 7.619 (5.980) | 2.99*** | 4.25*** |
| Cash flow to sales (%) | 4.459 (6.885) | 8.980 (9.480) | 3.87*** | 4.81*** |
| SD of stock returns | 0.229 (0.247) | 0.160 (0.174) | 2.68*** | 4.57*** |
| Debt to total assets | 0.282 (0.264) | 0.240 (0.220) | 2.15** | 2.66*** |
| MVBV | 1.432 (1.049) | 1.625 (1.287) | 2.14** | 3.65*** |
| R&D to sales (%) | 5.194 (3.770) | 6.165 (4.655) | 2.25** | 2.41** |
| **No. firms** | 294 | 204 |

*The sample in A consists of 563 US manufacturing firms (250 DCs which have a foreign sales ratio less than 10% and 313 MNCs which have a foreign sales ratio greater than 20%); the sample in B consists of 498 US manufacturing firms (294 DCs which have a foreign tax ratio less than 1% and 204 MNCs which have a foreign tax ratio greater than 25%); market value is measured by the product of common stock price and the common shares outstanding plus the book values of preferred stock; net sales growth is the average of 5-year sales growth; MVBV is measured by a firm’s market value divided by book value of equity; SD of stock returns is measured as S.D. of a firm’s monthly stock returns over a 2-year period.

*** Significance at the 0.01 level.
** Significance at the 0.05 level.
* Significance at the 0.10 level.
Table 2
Regression analysis of market value of domestic corporations (DCs) and multinational corporations (MNCs)\(^a\)

\[
\text{MVBV}_i = \beta_0 + \beta_1(\text{Cash Flow})_i + \beta_2(\text{Growth})_i + \beta_3(\text{Risk})_i + \beta_4(\text{R&D})_i + \epsilon_i
\]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Classified by foreign sales to total sales</th>
<th>Classified by foreign taxes to total taxes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DCs</td>
<td>MNCs</td>
</tr>
<tr>
<td>Intercept</td>
<td>0.441</td>
<td>0.910</td>
</tr>
<tr>
<td></td>
<td>(1.350)</td>
<td>(2.952)**</td>
</tr>
<tr>
<td>Cash flow</td>
<td>0.041</td>
<td>0.052</td>
</tr>
<tr>
<td></td>
<td>(4.102)**</td>
<td>(6.143)**</td>
</tr>
<tr>
<td>Growth</td>
<td>0.049</td>
<td>0.035</td>
</tr>
<tr>
<td></td>
<td>(5.819)**</td>
<td>(3.608)**</td>
</tr>
<tr>
<td>Risk</td>
<td>(-0.028)</td>
<td>(-0.005)</td>
</tr>
<tr>
<td></td>
<td>((-0.923))</td>
<td>((-0.154))</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>0.035</td>
<td>0.076</td>
</tr>
<tr>
<td></td>
<td>(3.022)**</td>
<td>(4.590)**</td>
</tr>
<tr>
<td>F-value</td>
<td>31.346***</td>
<td>15.343***</td>
</tr>
<tr>
<td>Adjusted (R^2)</td>
<td>0.231</td>
<td>0.169</td>
</tr>
<tr>
<td>No. firms</td>
<td>250</td>
<td>313</td>
</tr>
</tbody>
</table>

\(^a\) The dependent variable, MVBV, is measured by the product of common stock price and the common shares outstanding plus the book value of preferred stock, divided by the book value of equity; cash flow is measured as net income plus depreciation divided by total assets; growth is measured as 5-year sales growth; risk is measured as the S.D. of month stock returns over a 2-year period; R&D is measured as R&D expenditure divided by sales.

*** Significance at the 0.01 level; ** Significance at the 0.05 level; * Significance at the 0.10 level.

potential factors which might influence a firm’s market value, the relationship between R&D and the firm’s market value is positive and significant at the 0.01 level for both DC and MNC sample firms. These findings strongly support the notion that corporate R&D investment helps enhance the firm’s market value, regardless of whether the firm belongs to a DC or MNC group.

While US firms’ long term investments in R&D are valued highly in the market, a firm’s degree of multinationality appears to play, at least to some extent, a role in determining the magnitude of the effect of R&D investment. As shown in Table 2, the regression coefficients of R&D for MNCs are much greater than those for DCs, regardless of the classification criteria used, indicating greater contributions of R&D investment to the market value of MNCs than to that of DCs. These results are consistent with the predictions by the Internalization and Eclectic theories of multinational operations that as R&D intensive MNCs have a strong incentive to internalize flows of knowledge, their R&D intensity is positively related to both firms’ growth and profitability. According to the theory, the internalization of the markets and externalities of these activities and their integration generate the advantages of MNCs over DCs, and these firm-specific know-how advantages enable MNCs to transform the output of R&D into a new form of production at a lower cost and to reduce communication costs between R&D, production and
marketing (Buckley, 1989). The results are also in line with the observation that the link between domestic firms and domestic investment remains quite tight (Koechlin, 1995).

Table 2 also shows that there are differences on the effects of other control variables on the market value of a firm. To be more specific, both Cash Flow and Growth have significant positive impacts on the market value of a firm, regardless of the degree of a firm’s multinationality; a firm’s sales growth, however, generates a much greater impact on the market value of DCs than MNCs. It is also worthwhile to note that unlike DCs, the intercept terms for MNCs are all significant at the 0.01 level, suggesting that additional variables might be needed to fully count for the market values of MNCs.

4.2. Measuring determinants of R&D investment for MNCs and DCs

This section investigates whether the degree of a firm’s multinationality is associated with financial and market-related factors as determinants of the firm’s R&D investment. As MNCs and DCs operate in different environments and are exposed to different types of risk, different factors are expected to affect their long-term investment such as R&D.

R&D can be considered as an element of corporate investment. The Tobin’s Q theory is widely used to explain the cross-sectional investment behavior of firms (Tobin, 1969; Poterba and Summers, 1983). According to the Tobin’s Q theory, a firm should invest when the marginal benefit of investing exceeds the marginal cost. Variables commonly suggested to influence the costs of investing are stock returns, debt ratio, cash flow, and taxes. Based on the Q theory, the following four variables are used as indicators of R&D activity of a firm.

1. Stock returns: positive stock returns of a firm may signal the firm’s growth opportunities, and an increase in R&D would help take advantage of growth opportunities. Hence, a firm’s stock returns are expected to be positively related to its future R&D expenditure (Lach and Schankerman, 1989).

2. Debt ratio: R&D investment can be regarded as an intangible asset. When there are costs of financial distress, intangible assets quickly lose value and cannot be easily used to satisfy debtor claims. Thus, it would be sub-optimal for firms that are involved in R&D activities to carry a high debt ratio (Smith and Warner, 1979). Therefore, a negative relationship is expected between a firm’s debt ratio and its R&D investment.

3. Cash flow: cash flow is expected to be positively related to a firm’s future R&D investment. Fazzari et al. (1988) and Whited (1992) provide empirical evidence that a firm’s internally generated cash flow has a significant positive effect on corporate capital expenditure.

4. Taxes: since the value of R&D-related tax subsidies increases with the firm’s marginal tax rate, a positive relation between a firm’s tax rate and R&D expenditures could be expected. Higher tax rates in the future, however, could be disincentive to invest. The net of these two effects on R&D investment is an empirical question.
As a firm’s R&D activity in a given year would be, to a large extent, influenced by — or adjusted by — the firm’s characteristics discussed above in the previous year, an analysis of regressing the firm’s current year’s R&D expenditure against its previous year’s attributes would provide more meaningful evidence. Hence, R&D investment of firm $i$ is examined with lagged independent variables in the following regression model:

$$R&D_i = \gamma_0 + \gamma_1 R&D(-1)_i + \gamma_2 \text{DEBT}(-1)_i + \gamma_3 \text{ASR}(-1)_i + \gamma_4 \text{CF}(-1)_i + \gamma_5 \text{TAX}(-1)_i + \eta_i$$

where $X(-1)$ denotes a 1-year lagged variable of $X$, R&D is measured as R&D expenditures divided by sales, DEBT (debt ratio) as book value of debt divided by book value of total assets, ASR (stock return) as annual stock returns in domestic currency, CF (cash flow) as net income plus depreciation divided by total assets, and TAX (taxes) as corporate income taxes divided by total assets.

Before examining the determinants of R&D investment for MNCs and DCs through regression analysis, it is worthwhile to investigate the presence of multicollinearity among independent variables in Eq. (2). Panel A of Table 3 presents the Pearson correlation coefficients along with their significance levels. As one would expect, $R&D(-1)$ is highly correlated with $\text{DEBT}(-1)$, $\text{CF}(-1)$ and $\text{TAX}(-1)$. In addition, the other four variables are also highly correlated with each other. Therefore, it may be difficult to separate the influences of these variables on R&D.

However, examination of pairwise simple correlation coefficients will not necessarily disclose the existence of relations among groups of independent variables.

Table 3

<table>
<thead>
<tr>
<th>Variable</th>
<th>$R&amp;D(-1)$</th>
<th>$\text{DEBT}(-1)$</th>
<th>$\text{ASR}(-1)$</th>
<th>$\text{CF}(-1)$</th>
<th>$\text{TAX}(-1)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R&amp;D(-1)$</td>
<td>1.000</td>
<td>$-0.094^{**}$</td>
<td>$-0.015$</td>
<td>$-0.303^{***}$</td>
<td>$-0.168^{***}$</td>
</tr>
<tr>
<td>$\text{DEBT}(-1)$</td>
<td>$-0.094^{**}$</td>
<td>1.000</td>
<td>$-0.077^{*}$</td>
<td>$-0.029$</td>
<td>$-0.022$</td>
</tr>
<tr>
<td>$\text{ASR}(-1)$</td>
<td>$-0.015$</td>
<td>$-0.077^{*}$</td>
<td>1.000</td>
<td>0.069*</td>
<td>0.031</td>
</tr>
<tr>
<td>$\text{CF}(-1)$</td>
<td>$-0.303^{***}$</td>
<td>$-0.029$</td>
<td>0.069*</td>
<td>1.000</td>
<td>0.054*</td>
</tr>
<tr>
<td>$\text{TAX}(-1)$</td>
<td>$-0.168^{***}$</td>
<td>$-0.022$</td>
<td>0.031</td>
<td>0.054*</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Panel A: Analysis of pairwise correlation coefficients for independent variables

Panel B: Multicollinearity diagnostics using variance inflation factor (VIF)

$R^2$ | 0.816 | 0.385 | 0.206 | 0.649 | 0.151 |
| VIF | 5.435 | 1.626 | 1.259 | 2.849 | 1.178 |

$R^2$ is the coefficient of multiple determination when each independent variable is regressed on the other independent variables in the model; $VIF = (1 - R^2)^{-1}$.

* Significance at the 0.10 level.
** Significance at the 0.05 level.
*** Significance at the 0.01 level.

7 Regressions of R&D investment were also run using concurrent year’s independent variables. The results were qualitatively similar to those reported in this paper, with slightly higher adjusted $R^2$ values.
Hence, additional diagnostics were performed for multicollinearity by examining variance inflation factors (VIFs). These factors measure how much the variances of the estimated regression coefficients are inflated compared to the variances when the independent variables are not linearly related. It can be shown that the VIF for an estimated regression coefficient, $\hat{\beta}_k$, is: $(\text{VIF})_k = (1 - R^2_k)^{-1}$, $k = 1, 2, \ldots, n$, where $n$ represents the number of independent variables. $R^2_k$ is the coefficient of multiple determination when the $k$th independent variable is regressed on the other independent variables in the model. Hence, VIF$_k$ is equal to 1 when $R^2_k = 0$, i.e. when the $k$th variable is not linearly related to the other independent variables. A VIF value in excess of 10 is often taken as an indication of severe multicollinearity (see Neter et al., 1990).

Panel B of Table 3 reports $R^2$ and VIF values for each independent variable. VIF values range from 1.178 for TAX(-1) to 5.435 for R&D(-1), but none of the VIFs is in excess of 10, indicating no severe multicollinearity among groups of independent variables. A further examination of the mean of the VIF values provides additional evidence supporting that multicollinearity among independent variables in Eq. (2) does not seem to be unduly influencing the estimates of regression coefficients.8

Table 4 shows regression results of R&D investment for MNCs and DCs classified by both foreign sales ratio and foreign tax ratio. A total of five lagged independent variables explain more than 78% of variations in a firm’s current year R&D investment for both DCs and MNCs, with substantially greater explanatory power for MNCs than for DCs.

Looking first at the results based on the classification criteria of foreign sales ratio, prior year R&D investment, R&D(-1), is positively related with current-year R&D investment for both DCs and MNCs, and the relationship is statistically significant at the 0.01 level. These results indicate that greater prior-year R&D expenditure leads to greater current-year R&D expenditure, consistent with the evidence documented in Bhagat and Welch (1995). Prior-year cash flow, CF(-1), is also significantly positively related to current-year R&D expenditures, which lends support for the notion that a firm’s internally generated cash flows are the most likely source of R&D investment. These findings are consistent with the empirical evidence documented in Fazzari et al. (1988) and Whited (1992).9

Notable differences are, however, found for the relationships of a firm’s R&D to its capital structure (measured by the firm’s debt ratio) between DCs and MNCs. While prior-year debt ratio, DEBT(-1), is negatively related to current-year R&D

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8 The mean of the VIF values provides information about the severity of the multicollinearity in terms of how far the estimated regression coefficients are from the true coefficients. Mean VIF values considerably larger than 1 are indicative of a serious multicollinearity problem (Neter et al., 1990). The mean of the VIF values in the regressions is 2.469, which is not regarded as considerably larger than 1.

9 These results are in sharp contrast to those by Bhagat and Welch (1995), who found that a firm’s prior-year cash flows are significantly negatively related to its current-year R&D expenditures. They noted that these anomalous findings may be attributed to the measurement of internally generated cash flow.
Table 4
Regression analysis of determinants of R&D investment for domestic corporations (DCs) and multinational corporations (MNCs)*

\[ R&D_i = \gamma_0 + \gamma_1 R&D(-1)_i + \gamma_2 DEBT(-1)_i + \gamma_3 ASR(-1)_i + \gamma_4 CF(-1)_i + \gamma_5 TAX(-1)_i + \eta_i \]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Classified by foreign sales to total sales</th>
<th>Classified by foreign taxes to total taxes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DCs</td>
<td>MNCs</td>
</tr>
<tr>
<td>Intercept</td>
<td>0.324</td>
<td>0.075</td>
</tr>
<tr>
<td></td>
<td>(2.644)***</td>
<td>(0.386)</td>
</tr>
<tr>
<td>R&amp;D(-1)</td>
<td>0.815</td>
<td>0.935</td>
</tr>
<tr>
<td></td>
<td>(29.034)***</td>
<td>(57.608)***</td>
</tr>
<tr>
<td>DEBT(-1)</td>
<td>−0.066</td>
<td>−0.001</td>
</tr>
<tr>
<td></td>
<td>(−5.115)***</td>
<td>(−0.92)</td>
</tr>
<tr>
<td>ASR(-1)</td>
<td>0.001</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>(0.363)</td>
<td>(1.238)</td>
</tr>
<tr>
<td>CF(-1)</td>
<td>0.071</td>
<td>0.038</td>
</tr>
<tr>
<td></td>
<td>(3.131)***</td>
<td>(3.413)***</td>
</tr>
<tr>
<td>TAX(-1)</td>
<td>−0.172</td>
<td>−0.419</td>
</tr>
<tr>
<td></td>
<td>(−0.501)</td>
<td>(−0.306)</td>
</tr>
<tr>
<td>F-value</td>
<td>182.475***</td>
<td>782.934***</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.808</td>
<td>0.932</td>
</tr>
<tr>
<td>No. firms</td>
<td>250</td>
<td>313</td>
</tr>
</tbody>
</table>

* R&D is measured as R&D expenditures divided by sales; DEBT (debt ratio) is measured by book value of debt divided by book value of total assets; ASR (stock return) is measured as annual investment return; CF (cash flow) is measured as net income plus depreciation divided by total assets; TAX is measured as corporate income taxes divided by total assets; $X(-1)$ is a 1-year lagged variable of $X$.

*** Significance at the 0.01 level.
** Significance at the 0.05 level;
* Significance at the 0.10 level.

expenditures for both DCs and MNCs, the relationship is statistically significant at the minimum level of 0.10 for DCs only. Hence, a domestic firm with a higher debt ratio in the prior year is less likely to invest in R&D projects in the current year than an MNC does. The evidence on the significant negative relationship between \( DEBT(-1) \) and R&D for DCs is consistent with the implications of Myers (1977) and Smith and Warner (1979) and with the empirical findings of Bhagat and Welch (1995). Indeed, as a debt may bring in financial distress costs, a domestic firm with a relatively high debt ratio would be less likely to finance its future growth opportunities through debt financing. On the contrary, the degree of financial leverage in the prior year appears to have little, if any, negative impact on the R&D expenditures for MNCs. As MNCs are on average less leveraged than DCs, MNCs would be more capable of investing in R&D projects through additional debt financing without endangering their capital structure position.

The results also show that for both DCs and MNCs current-year R&D expenditures are positively related to prior-year stock returns, \( ASR(-1) \), as expected, and are negatively to prior-year taxes, \( TAX(-1) \). Neither of these relationships is,
however, statistically significant at the 0.10 level. Hence, these findings indicate that prior-year stock returns and taxes do not play a significant role in determining current-year R&D expenditures for either DCs or MNCs. The findings on the insignificant relationship between \( \text{TAX}(-1) \) and R&D are consistent with those in Bhagat and Welch (1995).

Turning to the regression results for sample firms classified by foreign tax ratio, the estimated regression coefficients of explanatory variables are in line with those for firms classified by foreign sales ratio with respect to their signs and significance levels. To be more specific, R&D\((-1)\) and CF\((-1)\) have significant (at the 0.01 level) positive coefficients for both DCs and MNCs; CF\((-1)\) has significant (at least at the 0.05 level) negative coefficients for both DCs and MNCs; DEBT\((-1)\) carries negative signs for both DCs and MNCs, but is significant at the 0.01 level only for DCs. The other two variables, ASR\((-1)\) and TAX\((-1)\), carry mixed signs, but neither of the two coefficients is statistically significantly different from zero at the 0.10 level. Hence, the regression results of R&D determinants remain robust, regardless of the classification criteria for a firm’s multinationality.

5. Summary and conclusions

A firm’s R&D investment plays a pivotal role in the firm’s innovation activities, representing future growth opportunities. This paper has first developed a testing hypothesis built upon the Internalization (and the Eclectic) theory of the development of MNCs, and then empirically examined the effects of the degree of a firm’s multinationality on the firm’s R&D activities. The results show that R&D expenditures as a percentage of sales are, on average, greater for MNCs than for DCs, and the difference is statistically significant. Regression analysis shows that after controlling for firm and market-related factors, R&D investment has a persistently positive effect on the market value for both DCs and MNCs, with a more pronounced effect for MNCs. These results indicate that while long-term investments of firms such as R&D are valued highly in capital markets regardless of their multinationality, they make relatively more contributions to the market values of MNCs. Hence, a firm’s degree of multinationality plays, at least to some extent, a role in determining the effect of R&D investment. These findings are in general consistent with the predictions by the Internalization theory of the multinational operations.

The results further show that there exist similarities but, at the same time, notable differences in R&D determinants between DCs and MNCs. For both DCs and MNCs current-year R&D expenditures are significantly positively related to prior-year R&D expenditures and cash flows. A firm’s prior-year debt ratio is, however, significantly negatively related to the current-year R&D expenditures only for DCs. Hence, the degree of financial leverage appears to have little impact on MNCs’ R&D expenditures.

A possible avenue for future research would be to extend the scope of this paper to a global sample of firms and examine the supposedly different degrees of
effectiveness of R&D investments for DCs and MNCs across different nations. The
evidence from this analysis would provide additional insights into the importance of
a firm’s multinationality in promoting the nation’s overall innovation activities.

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