Innovation Efficiency, Global Diversification, and Firm Value

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ABSTRACT

This paper investigates whether multinational firms are inefficient in innovation and whether efficient innovation can mitigate the valuation discount of global diversification. Using patents or citations scaled by R&D expenses and R&D capital as the measures for innovation efficiency, we find that multinational firms have lower levels of innovation efficiency than purely domestic firms, and innovation inefficiency could partially explain the negative valuation effect of global diversification. The results further suggest that innovation efficiency is more beneficial to multinational firms that are within concentrated industries and to those that mainly diversify into developed markets or markets with better patent protections.

Keywords: Global Diversification, Innovation Efficiency, Multinational Firms, Firm Value

JEL Classification Number: F23, F30, G15, G32, O32

1. INTRODUCTION

The internalization theory predicts that the geographic boundaries of firms are determined by the costs and benefits of internalizing markets for their intangible assets such as managing and marketing skills, patents, technological know-how, goodwill and brand recognition, etc. [1] According to the theory, multinational enterprises set up subsidiaries to exploit their advantages in information-related intangible assets as these assets have public good properties and are difficult to be exchanged in external markets. This implies that, when firms possess substantial information-based assets, global diversification should create more value for shareholders due to the increased scale over which such intangible assets are applied. However, the literature documents a significant value discount associated with global diversification with a few exceptions. [2] To explain why geographically diversified firms are worth less than their geographically concentrated counterparts, Denis, Denis, and Yost (2002) provide an agency problem-based explanation. Geographic expansions can arise from agency problems as such activities, while might not be value maximizing to shareholders, provide monetary and nonmonetary incentives to management. This paper attempts to interpret the valuation effect of global diversification from another perspective - inefficient corporate innovation of multinational firms. Specifically, we explore whether multinational firms are less efficient in innovation and whether efficient R&D expenditures can mitigate the negative valuation effect associated with global diversification.

We define innovation efficiency as patents or patent citations scaled by either R&D expenses or R&D capital.[3] In other words, the innovation efficiency measures firms' ability to generate patents and patent citations for every unit of investment in R&D. The results show that multinational firms are less efficient in innovation than purely domestic firms. For example, globally diversified firms have much more investment in R&D expenditure than their domestic counterparts ($47.7 million

[1] See Coase (1937), Buckley and Casson (1976, 2009), Rugman (1981), Helpman (1984), Caves (1985), and others.

[2] For example, Denis, Denis, and Yost (2002), Fauver and Andy (2004), Bodnar, Tang, and Weintrop (2004), Gao, Ng, and Wang (2008) show that globally diversified firms are valued significantly less than their domestic counterparts. Morck and Young (1991) find that global diversification per se has no significant valuation impact. Gande, Schenzler, and Senbet (2009) and Creal, Robinson, Rogers, and Zechman (2013) document that global diversification enhances firm value.

[3] We refer the ratio of patents to R&D expenses as Prd, the ratio of patents to R&D capital as Prdc, the ratio of patent citations to R&D expenses as Crd, the ratio of patent citations to R&D capital as Crdc, respectively.

v.s. \$12.1 million). However, the Crd and Prd ratios for globally diversified firms are 6.78 and 0.45 which are significantly lower than 8.26 and 0.51 for domestic firms. The multivariate analysis with various controls that are documented to have an impact on corporate innovation provide consistent results. We also find that industrial diversification reduces innovation efficiency but does not subsume the negative effect of global diversification on corporate innovation efficiency. To confirm our findings, we further examine how the change of global diversification status is related to subsequent innovation efficiency and find that innovation efficiency decreases when firms become globally diversified and vice versa.

Next, we study how corporate innovation efficiency affects firm value for multinational firms by interacting global diversification with innovation efficiency measures. Specifically, we examine whether globally diversified firms exhibit less value discount if they are more efficient in innovation. Overall, we find that improvements in innovation efficiency are associated with significant increases in firm value for average firms. Globally diversified firms can particularly gain more benefit from being efficient in innovation, though global diversification per se still has negative effect on firm value. Thus, the negative valuation impact of global diversification has been reduced significantly if innovation efficiency improves. For example, we find that, for an increase of one standard deviation in innovation efficiency measures- Crd or Prd, the value discount associated with global diversification will reduce by 12.5% or 32.2%, respectively. This piece of evidence suggests that the discount in firm value associated with global diversification partly stems from inefficient investments or inefficient allocation of corporate resources.

Finally, we investigate the valuation effect of innovation efficiency for multinational firms in various business environments such as product market competition, the extent of economy development, and the strength of patent protections. We find that firms with greater innovation efficiency tend to have better firm valuation if they operate in concentrated industries rather than competitive industries. This can be interpreted as that firms appropriate more rents from their innovations by going international if their business environment is not very competitive. We further find that multinational firms gain more benefit from improving innovation efficiency if they diversify into developed markets or markets with better patent protections as such kind of countries usually have better governance quality and better protections on intellectual property which enable patents to create more value for firms.

Our study makes several contributions to the literature. First, our empirical evidence that links innovation inefficiency directly to multinational firms expands the understanding on the valuation impact of global diversification. Denis, Denis, and Yost (2012) attribute the value discount associated with global diversification to the cost of agency problem. We demonstrate that globally diversified firms are inefficient in innovation which could potentially contribute to the negative valuation effect of global diversification. s which is related to inefficient investments and resource allocation. Second, our explanation for the negative valuation effect of geographic diversification is in align with the arguments of the theoretical studies that diversification discount could arise from sub-optimal investment decisions in diversified firms (Raja, Servaes, and Zingales (2000) and Scharfstein and Stein (2000)). This is also consistent with the empirical findings for industrially diversified firms (Lamont (1997) and Shin and Stulz (1998)). Finally, we extend the recent literature that attempts to find out how product market competition and patent protection affect innovation. Schumpeter (1942) contends that large firms in concentrated industries drive the innovation while Arrow (1962) firms in competitive industries have a stronger incentive to innovate. Aghion and Howitt (1992) assert that patent protection is good for innovation and competition is detrimental to innovation. In contrast, Boldrin and Levin (2002) demonstrate that patent protection actually hurts innovation and competition stimulates firms to innovate. We introduce another dimension to show the potential impacts of competition and patent protection on innovation - the valuation effect of innovation. We find that innovation efficiency adds more value to multinational firms in concentrated industries and in countries with better patent protections.

The rest of the paper is organized as follows. Section 2 reviews the related literature and presents the testable hypotheses. Section 3 describes the sample and variables employed in the empirical tests as well as summarizes their statistics. Section 4 presents the empirical results, and Section 5 evaluates the impacts of innovation efficiency under various business environments. The final section concludes.

2. MOTIVATION AND HYPOTHESES DEVELOPMENT

Recent studies find that globally diversified firms have high levels of R&D expenses than purely domestic firms and that diversification decisions are driven by the innovation (see, e.g., Morck and Yeung, 1991; Rodriguez-Duarte et al., 2007). If innovation is positively associated with a firm's long term performance (Lev and Sougiannis, 1996; Chan, Lakonishok, and Sougiannis, 2001; Penman and Zhang, 2002; Lev, Sarath, and Sougiannis, 2005; Pandit, Wasley, and Zach, 2011), globally diversified firms are supposed to have better performance even though global diversification does not necessarily add value to firms. However, empirical evidence shows that globally diversified firms are valued at a discount. That is, multinational firms have lower firm value than their counterpart domestic firms (Denis, Denis, and Yost, 2002). This casts some doubts about whether the innovation is less efficient in multinational firms.

There are several reasons that multinational firms may be less efficient in innovation. First, the organization structures are generally more complex in multinational firms. Multinational firms usually have R&D centers in several locations in order to take the advantage of low-cost inputs (Morck and Young, 1991). This can lead to high costs of cooperation among R&D centers and monitoring in the progress of R&D projects, resulting in reduced innovation performance at firm level (Harris, Kreibel, and Raviv, 1982; Bodnar, Tang, and Weintrop, 1999). Moreover, some big multinational firms can even own operations in over a hundred countries. Since each segment has its own culture and characteristics, the probability that a unit hides its own private information to protect itself or for benefits is increased and this increases the asymmetric information between each unit and the headquarters. As a result, resources in a firm are not allocated as efficient as investors expect. For example, Harris and Raviv (1982) demonstrate that firms allocate resources among divisions based on the transfer prices. This resource allocation method can minimize costs but is not efficient because the division which needs the resources most may not have the highest priority. Rajan, Servaes, and Zingales (2000) document that each division in a firm can influence the resource distribution. When divisions have different levels of incentives, resources are allocated through negotiations and funds may actually flow from the best divisions to divisions with few opportunities causing sub-optimal allocation of corporate resources and less profitable investments.

Second, even though resources are allocated efficiently in a firm, multinational firms still face some more difficulties than domestic firms when engineering similar products. For example, varying cultures, political, economic and legal systems, regulations and languages require multinational firms to pour a great amount of resources into R&D to meet the demand of local people from different countries. One example is that the electronic devices need to offer users an option to change display languages, to adjust the user interface, to change the look and feel, and to add/remove some functions corresponding to local needs. Therefore, globally diversified firms will face a steeper learning curve than purely domestic firms to design a product although the products deliver a similar function. This is because when firms innovate, firms have to consider all possible situations that they may encounter in their target markets and the innovation for multinational firms becomes more complex, difficult and time-consuming.

Lastly, barriers to market entry and weak copyright protection in the global market can prevent multinational firms from innovating efficiently. Unless foreign goods are significantly superior to local products at the same price level, consumers will tend to purchase local products because of the ease to access customer service and the familiarity to the local firms. However, due to the principle of diminishing marginal productivity, more resources put into R&D do not necessarily guarantee increased quality of innovation. Weak copyright protection and trade protection in the global market further make the innovation less efficient for globally diversified firms. To protect intellectual property, globally diversified firms need to invest extra money and time on R&D to stop piracy. Local governments also can implement different levels of regulations on foreign products. After multinational firms resolve all the regulatory issues, local firms have provided alternatives to the foreign products. Thus, firms cannot merely focus on innovation and resources are usually not optimally utilized. Based upon the above discussion, we hypothesize that:

Hypothesis: Ceteris paribus, multinational firms are inefficient in innovation than domestic firms.

We further argue that the inefficient innovation of multinational firms may be one of the reasons that globally diversified firms are valued at a discount. As Hirshleifer, Hsu and Li (2012) document, information related to new technologies or innovations are difficult to process for investors due to high uncertainty and lack of appropriate evaluation method. Therefore, there is a positive relation between innovation efficiency and future stock performance because firms with higher levels of innovation efficiency has been undervalued by investors relative to inefficient firms. Since multinational firms are more complex (Denis, Denis, and Yost, 2002), we expect that innovation inefficiency will be discounted more for globally diversified firms than purely domestic firms. Or, in another way, improved innovation efficiency will mitigate the negative impact of international diversification on firm value. Therefore, we develop the hypothesis as follows:

Hypothesis: Higher innovation efficiency reduces the negative impact of international diversification on firm valuation.

In the innovation literature, business environment affect firms innovation. Among all environmental factors, product market competition and patent protection are two widely discussed topics. Some researchers argue that competition hurts innovation. Some other researchers think that competition can stimulate firms to innovate. For example, Schumpeter (1942) contends that firm size and industry matter for innovation. In his theory, large firms in concentrated industries are the main force to innovate. Arrow (1962) argues that incentive to innovate for firms is stronger in competitive industries. Aghion and Howitt (1992) assert that competition reduces firms' motive to innovate but patent protection is good for innovation. Contrast to Aghion and Howitt, Boldrin and Levin (2002) demonstrate that patent protection is detrimental to innovation; however, competition provides a mechanism to force firm managers to innovate.

To investigate the effect of innovation efficiency on firm value for multinational firms while considering for business environments, we focus on product market competition at the firm level, and patent protection and market efficiency at the country level. The economic literature offers two possible explanations to show how product market competition may reduce agency costs and improve investment efficiency. First, Hart (1983) demonstrates that competition among firms can provide investors more accurate information. With more information available, managers have less discretion to hide their private information and to gain private benefits (Holmstrom, 1982; Hermalin, 1992). Second, competition raises the probability of liquidation that motivates managers to improve their performance in order to avoid losing their job (Schmidt, 1997). The fear of this liquidation creates incentive for firm managers to innovate (Allen and Gale, 2000). Since product market competition has provided information and disciplinary force, managers of multinational firms are not able to exploit rents for their benefits and they have to strive to improve operating efficiency in order to survive. Thus, innovation efficiency may add little value to multinational firms in competitive industries. However, efficient innovation becomes important for multinational firms to reduce diversification discount in concentrated industries due to fewer information sources and lack of disciplinary force on firm managers.

Aghion, Howitt, and Prantl (2013) document that the incentive to innovate for firms depends on the net innovation rent which is the difference between post-innovation rent and pre-innovation rent. Although product market competition reduces pre-innovation rent as well as post-innovation rent, the amount that the pre-innovation rent will be reduced is more than the reduction of post-innovation rent. Therefore, the net innovation rent in competitive industries is still large enough to stimulate firms to innovate but not enough for firm managers to exploit the rent for their private benefits. In the concentrated industries, firms can decide their price to maintain their revenue. Since the pre-innovation rent is high and firms do not need to be aggressive on innovation, innovation efficiency may not be valued for investors in the concentrated industries. Therefore, we develop the hypothesis as follows:

Hypothesis: Innovation efficiency matters more for multinational firms in concentrated industries than in competitive industries.

Hypothesis: Innovation efficiency is valued more in competitive industries than in concentrated industries.

Market and country characteristics are also important for foreign trades, especially intangible assets. Among all market characteristics, we are interested in developed and emerging markets because the definition of developed and emerging markets is clear and communicative. In addition, this classification is widely used in academia and practice. Fan, Wei, and Xu (2011) argue that firms in emerging markets are structurally different from firms in developed markets. Emerging markets also feature poor government quality, weak law enforcement, high state ownership, poor financial market development and weak patent protection. Although entering emerging markets could provide diversification benefits for U.S. multinational firms, it is still not clear whether investing in emerging markets benefit intellectual assets based and R&D intensive multinational firms due to high entry cost, weak copyright protection, inefficient government and weak law enforcement.

As document before, the incentive to innovate for firms depends on the net innovation rent. We predict that efficient innovation creates more value in well-developed countries. This is because patent protection on innovation increases the post-innovation rent and this creates incentive for firms to innovate (see, Aghion and Howitt, 1992; Aghion, Howitt, and Prantl, 2013). In addition, well-developed countries have lower costs to enter and fewer barriers for foreign investors. This reduces the pre-innovation rent and increase the net innovation rent for multinational firms in developed countries. We expect that the net innovation rent is greater in developed than emerging markets. Therefore, we formalize them in terms of the following testable hypothesis:

Hypothesis: Innovation efficiency matters more for multinational firms in countries which are developed markets and provide stronger patent protection.

3. DATA AND SAMPLE DESCRIPTION

3.1 Information on Innovation Efficiency

Our sample consists of firms in the intersection of the NBER patent database and Compustat segment files. Our sample period is 1980 to 2003. [4] The NBER patent dataset contains detailed information on all U.S. patents granted by the U.S. Patent and Trademark Office (USPTO) between 1976 and 2006. Patents are included in the database only if they are eventually granted. Following the literature on innovation, we use patent data recorded by the application year as the innovative

[4] Since the accounting treatment of R&D expense reporting was standardized in 1975 (Financial Accounting Standards Board Statement No. 2), we start the sample in 1980 which allows for a full five-year period with reliable R&D expenditure data for computing R&D capital. We choose 2003 as the last year for the patent data because patent counts toward the end of the NBER patent database are subject to truncation bias as it takes on average two years from the time a patent is applied for to the time it is granted (Hall, Jaffe, and Trajtenberg, 2001).

output. Patent counts for a firm each year are the number of patent applications filed that year that were eventually granted. Patent citations are the total number of citations a firm receives in the subsequent years on all the patents it produces in a year. Citations are adjusted for the truncation bias using the approach suggested by Hall, Jaffe, and Trajtenberg (2001).

Innovative efficiency is measured by a firms ability to generate patents or citations per dollar of R&D investment. Patents are a measure of innovative output since innovations are usually officially introduced to the public in the form of approved patents with detailed information. Owing to the creation of the Court of Appeals for the Federal Circuit in 1982 and several well-documented patent lawsuits (e.g., the Kodak-Polaroid case), US firms have increasingly recognized the necessity to patent their innovations and, hence, have been especially active in patenting activities since the early 1980s (Hall and Ziedonis, 2001; and Hall, 2005). Patents are thus the most important measure of contemporary firms? innovative output (Griliches, 1990), and they are actively traded in intellectual property markets (Lev, 2001). Patent citations reflect the technology or economic significance of patents better as the simple count of patents does not distinguish breakthrough innovations from less significant or incremental technological discoveries (Griliches, 1990)). Citations thus introduce a way of gauging the enormous heterogeneity in the value of patents.

Four measures of innovative efficiency are employed: patent citations scaled by R&D expenditure (Crd), patent citations scaled by R&D capital (Crdc), patent counts scaled by R&D expenditure (Prd), and patent counts scaled by R&D capital (Prdc). R&D capital is defined as the weighted average of R&D expenditures over the last five years with an annual depreciation rate of 20% (Chan, konishok, and Sougiannis , 2001). Specifically, R&D capital for firm i in year t is calculated as:

$$R\&D\ Capital_{it} = R\&D_{it} + 0.8R\&D_{it-1} + 0.6R\&D_{it-2} + 0.4R\&D_{it-3} + 0.2R\&D_{it-4} \quad (1)$$

Missing R&D has been set to zero in computing innovative efficiency measures. We scale innovative outputs by cumulative R&D expenses is premised on R&D expenses over the preceding five years all contributing to successful patent applications filed in year t (Hirshleifer, Hsu, and Li, 2012).

3.2 Information on Diversification

We augment patenting firms with all the firms listed on Compustat segment files that operate in the same 4-digit SIC industries as the patenting firms but who do not have patents. We take the patent count to be zero for these firms (Seru, 2011)). We further impose some requirements on the merged sample. Specifically, we exclude utility and financial firms (SIC codes 4900-4999 and 6000-6999, respectively) and firms with any industrial segment in utility or financial industries. We also exclude firm-years in which the consolidated firm sales are less than $20 million and firm-years in which the total of either industrial or geographic segment sales is not within one percent of total consolidated firm sales for that year. Following Berger and Ofek (1995) and Denis, Denis, and Yost (2002), we exclude outliers that are defined as those observations for which the firm's actual value is either more than four times its imputed value or less than one-fourth its imputed value. Imputed value of a diversified firm is the sum of the segment values, with each segment valued using median sales multipliers of single-segment firms in that industry. [5]The industry definitions are based on the narrowest SIC grouping that includes at least five firms. Our selection procedure results in a sample of 36,718 firm-years associated with 6,625 firms.

The definition of global diversification is based on Compustat geographic segment files. A firm is defined as globally diversified if it reports any sales by foreign subsidiaries. Firm excess value is measured as the log of the ratio of the firm's actual value to its imputed value. We also consider a list of firm characteristics that are documented to affect firm investment or firm valuation. Tobin's q is measured as market valuation over book assets where market valuation is computed as the sum of book assets and market value of common shares minus common equity and deferred taxes. Institutional ownership data are obtained from SEC 13F filings compiled by Thomson Reuters. Firm age is the number of years a firm is listed on CRSP. R&D intensity is proxied by RD_sale which is defined as R&D expenditure scaled by sales. Debt is long-term debt and notes payable over total assets. Capex_sale is capital expenditure scaled by sales. Advex_sale is advertising expenditure over sales. Firm profitability is measured by EBIT_sale, i.e., operating income after depreciation plus nonoperating income deflated by sales. Cashfl is income before

[5]We also use median assets multiplier and the results are qualitatively the same.

extraordinary items plus depreciation and amortization deflated by total assets. The extent of industry competition is proxied by Herfindahl index which is computed at the level of 3-digit SIC code. Forecast error serves as a measure of information environment surrounding a firm and it is constructed using the earnings forecast information from I/B/E/S. Specifically, it is computed as the absolute value of the ratio of the difference between median earnings forecast and actual earnings per share over actual earnings per share.

3.3 Descriptive Statistics

Table 1 reports summary statistics of the innovation efficiency measures, excess value measure, and control variables used in the regression analyses later. All variables are winsorized at the 1% and 99% levels to mitigate the influence of outliers. In Panel A, both the full sample and patenting firms are classified along whether they are globally diversified. T-test is performed on the difference between globally diversified and non-globally diversified firms. Results shows that, compared to non-globally diversified firms, globally diversified firms exhibit less innovation efficiency and the relation holds for all the four efficiency measures. For example, the difference in Pat_RD (Cite_RD) is 0.053 (1.482) between non-globally diversified and globally diversified firms and it is statistically significant at 1%. Globally diversified firms have greater excess value than non-globally diversified firms, which is different from the existing findings that global diversification is associated with value discount. However, most of the control variables exhibit significant difference between globally diversified firms and their counterparts and thus the univariate results may not be very informative. For example, globally diversified firms tend to have more institutional ownership, more R&D expenditure, less debt, less capital expenditure and more advertising expense. Also, they are older, larger, and more profitable. Patenting firms show similiar patterns as well except that the contrast between globally diversified firms and non-globally diversified firms is even remarkable.

Panel B further controls for industrial diversification. Basically, it shows that, regardless of the industrial diversification status, globally diversified firms are significantly less innovation efficient than their counterparts though they have significantly more R&D expenditure.

Table 2 presents the correlations among all these variables. In general, the four measures of innovation efficiency are highly correlated with each other but they are not highly correlated with other firm characteristics. The correlation coefficient between any two of them ranges from 0.749 to 0.966. The various innovation efficiency measures are positively correlated with firm excess value, capital expenditure, profitability and cash flows and negatively correlated with institutional ownership, firm size, and R&D expenditure.

4. EMPIRICAL ANALYSIS

Previous studies document a valuation discount for global and industrial diversifications. For example, Christophe (1997) and Denis, Denis, and Yost (2012) find that multinational firms are valued at a discount than purely domestic firms. Denis, Denis, and Yost (2012) further attribute this fact to the cost of agency problem. However, as Harris and Raviv (1982), and Rajan, Servaes, and Zingales (2000) demonstrate that diversified firm are inefficient in resource allocation and investment decisions. Thus, we conjecture that multinational firms are less efficient in innovation and this could be one of factors that cause a lower firm value for globally diversified firms than purely domestic firms.

In the following subsection, we test whether multinational firms are inefficient in innovation. Then, we explore whether increases in innovation efficiency could mitigate the negative effect of global diversification on firm value.

4.1 Innovation Efficiency and Global Diversification

We use the following Tobit regression model to compare innovation efficiency across firms with global and industrial diversifications versus average purely domestic firms:

$$\begin{aligned} IE\ Measures \ = \ & \beta_0 + \beta_1 GblDiv + \beta_2 IndDiv + \beta_3 IO + \beta_4 Age + \beta_5 Ln(Sales) + \beta_6 Q \\ & + \beta_7 Ln(RDc) + \beta_8 Lev + \beta_9 EBIT + \beta_{10} CapEx + \beta_{11} Adv \\ & + \beta_{12} CF + \sum \beta_i Industry\ Controls + \sum \beta_j Year\ Controls + \varepsilon, \end{aligned} \tag{2}$$

where IE measures are Crd, Crdc, Prd, and Prdc. Crd and Crdc are adjusted citations over R&D expenditure and R&D capital (Hall, Jaffe, and Trajtenberg, 2001). Prd and Prdc are patent counts over R&D expenses and R&D capital. GblDiv and IndDiv are dummies to indicate globally and industrially diversified firms. IO and Age are the institutional ownership and firm age. Ln(Sales) and LN(RDc) are sales and R&D capital in log. Tobin's q is measured as market valuation over book assets. Lev, CapEx, Adv, EBIT and CF are debt ratio, capital expenditure, advertising expenditure, earnings before interest and taxes, and operating cash flow, respectively. Regressions are adjusted for year and industry fixed effects and standard errors are clustered at the firm level. See Data section for a detailed descriptions of these variables.

Table 3 reports the results of estimating equation (2) with all firms as the sample in the left panel and with patenting firms only in the right panel. When including all firms in the sample, results show that the coefficient estimates of GblDiv and IndDiv are significantly negative at 1% level. This analysis indicates that both globally and industrially diversified firms are inefficient in innovation than purely domestic firms. Although industrial diversification is also related to inefficient innovation, it does not subsume the negative effect of global diversification on innovation efficiency for firms. Thus, global and industrial diversifications may have different characteristics. Denis, Denis, and Yost (2002) find that trends for firms that are globally and industrially diversified are different over years. Firms tend to focus on fewer industries in the recent years. However, firms are becoming globally diversified.

As argued in the previous studies, global diversification is driven by innovation (see, e.g., Morck and Yeung, 1991). Therefore, our findings may be biased because domestic firms do not innovate and spend less in R&D. In the right Panel of Table 3, we only include patenting firms in the sample and rerun our regressions to see whether there is any change to our findings. Although global diversification is still negatively associated with innovation efficiency, the significance of coefficients reduces when depend variables are Prd and Prdc. However, they are still significant at the 10% level. In unreported tables, we implement OLS regressions to test the relation between innovation efficiency and global diversification and find the coefficient estimates of global diversification are significant at all conventional levels across all innovation efficiency measures. Since the number of patents during a year for firms is generally limited in a range and does not vary too much, it is more reasonable to use the Tobit regressions to estimate coefficients. To be conservative to our conclusions, we list Tobit regression results in the Table 3.

It is interesting to note that older firms are generally efficient in innovation, but institutional ownership is negatively related to innovation efficiency. Thus, experience matters for innovation efficiency because knowledge and know-how can be cumulative and can be used to shorten learn curve when firms involve in innovation. However, our findings seem to be inconsistent with Aghion, Van Reenen, and Zingales (2009). In their study, they find that firms with higher institutional ownership have a stronger incentive to innovate. One possible explanation is that institutional investors tend to invest in big firms (see, e.g., Gompers and Metrick, 2001) and this causes the negative relation between institutional ownership and innovation efficiency. In our sample, we find that multinational firms tend to be big in size. Furthermore, there is a negative correlation between firm size (proxied with sales) and innovation efficiency measures. The institutional ownership is very likely to be negatively associated with innovation efficiency. Firm value (Q) and operating performance (EBIT) are in general positively related to innovation efficiency except when using Prd as the dependent variable. However, R&D capital (Ln(RDc)) is negatively associated with innovation efficiency; for example, the coefficients of Ln(RDc) are -2.077, -2.083, -0.154 and -0.163 when dependent variables are Crd, Crdc, Prd and Prdc in the left panel of the table, respectively. Similar results also can be found when only using patenting firms. This indicates that more capital invested in R&D does not necessarily guarantee better innovation performance.

4.2 Switching Global Diversification Status and Change of Innovation Efficiency

We further examine whether changes in global diversification status are associated with changes in innovation efficiency. It is possible that the choice of global diversification may be endogenously determined as firms with inefficient investment may go global in order to maximize its benefits from intangible assets (Mork and Yeung, 1991). To address this issue, we conduct three different tests and report the results in Table 4.

In the first test, we exploit the effect of changes in global diversification status on subsequent changes in innovation efficiency for subsample which includes all event firms. We define the change of global diversification status between year t-1 and t. Then, we measure the change of innovation efficiency between year t-1 and t+3, and between year t-1 and t+5 to test how innovation efficiency changes with the change of global diversification status. In the following two tests, we use the same methodology but with subsample conditional on firms' industrial diversification status. Panel A (B) reports subsample firms which switch from domestic firms (multinational firms) to multinational firms (domestic firms). Results highlight the changes of innovation efficiency measures (Crd, Crdc, Prd, and Prdc) with their associated robust t-statistics, and the number of observations.

The overall finding from Panel A indicates that when firms change their global diversification status from domestic firms to multinational firms, their innovation efficiency reduces no matter which IE measures are used. Further, the results are driven by single segment firms (industrially concentrated firms). For example, using all event firms and the period between year t-1 and t+3, the value of IE measures reduces by 4.658, 1.974, 0.196 and 0.089 with Crd, Crdc, Prd and Prdc as the measure, respectively. All reduced values are significantly different from zero at all conventional levels. Same observation also exists for the period of t-1 and t+5. When focusing on subsample which only includes single segment firms, the decreasing trend in innovation efficiency when firms switch from domestic firms to multinational firms is more significant than previous findings using all event firms. The differences in IE measures between t+5 and t-1 are all greater than the ones between t-1 and t+3. However, this observation does not apply to firms with industrial diversification in the last two columns in the Panel A. Thus, global diversification does are associated with decreased innovation efficiency.

However, when firms switch from multinational to domestic firms in Panel B, the innovation efficiency ceases to decreasing; instead, the firms tend to be more efficient in innovation than before. This trend of increasing innovation efficiency is more evident in firms classified as industrially concentrated. For example, when Crd and Crdc are the IE measures, the differences in Crd and Crdc between t-1 and t+3 are 0.737 and 0.421, and between t-1 and t+5 are -0.524 and -0.224, respectively. All the differences become positive in the subsample of single segment firms. Although these differences are not statistically significant, firms in Panel A and Panel B do have different behavior patterns in the innovation efficiency. When we compare the difference in differences for changes in innovation efficiency between in Panel A and in Panel B, all differences in differences for IE measures are statistically significant at conventional levels using all event firms and single segment firms. Thus, we conclude that when firms change their global diversification status, their innovation efficiency also change correspondently, i.e. multinational firms tend to be inefficient in innovation.

It is interesting to note that firms generally invest more capital in R&D no matter evaluated in total amount or percent of sales when firms change their global diversification status from domestic to multinational firms, and vice versa. Changes of R&D expenditure and R&D per sales are higher and positive in Panel A and generally become negative in Panel B. Again, the change of innovation efficiency is clearer when only single segment firms are included in the sample. The findings confirm Morck and Yeung's (1991) arguments that superior intangible assets drive the global diversification. Results further confirm our previous findings that global diversification is associated with inefficiency investment in R&D.

4.3 Innovation Efficiency, Global Diversification and Firm Value

In this subsection, we investigate the relation between innovation efficiency and firm value and test whether this relation can mitigate the effect of valuation discount for global diversification if innovation efficiency is positively related to firm value. Specifically, we test the following model:

$$\begin{aligned} EV &= \beta_0 + \beta_1 GblDiv + \beta_2 IndDiv + \beta_3 GblDiv \times IE + \beta_4 IE + \beta_5 Size + \beta_6 RDs + \beta_7 Lev \\ &\quad + \beta_8 EBIT + \beta_9 CapEx + \beta_{10} Adv + \sum \beta_j Year\ Controls + \varepsilon, \end{aligned} \tag{3}$$

where EV is the excess firm value defined in the Data section; GblDiv and IndDiv are dimmy variables to indicate global and industrial diversifications; and IE is the innovation efficiency measures as we document before. All other control variables are relative measures, computed as the difference between the value for the firm and the median value for the domestic single segment firms operating in the same primary industry (Denis, Denis, and Yost, 2002). Same as excess values, industry median values are based on the narrowest SIC grouping that has at least five single-segment domestic firms. See Data section for detailed description of variables.

Panels A and B of Table 5 report the estimates of regression (3) without and with the interaction of GblDiv and each measure of innovation efficiency, respectively. Among eight models reported in the table, Models M1-M4 report the regression results using all firms while Model M5-M8 show results using patenting firms as robustness check. In Panel A, it is evident that there is a discount associated with both global and industrial diversifications. For example, the coefficient estimates are -0.135 for global diversification and -0.244 for industrial diversification in the Model 1. These two coefficients are all significant at 1% level. However, industrial diversification seems to be more detrimental to firm value. Both diversification variables are significant at conventional levels across all models in Panel A even after controlling for innovation efficiency. As expected, there is a positive relation between innovation efficiency and firm value. This indicates that innovation efficiency may not be the only reason causing the diversification discount since the discount for global and industrial diversification is not subsumed by inefficient innovation. Firm size, R&D expenditure per sales, operating income and capital expenditure are all positively related to firm value. However, leverage reduces firm value and advertising expenditure has no significant relation with firm value. We also exclude innovation efficiency measures from the regression and find that the relation between global diversification and firm value is still significant and negative (unreported results).

We next assess the assumption that increases in innovation efficiency for multinational corporations mitigate the diversification discount. In the Panel B of Table 5, global diversification dummy is interacted with innovation efficiency measures. Results show that the coefficients on the interaction term between global diversification dummy (GblDiv) and innovation efficiency measures (IE) are all significantly positive at 1% level. This indicates that multinational firms with higher innovation efficiency will experience a smaller diversification discount. Although coefficients of interaction term between GblDiv and IE across models are not large compared to the coefficients of GblDiv, they are economically significant. Using equation (3) and focusing on the global diversification discount, we can get:

$$G\_Discount = \beta 1 + \beta_3 IE, \tag{4}$$

Therefore, the global diversification discount is the coefficient of GblDiv plus the coefficient of

GblDiv× IE times IE measures.[6] To see how change of innovation efficiency affects global diversification discount, we can rewrite the equation as:

$$\Delta G\_Discount\% \quad = \quad \beta_3(IE_2 - IE_1)/G\_Discount_1, \tag{5}$$

Since the standard deviations for Crd and Crdc are 18.09 and 10.62, if a multinational firm improve its innovation efficiency by one standard deviation, the firm can reduce its diversification discount by 12.48% and 32.18% when Crd and Crds are used as IE measures. Similar results can be found by using Prd and Prdc as IE measures.

In summary, the findings from Table 3, Table 4 and Table 5 are consistent with our hypotheses that multinational firms are inefficient in innovation and improving innovation efficiency can mitigate the diversification discount for multinational firms. Thus, inefficient innovation could be one of important factors that cause a valuation discount for globally diversification.

5. INNOVATION EFFICIENCY, GLOBAL DIVERSIFICATION AND MARKETS

In the innovation literature, product market competition and patent protection are two widely discussed topics. Some researchers argue that competition hurts innovation (Schumpeter, 1942). Some other researchers think that firms' incentive to innovate is stronger in competitive industries than in concentrated industries (Arrow, 1962). Aghion and Howitt (1992) assert that product market competition impedes firms from innovating but patent protection stimulates innovation. Boldrin and Levin (2002) demonstrate that patent protection is detrimental to innovation but competition provides a mechanism to force firm managers to innovate.

In the following subsections, we first investigate how the efficient innovation could reduce the diversification discount regarding product market competition. Then, we explore whether multinational firms with high levels of innovation efficiency could benefit from well-developed economy and patent protection for their investments.

[6] The equation (4) can be found by setting GblDiv=1 and GblDiv=0 for the equation (3).

5.1 Product Market Competition and Innovation Efficiency

In this subsection, we separate industries into high competition industries (competitive industries) and low competition industries (concentrated industries) to explore how the valuation effect of innovation efficiency for multinational firms varies with product market conditions. Specifically, we separately evaluate equation (3) for firms in competitive industries and in concentrated industries. Table 6 reports the estimation results.

We find that global diversified firms are negatively associated with firm value in both competitive and concentrated industries. Thus, even though product market competition provides disciplinary force on the firm management, it still could not eliminate global diversification discount. We further find that the coefficients on the interaction term between global diversification (GblDiv) and innovation efficiency (IE) are generally insignificant in competitive industries but are significant in concentrated industries. Results confirm our hypothesis and indicate that innovation efficiency only adds value to multinational firms in concentrated industries. When multinational firms in the concentrated industries improve their innovation efficiency, they will have lower global diversification discount.

It is interesting to note that higher levels of innovation efficiency increases firm value for average firms in competitive industries. For example, the coefficients on IE are 0.002, 0.007, 0.026 and 0.092 when the IE measure is Crd, Crdc, Prd and Prdc, respectively. All coefficients are significant at 1% level. Thus, our results seem to support Arrow (1962) and Boldrin and Levin (2002) that product market competition creates incentive for firm managers to concentrate on innovation. Investors also reward innovative firms with better valuation. However, innovation efficiency has no relation with firm value in concentrated industries. The coefficient estimates of innovation efficiency in the right Panel of the Table are generally positive across all models but none of these coefficients is significant.

We also find that some factors consistently show the same effect on firm value in both competitive and concentrated industries. For example, large firm size, higher R&D expenditures, smaller debt ratio, higher operating income and higher capital expenditures are associated with higher firm value no matter in competitive industries or in concentrated industries. Therefore, the analysis in Table 6 finds that innovation efficiency has different valuation effects on multinational firms pertaining to the product market competition. Specifically, the diversification discount will be smaller for efficient multinational firms in concentrated industries but not in competitive industries. However, we also find that innovation efficiency increases with firm value for average firms in competitive industries but not in concentrated industries.

5.2 Patent Protection and Market Development

In this subsection, we first partition countries into two groups according to market development and patent protection. Thus, countries are categorized as developed versus emerging markets, and strong patent protection (more protection) versus weak patent protection (less protection). When using patent protection to classify countries, countries having patent protection score above or equal to the median are categorized as 'strong protection' countries; otherwise, 'weak protection' countries. Patent protection score is obtained from Ginarte and Park (1997) and Park (2008).

Then, multinational firms are defined as: (1) 'developed markets' firms if the percentage of foreign subsidiaries in developed countries is greater than or equal to the median across all firms; otherwise, the firms are defined as 'emerging markets'; (2) 'strong protection' firms if the percentage of foreign subsidiaries in countries which are classified as 'strong protection' is greater than or equal to the median of all firms; otherwise, the firms are categorized as 'weak protection' firms. Sample in this section only includes multinational firms over the period 1993 to 2003. The information of corporate subsidiaries is obtained from the database of Directory of Corporate Affiliations (DCA). DCA contains business profiles and geographic distribution of subsidiaries and allows us to identify the proportion of foreign subsidiaries in developed markets and in strong patent protection countries for each globally diversified firm. We then estimate equation (3) for each subgroup of firms. Table 7 and Table 8 report results by classifying firms using market development and patent protection, respectively.

The results in Table 7 indicate that increases in innovation efficiency are related to higher firm value when multinational firms have most investments in developed markets. The coefficients on IE in the left Panel are 0.002, 0.005, 0.032, and 0.091 across four models and are statistically significant at conventional levels. However, the coefficient estimates of IE are all insignificant in emerging markets. Thus, market development matters for multinational firms. When they invest more in developed markets, the diversification discount will be smaller if they also improve their innovation efficiency. We further find that there is a discount associated with industrial diversification in both developed and emerging markets. The discount seems to be smaller for multinational firms in developed markets. Consistent with our previous findings, firm size and R&D expenditure have a positive effect on the firm value. EBIT becomes insignificant in emerging market and capital expenditure is no longer significant in developed market.

Table 8 reports the test of our hypothesis that global diversified firms gain more value in countries with stronger patent protection. We find that multinational firms with higher levels of innovation efficiency have better firm performance in countries with stronger patent protection. All the coefficients on IE are statistically significant in the left Panel of the Table 8. Although innovation efficiency is also positively associated with firm value, the coefficients on IE are smaller in countries with weak patent protection than in countries with strong patent protection. Thus, patent protection is important for innovative multinational firms, especially for globally diversified firms with higher innovation efficiency. We note, however, that our investigation is subject to some limitations because innovation efficiency does not equal to innovation that commonly documented in the literature.

In summary, our analyses in this section show some important findings. First, multinational firms with higher innovation efficiency have a smaller diversification discount in concentrated industries but not in competitive industries. Second, product market competition matters for firms with higher levels of innovation efficiency and efficient firms perform better in competitive industries. Third, market development and stronger patent protection play a key role on improving firm value for multinational firms with higher innovation efficiency. The overall findings indicate that product market competition stimulates innovation and at the same time also discipline executives in firms. This is because competition reduces both pre- and post-innovation rents and leaves enough net innovation rent for firms to engage in innovation. However, the rent is not large enough for firm managers to exploit for their private benefits. In addition, competition has provided disciplinary force on firm managers. If they do not work hard, they will be removed from their position. Well-developed countries have lower pre-innovation rent and higher post-innovation rent. This will offer greater incentive for firms to innovate because they will gain profit from their innovation (due to higher net innovation rent). In the emerging markets, the entry costs are high and the patent protection is weak. Since the net innovation rent is small, efficient innovation will not be valued in emerging market. Our last finding provide evidence to innovation literature that patent protection is important for multinational firms which are more efficient in innovation.

6. CONCLUSION

Previous studies find that multinational firms are valued at a discount than domestic firms. The cost of agency problem and inefficient resource allocation are two of possible explanations for this valuation discount of global diversification. As literature documents, multinational firms have a complex organization structure and the resource allocation is not efficient within the firm. We conjecture that global diversified firms may be inefficient in innovation which leads to lower firm value. Therefore, the purpose of this study is to investigate the relation between innovation efficiency and global diversification and the valuation effect of innovation efficiency on multinational firms.

We find that multinational firms have lower levels of innovation efficiency than purely domestic firms. For example, multinational firms invest 7.7% of their sales in R&D but the ratio of patents to R&D expenses is only 0.454 while domestic firms investing 7.8% of sales in R&D with 0.507 for the innovation efficiency ratio. Thus, domestic firms are more efficient in innovation. Results are still consistent even after controlling for variables that are previously shown to affect innovation efficiency or firm investments. We also find that industrial diversification is associated with inefficient innovation; however, the negative effect of global diversification on innovation efficiency is still significant at conventional levels when we control the industrial diversification effect in the regressions. To make sure our findings are robust, we examine how change of global diversification status is related to subsequent innovation efficiency. Results indicate that firms become inefficient in innovation when they switch their status from domestic firms to multinational firms and tend to be more efficient when they change from multinational firms to domestic firms. We further find that efficient innovation is related to higher firm value. When multinational firms are efficient in innovation, their valuation discount will be smaller than average globally diversified firms. The discount effect of global diversification seems to, in part, stem from inefficient corporate investment decisions.

In the innovation literature, product market competition and patent protection are widely discussed. Some researchers argue that competition and patent protection could foster innovation. However, some other researchers disagree with such an argument. Therefore, we explore how the effect of innovation efficiency on firm value for multinational firms varies with several business environments. Further analyses demonstrate that efficient firms have better firm value than inefficient firms in competitive industries. However, multinational firms only gain additional benefits from being efficient in innovation in concentrated industries. We further find that multinational firms have better performance when they have more subsidiaries located in countries which are developed markets and have stronger patent protections.

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Table 1

Descriptive Statistics of Globally Diversified and Domestic Firms

This table presents the summary statistics of innovation efficiency (IE) measures and firm characteristics. Firms are classified using Compustat geographic segment files to indicate their international diversification status in Panel A, and both international and industrial diversifications in Panel B. Globally (industrially) diversified firms are firms with sales from foreign subsidiaries (more than one business segment) in a given year. Crd is adjusted citations over R&D expenditure and Crdc is adjusted citations over R&D capital. Prd is patent counts divided by R&D expenditure. Prdc is patent counts over R&D capital. R&D capital is defined as the weighted average of R&D expenditures over the last five years with an annual depreciation rate of 20%. EV is the excess value of a firm measured as the log of the ratio of firm's actual value to its imputed value. IO is the percentage of institutional ownership. Age is the number of years a firm listed on CRSP return files. Sales, RD, and RDc are sales, R&D expenditure, and R&D capital in millions of dollars. Q is Tobin's q measured as market valuation over book assets. RDs is R&D expenditure deflated by sales. Lev is long-term debt and notes payable over total assets. CapEx, Adv and EBIT are capital expenditure, advertising expenditure, and operating income after depreciation plus nonoperating income scaled by sales. CF is income before extraordinary items plus depreciation and amortization deflated by total assets. Herf is Herfindahl index computed at the level of 3-digit SIC code. Sample period is from 1980 to 2003. *** , **, and * indicate significance at 1%, 5%, and 10%, respectively.

Panel A: All Firms v.s. Patenting Firms										
	All Firms									
	Overall			Domestic Firms			Globally Diversified Firms			
Variable	N	Mean	Median	N	Mean	Median	N	Mean	Median	Diff(D,G)
Crd	20,658	7.352	0.708	8,033	8.257	0.000	12,625	6.775	1.468	1.482***
Crdc	16,597	2.795	0.444	5,921	3.204	0.000	10,676	2.567	0.700	0.637***
Prd	20,658	0.474	0.105	8,033	0.507	0.000	12,625	0.454	0.157	0.053***
Prdc	16,597	0.185	0.055	5,921	0.203	0.000	10,676	0.174	0.071	0.029***
EV	20,658	−0.001	−0.010	8,033	−0.001	0.000	12,625	0.000	−0.020	−0.001
IO	20,658	0.365	0.339	8,033	0.281	0.235	12,625	0.418	0.419	−0.137***
Age	20,658	15.885	11.000	8,033	12.749	9.000	12,625	17.880	13.000	−5.131***
Sales	20,658	869.127	140.090	8,033	344.777	75.085	12,625	1202.760	233.797	−857.983***
RD	20,658	33.856	7.029	8,033	12.060	3.278	12,625	47.725	11.442	−35.664***
RDc	20,658	126.557	12.294	8,033	29.426	4.486	12,625	188.359	23.552	−158.932***
Q	20,658	1.909	1.448	8,033	1.929	1.422	12,625	1.897	1.459	0.033
RDs	20,658	0.077	0.042	8,033	0.078	0.037	12,625	0.077	0.044	0.001
Lev	20,658	0.169	0.137	8,033	0.159	0.111	12,625	0.175	0.152	−0.016***
CapEx	20,658	0.064	0.044	8,033	0.066	0.041	12,625	0.062	0.046	0.004***
Adv	20,658	0.012	0.000	8,033	0.011	0.000	12,625	0.013	0.000	−0.002***
EBIT	20,658	0.060	0.085	8,033	0.046	0.078	12,625	0.068	0.090	−0.022***
CF	20,658	0.063	0.094	8,033	0.058	0.093	12,625	0.067	0.095	−0.009***
Herf	20,658	0.193	0.141	8,033	0.193	0.141	12,625	0.193	0.141	0.000
				Patenting Firms						
Crd				3,726	17.802	6.935	8,165	10.476	4.834	7.326***
Crdc				2,951	6.429	2.525	7,293	3.758	1.772	2.670***
Prd				3,726	1.092	0.561	8,165	0.702	0.396	0.390***
Prdc				2,951	0.408	0.210	7,293	0.255	0.147	0.153***
EV				3,726	0.037	0.000	8,165	0.039	0.015	−0.002
IO				3,726	0.331	0.292	8,165	0.463	0.481	−0.132***
Age				3,726	14.729	11.000	8,165	21.158	16.000	−6.429***
Sales				3,726	542.752	107.463	8,165	1678.890	433.605	−1136.138***
RD				3,726	19.760	5.381	8,165	65.869	18.087	−46.110***
RDc				3,726	52.029	8.627	8,165	273.596	41.550	−221.567***
Q				3,726	1.985	1.471	8,165	1.872	1.453	0.113***
RDs				3,726	0.090	0.043	8,165	0.072	0.042	0.018***
Lev				3,726	0.153	0.108	8,165	0.185	0.172	−0.032***
CapEx				3,726	0.074	0.047	8,165	0.066	0.050	0.008***
Adv				3,726	0.010	0.000	8,165	0.013	0.000	−0.003***
EBIT				3,726	0.048	0.079	8,165	0.083	0.095	−0.034***
CF				3,726	0.064	0.097	8,165	0.082	0.100	−0.018***
Herf				3,726	0.185	0.128	8,165	0.197	0.148	−0.012***

Table 1 (continued)

Panel B: Industrially Concentrated Firms and Industrially Diversified Firms														
	Industrially Concentrated Firms							Industrially Diversified Firms						
	Domestic Firms			Globally Diversified Firms				Domestic Firms			Globally Diversified Firms			
Variable	N	Mean	Median	N	Mean	Median	Diff(D,G)	N	Mean	Median	N	Mean	Median	Diff(D,G)
Crd	6,718	8.286	0.000	8,930	6.734	0.643	1.553***	1,315	8.110	1.575	3,695	6.877	3.228	1.233***
Crdc	4,777	3.286	0.000	7,230	2.599	0.376	0.687***	1,144	2.862	0.633	3,446	2.502	1.218	0.361**
Prd	6,718	0.477	0.000	8,930	0.410	0.091	0.067***	1,315	0.659	0.213	3,695	0.560	0.316	0.099***
Prdc	4,777	0.195	0.000	7,230	0.161	0.045	0.035***	1,144	0.237	0.082	3,446	0.202	0.119	0.035***
EV	6,718	0.023	0.000	8,930	0.007	−0.012	0.016*	1,315	−0.123	−0.137	3,695	−0.018	−0.040	−0.105***
IO	6,718	0.274	0.224	8,930	0.393	0.374	−0.119***	1,315	0.322	0.298	3,695	0.480	0.507	−0.158***
Age	6,718	10.411	8.000	8,930	12.851	10.000	−2.440***	1,315	24.694	21.000	3,695	30.033	26.000	−5.339***
Sales	6,718	205.313	59.263	8,930	661.875	140.743	−456.561***	1,315	1057.260	283.464	3,695	2509.960	1069.490	−1452.700***
RD	6,718	10.051	3.133	8,930	36.463	9.176	−26.412***	1,315	22.327	4.248	3,695	74.941	22.000	−52.615***
RDc	6,718	20.767	3.758	8,930	130.468	17.228	−109.701***	1,315	73.667	9.142	3,695	328.269	55.881	−254.602***
Q	6,718	2.051	1.524	8,930	2.067	1.568	−0.016	1,315	1.308	1.145	3,695	1.485	1.260	−0.177***
RDs	6,718	0.088	0.050	8,930	0.095	0.063	−0.006***	1,315	0.024	0.012	3,695	0.035	0.021	−0.010***
Lev	6,718	0.150	0.087	8,930	0.153	0.110	−0.003	1,315	0.210	0.200	3,695	0.229	0.217	−0.019***
CapEx	6,718	0.068	0.042	8,930	0.064	0.046	0.005***	1,315	0.053	0.038	3,695	0.058	0.047	−0.005***
Adv	6,718	0.011	0.000	8,930	0.012	0.000	−0.001	1,315	0.007	0.000	3,695	0.014	0.000	−0.007***
EBIT	6,718	0.041	0.078	8,930	0.058	0.089	−0.017***	1,315	0.073	0.077	3,695	0.091	0.093	−0.018***
CF	6,718	0.053	0.093	8,930	0.059	0.095	−0.005**	1,315	0.083	0.095	3,695	0.087	0.096	−0.004
Herf	6,718	0.182	0.127	8,930	0.173	0.122	0.009***	1,315	0.252	0.222	3,695	0.241	0.190	0.011**

Table 2
Correlation Coefficients

This table reports the average of time-series correlations among innovation efficiency (IE) measures and firm characteristics. IE measures include adjusted citations/R&D expenditure (Crd), adjusted citations/R&D capital (Crdc), patent counts/R&D expenditure (Prd) and patent counts/R&D capital (Prdc). R&D capital is defined as the weighted average of R&D expenditures over the last five years with an annual depreciation rate of 20%. Firm characteristics include firms excess value (EV), institutional ownership (IO), firm age (Age), sales (Sales), R&D expenditure (RD), R&D capital (RDc), Tobin's q (Q), R&D expenditure deflated by sales (RDs), debt ratio(Lev), capital expenditure (CapEx), advertising expenditure, earnings before interest and taxes (EBIT), cash flow (CF) and Herfindahl index (Herf). Sales, RD, and RDc are in millions of dollars. The sample period used in this study is from year 1980 to 2003.

	Crd	Crdc	Prd	Prdc	EV	IO	Age	Sales	RD	RDc	Q	RDs	Lev	CapEx	Adv	EBIT	CF
Crdc	0.969																
Prd	0.787	0.749															
Prdc	0.786	0.795	0.966														
EV	0.049	0.071	0.003	0.028													
IO	-0.030	-0.037	-0.053	-0.066	0.219												
Age	0.002	-0.021	0.061	0.023	-0.037	0.199											
Sales	-0.028	-0.034	-0.018	-0.031	0.059	0.293	0.433										
RD	-0.038	-0.036	-0.056	-0.061	0.051	0.248	0.307	0.586									
RDc	-0.020	-0.026	-0.031	-0.041	0.037	0.117	0.229	0.483	0.680								
Q	0.000	0.029	-0.073	-0.039	0.338	0.145	-0.117	-0.011	0.098	0.045							
RDs	-0.103	-0.091	-0.172	-0.155	0.096	0.103	-0.162	-0.079	0.233	0.089	0.245						
Lev	0.007	-0.006	0.050	0.026	-0.013	-0.093	0.043	0.070	-0.057	-0.013	-0.188	-0.266					
CapEx	0.054	0.082	0.014	0.046	0.162	0.055	-0.097	-0.018	-0.006	-0.004	0.008	0.006	0.178				
Adv	-0.021	-0.019	-0.025	-0.019	0.049	-0.021	0.036	0.057	0.051	0.036	0.048	-0.009	-0.030	-0.048			
EBIT	0.076	0.093	0.062	0.083	0.151	0.179	0.089	0.092	0.049	0.044	0.101	-0.362	-0.045	0.006	-0.051		
CF	0.080	0.095	0.079	0.097	0.103	0.168	0.093	0.086	0.032	0.030	0.069	-0.327	-0.148	0.019	-0.036	0.731	
Herf	-0.017	-0.024	0.047	0.043	0.001	-0.019	0.147	0.071	-0.003	0.021	-0.097	-0.213	0.056	-0.094	0.008	0.081	0.102

Table 3

Effect of International Diversification on Innovation Efficiency

This table shows the relationship between international diversification and firms' efficiency of R&D expenditures proxied by various IE measures. The dependent variables are IE measures which include adjusted citations/R&D expenditure (Crd), adjusted citations/R&D capital (Crdc), the number of patents/R&D expenditure (Prd), and the number of patents/R&D capital (Prdc). GblDiv (IndDiv) is a dummy variable that takes the value of 1 if a firm is a globally (industrially) diversified firm and 0 if otherwise. The control variables include the percentage of institutional ownership (IO), firm age (Age), log of sales (Ln(Sales)), firm value (Q), log of R&D capital (Ln(RDc)), debt ratio (Lev), earnings before interest and taxes (EBIT), capital expenditure (CapEx), advertising expenditure (Adv), and cash flow (CF). Lev is the ratio of long-term debt and notes payable to total assets. EBIT, CapEx, and Adv are operating income after depreciation plus nonoperating income, capital expenditure, and advertising expenditure divided by sales, respectively. CF is income before extraordinary items plus depreciation and amortization deflated by total assets. All regressions include unreported industry- and year-fixed effects. *t*-statistics reported in parentheses are adjusted for firm-level clustered standard errors. The sample period is from 1980 to 2003.

	All Firms				Patenting Firms			
	Crd	Crdc	Prd	Prdc	Crd	Crdc	Prd	Prdc
Intercept	47.565	13.132	2.346	0.609	13.589	2.641	1.298	0.351
	(13.71)	(9.53)	(13.24)	(8.72)	(1.81)	(1.51)	(3.85)	(3.56)
GblDiv	-2.118	-0.716	-0.092	-0.027	-2.473	-0.893	-0.090	-0.032
	(-5.66)	(-4.95)	(-4.80)	(-3.71)	(-2.51)	(-2.44)	(-1.78)	(-1.67)
IndDiv	-1.583	-0.943	-0.043	-0.045	-2.453	-0.982	-0.119	-0.049
	(-3.59)	(-5.83)	(-1.87)	(-5.51)	(-2.99)	(-3.27)	(-2.50)	(-2.87)
IO	-5.141	-1.303	-0.333	-0.085	-1.404	-0.538	-0.177	-0.065
	(-5.89)	(-3.91)	(-7.54)	(-5.18)	(-0.75)	(-0.78)	(-2.04)	(-1.97)
Age	0.085	0.013	0.007	0.001	0.049	0.011	0.005	0.001
	(6.55)	(2.74)	(10.57)	(6.00)	(1.77)	(1.05)	(3.14)	(2.31)
Ln(Sales)	-2.528	0.536	-0.114	0.072	2.377	0.907	0.250	0.094
	(-13.65)	(5.85)	(-12.00)	(15.59)	(4.23)	(4..35)	(8.48)	(8.48)
Q	0.053	0.437	-0.033	0.015	1.312	0.601	0.044	0.022
	(0.42)	(8.27)	(-5.22)	(5.77)	(5.32)	(6.13)	(4.47)	(5.54)
Ln(RDc)	-2.077	-2.083	-0.154	-0.163	-5.434	-1.960	-0.478	-0.174
	(-16.87)	(-27.81)	(-24.37)	(-42.89)	(-10.47)	(-10.37)	(-16.54)	(-16.57)
Lev	2.152	-1.011	0.268	-0.054	-1.969	-0.677	-0.073	-0.042
	(1.93)	(-2.35)	(4.69)	(-2.50)	(-0.95)	(-0.90)	(-0.67)	(-1.06)
EBIT	2.496	9.737	-0.459	0.420	28.899	12.729	1.103	0.587
	(1.04)	(9.43)	(-3.82)	(8.36)	(4.23)	(4.86)	(3.99)	(4.98)
CapEx	-7.916	-1.282	-0.899	-0.191	-6.361	-1.070	-0.795	-0.180
	(-1.31)	(-0.55)	(-2.92)	(-1.62)	(-0.64)	(-0.31)	(-1.26)	(-0.81)
Adv	8.477	1.823	0.272	-0.020	2.669	1.407	-0.213	-0.053
	(5.12)	(2.75)	(3.31)	(-0.63)	(1.03)	(1.46)	(-1.48)	(-1.00)
CF	0.862	-1.747	0.305	-0.020	-2.966	-0.611	0.033	0.045
	(0.43)	(-2.21)	(3.06)	(-0.52)	(-0.89)	(-0.54)	(0.20)	(0.78)
Industry fixd effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.138	0.167	0.175	0.235	0.185	0.195	0.293	0.299
Obs.	20,658	16,597	20,658	16,597	10,237	10,244	10,237	10,244

Table 4

Switch of Global Diversification and Innovation Efficiency Change

Panel A tests whether a firm switching its diversification status from a domestic firm to a globally diversified firm in year t reduces its subsequent innovation efficiency. Sample only includes firms with diversification status changed. First two columns report results with all event firms and the other columns report results conditional on industrial diversification. t_{-1} is one year before the change in global diversification status. t_3 and t_5 indicates three and five years after a firm switches its diversification status from a domestic firm to a globally diversified firm. The first (second) column in each subsample of event firms reports differential tests of IE measures (Crd, Crdc, Prd, and Prdc) and R&D expenditures (RD and RDs) between year t+3 (t+5) and t-1. Panel B reports similar tests with firms switching from globally diversified firms to domestic firms. Sample period is from 1980 to 2003. *** , **, and * indicate significance at 1%, 5%, and 10%, respectively.

	Panel A: Switch to Globally Diversified Firms											
	All Event Firms				Industrially Concentrated Firms				Industrially Diversified Firms			
Variables	$t_3 - t_{-1}$		$t_5 - t_{-1}$		$t_3 - t_{-1}$		$t_5 - t_{-1}$		$t_3 - t_{-1}$		$t_5 - t_{-1}$	
Crd	270	−4.658***	128	−4.268**	209	−5.132***	90	−6.502***	61	−3.035	38	1.023
Crdc	208	−1.974***	116	−1.749**	154	−2.376***	84	−2.673***	54	−0.826	32	0.675
Prd	270	−0.196***	128	−0.217*	209	−0.233***	90	−0.346**	61	−0.070	38	0.090
Prdc	208	−0.089***	116	−0.072*	154	−0.109***	84	−0.117**	54	−0.034	32	0.045
RD	410	14.245***	200	12.757***	302	16.443***	135	15.192***	108	8.096***	65	7.699***
RDs	410	0.002	200	0.011**	302	0.001	135	0.009	108	0.006	65	0.015*
	Panel B: Switch to Domestic Firms											
Crd	51	0.737	31	−0.524	40	0.749	23	0.350	11	0.695	8	−3.036
Crdc	44	0.421	29	−0.224	35	0.567	22	0.285	9	−0.145	7	−1.826
Prd	51	−0.019	31	0.049	40	0.076	23	0.159	11	−0.366	8	−0.265
Prdc	44	0.017	29	0.020	35	0.058	22	0.075	9	−0.144	7	−0.153
RD	121	−1.511	83	−0.115	88	−1.512	61	0.367	33	−1.509	22	−1.452
RDs	121	−0.003	83	−0.005	88	−0.005	61	−0.003	33	0.002	22	−0.011

Table 5

Valuation Impact of Innovation Efficiency

This table shows the impact of firms' efficiency of R&D expenditures (IEs) on firm valuation while controlling for their diversification status and firm characteristics. The dependent variable is excess value calculated as the log of (a firm's true value/it's imputed value). 'IE' on the left column is the IE measure on the top of each Model. IE measures include adjusted citations/R&D expenditure (Crd), adjusted citations/R&D capital (Crdc), the number of patents/R&D expenditure (Prd), and the number of patents/R&D capital (Prdc). GblDiv (IndDiv) is a dummy variable that takes the value of 1 if a firm is a globally (industrially) diversified firm and 0 if otherwise. The control variables include the firm size (Size), ratio of R&D to sales (RDs), debt ratio (Lev), earnings before interest and taxes (EBIT), capital expenditure (CapEx), and advertising expenditure (Adv). Firm size is the market value of total assets. Debt ratio is the ratio of long-term debt and notes payable to total assets. EBIT, CapEx, and Adv are operating income after depreciation plus nonoperating income, capital expenditure, and advertising expenditure scaled by sales, respectively. Following Denis, Denis and Yost (2002), control variables except dummies are adjusted with industry median values. All regressions include unreported year-fixed effects. t-statistics reported in parentheses are adjusted for firm-level clustered standard errors. The sample period is from year 1980 to 2003.

Panel A: Impact of Innovation Efficiency on Firm Valuation								
	All Firms				Patenting Firms			
IE Measures	Crd	Crdc	Prd	Prdc	Crd	Crdc	Prd	Prdc
Intercept	-0.045	-0.073	-0.047	-0.076	-0.152	-0.177	-0.167	-0.198
	(-2.34)	(-3.54)	(-2.42)	(-3.70)	(-5.74)	(-6.39)	(-6.22)	(-7.03)
GblDiv	-0.135	-0.121	-0.136	-0.122	-0.094	-0.084	-0.096	-0.085
	(-9.93)	(-7.67)	(-9.99)	(-7.75)	(-5.29)	(-4.19)	(-5.43)	(-4.29)
IndDiv	-0.244	-0.202	-0.247	-0.207	-0.196	-0.162	-0.206	-0.174
	(-13.18)	(-10.19)	(-13.34)	(10.44)	(-9.07)	(-7.14)	(-9.55)	(-7.66)
IE	0.002	0.006	0.019	0.079	0.003	0.010	0.050	0.166
	(4.97)	(5.36)	(3.20)	(4.20)	(8.41)	(7.97)	(7.04)	(7.13)
Size	0.170	0.162	0.170	0.162	0.154	0.151	0.156	0.154
	(28.98)	(25.91)	(29.01)	(25.98)	(21.63)	(20.15)	(21.56)	(20.14)
RDs	1.500	1.604	1.500	1.609	1.747	1.808	1.768	1.844
	(18.33)	(16.50)	(18.29)	(16.55)	(16.33)	(15.02)	(16.42)	(15.27)
Lev	-0.308	-0.296	-0.311	-0.297	-0.246	-0.226	-0.250	-0.224
	(-7.63)	(-6.36)	(-7.71)	(-6.40)	(-4.56)	(-3.74)	(-4.65)	(-3.73)
EBIT	3.586	3.523	3.592	3.532	3.516	3.433	3.571	3.474
	(13.88)	(11.26)	(13.89)	(11.31)	(9.76)	(8.26)	(9.93)	(8.41)
CapEx	1.337	1.377	1.355	1.399	1.208	1.232	1.244	1.270
	(14.96)	(12.14)	(15.12)	(12.32)	(9.87)	(8.40)	(10.13)	(8.63)
Adv	0.136	0.388	0.132	0.380	0.611	0.766	0.615	0.753
	(0.50)	(1.12)	(0.48)	(1.10)	(1.64)	(1.80)	(1.66)	(1.78)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.331	0.341	0.329	0.339	0.322	0.328	0.319	0.326
Obs.	20,658	16,597	20,658	16,597	11,891	10,244	11,891	10,244

Table 5 (continued)

	Panel B: Interaction of Innovation Efficiency and Global Diversification							
	All Firms				Patenting Firms			
IE Measures	Crd	Crdc	Prd	Prdc	Crd	Crdc	Prd	Prdc
Intercept	-0.038	-0.064	-0.036	-0.063	-0.135	-0.159	-0.139	-0.169
	(-1.96)	(-3.12)	(-1.83)	(-3.04)	(-5.02)	(-5.65)	(-4.99)	(-5.71)
GblDiv	-0.145	-0.132	-0.153	-0.142	-0.116	-0.107	-0.138	-0.129
	(-10.18)	(-7.96)	(-10.65)	(-8.44)	(-5.75)	(-4.75)	(-6.48)	(-5.40)
IndDiv	-0.244	-0.202	-0.248	-0.208	-0.196	-0.161	-0.208	-0.175
	(-13.18)	(-10.19)	(-13.42)	(-10.51)	(-9.08)	(-7.14)	(-9.68)	(-7.77)
GblDiv x IE	0.001	0.004	0.036	0.104	0.002	0.004	0.045	0.126
	(2.19)	(2.06)	(3.44)	(3.18)	(2.28)	(2.17)	(3.63)	(3.30)
IE	0.001	0.004	0.002	0.029	0.002	0.008	0.028	0.103
	(2.34)	(2.74)	(0.21)	(1.14)	(4.78)	(4.56)	(2.87)	(3.16)
Size	0.169	0.162	0.170	0.163	0.154	0.151	0.157	0.155
	(29.00)	(25.93)	(29.10)	(26.10)	(21.75)	(20.28)	(21.84)	(20.46)
RDs	1.502	1.604	1.502	1.611	1.745	1.803	1.766	1.839
	(18.35)	(16.52)	(18.33)	(16.59)	(16.33)	(15.02)	(16.42)	(15.27)
Lev	-0.310	-0.298	-0.313	-0.299	-0.249	-0.228	-0.252	-0.224
	(-7.69)	(-6.40)	(-7.76)	(-6.43)	(-4.62)	(-3.77)	(-4.68)	(-3.72)
EBIT	3.593	3.536	3.592	3.541	3.514	3.440	3.542	3.460
	(13.91)	(11.30)	(13.91)	(11.34)	(9.77)	(8.28)	(9.87)	(8.38)
CapEx	1.332	1.369	1.348	1.389	1.199	1.220	1.230	1.253
	(14.92)	(12.10)	(15.05)	(12.26)	(9.82)	(8.36)	(10.03)	(8.56)
Adv	0.144	0.398	0.147	0.399	0.628	0.786	0.648	0.791
	(0.52)	(1.15)	(0.54)	(1.16)	(1.69)	(1.84)	(1.76)	(1.88)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.331	0.341	0.330	0.340	0.323	0.329	0.321	0.328
Obs.	20,658	16,597	20,658	16,597	11,891	10,244	11,891	10,244

Table 6

Valuation Impact of Innovation Efficiency on Globally Diversified Firms in Competitive and Concentrated Industries

This table reports the impact of innovation efficiency (IE) on firm valuation for globally diversified firms under different levels of product market competition. Each year, industries are sorted into two groups, competitive and concentrated industries, according to their Herfindahl index. The index is given by the sum of squared market shares of all firms from Compustat in an industry, where industries are defined by three-digit SIC classification. The dependent variable is a firms excess value. 'IE' on the left column is the IE measure on the top of each Model. IE measures include adjusted citations/R&D expenditure (Crd), adjusted citations/R&D capital (Crdc), the number of patents/R&D expenditure (Prd), and the number of patents/R&D capital (Prdc). GblDiv (IndDiv) is a dummy variable that takes the value of 1 if a firm is a globally (industrially) diversified firm and 0 if otherwise. Control variables include variables used in Table 5. Year fixed effects are included and standard errors are clustered at firm level. The sample period is from year 1980 to 2003.

	Competitive Industries				Concentrated Industries			
IE Measures	Crd	Crdc	Prd	Prdc	Crd	Crdc	Prd	Prdc
Intercept	0.005	-0.019	0.005	-0.020	-0.127	-0.151	-0.127	-0.152
	(0.21)	(-0.79)	(0.21)	(-0.82)	(-3.70)	(-4.15)	(-3.67)	(-4.17)
GblDiv	-0.167	-0.160	-0.172	-0.167	-0.121	-0.106	-0.129	-0.114
	(-9.92)	(-8.34)	(-10.10)	(-8.51)	(-5.71)	(-4.27)	(-6.00)	(-4.53)
IndDiv	-0.239	-0.196	-0.246	-0.205	-0.229	-0.197	-0.230	-0.198
	(-9.8)	(-7.55)	(-10.08)	(-7.89)	(-9.57)	(-7.53)	(-9.61)	(-7.59)
GblDiv x IE	0.000	0.001	0.013	0.050	0.003	0.007	0.047	0.129
	(0.2)	(0.42)	(0.98)	(1.21)	(2.98)	(2.57)	(3.59)	(3.06)
IE	0.002	0.007	0.026	0.092	-0.0004	0.0004	-0.013	-0.012
	(4.14)	(3.91)	(2.49)	(2.69)	(-0.73)	(0.18)	(-1.46)	(-0.38)
Size	0.191	0.181	0.192	0.183	0.143	0.138	0.143	0.138
	(24.81)	(22.47)	(24.93)	(22.64)	(17.83)	(15.87)	(17.87)	(15.94)
RDs	1.494	1.558	1.497	1.565	1.690	1.820	1.695	1.837
	(17.12)	(15.10)	(17.16)	(15.23)	(9.37)	(8.44)	(9.38)	(8.50)
Lev	-0.383	-0.333	-0.390	-0.338	-0.207	-0.230	-0.206	-0.229
	(-8.08)	(-6.12)	(-8.23)	(-6.22)	(-3.45)	(-3.33)	(-3.44)	(-3.31)
EBIT	3.591	3.686	3.597	3.682	4.149	3.889	4.139	3.885
	(12.63)	(10.68)	(12.63)	(10.69)	(8.20)	(6.32)	(8.18)	(6.30)
CapEx	0.931	0.947	0.950	0.965	2.136	2.186	2.144	2.201
	(9.27)	(7.32)	(9.44)	(7.50)	(14.84)	(12.35)	(14.92)	(12.48)
Adv	-0.351	-0.158	-0.354	-0.178	0.580	0.750	0.596	0.772
	(-1.07)	(-0.40)	(-1.07)	(-0.45)	(1.44)	(1.52)	(1.49)	(1.57)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.372	0.388	0.369	0.385	0.300	0.306	0.300	0.306
Obs.	11,034	8,682	11,034	8,682	9,624	7,915	9,624	7,915

Table 7

Valuation Impact of Innovation Efficiency in Developed Markets and Emerging Markets

This table shows whether the effect of innovation efficiency (IE) on firm valuation is market dependent for globally diversified firms. National markets are categorized into developed and emerging markets. Each year, the percentage of foreign subsidiaries in developed market is calculated for every globally diversified firm. The firm is classified as a developed market firm if the percentage of foreign subsidiaries in developed markets is greater than or equal to the median of globally diversified firms, and an emerging market firm if otherwise. The dependent variable is firms excess value. IE measures include adjusted citations/R&D expenditure (Crd), adjusted citations/R&D capital (Crdc), the number of patents/R&D expenditure (Prd), and the number of patents/R&D capital (Prdc). 'IE on the left column is the IE measure on the top of each Model. Control variables include dummy for industrial diversification, and variables used in Table 5. All the firm characteristics are relative to the median firm in the same industry. All regressions include unreported year-fixed effects. t-statistics reported in parentheses are adjusted for firm-level clustered standard errors. The sample in this analysis only includes globally diversified firms from year 1993 to 2003.

	Developed Markets				Emerging Markets			
IE Measures	Crd	Crdc	Prd	Prdc	Crd	Crdc	Prd	Prdc
Intercept	-0.241	-0.233	-0.255	-0.248	-0.306	-0.302	-0.310	-0.306
	(-5.47)	(-5.23)	(-5.7)	(-5.48)	(-6.75)	(-6.35)	(-6.75)	(-6.39)
IndDiv	-0.071	-0.082	-0.079	-0.089	-0.085	-0.079	-0.085	-0.081
	(-1.61)	(-1.81)	(-1.77)	(-1.96)	(-2.16)	(-1.98)	(-2.19)	(-2.02)
IE	0.002	0.005	0.032	0.091	0.000	0.002	0.009	0.033
	(3.22)	(2.92)	(2.77)	(2.36)	(0.90)	(1.31)	(1.05)	(1.66)
Size	0.178	0.177	0.180	0.179	0.124	0.122	0.125	0.123
	(14.73)	(14.31)	(14.96)	(14.63)	(10.47)	(10.12)	(10.49)	(10.16)
RDs	2.138	2.112	2.159	2.132	3.198	3.380	3.213	3.400
	(9.91)	(9.08)	(9.98)	(9.14)	(8.99)	(9.11)	(9.02)	(9.17)
Lev	-0.433	-0.440	-0.440	-0.443	-0.550	-0.592	-0.548	-0.589
	(-3.46)	(-3.31)	(-3.52)	(-3.33)	(-4.85)	(-4.98)	(-4.84)	(-4.97)
EBIT	3.895	3.763	4.025	3.879	1.004	1.194	0.984	1.175
	(4.16)	(3.94)	(4.26)	(4.03)	(0.96)	(1.21)	(0.94)	(1.18)
CapEx	0.008	-0.016	0.000	-0.034	1.512	1.617	1.525	1.624
	(0.03)	(-0.04)	(0.01)	(-0.09)	(4.34)	(5.00)	(4.39)	(5.02)
Adv	0.256	0.422	0.186	0.324	0.892	1.086	0.898	1.092
	(0.30)	(0.48)	(0.22)	(0.37)	(0.96)	(1.08)	(0.97)	(1.09)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.389	0.39	0.387	0.388	0.365	0.38	0.365	0.381
Obs.	1,863	1,774	1,863	1,774	1,596	1,510	1,596	1,510

Table 8

Valuation Impact of Innovation Efficiency in Countries with Strong Patent Protection and Weal Patent Protection

This table reports fixed-effect regressions of firms' excess value on innovation efficiency (IE) under different firm-level patent protection environment. Control variables and IE measures are the same as those in Table 7. All globally diversified firms are classified into strong and weak patent protections based on the weighted average of patent protection score of the countries where foreign subsidiaries reside. Patent protection score is obtained from Ginarte and Park (1997). Firms are grouped as strong patent protection if the weighted average of patent protection score for a firm's foreign subsidiaries is higher than or equal to the median of globally diversified firms; otherwise, the firm is classified as weak patent protection. Year fixed effects are included and standard errors are clustered at firm level. The sample only includes globally diversified firms and the period is from 1993 to 2003.

	Strong Protection				Weak Protection			
IE Measures	Crd	Crdc	Prd	Prdc	Crd	Crdc	Prd	Prdc
Intercept	-0.281	-0.286	-0.294	-0.302	-0.316	-0.313	-0.321	-0.318
	(-6.81)	(-6.7)	(-7.07)	(-7.03)	(-5.85)	(-5.76)	(-5.91)	(-5.82)
IndDiv	-0.070	-0.068	-0.075	-0.075	-0.091	-0.095	-0.096	-0.100
	(-1.77)	(-1.68)	(-1.93)	(-1.86)	(-2.35)	(-2.42)	(-2.46)	(-2.54)
IE	0.003	0.009	0.063	0.208	0.002	0.006	0.030	0.085
	(2.82)	(3.31)	(3.70)	(4.44)	(2.35)	(2.13)	(1.63)	(1.48)
Size	0.186	0.183	0.188	0.186	0.138	0.139	0.138	0.139
	(15.05)	(14.28)	(15.37)	(14.71)	(12.38)	(12.39)	(12.35)	(12.33)
RDs	2.385	2.387	2.417	2.417	2.616	2.611	2.621	2.620
	(11.56)	(10.87)	(11.69)	(11.0)	(7.93)	(7.72)	(7.96)	(7.76)
Lev	-0.454	-0.452	-0.450	-0.443	-0.564	-0.605	-0.571	-0.611
	(-3.81)	(-3.56)	(-3.81)	(-3.51)	(-4.66)	(-4.89)	(-4.72)	(-4.95)
EBIT	3.380	3.263	3.388	3.273	1.797	2.029	1.872	2.100
	(4.52)	(4.29)	(4.55)	(4.33)	(1.37)	(1.57)	(1.42)	(1.60)
CapEx	0.674	0.817	0.686	0.812	1.089	1.108	1.118	1.129
	(2.45)	(2.69)	(2.50)	(2.68)	(2.70)	(2.76)	(2.79)	(2.84)
Adv	-0.141	0.115	-0.205	-0.001	1.075	1.110	1.060	1.094
	(-0.14)	(0.10)	(-0.20)	(0.01)	(1.55)	(1.54)	(1.52)	(1.51)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.416	0.417	0.418	0.42	0.354	0.363	0.352	0.362
Obs.	1,757	1,653	1,757	1,653	1,860	1,790	1,860	1,790