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The Impact of Internationalization on Firm Performance: A Quantile Regression Analysis

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Abstract: In the context of internationalization, we study the impact of a firm's breadth and depth on its performance using quantile regression. Quantile regression allows us to study the effects of internationalization on performance at various quantiles of conditional performance distribution. Our results suggest that breadth (measured by the number of foreign countries where a firm has direct investments) has positive effects on firm performance (measured by Tobin's Q) and depth (measured by the number of foreign investment sites in top two countries divided by total number of foreign investment sites) is negatively correlated with firm performance. The quantile regression analysis also shows that the impacts of breadth and depth are heterogeneous across levels of performance. The implication is that, for firms with high performances, their performances are sensitive to internationalization activities; however, for firms with low performances, the stock market barely recognizes their attempts to internationalize.

1. Introduction

Previous studies have investigated the relation between internationalization and firm performance. In general, some studies find that internationalization is positively correlated with firm performance while others conclude the opposite. We argue that the mixed findings are due, in part, to using ordinary least square estimation methods. The statistical property of ordinary least square models cannot show the fact that Firms with different firm performance across the distribution respond differently in magnitude to their degree of internationalization.

The objective of this study is to use a quantile regression analysis to examine the effects of internationalization on firm performance. Our study is distinct but related to literature in two aspects. First, we provide evidence to suggest that a firm's breadth (depth) in internationalization is positively (negatively) correlated with firm performance (Tobin's Q). These positive and negative relations, however, are not uniform across firm performance distribution. That is, level of internationalization in terms of breadth and depth has differential impact on firms with high, moderate, and low performances. Hence, our findings help explain the mixed conclusions regarding internationalization and firm performance in the literature. Second, we use a sample of Taiwanese firms in our analysis. With the exceptions of Chiang and Yu (2005) and Contractor, Kumar, and Kundu (2007), the literature primarily focuses on developed markets. The results from an emerging market offer different perspectives on the impact of internationalization on firm performance.

In addition, the findings of distinct breadth and depth effects on Tobin's Q across Tobin's Q distribution suggest that for firms with high performances, their market values are sensitive to internationalization activities; but for firms with low performances, the stock market barely recognizes their attempts to internationalize.

2. Literature review

There are two strands of literature in internationalization and firm performance. The first strand discusses the theoretical foundation and measures of internationalization. Vernon (1966) first proposes the international product life cycle theory. He argues that there are three stages in the development of a product: new product stage, mature product stage, and standardized product stage. These stages indicate a process in which a firm develops a new product and sells to its home market, then exports to foreign markets, and finally establishes subsidiaries in foreign countries. As a product evolves through the product life cycle, a firm gradually gets involved in foreign markets and increases its degree of internationalization. Although Vernon does not explicitly formulate a definition of "internationalization," he does show that internationalization is a dynamic and continuous process.

Johanson and Vahlne (1977) propose that internationalization means the attitudes of a firm towards overseas activities or its established activities overseas. Dunham and Pierce (1989) define internationalization as the level and style of a firm's commitment and its management toward foreign sources of sales. Fayerweather (1978) considers that internationalization happens when a firm transfers specific resources across countries, including nature resources, capital, labor, technology, and management skills. Although the definitions of internationalization proposed by researchers vary widely, they all agree that internationalization is a type of behavior that a firm's operations have developed outwardly or/and inwardly. Hitt, Hoskisson, and Kim (1997) suggest that a firm is pursing internationalization as long as it extends any kind of operation across national borders or penetrates into different geographic regions (or foreign markets).

Sullivan (1994a) classifies various measures of multinationality employed by researchers into three attributes: performance, structure, and attitudinal attribute, respectively.[1] The most commonly used performance attribute is "foreign sales as a percentage of total sales" (e.g., Geringer, Beamish, and daCosta, 1989), while "number of overseas subsidiaries" (e.g., Morck and Yeung, 1991) is the most widely adopted structural attribute. Although Sullivan suggests researchers use "top managers' international experience" to measure the attitudinal attribute of multinationality, this attribute is relatively rarely seen compared to the other two categories.

The second strand of literature examines the impact of internationalization on firm performance. The literature uses different model specifications to study the relations. Previous studies present six general models to explain the relation: linear and positive, linear and negative, U-shaped, inverted U-shaped, S-shaped, and inverted S-shaped. A number of studies examine the internationalization and firm performance relation using square or cubic measure of internationalization in an ordinary least square empirical model. While different studies use different measures of internationalization, many of them use a firm's ratio of foreign sales to total sales to capture a firm's level of multinationality.

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[1] See Sullivan (1994a, 1996) for the rationale and detailed classification for degree of internationalization.

Errunza and Senbet (1984), Morck and Yeung (1991), and Tallman and Li (1996) support a positive linear relation between firm performance and degree of internationalization. The recent research finds that the positive and linear relation is augmented by other factors such as a firm's R&D and marketing capabilities (Kotabe, Srinivasan, and Aulakh, 2002). Other studies, such as Siddharthan and Lall (1982) and Geringer, Tallman, and Olsen (2000), however, reveal a negative relation between internationalization and firm performance.

Kogut (1985), Porter (1985), Sullivan (1994b), Contractor (2002), and Contractor, Kumar, and Kundu (2007) offer arguments and evidence to suggest that the assertion "more internationalization is better" is not always true. These studies recognize that internationalization encounters with both risks and advantages, and thus, introduce costs and benefits. Because of the characteristics, these studies incorporate squared terms to be curvilinear model. There exists a "threshold" in the curvilinear model. Thus, the relation between internationalization and firm performance becomes U shaped or inverted-U shaped.

Contractor, Kundu, and Hsu (2003) integrate the literature into a three-stage theory of international expansion, an S-shaped relation. They consider the possibility that the past inconsistent findings could be due, in part, to the S-shaped model. Specifically, a firm's performance declines, then increases, and finally decreases as the degree of internationalization increases, creating two thresholds. Contractor, Kundu, and Hsu (2003) argue that the prior contradictory findings may capture only part of an overall S-shaped function. Lu and Beamish (2004) offer evidence to support the S-shaped relation in a sample of Japanese firms.

Chiang and Yu (2005) find an inverted S-shaped relation between internationalization and Taiwan firms' performances for the period from 1998 to 2002. They argue that foreign direct investments of Taiwan firms concentrate in Asia (especially in Mainland China), which is both geographically and culturally in close proximity to Taiwan, in order to obtain the "market familiarity" advantage. The market familiarity facilitates the transfer of technology and managerial skills, but the continued expansion has to contend with the increasing complexity of global operation.

Different from other researchers who use uni-dimentional measures of internationalization, Allen and Pantzalis (1996) study two dimensions of multinationality on a firm's performance: breadth and depth. Breadth is measured by the number of foreign countries where a firm has subsidiaries, while depth is measured by a firm's number of foreign subsidiaries in its top two countries divided by total number of foreign subsidiaries. Allen and Pantzalis find that breadth is a value-enhancing effect of internationalization, but, depth is a value-reducing effect of internationalization on a firm's performance.

We follow Allen and Pantzalis (1996) to investigate how the two characteristics of a multinational network, breath and depth, affect multinational corporation's (hereafter as MNC) performance. However, in contrast to Allen and Pantzalis, we focus on the impacts of the two dimensions of internationalization on firms with variant levels of performances. A quantile regression analysis allows us to capture the unequal marginal effects of multinationality on performance among MNCs. As compared to traditional ordinary least square model results, our empirical findings provide strategic implications for MNCs with different levels of performances to penetrate into foreign markets.

Furthermore, a quantile regression model also enables us to study the association between the degree of internationalization and performance in a cross-sectional basis. Therefore, our results complement recent literature which focuses on the S-shaped or inverted S-shaped relation between internationalization and firm performance. Our quantile regression model helps us capture different stages among firms in the S-shaped or inverted S-shaped relation between internationalization and firm performance in a cross-sectional sample of firms that fall on different positions on the S-shaped or inverted S-shaped function.

3. Research method

It is common to use the ordinary least squares (OLS) model to specify a linear regression model and to estimate its unknown parameters. It is well known that the OLS method computes parameter estimates by minimizing the sum of squared errors and leads to an approximation to the "mean" function of the conditional distribution of the response variable. On the other hand, an alternative to the OLS method is the least absolute deviation (LAD) model. The LAD method minimizes the sum of absolute errors and yields an approximation to the "median" function of the conditional distribution of the response variable.

Many internationalization studies use OLS methodology to estimate the "average" marginal effect of the degree of internationalization on firm performance. The OLS regression technique generally provides summary point estimates that calculate the average effect of the independent variables on the "average firm"

(Coad and Rao, 2006). The focus on the average firm can mask important features of the underlying relationship, however. A quantile regression analysis allows us to estimate the marginal effect of internationalization at various quantiles of conditional performance distribution.

Koenker and Bassett (1978) first introduce the quantile regression analysis. Quantile regression utilizes the concepts of regression analysis to quantile and extracts the information from whole conditional distributions of the dependent variable. While the least square estimator leads to the approximation of the conditional mean function of the dependent variable by minimizing the sum of the squared errors, a quantile regression approach yields estimates for the conditional quantile functions by minimizing an asymmetric version of the absolute errors and nests the LAD estimator as a special case. Let the conditional distribution of Y be linearly associated with covariates X at a given θ, as follows:

$$Q_\theta(y_t \mid x_t) = \zeta_\theta(x_t, \beta) = x_t \beta(\theta),\ t = 1, \cdots, n, \tag{1}$$

where $\zeta(\theta)$ is the response of the explanatory variables for the given θ. It is quite easy to see that:

$$\theta = \int_{-\infty}^{x_t \beta(\theta)} f_Y(s \mid x_t) ds,$$

where $f_Y(\cdot \mid x_t)$ is the conditional density function of Y, given X. The key to determining the conditional quantile function involves the identification of the parameter vector $\beta(\theta)$, which is essentially the optimum:

$$\beta(\theta) = \arg\min_{\beta \in \Re^k} E[\rho_\theta(y_t - x_t \beta)]; \tag{2}$$

$\rho_\theta(\cdot)$ is an asymmetric weighting *check function* that for any $\theta \in (0,1)$:

$$\rho_\theta(u) = u \cdot [\theta - I_{\{u<0\}}], \tag{3}$$

where $I_{\{A\}}$ is an indicator function of event A. The parameter $\beta(\theta)$ varies with different θ.

To obtain the sample counterpart, just as the least square estimator is produced through the minimization of the sum of the squared residuals, the conditional quantile estimators are the solutions resulting from the minimization of the sum of the asymmetrically weighted absolute residuals from a pre-specified model as

$$\begin{aligned}&\min_{\beta\in\Re^k}\frac{1}{n}\sum_{t=1}^{n}[\theta-I_{\{y_t-x_t\beta<0\}}](y_t-x_t\beta)\\&=\min_{\beta\in\Re^k}\frac{1}{n}\left[\sum_{t\in\{t:y_t\geq x_t\beta\}}\theta\,|\,y_t-x_t\beta\,|+\sum_{t\in\{t:y_t<x_t\beta\}}(1-\theta)\,|\,y_t-x_t\beta\,|\right].\end{aligned}\qquad(4)$$

We can numerically solve for the estimated coefficient $\hat{\beta}_\theta$ for different $\theta\in(0,1)$ by means of linear programming. $\hat{\beta}_\theta$ measures the extent to which the θ-th quantile of the response variable y_t changes, given a unit change in the covariate x_t. The estimates obtained from this pre-specified model, $\hat{\beta}(\theta)$, are then capable of characterizing the response variable over the whole conditional distribution, given any different θ. Plotting the quantile coefficient of specific covariates, x_k, against $\theta\in[0,1]$ is a *quantile process plot* which is employed to see how the impact from x_k to Y evolves as we change our focus on Y from the lower tail to the upper tail.

On the issue of asymptotic properties, both Koenker and Bassett (1978) and Powell (1986) have proven that $\hat{\beta}_\theta$ is consistent with β_θ and asymptotically distributed as:

$$\sqrt{n}(\hat{\beta}_\theta-\beta_\theta)\overset{A}{\sim}N(0,G(\beta_\theta)^{-1}\Sigma(\beta_\theta)G(\beta_\theta)^{-1}),$$

where

$$G(\beta_\theta)=-E[x_t x_t f_{e(\theta)|x}(0)]$$
$$\Sigma(\beta_\theta)=\theta(1-\theta)E[x_t x_t]$$

and where $f_{e(\theta)|x}(0)$ is the conditional density of the error term under quantile θ evaluated at 0. A typical way is to assume that $f_{e(\theta)|x}(0)$ is the same as its unconditional counterpart, $f_{e(\theta)}(0)$. $G(\beta_\theta) = -f_{e(\theta)}(0)E[x_t x_t]$; therefore, the asymptotic distribution reduces to:

$$\sqrt{n}(\hat{\beta}_\theta - \beta_\theta) \overset{A}{\sim} N(0, \frac{\theta(1-\theta)}{f_{e(\theta)}(0)} E[x_t x_t]^{-1}).$$

However, the unconditional density function of e within the asymptotic variance covariance matrix is difficult to estimate; thus, we use the bootstrap method here, as suggested by Buchinsky (1998), as the means of resolving this problem. It has also been proven that, although computationally intensive, going through the bootstrapping process, as opposed to approximating $f_{e(\theta)}(0)$, does indeed produce more accurate estimates.

We can test the differences between the parameter estimates from the different conditional quantiles in order to determine whether the impact from a specific covariate is constant across the quantiles of the response variable (as is assumed in the least squares regression). To verify whether the effects of a specific covariate are vastly different from one firm performance quantile to another, we test the inter-quantile difference in the estimated coefficients, based on bootstrapped standard errors with 1,000 iterations; $H_0 : \beta_{k,\theta_i} = \beta_{k,\theta_j}$, where β_{k,θ_i} denotes the coefficient for the k-th covariate under the θ_i-th quantile. We set symmetric θ_i s simply to see whether parametric coefficient of degree of internationalization, especially breadth and depth, are heterogeneous across the firm performance distribution under investigation.

In summary, by estimating quantile regressions for various θ, we are able to characterize the conditional distribution of the Tobin's Q. There have been some quantile regression applications in labor economics (e.g., Buchinsky, 1998), health economics (e.g., Koenker and Hallock, 2001), finance (e.g, Fattouh, Scaramozzino and Harris, 2005; Coad and Rao, 2006; and Hallock, Madalozzo, and Reck, 2010), and real estate (e.g., Zietz, Zietz and Sirmans, 2008). In general, these studies find that the estimated quantile regressions can be quite different across quantiles. The quantile regression results usually lead to interesting empirical interpretations in the literature.[2]

There are two advantages to using quantile regression. First, we can attain multiple vectors of estimators in breadth and depth corresponding to each conditional quantile of firm performance distribution. Quantile regression provides more information about the relation between the degree of internationalization and firm performance. Second, we can abandon the normality assumption of OLS regression because quantile regression does not presume the normality of unobserved errors. Quantile regression enables researchers to apply it to asymmetric, fat-tailed, or truncated distributions. Quantile regression estimators are characteristically robust to outliers, skew-tailed, or truncated distribution (Coad and Rao, 2006).

We use quantile regression to estimate whether there exists different effects of breadth and depth at different quantile points of conditional performance distribution. In addition, we use interquantile regression to examine whether there are asymmetric effects of breadth and depth at opposite quantile points of conditional firm performance. With the method, we are able to characterize the behavior at each quantile of the conditional firm performance distribution and to test whether parametric coefficients of degree of internationalization, especially breadth and depth, are heterogeneous across the firm performance distribution.

4. Data, variables, empirical model, and testable hypotheses

4.1 Data

The basic firm data are from the Taiwan Economic Journal (TEJ) database and covers a six-year period from 2000 to 2005. We collect the necessary financial information to calculate the Tobin's Q and various control variables from each firm's financial reports. We also use the overseas operations database of the

[2] For instance, Zietz, Zietz, and Sirmans (2008) study the determinants of housing price using quantile regression. The findings suggest that higher-priced home buyers value certain housing characteristics such as square footage, the number of bathrooms, and age very different from buyers of lower-priced homes. The results help explain why prior studies find that the determinants of housing prices are different in different price ranges. Thus, it would be less informative to use an ordinary least squares method to estimate the determinants of housing prices.

Taiwan Economic Journal and the website of Taiwan Securities & Futures Information Center to collect the number of foreign countries where a firm has direct investments to represent a firm's breadth.[3] We use the following criteria to choose the sample:

(1) Non-financial Taiwanese firms listed on Taiwan Stock Exchange and over-the-counter markets,

(2) Firms with at least 20 percent equity share of any foreign subsidiary to help us confine the sample of firms as "multinational corporations", and

(3) Firms that have complete financial data covering a set of accounting items, including total assets, long-term debts, and market value of equity, that are required for the construction of Tobin's Q to represent the firm performance.

(4) After screening, our research sample consists of an unbalanced data of 4,667 firm-year observations during the six-year period from 2000 to 2005.

4.2 Variables

Similar to other studies, we use the Chung and Pruitt (1994) approach to calculate Tobin's Q:

$$Tobin's\ Q = \frac{MVE + PS + DEBT}{TA}$$

where MVE = market value of the equity; PS = book value of preferred stock; $DEBT$ = book value of long-term debt plus short-term liabilities minus short-term assets; and

TA = book value of total assets.

We measure breadth by the number of foreign countries in which a firm has direct investments. Depth is a measure of concentration of the firm's foreign investment sites in a few foreign countries. Depth is calculated as follows:

[3] These two data sets include the data of all significant foreign physical capital investments of Taiwanese based firms without specifically classifying its type of legal entity as subsidiaries, branches, or service sites.

$$Depth = \frac{\text{Number of Foreign Investment Sites in the Top Two Foreign Countries}}{\text{Number of Total Foreign Investment Sites}}$$

We include several variables to control the potential influences on firm performance:

(1) Advertising Intensity (ADI)

Advertising expenditure is widely used to measure intangible assets of a firm. We use advertising intensity (annual advertising expenditure as a percentage of sales) as our measure of advertising assets, such as goodwill, brand name, and marketing capability. The ADI is computed as follows:

$$ADI = \frac{\text{Advertising Expenditure}}{\text{Sales}}$$

(2) R&D Intensity (RDI)

Research and development expenditure is also often used to measure intangible assets of a firm. We use R&D intensity (annual R&D expenditure as a percentage of sales) as our measure of technological assets, such as patents and technological know-hows. R&D intensity is computed as follows:

$$RDI = \frac{\text{Research and Developement Expenditure}}{\text{Sales}}$$

(3) Debt ratio

LTDEBT (long-term debt as a percentage of total assets) is included to control the potential impact of leverage on firm performance. It is computed as the follows:

$$LTDEBT = \frac{\text{Long-term Debt}}{\text{Total Assets}}$$

(4) SIZE

SIZE (nature log of total assets) is used to control the influence of firm size on firm performance. It is shown as follows:

$$SIZE = \text{Log (Total assets)}$$

We summarize the statistics of the variables in Table 1. The distributions of all variables do not conform to normal distributions as shown in the large values of skewness and kurtosis. Specifically, the asymmetries in the distribution of the dependant variable (the Tobin's Q distribution exhibits a rightward skewness of 4.01 and leptokurtosis of 33.88) should be taken into account by employing the quantile regression. On average, each firm has 2.86 foreign countries as its direct investment sites (breadth) and an approximate 0.35 concentration (depth) in its internationalization effort.

Table 1:

Descriptive statistics of variables (N=4,667)

We present the summary statistics of all variables in Table 1. The distributions of the variables do not conform to normal distributions as shown in the large values of skewness and kurtosis. Tobin's Q = (market value of the equity + book value of preferred stock + book value of long-term debt plus short-term liabilities minus short-term assets)/book value of total assets; Breadth = the number of foreign countries in which a firm has subsidiaries; Depth = number of foreign subsidiaries in the top two foreign countries/total number of foreign subsidiaries; Advertising Intensity (ADI) = advertising expenditure/sales; R&D Intensity (RDI) = R&D expenditure/sales; LTDEBT = long-term debt/total assets; SIZE = nature log of total assets.

	Tobin's Q	*Breadth*	*Depth*	*ADI*	*RDI*	*LTDEBT*	*SIZE*
Mean	0.7543	2.8620	0.3505	0.0052	0.0260	0.4498	6.6333
Median	0.5520	2.0000	0.3636	0.0003	0.0088	0.4568	6.5455
STD.	0.7758	3.0828	0.3008	0.0162	0.1002	0.1718	0.5777
Skewness	4.0127	2.3039	0.3786	8.0452	32.9070	0.1683	0.7855
Kurtosis	33.8780	15.5040	2.2277	106.4300	1559.6000	3.0997	3.6148

4.3 Empirical model

We follow Morck and Yeung (1991), Allen and Pantzalis (1996), and others to relate a firm's Tobin's Q and its degree of internationalization in terms of breadth and depth. We use the following functional relation:

$$Tobin's\ Q = \beta_0 + \beta_1 Breadth + \beta_2 Depth + \beta_3 RDI + \beta_4 ADI + \beta_5 LTDEBT$$

$$+ \beta_6 SIZE + \Sigma\beta_j\, Industry + \varepsilon,$$

where industry is the dummy variable for 17 industries and other variables as defined earlier.

4.4 Testable hypotheses

Kogut (1985) asserts that MNCs derive their advantages over domestic firms from a transnational network of operations that provides them with operating flexibility. Operating flexibility is the ability of the MNCs to arbitrage markets by shifting factors of production across borders and by transferring resources within their network of affiliates that includes production, marketing, sales, research, and financial subsidiaries located in foreign countries. We argue that a MNC, as if owns a real option, can respond to uncertain events, such as government policies, competitors' decisions, or the arrival of new technologies. Therefore, the breadth of geographical dispersion determines the option value of multinational operating flexibility. For instance, the number of foreign countries in which the MNC has investment sites enables the MNC to transfer firm-specific knowledge, innovation technologies, and marketing competences within a network of multinational diversification. Additionally, the value of operating flexibility partially derives from the effect of operating hedge under uncertain exchange rate changes.[4]

Specifically, breadth offers a value-enhancing effect in internationalization. It acts like a valuable portfolio of real options to manage operating exposure by engaging in "real hedging". By contrast, depth is a value-reducing effect of internationalization stemming from the agency cost of managing or coordinating extensive multinational networks. Allen and Pantzalis (1996) find that a MNC's performance is maximized resulting from breadth, but not depth. They suggest that the returns to internationalization increase as the firm expands its holdings of real options (i.e., widens the breadth of its multinational network), but decrease with the acquisition of redundant real options (i.e., multiple subsidiaries in each country) that increase agency costs.

Therefore, we expect that MNCs having high performance (Tobin's Q) derive more value of real options from the breadth of geographical dispersion. There is a positive influence of breadth on firm performance and the influence gradually increases from lower quantiles to upper quantiles of firm performance distribution. Similarly, we argue that MNCs with lower (higher) firm performance suffer more (less) agency costs of managing or coordinating multinational networks and do not (do) effectively hedge currency risk in a few geographic regions. We hypothesize that there is a negative influence of depth on firm performance and the influence

[4]Kogut and Kulatilaka (1994) and Mello, Parsons, and Triantis (1995) use a real options approach to demonstrate the product value enhancing mechanism and agency cost reducing effect of MNC's operational flexibility, respectively.

gradually decreases from lower quantiles to upper quantiles of firm performance distribution. In sum, breadth and depth have opposite effects on firm performance across firm performance distribution. The testable hypotheses are:

H1A: The effects of breadth are significantly positive for all quantiles in the conditional firm performance distribution.

H1B: The magnitude of positive effect of breadth is significantly larger for upper quantiles or/and are significantly smaller for lower quantiles in the conditional firm performance distribution.

H2A: The effects of depth are significantly negative for all quantiles in the conditional firm performance distribution.

H2B: The magnitude of negative effect of depth is significantly smaller for upper quantiles or/and are significantly larger for lower quantiles in the conditional firm performance distribution.

5. Results and discussion

5.1 Estimated effects of breadth and depth on Tobin's Q

We present the quantile regression results in Table 2 using nine different quantiles (0.1 to 0.9). We also show the estimation results of OLS to contrast with the results of quantile regression. Breadth variable coefficients are both significantly positive with Tobin's Q in OLS and quantile regression models, indicating that the breadth or geographical dispersion of firms has a positive impact on Tobin's Q. The finding supports our Hypothesis 1A. More precisely, we observe that the magnitude of the estimated positive effects of breadth gradually increases from lower quantile to upper quantile of the Tobin's Q distribution, which offers support to Hypothesis 1B. For example, the breadth coefficient is 0.009, 0.028, and 0.064 at 10th, 50th, and 90th quantiles, respectively. As the quantiles increase, the magnitude of breadth coefficient also increases. The results imply that firms with high Tobin's Q derive more value from a higher degree of breadth than firms with low Tobin's Q for the same degree of breadth. We conjecture that high Tobin's Q firms are able to conduct real hedge or have better operating flexibility responding to uncertain events, such as exchange rate fluctuations, production cost changes, and competitor's decisions; and therefore, these high Tobin's Q firms are able to capture the benefits of higher degree of breadth than low Tobin's Q firms.

Table 2:

OLS and quantile regression results (dependent variable is Tobin's Q) (N=4,667)

We present the quantile regression results in Table 2 using nine different quantiles (0.1 to 0.9). The standard errors are reported in the parentheses. We obtain the standard errors of the coefficients by bootstrapped methods using 1,000 bootstrap replications. We also show the estimation results of OLS to contrast with the results of quantile regression. As the quantiles increase, the magnitude of breadth coefficient also increases. The magnitude of the estimated negative effects of depth gradually increases from middle quantiles (40^{th}, 50^{th}, 60^{th}) to upper quantiles (70^{th}, 80^{th}, 90^{th}). As the quantiles increase, the magnitudes of depth coefficient also increase. *, **, and *** denote coefficients that are significantly different from zero at 10%, 5%, and 1% significance levels, respectively.

		Quantile at								
Independent variable	OLS	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
ADI	-0.723	0.336	-0.228	-0.135	-0.220	-0.719	-0.521	-1.071	-1.476	-0.427
	(0.698)	(0.358)	(0.383)	(0.413)	(0.429)	(0.456)	(0.677)	(0.790)	(1.000)	(1.545)
RDI	0.369***	0.156	0.284	0.466	0.479*	0.572	0.563	0.953**	1.353	3.413**
	(0.108)	(0.169)	(0.243)	(0.285)	(0.282)	(0.353)	(0.392)	(0.401)	(0.848)	(1.706)
LTDEBT	-1.124***	-0.159***	-0.247***	-0.312***	-0.362***	-0.506***	-0.715***	-0.847***	-1.109***	-1.392***
	(0.064)	(0.044)	(0.049)	(0.047)	(0.045)	(0.055)	(0.070)	(0.074)	(0.099)	(0.153)
SIZE	0.120***	0.121***	0.116***	0.124***	0.114***	0.119***	0.124***	0.121***	0.095***	0.136***
	(0.021)	(0.014)	(0.017)	(0.013)	(0.014)	(0.016)	(0.020)	(0.022)	(0.033)	(0.045)
Breadth	0.045***	0.009***	0.010**	0.011***	0.018***	0.028***	0.041***	0.053***	0.063***	0.064***
	(0.004)	(0.003)	(0.004)	(0.003)	(0.004)	(0.006)	(0.007)	(0.006)	(0.006)	(0.005)
Depth	-0.227***	0.027	0.003	-0.014	-0.063**	-0.119***	-0.156***	-0.247***	-0.300***	-0.372***
	(0.039)	(0.024)	(0.027)	(0.023)	(0.027)	(0.034)	(0.037)	(0.037)	(0.048)	(0.062)
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

To depict the property of quantile regression, we show estimated breadth coefficients at 19 points of the conditional Tobin's Q distribution in increments of 0.05 for breadth variable in Figure 1 of Panel A. As shown in Panel A, significant breadth coefficients are smaller in the magnitude for low-Q firms, with a coefficient of 0.009 at the 10th quantile, indicating that a one-country increase in geographical dispersion leads to a 0.009 increase in Tobin's Q. Breadth effects increase monotonically when moving from the 10th quantile to the 40th quantile, and then progressively increase to a coefficient of 0.064 at 90th quantile. The breadth coefficient of OLS is a significant 0.045. Thus, we find that the OLS method underestimates the effects of firms located in the upper part of the conditional distribution (70th, 80th, 90th), and the bias is economically significant because those quantile estimates fall out of the confidence interval of the OLS coefficient.

We find that the estimated coefficients of depth are significantly negative in the OLS model and at 40th, 50th, 60th, 70th, 80th, and 90th quantiles in the quantile regression model. The results indicate that the depth of geographical concentration has a negative impact on Tobin's Q. The findings also lend support to Hypothesis 2A. The magnitude of the estimated negative effects of depth gradually increases from middle quantiles (40th, 50th, 60th) to upper quantiles (70th, 80th, 90th). For example, the depth coefficients are -0.063, -0.119, -0.156, -0.247, -0.300, and -0.372 at 40th, 50th, 60th, 70th, 80th, and 90th quantiles, respectively. As the quantiles increase, the magnitudes of depth coefficient also increase. The finding does not support Hypothesis 2B. Figure 1 of Panel B plots the coefficients for depth and the interpretations are similar to Panel A.

5.2 Inter-quantile regression

We examine the inter-quantile differentials for estimated coefficients of breadth and depth. The t-test rejects the null hypothesis of homogeneous coefficients at the conventional significance level for two symmetrical quantiles, indicating that the impact of the explanatory variables is different across the firm's performance distribution. The purpose of the inter-quantile regression is to provide conclusive evidence of the heterogeneity of breadth or depth across the firm performance distribution.

Table 3:

Inter-quantile regression results (dependent variable is Tobin's Q) (N=4,667)

Table 3 presents inter-quantile results of Tobin's Q. The standard errors are reported in the parentheses. We obtain the standard errors of the coefficients by bootstrapped methods using 1,000 bootstrap replications. There are statistically significant differences in the parameter estimates of breadth/depth for symmetrical two quantiles, which suggest that both breadth and depth have heterogeneous effects across the Tobin's Q distribution. *, **, and *** denote coefficients that are significantly different from zero at 10%, 5%, and 1% significance levels, respectively.

Independent variable	Quantile								
	95th-5th	**90th-10th**	**85th-15th**	**80th-20th**	**75th-25th**	**70th-30th**	**65th-35th**	**60th-40th**	**55th-45th**
ADI	-1.695	-0.763	-1.875	-1.248	-0.719	-0.936	-0.433	-0.300	0.043
	(2.459)	(1.575)	(1.196)	(1.013)	(0.828)	(0.680)	(0.576)	(0.511)	(0.345)
RDI	5.935**	3.256**	1.575*	1.070	0.443	0.487	0.343	0.083	0.204
	(2.278)	(1.606)	(0.956)	(0.703)	(0.489)	(0.317)	(0.256)	(0.219)	(0.145)
LTDEBT	-1.589***	-1.232***	-1.028***	-0.862***	-0.646***	-0.535***	-0.452***	-0.353***	-0.160***
	(0.204)	(0.153)	(0.118)	(0.095)	(0.093)	(0.065)	(0.061)	(0.050)	(0.039)
SIZE	-0.002	0.015	0.008	-0.022	-0.022	-0.002	0.007	0.010	0.011
	(0.078)	(0.045)	(0.036)	(0.033)	(0.026)	(0.022)	(0.018)	(0.016)	(0.012)
Breadth	0.052***	0.0539***	0.0538***	0.053***	0.047***	0.041***	0.034***	0.023***	0.013***
	(0.010)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.004)	(0.004)
Depth	-0.343***	-0.399***	-0.342***	-0.300***	-0.276***	-0.232***	-0.185***	-0.093***	-0.056**
	(0.116)	(0.070)	(0.053)	(0.046)	(0.041)	(0.032)	(0.029)	(0.027)	(0.022)

Table 3 presents inter-quantile results of Tobin's Q. There are statistically significant differences in the parameter estimates of breadth/depth for two symmetrical quantiles. For the explanatory variable breadth, there is a statistically significant positive difference, indicating that breadth has a significantly stronger positive effect on the firms located at the 90th quantile than the effect on those located at the 10th quantile. For example, the difference between the 90th and 10th quantiles is a significant 0.0539, suggesting that the firms located at the 90th quantile have an additional 0.0539 increase for Tobin's Q. As for explanatory variable depth, there are also statistically significant differences for two symmetrical quantiles.

Figure 1.

Estimated coefficients and 95% confidence interval (Dependent variable is Tobin's Q)

(a) Estimated coefficient: breadth

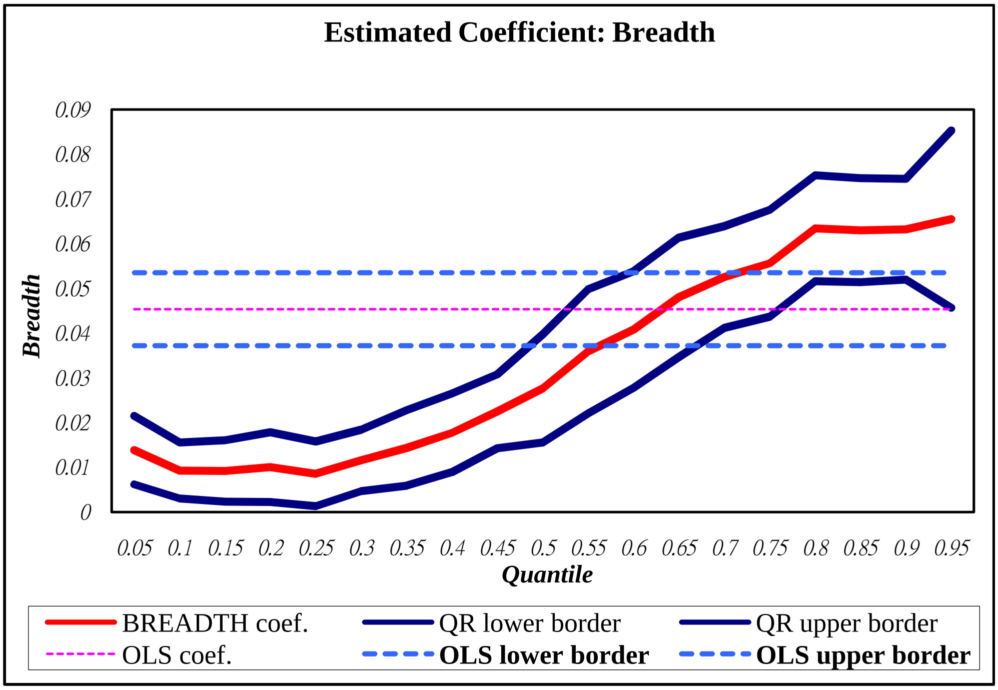
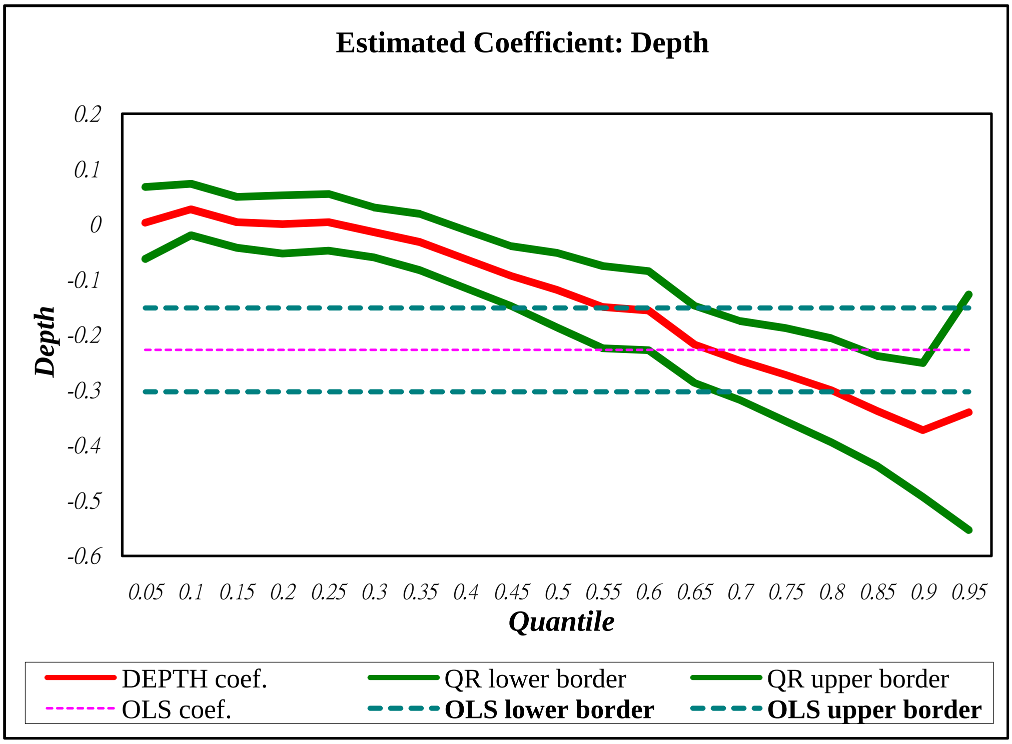


Figure 1.

Estimated coefficients and 95% confidence interval (Dependent variable is Tobin's Q)
(b) Estimated coefficient: depth



6. Conclusions

By using cross-sectional firm-level data covering a period from 2000 to 2005, we investigate the effects of internationalization activity on firm performance. The quantile regression provides a useful and powerful approach to evaluate the differences on the effects of internationalization activity across firm performance distribution. The conventional OLS estimation results only provide limited information about the differences in the effects of internationalization activity on firm performance because it only provides a summary point estimator.

In general, we find that breadth (i.e., number of foreign countries in which a firm has investment sites) has positive effects on market-based performance (Tobin's Q). By using inter-quantile tests, we find that the breadth effect on Tobin's Q is significantly different in the magnitude across Tobin's Q distribution. The results suggest that the effect of breadth on Tobin's Q varies dramatically across the market value distribution. Additionally, the finding has important implications for firms with the high values of Tobin's Q as their market value is particularly sensitive to internationalization activity; however, for firms with low values of Tobin's Q, the stock market barely recognizes their attempts to internationalize. Furthermore, the study also finds that depth (i.e., the number of foreign investment sites in top two countries divided by the total foreign investment sites) has negative effect on Tobin's Q especially for firms with better performances. To sum up, our findings imply MNCs, even with high firm values, should still be aware of the negative impact on firm value from investing deeperly in several specific countries/regions, since they don't tend to have superior management skills which help them avoid the possible arising agency costs.

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