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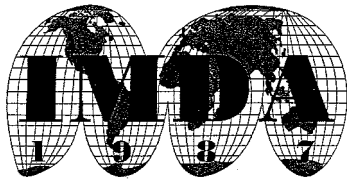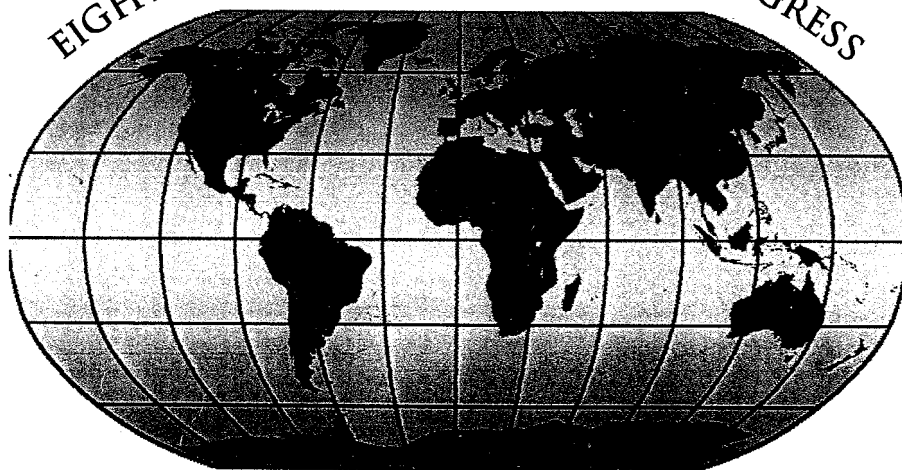
ADVANCES IN GLOBAL MANAGEMENT DEVELOPMENT

R&D Intensity, Export Activity, and Firm Performance: A Comparative Study of American and Chinese Firms

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In this study, we examine whether R&D intensity and export intensity lead to better performance in American and Chinese companies. Both market and accounting-based measures of performance are employed for a sample of 315 American and 295 Chinese companies across various industries. The findings, based on a longitudinal study of firms 20 different industries over a 4-year period, indicate that American and Chinese firms' performance relates to investment in research and development and the intensity of exporting. These results lend support for the theories of resource-based view of firms' and internationalization.

Introduction

Over the past four decades, R&D intensity and export activity have been one of the most researched topics as both constructs help firms sustain or enhance their competitive positions in the ever-changing world marketplace. The extant literature presents ample evidence that firms that invest in research and development (Franko, 1989; Hoskisson and Turk, 1990; Kotabe, Srinivasan and Aulakh, 2002) and involve with export activities (Cavusil, 1980; Cavusgil and Zou, 1994; Leonidou and Katsikeas, 1996; Zhao and Zou, 2002) are in a better position to earn higher profits. The purpose of this paper is to build on existing research and examine and compare the role of R&D intensity and export intensity in the performance of American and Chinese companies. Understanding the performance of American and Chinese firms contributes to the current body of literature in several ways. First, according to the World Trade Organization (WTO), the U.S. and China are very competitive global players each accounting for 11.2% and 7.7% of the total world trade volume respectively. Second, both countries present firms with international opportunities for expansion, growth, scalability, and knowledge accumulation. Third, the US makes up 30% of Chinese exports while China accounts for 7% of US total exports. Trade between the two countries has grown substantially over the past decade, making the United States the top trading partner of China and China the second largest trading partner of the United States. Given their significant role in world trade, both countries provide excellent research context to determine how U.S.

and Chinese firms coming from two different business environments perform similarly or differently. It is also useful for managers to determine the appropriateness of a certain competitive strategy in a given economic context. Does investing in R&D pay off or does export involvement help firms improve their performance in the United States and China? Further, the findings of this study could offer firms insights into the nature of their competition. What gives the Chinese and American firms a competitive edge? In sum, the main question addressed in this paper relates to how R&D and foreign trade by export influence the firm performance in diverse economic environments such as the U.S. and China. Its comparative scope is important in supplementing the current body of literature in China that has developed since its accession into the World Trade Organization (for extensive literature, see, for example, Journal of International Business Studies).

Theoretical Bases

According to the resource-based view of the firm (Barney, 1991; Buckley, 1989; Buckley and Casson, 1976; Dunning, 1977), unique internal capabilities such as R&D investment allow firms to achieve differential advantages in both domestic and international markets. This can be achieved by focusing on product and process development, differentiating the firm's product from competitors, and lowering production costs (Kotabe, Srinivasan, and Aulakh, 2002). All of these can be translated into marketing capabilities where firms can command premium prices for their innovative products or they can compete on prices as they can achieve economies of scale in their innovative production process. Porter(1990) argues that firms that are better equipped with R&D facilities can possibly create new advantages for product changes, process changes, new marketing approaches, new forms of distribution, and new breakthrough products.

Several studies empirically have investigated the relationship between R&D investment and performance (Franko, 1989; Hoskisson and Turk, 1990). Evidence indicates that irrespective of industry and size, company performance increases along with increases in R&D. In a study of the PIMS database, Holak, Parry, and Song (1991), for example, found significant differences in performance

among firms based on their R&D expenditures. Thus, the more innovative the firms are, the better they will perform in both domestic and international markets.

Past studies also point out that firms that involve with exporting activities can reap numerous benefits such as economies of scale, larger market shares, investment amortization, high profits, risk diversification, and extended product life cycle (Bilkey, 1978; Cavusgil, 1980; Czinkota and Johnston, 1982; Czinkota, Ronkainen and Donath, 2004; Katsikeas, Leonidou, and Morgan, 2000; Leonidou and Katsikeas, 1996). It has been indicated that firms of all sizes that engaged in international activities outperform their strictly domestic competitors (Czinkota, Ronkainen and Donath, 2004). With access to more customers, exporting firms can produce more at better effectiveness levels, and realize lower costs and higher earnings. In fact, they can grow twice as fast, and achieve higher returns on investment and equity than those who do not export. Thus, the more involved with exporting the firm is the better it will perform.

Empirical Design and Methodology

Sample and Data Collection

The initial sample for the present study started with the firms as listed in the top 1,000 publicly listed companies in the U.S. and China over a five-year period (2001-2005). Firms have to meet several criteria to be included in the final sample. First, they had to be included on the listed firms for the years being studied, 2001-2005. Second, they had to report complete information on export activity and R&D expenditure. Third, all financial firms were eliminated from the sample due to their lack of emphasis on R&D activites. Finally, in order to increase generalizability and reliability, the samples of U.S. and Chinese firms were matched on the basis of industry type. As a result of sample selection criteria and data availability, a total of 610 firms, comprising 315 U.S. firms and 295 Chinese firms in both manufacturing and non-manufacturing industry sectors, were included in data analysis. All firm data were collected primarily from *Compact-D Worldscope* data base. The selected data represent arithmetic averages of the firm activities for the most recent five-year period (2001-2005). Table 1 presents the sample characteristics.

Description and Measurement of Variables

To investigate the impacts of export activity and R&D intensity on a firm's various performance (i.e., accounting and market performance), the following proxies for the dependent variables, independent variables and control variables are selected.

Performance Measures

One common characteristic of past empirical studies on R&D intensity and export activity is the use of

accounting-based measures of performance. In an attempt to ensure the comparability of the results of the current study across a broad range of research studies, we opted to use both accounting- and market-based measures of performance. The accounting-based measures of performance that were used as proxies of firm performance were: operating profit return on assets (OPROA), operating profit return on shareholders' equity (OPROE), and operating profit return on investment (OPROI). In addition to the accounting-based measures of performance just outlined, two market-based measures of performance,

Table 1: Sample Characteristics

Industry	Classification	USA	China
Food, Drink & Tobacco	Low-tech		2
Mining & Drilling	Low-tech	14	3
Construction	Low-tech	3	6
Food, Drink & Tobacco	Low-tech	15	7
Textile & Apparel	Low-tech	8	16
Lumber & Wood Products	Low-tech	11	4
Printing & Publishing	Low-tech	8	5
Chemicals & Drugs	High-tech	36	31
Mining & Drilling	Low-tech	8	3
Rubber, Plastic & Leather	Low-tech	6	4
Stone, Clay, and Glass Product	Low-tech		8
Primary & Fabric Metals	High-tech	12	35
Machinery & Computer Equipment	High-tech	25	25
Electric & Electronics	High-tech	32	15
Transportation Equipment	High-tech	11	20
Instruments & Related Products	High-tech	24	10
Miscellaneous Mfg. Products	Low-tech	5	4
Services: Railroad & Transportation	Low-tech	6	17
Services: Communication	Low-tech	11	6
Services: Gas, Electric, Sanitary	Low-tech	13	5
Wholesale Trade	Low-tech	9	20
General Trade	Low-tech	27	26
Business Services	Low-tech	24	16
Other Services	Low-tech	2	7
Total		315	295

Tobin's Q and sales growth, were also employed to more accurately reflect the investor's expectations about future performance and to test the robustness of the results. These measures are commonly used in the literature (see, for example, Bae, Park, and Wang, 2008; Contractor, Kundu, and Hsu, 2003; Lu and Beamish, 2004)

The measures of firm performance that were employed in the present research were calculated as follows:

- OPROA = Operating income / Total Assets
- OPROE = Operating income / Shareholders' Equity
- OOPROI = Operating income / Total invested capital
- Tobin's Q = (Market value of Equity + Liquidating value of Preferred Stock +
- Sales Growth = (Net sales $_t$ – Net sales $_{t-1}$) / Net sales $_{t-1}$

Explanatory Variables- Export Intensity and R&D Intensity

Export intensity was measured by the ratio of export volume by foreign sales to total sales. R&D intensity was measured by the ratio of R&D expenditure to total sales. These, too, are commonly used measures of the constructs.

Control Variables

To examine the effect of export intensity and R&D intensity on the various firm performances, it is important to include some control variables that have been found to have an effect on the firm performance. The following variables were included in data analysis as control variables:

- Firm Size = Natural log value of total sales revenue
- Capital Intensity = Total assets / Total Sales
- Debt Leverage = Book value of Total Debt / Shareholders' Equity
- Current Ratio = Current Assets / Current Liabilities
- Dummy variables for High-tech (= 1) vs. Low-tech (=0)

Firm size is one of the most frequently studied factors in performance studies. Though there is no consensus about the nature of its effects, there are certainly a large number of empirical studies that establish a significant relationship between firm size and performance (Zhao and Zou, 2002). Hence, it is treated as a control variable in the present study. Firm size is measured by the natural log value of total number of employees because the total number of employees are most likely to be employed as a proxy measure of firm size in most empirical studies relating to exporting rather than total assets or sales revenues.

In addition, several studies (see, for example, Cavusgil and Zou, 1994; Chakbarti, 1991) indicate that technology intensiveness is an important correlate of firm strategy. It is expected that technologically intensive industries are more likely to have higher R&D intensity than those that are not. Hence, the technological intensity of the industry is used as a control variable and dummy coded as 1 for high tech and 0 for low tech sectors.

Empirical Model and Statistical Methods

To investigate the relationships between R&D intensity, export intensity, and performance, an ordinary least squares (OLS) multiple regression was employed. This method is appropriate for this study because it is primarily designed to explore the relative significance of independent variables on the performance measures. Separate regression analyses for the US and China were used. This statistical procedure is suggested for multi-country studies (Douglas and Craig, 1999).

Results and Discussion

Descriptive Statistics

Table 2 (A and B) presents means, standard deviations, and intercorrelations for all variables employed in this study. The problem of multicollinearity does not appear to exist since correlations coefficients are less than 0.90 (Hair, Anderson, Tatham, and Black, 1998). A comparison of means in the two countries reveals some interesting features. First, contrary to the previous studies (Blaine, 1993; Lee & Blevins, 1990), for the most corporate performance except Tobin's Q which is generally accepted as being a reliable means of evaluating the market performance of a company, Chinese firms have relatively higher performance than their US counterparts. One plausible explanation is a tendency of higher debt and the market growth strategy prescribed by the Chinese government's export driven policy. Second, the level of export by foreign sales appears, on average, to be much higher with Chinese firms compared to the US firms whereas R&D intensity is higher with the US firms. Third, debt leverage is also relatively lower in the US firms than in the Chinese firms. Table 2 also presents the intercorrelations among variables used in this study. Overall, the results show the diverse inter-correlations between export activity and R&D intensity and performance measures in the two countries. Export activity is highly significant and positively correlated with most accounting performance measure for the U.S. firms (p<0.01). However, the relationship is not statistically significant for growth in sales and Return on Equity. Contrary to the diverse results of the US firms, the export activity in Chinese firm is highly significant

Table 2A: Mean, Standard Deviation and Correlation: US Firms (n=315)

Variables	Mean	St. Dev.	1	2	3	4	5	6	7	8	9	10	11	12
1. Dummy: High vs. Low	0.509	0.501	.158**											
2. Return on Investment	0.136	0.234	.002	-.076										
3. Return on Equity	18.394	49.490	-.052	-.024	.557***									
4. Return on Assets	6.112	11.452	-.051	-.101	.836***	.524***								
5. Growth in Sales	10.774	19.956	-.143**	-.070	.046	-.010								
6. Tobin's Q	2.128	1.654	.106*	.261***	.333***	.162*†	.077							
7. Firm Size: Ln (Sales)	15.424	1.487	-.025	-.186***	.495***	.283***	.320***	.231**						
8. Debt Leverage	0.020	22.797	.004	.074	.034	.179***	.044	.000*	-.120*					
9. Capital Intensity	1.590	1.332	-.014	.029	.252***	.197***	.323***	.032	-.093+	-.222***				
10. Current Ratio	1.982	1.670	-.034	.266***	-.168**	-.158**	-.157**	-.032	-.325***	-.349***	.012			
11. Export by Foreign Sales	33.467	21.210	-.137**	.407***	.103+	.132*	.078	-.032	-.226***	.023	.010	.375***	.160**	
12. R&D Intensity	5.141	6.078	.097	.453***	.150*	.110+	.187***	.015	.430***	-.025	.006	.561***	.241***	.439***

+ P<0.10, *P<0.05;**P<0.01;***P<0.001

Table 2B: Mean, Standard Deviation and Correlation: Chinese Firms (n=295)

Variables	Mean	St. Dev.	1	2	3	4	5	6	7	8	9	10	11	12
1. Dummy: High vs. Low	0.406	0.492	-.028											
2. Return on Investment	0.175	0.387	-.033	.070										
3. Return on Equity	19.884	62.386	-.045	.033	.619***									
4. Return on Assets	8.276	16.263	-.011	.064	.909***	.383***								
5. Growth in Sales	44.560	67.798	-.021	-.051	.219***	.108	.096							
6. Tobin's Q	1.104	0.595	-.011	.082	.040	-.101	.123*	.002						
7. Firm Size: Ln (Sales)	12.567	1.168	-.283***	-.129*	-.153**	.162**	.116+	.014	-.078					
8. Debt Leverage	1.041	1.697	-.020	-.024	.048	-.204***	-.042	.073	-.095	.025				
9. Capital Intensity	1.473	1.229	.140*	-.120*	-.081	-.095	-.020	-.167**	-.095	-.365***	.083			
10. Current Ratio	1.503	1.803	.225***	.064	-.010	.054	.254***	.022	.005	-.167**	-.167**	.110+		
11. Export by Foreign Sales	6.978	13.911	.024	.379***	.382***	.193**	-.027	-.083	-.167**	.046	-.045	.379***	.213***	
12. R&D Intensity	1.050	2.114	.380***	.149**	.332***	.400***	.407***	.117+	-.198**	-.365**	-.118+	.147	.226***	.706

+P<0.10, *P<0.05;**P<0.01;***P<0.001

(P<0.001 and positively correlated with all indices of performance except for ROI. In fact, business operations by penetrating into foreign markets provide a firm with several competitive benefits regardless of different economic contexts across countries. Thus, export activity is expected to help build a firm's competitive position and to stabilize the corporate performance, particularly when a domestic market is slow and downturned or when a company's capacity exceeds the needs of its local market. The emphasis on foreign market activities stems mainly from a belief that external diversity by export could be a major source of profitability and growth. R&D intensity is generally more influential in China than in the U.S. R&D intensity is highly significant and shows a positive sign with respect to accounting-based performance (except for OPROA and Tobin's Q) in the US firm. With respect to the control variables, firm size (FSIZE) is significant (at least by 5% level) and positively related to most performance measure (except for Tobin's Q) in US while it only is statistically significant with respect to the accounting performance only in China. The use of debt is significantly (p<0.001) and positively associated with OPROA only in the two countries while positively associated with Tobin's Q in the U.S. only. Capital intensity is not uniformly correlated with firm performance in the two countries: CAPIN is negatively correlated with most accounting performance in the U.S. only and it is negatively related with OPROI and Tobin's Q in China.

Results of Data Analysis

Results of the regression analysis with respect to each indices of performance are summarized in Tables 3(U.S. firms) and 4 (Chinese firms). Overall, all OLS regression models with different indices of performance measures explains the relationships between dependent and independent variables in the two countries are statistically significant at least at the 0.01 level in both countries. The variance inflation factors (VIF) for predictor variables ranged from 1.015 to 2.467 in both countries. A VIF in excess of 10 is often taken as an indication that multicollinearity may be adversely influencing the result of stepwise regression analysis (see Cryer & Miller, 1994; Tabachnick & Fidell, 1989). Since the results do not indicate any serious threat of multicollinearity, individual coefficient estimates can be warranted for its interpretation. Export activity and R&D intensity exhibits a positive relationship with most performance for both countries. The results for the U.S. firms (Table 3) indicate that the export activity is highly significant (the first or second major explanatory power) and explains 20.14 % to 25.74% of the variation of a firm's performance. Particularly, the export activity is significant (P<0.05) and positively associated with OPROA, OPROE, and Growth in Sales. This finding lends a support to previous studies that have shown that

exporting helps companies to expand profits through larger markets, and better risk diversification (Contractor, Kundu, and Hsu, 2003). No relationship with return on investment may be the result of stage theories that are suggested in the literature. For example, when firms initially start exporting they initially experience negative returns due to expansion and knowledge acquisition costs (Contractor, Kundu, and Hsu, 2004; Johanson and Vahlne, 1977; Kotabe, Srinivasan, and Aulakh, 2002). At later stages, performance levels off before the firm experiences growth. Hence, at a certain stage of internationalization firms performance may be steady regardless of export activity until they reach to the point of performance increase.

R&D intensity is also highly significant (P<0.001) and positively associated with most performance measures (except for growth in sales) lending support to the existing literature. It appears that the investment in research and development pays off well for American companies. However, a further study is needed to identify the reasons for lack of relationship between R&D intensity and sales growth. It would be beneficial to divide the research and development activities into product and process innovation to better assess their marketing implications.

As a conclusion, market penetration by export and R&D intensity seem to be a major determinant of the firm performance in the case of the United States. Firm size shows a significant (p<0.05) and positive relationship with most performance measures (except Growth in Sales and Tobin's Q).

In the case of Chinese firms (Table 4), both export activity and R&D intensity are also significant and positively associated with most performance measures (except for Tobin's Q and ROI with respect to export and Growth in Sales with respect to R&D intensity). The direction of its linkage is positive with respect to performance measures. Our results virtually lend support to the previous findings (Bilkey, 1978; Geringer et al., 2000; Grant et al., 1988; Kim et al.1989) arguing that profitability in the home market encouraged overseas expansion which, in turn, generates increased profit and market growth. The findings for the Chinese firms are similar to those for the US firms. Hence, the aforementioned rationale for the results applies to the case of China. However, contrary to the U.S. case, return on investment is positively associated with export activity. The recent success of Chinese companies may be the result of their reliance on the labor-intensive products (Zhao and Zou, 2002). This may imply that China takes full advantage of labor abundance and leverages it in international markets. Coupled with access to open markets, these firms can compete effectively based on their factor endowment and improve their performance.

In conclusion, the results of this study indicate that performance of firms within developed and emerging country contexts follows similar patterns when research and development and export activity are part of the firm's strategic direction. Both R&D and exporting are necessary

Table 3: Results of OLS Multiple Regression Analysis: US Firms

Variables	Return on Assets	Return on Equity	Return on Investment	Growth in Sales	Tobin's Q
(Constant)	-33.815*** (5.86)	-79.411 (35.4)	-0.748*** (.105)	135.734 (59.74)	3.409*** (.972)
Dummy: High (1) vs. Low (0)	-1.109 (1.22)	-9.416	-0.037 (.022)	-16.309 (9.26)	-0.056 (.203)
Firm Size: Ln (Sale)	2.327*** (.368)	5.939** (2.22)	0.054*** (.007)	-6.101 (4.47)	-0.088 (.038)
Debt Leverage	0.029 (.019)	0.424*** (.121)	0.001* (.000)	3.632 (2.61)	-0.044 (.023)
Capital Intensity	0.501 (.518)	1.726 (2.31)	0.004 (.012)	4.793*** (2.06)	0.303*** (.093)
Current Ratio	2.339*** (.456)	-0.026 (2.74)	0.028*** (.008)	0.193 (2.67)	0.307*** (.076)
Export by Foreign Sales	0.303* (.115)	0.329* (.164)	0.000 (.000)	1.262** (.057)	0.000 (.076)
R&D Intensity	0.799*** (.101)	1.481** (.608)	0.012** (.002)	-2.896 (3.97)	0.106*** (.017)
Adjusted R²	0.2753	0.2284	0.2913	0.2358	0.2365
F-Ratio	20.304***	8.7456***	17.946***	3.987**	4.3526**

Table 4: Results of OLS Multiple Regression Analysis: Chinese Firms

Variables	Return on Assets	Return on Equity	Return on Investment	Growth in Sales	Tobin's Q
(Constant)	-30.345* (12.8)	-126.810** (48.1)	-0.578+ (.310)	125.881* (58.4)	2.819*** (1.07)
Dummy: High (1) vs. Low (0)	2.410 (2.03)	5.696 (7.94)	-0.052+ (.029)	-15.433+ (9.22)	-0.139 (.213)
Firm Size: Ln (Sale)	2.493** (.954)	10.026** (3.63)	0.053* (.023)	-5.431 (4.35)	-0.070 (.066)
Debt Leverage	-0.446 (.569)	6.977** (2.21)	0.003 (.014)	3.725 (2.59)	0.002 (.004)
Capital Intensity	0.652 (.858)	-1.888 (3.34)	-0.041*** (.013)	-11.860** (3.91)	-0.371*** (.091)
Current Ratio	1.557** (.561)	0.876 (2.18)	-0.018 (.014)	0.221 (2.56)	0.303*** (.068)
Export by Foreign Sales	0.295** (.114)	0.322* (.167)	0.007** (.003)	1.262* (.502)	0.000 (.005)
R&D Intensity	1.776* (.735)	9.680*** (2.97)	0.008*** (.002)	-2.827 (3.37)	0.106*** (.018)
Adjusted R²	0.2234	0.2448	0.2746	0.2014	0.2574
F-Ratio	10.324***	11.928***	14.523***	3.726**	12.568***

Values indicate unstandardized regression coefficients. Standard errors are in parentheses.
+ $P<0.10$, *$P<0.05$, **$P<0.01$, ***$P<0.001$

but not sufficient conditions to remain viable, competitive, and profitable to survive and compete in global markets. The data set used in this study does not allow us to see the recent behavioral changes in the United States and China. Future research is recommended which would better address these changes.

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