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Gao, Yanyan and Liu, Zhibiao and Song, Shunfeng and Zheng, Jianghuai

Management and Economics School, Southeast University, Nanjing, Center for Yangtze River Delta's Socio-Economic Development,Nanjing University, Department of Economics, University of Nevada, Department of Industrial Economics, Nanjing University

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Yanyan GAO
adamesky@gmail.com or gao-yanyan@live.cn
Management and Economics School
Southeast University, Nanjing 210008, China

Zhibiao LIU
zbliu@nju.edu.cn
Professor and Dean
School of Economics
Center for Yangtze River Delta's Socio-Economic Development
Nanjing University, Nanjing 210093, China

Shunfeng SONG
song@unr.edu
Department of Economics
University of Nevada
Reno, NV 89557 USA and
Center for Research of Private Economy
Zhejiang University,
Hangzhou, China

Jianghuai ZHENG
zhengjh@nju.edu.cn
Professor and Chair
Department of Industrial Economics
School of Economics
Executive Director
Center for Yangtze River Delta's Socio-Economic Development
Nanjing University, Nanjing 210093, China

Technology Capacity, Product Position and Firm's Competitiveness: An Empirical Analysis[1]

Yanyan GAO, Zhibiao LIU, Shunfeng SONG, Jianghuai ZHENG

Abstract: Using firm-level data from a 2009 survey conducted in Suzhou City, Jiangsu Province, China, this paper examines impacts of technology capacity and value-chain position on firm's product competitiveness. Both technology capacity and product competitiveness are self-assessed relative to other firms and products in the same industry. The position of value-chain is measured relative to if a firm is an original brand manufacturer or not. Our empirical results show that competitiveness rises with firm's technology capacity and its position in the global value chain. This finding is consistent with the theoretical prediction. The paper also investigates determinants of technology capacity and value-chain position, including firm's size, R&D spending, location dummies, education level of technical and management personnel, wages of technical and management personnel, and enterprise ownership. Bootstrapping, Probit, and linear probability regression models are employed.

Key Words: Technology Capacity, Original Brand Manufacturer, Competitiveness, Global Value Chain, Bootstrapping

JEL Codes: D2, L6

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1. INTRODUCTION

The concept of competitiveness has been widely used in economics (e.g., Jin, 2001; Porter, 2002; Li, 2007). Generally, competitiveness measures the comparative ability and performance of a firm, sub-sector or country to sell and supply goods and/or services in a given market. On this general level the idea about competitiveness is quite uncontroversial. However, there is little agreement in the Chinese literature about the specific forces that best measure and determine competitiveness, especially at the firm level. Hence, competitiveness is a slippery notion, one of those common terms that everyone uses until faced with the problem of defining and measuring it. Often, such a notion results in difficulties in providing a truly satisfactory definition and complicates its measurement on a quantitative basis.

At the firm level, Li (2007) argues that competitiveness is attributed to firm's factor market, product market and operation efficiency, with the product market showing the ultimate comparative ability and performance. In the literature, many researchers have studied the relationships between product competition and firm governance (Parrino, 1997; Defond and Park, 1999; Jiang R. and Chen L.R., 2007), managerial incentives (Schmidt, 1997; Raith, 2003), innovation (Aghion *et al.*, 2001), and capital institutions (Liu Z.B. *et al*, 2003). Yet, the literature still lacks empirical evidence on what determines a firm's competitiveness in the product market. To fill this gap, this paper uses micro data from manufacturing enterprises in Suzhou, China to examine the determinants of firm's competitiveness.

This paper measures firm's competitiveness through its products. Determinants of firm's competitiveness include internal factors such as technology and management and external factors such as market structure and relative position in the product market. In recent years, China has been promoting its international competitiveness and industrial upgrade. Hence, it is important to investigate how a firm's competitiveness is affected by its technology capacity and product position in the global value chain. Findings of this study will shed insightful light on how Chinese firms further raise their international competitiveness.

The data used in this study come from a survey conducted in Suzhou, Jiangsu Province in January 2009. Suzhou is a typical city in the Yangtze River Delta regarding the industrial structure and openness of economy. For example, in 2005, the ratio of manufacturing production to the large-scale industrial output is 98.63% for Suzhou, 97.45% for Nanjing, and 98.45% for Wuxi. The share of the top 5 industries' output to the local total industrial outputs is 63.72% for Suzhou, 68.8% for

Nanjing, and 56.68% for Wuxi (Wu, 2006). Suzhou is also one of the most opened-up cities in China that actively participates in the global value chain and labor division systems. In 2007, Suzhou had a total international trade of $211.8 billion and utilized $7.2 billion foreign capital. Among the top 500 companies in the world, 122 have set up branches in Suzhou.[2] Not surprisingly, through foreign direct investment (FDI) and international trade, manufacturing firms in Suzhou are able to upgrade their production technology and improve their product position in the global value chain (GVC). Studying manufacturing firms in Suzhou will certainly help us better understand how technology and global value chain affect a firm's product competitiveness.

The remaining paper is organized as follows. Section 2 gives a background review. Section 3 describes the data and discusses the methods. Section 4 presents empirical results on determinants that affect firm's competitiveness, technology capacity, and product position in the global value chain. The last section provides conclusions and implications.

2. BACKGROUND

China's experience largely proves the so-called "catching-up" advantage in its economic development. With the economic reform and the open-door policy, China stands out as a successful model in utilization of FDI. It has been the largest FDI recipient among developing countries and the fastest-growing economy in the world for more than three decades. A large-scale inward foreign investment not only relieves the capital scarcity problem that the Chinese economy was facing but also brings in advanced technology and management skills. Through spillovers, local Chinese firms start to catch up and utilize more advanced technology and managerial know-how. In consequence, Chinese companies have raised their international competitiveness, improved their product position in the global value chain system, and expanded their markets overseas.

A number of studies have investigated FDI spillover effects on local companies. For example, Yuan and Lu (2005) analyzed the management spillovers of FDI activities; Johansson and Nilsson (1997), Lai *et al* (2005), and Ping (2007) examined

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[2] About the data of Suzhou, the nation and the Yangtze River Delta respectively came from the statistics yearbook of Suzhou, the nation and the Yangtze River Delta of 2008. Especially, data of Suzhou is accessible in the website of statistics information of Suzhou: http://www.sztjj.gov.cn/tjnj/2008/index.htm.

the spillover effects of technology and scientific research activities; Zhong (2006) discussed the industrial spillovers; and Jovorcik and Spatareanu (2008) investigated the differences of spillovers based on firm ownerships. Using cases of Chinese firms, An (2003) studied the influence of a firm's learning strategy on its technology capacity and technological selections. Through FDI, Zheng J.H. *et al.* (2008) showed that firms could increase technology capacity and improve production performance. All of the above studies have proved that developing countries in their transitions could benefit from FDI spillovers, imitate and learn the more advanced technology from developed countries, and thus improve their product competitiveness.

Some previous studies have argued that firm's competitiveness also depends on how a firm's production fits into the global labor division system and what position its product locates in the global value chain. The globalization of economy has greatly changed the scope and ways of firm operations, forcing firms to become a part of the global labor division and specialization system (Arndt and Kierzkowski, 2001; Lu F., 2004). With regard to international trade, the growing economic interaction between different countries and the decreasing trade barriers have further promoted trade integration (Feenstra, 1998; Liu Z.B. and Wu F.X., 2006). With the change of global economic environment, firms' product markets expand to every country, forming a so-called "global value chain (GVC)". For firms to enhance their competitiveness and market potential, they have to continue to improve their production technology and move up their product position in the global value chain (Gereffi, 1999, 2001; Zhang H., 2006).

Moving product position up in the GVC could be relatively easy from assembly outsourcing to original equipment manufacturers (OEMs) and even original design manufacturers (ODMs). Further moving-up to original brand manufacturers (OBMs), however, could be subdued by the upholders on top of the value chain. In fact, local firms could be "captured" by multinationals if they are forced to stay at the low end of the international labor division system and position their products at the low end of the GVC. If such a "captured" position persists, domestic industries could be unsustainable because of the competition from other countries or regions that also produce at the low end of the GVC (Liu, 2007). Therefore, becoming OBMs strongly indicates firm's competitiveness.

In short, firm's competitiveness mainly depends on what it produces, how it produces and who it produces for. Given a market structure, the competitiveness of firms with products of independent brand will be stronger than that of those conducting assembly outsourcing or OEM activities. Firms producing high-tech goods have stronger competitiveness than those producing low-tech goods; firms that produce for high-end consumers surpass those firms producing for ordinary consumers in terms of differentiation, quality and technology proportion of products. In this paper, we categorize the factors that affect firm's competitiveness into two major aspects: firm technology capacity and firm positions in the GVC. Specifically, firm technology capacity ensures its capacity of supplying high-quality products; firm position in the GVC determines its capacity of meeting and shaping market demands.

3. DATA AND METHODS

In this section, we describe the data and discuss the methods.

3.1 Data

The firm-level data used in this paper were collected from "Suzhou Industrial Upgrading and Talent Structure Optimization Questionnaire (among manufacturing firms)" jointly conducted by the Executive Office of Talent Attraction, Suzhou and the Center for Yangtze River Delta's Socio-Economic Development, Nanjing University. The survey distributed 332 questionnaires and collected 315 valid samples. The effective sample consists of 45 from Changshu, 39 from downtown Suzhou, 42 from Kunshan, 35 from Taicang, 32 from Xiangcheng, 38 from Wujiang, 32 from Wuzhong, 33 from Zhangjiagang, 12 from Gaoxin District, and 7 from Industrial Park. The authors believe that the sample well represents manufacturing firms in Suzhou.[3] The survey includes 54 questions on firm's profile, industrial upgrade, and human resource. Firm profile provides information on which industry the firm belongs to, physical location, fixed asset volume, production scale, employment, sales, ownership, and product competitiveness. Information about firm's industrial upgrade tells the types and features of product, R&D and training efforts, production models (OEM, ODM or OBM), and comparative advantages and disadvantages in competition. Human resource data include hiring of employees, labor turn-over, work experiences, educational background, management and technology training, and involvements of government and trade associations.

[3] The survey covers all manufacturing firms in Suzhou that have sales revenues higher than 5 million RMB, with physical locations distributed both in and outside of economic development zones. The firms are also the ones covered by the National Bureau of Statistics of China.

In this paper, we construct the following variables to investigate determinants of a firm's competitiveness. The first is the dependent variable, a firm's product competitiveness (*Proc*). As we discussed in part 2, we measure a firm's competitiveness by an index of its product competitiveness. Such an index was established by the ranking of firm product competitiveness in the industry. Specifically, the ranking involves 8 categories: internationally leading, internationally higher than average, internationally average, internationally lower than average, nationally leading, nationally higher than average, nationally average, nationally lower than average. Numerically, in the questionnaire, we assigned values of 10, 8, 5, 3 and 8, 6, 4, 2, respectively to each of the above categories. The final value of the competitiveness variable is a weighted average, with a maximum of 10 and a minimum of 2.[4]

The second variable is a firm's production technology capacity, *Tecc*. In the survey, we asked a question about a firm's production technology capacity similar to the one for the firm's product competitiveness. Therefore, this variable is also an index, which is a weighted average, with a maximum of 10 and a minimum of 2.

The third variable is about product position in the value chain, *Obm*. As mentioned in the previous section, becoming an OBM indicates a firm's strong competitiveness in the global market. Accordingly, in our analysis, we tell a firm's product position in the value chain by learning if the firm conducts OBM activities from asking "Whether your firm conducts OBM activities or not." Hence, the firm's product position is a binomial dummy variable, with 1 for yes and 0 for no.

The fourth is a set of other variables that could influence a firm's competitiveness, technology capacity, and whether it is an OBM. It includes the following variables. Firm scale, a three-choice dummy (*Fsiz1*, *Fsiz2*, and *Fsiz3*), tells if a firm is "larger than the national average", "about the national average", or "smaller than the national average".[5] The education variable (*Medu*) provides average years of schooling of technicians and managers in the firm. We expect that this variable could promote a firm's technology capacity. Variables *Dzd* and *Icd* are dummies showing if the firm is

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[4] This problem is a multi-choice question, reflecting firm's competitiveness both at home and abroad. For example, if a firm chooses "internationally leading" and "nationally leading", then its competitiveness will be calculated as (10+8)/2=9. We value "internationally leading" as 10 while valuing "nationally leading as 8" because China is a developing country and its nationally leading firms are still lagging behind internationally leading firms in terms of product competitiveness. In regression, we tried to different numerical sets of indices for this variable. Our results suggested that the major conclusions remain unchanged.

[5] We didn't use firm sales volume to measure the scale because the definitions of firm scale have different criteria for different manufacturing industries. Hence, the same sales volume often represents different firm scale in different industries.

located in development zones or industrial clusters. *OEM* and *ODM*, respectively, indicate production models of original equipment manufacturers and original design manufacturers. The variable *rdr* measures R&D intensity of a firm, which is the ratio of R&D expense to the total sales volume. *Asa* is the firm's average wage; while *Mtw*, *Htw*, *Mmw*, *Hmw* are average wages of different employee categories, all relative to *Asa*. *Gme* gives the number of years that the firm's CEO has worked in Suzhou. The variable *The* tells the average number of years that senior technicians have worked in the firm. *Npr* is the proportion of total sales contributed by new products. *Exr* measures the proportion of export to the total sales. The descriptive statistics of all variables are summarized in Table 1.

Table 1. Descriptive Statistics of Variables

Variables	Definitions	Samples	Average	SD	Min	Max	Remarks
Proc	Product competitiveness	305	6.070	2.058	2	10	Weighted index
Tecc	Technology capacity	305	6.015	2.016	2	10	Weighted index
Obm	OBM production model	315	0.521	0.500	0	1	Dummy variable
Oem	OEM production model	315	0.156	0.363	0	1	Dummy variable
Odm	ODM production model	315	0.089	0.285	0	1	Dummy variable
Asa08	Average wage in 2008	285	2.502	1.838	0.15	28	Unit: 10,000 yuan
Mtw	Medium-level technicians' wage in 2008	165	1.311	0.735	0.143	7.742	In comparison with average wage
Htw	High-level Technicians'wage in 2008	131	2.063	1.364	0.179	12	In comparison with

							average wage
Mmw	Medium-level managers' wage in 2008	197	2.006	1.286	0.250	14.286	In comparison with average wage
Hmw	High-level managers' wage in 2008	178	4.715	4.709	0.319	50	In comparison with average wage
Npr08	New product ratio in the total sales in 2008	297	0.139	0.624	0	10	In proportion
Exr08	Export ratio in total sales	296	0.166	0.533	0	7.824	In proportion
Dzd	Located in development zones	315	0.441	0.497	0	1	Dummy variable
Icd	Located in industrial clusters	315	0.162	0.369	0	1	Dummy variable
Tedu	Technicians' average education level	225	12.908	2.286	9	17.092	Unit: Year
Medu	Managers' average education level	235	13.360	2.308	9	19	Unit: Year
Rdr08	R&D Intensity in 2008	143	0.060	0.195	0	2.112	In proportion
Rdr07	R&D intensity in 2007	135	0.048	0.100	0	0.765	In proportion
Rdr06	R&D intensity in 2006	122	0.043	0.088	0	0.622	In proportion
Fsiz3	Larger than the	298	0.312	0.464	0	1	Relative

	national average scale						measure, Dummy variable
Fsiz1	National average scale	298	0.513	0.501	0	1	
Fsiz2	Less than the national average scale	298	0.174	0.380	0	1	
The	Working years of senior technicians in the company	181	5.613	2.621	1.5	10	Unit: Year
Gme	Local working years of the general managers	207	15.986	10.461	0	55	Unit: Year

3.2 Methods

In addition to OLS regression, this paper employs a bootstrap method to ensure more robust results. The least squares method guarantees the best linear unbiased coefficient estimation if the error term is independent, homoscedastic, and normally distributed. However, when the error term distribution is heavy-tailed or includes some outliers, the least square method is not the best method (Chernick, 2008: p. 83). Fortunately, the use of bootstrapping provides an alternative means for statistical inference when more general results about the sampling properties of the estimators are non-existent or intractable (Efron and Tibshirani, 1986). The algorithm described in Simar and Wilson (2007) details the data generating process and subsequently the means by which inference might proceed. Practically, the bootstrap method repeatedly extracts and discharges samples to make the regression conclusions better reflect the true characteristics, under the condition that the original sample well represents the population. In this case, the bootstrap method attempts to acquire a probability distribution from the sample itself, not relying on the central limit theorem. Specifically, we extract individual samples randomly from the original sample to form a new sample in which some individual observations might be chosen multiple times, and then calculate the distribution statistics of this new sample. Redo the sampling process for 100-1000 times and obtain distribution patterns of the extracted samples.

Two different methods can be used: bootstrapping residuals and bootstrapping pairs (Efron, 1982, pp. 35-36). The second method is not as sensitive to model misspecification as the first method, because it does not bootstrap residuals and thus is not sensitive to the hypotheses of independence and exchangeability of error term (Chernick, 2008, pp. 82). Therefore, even if the error distribution is not of Gaussian type or not available to us, bootstrapping provides a way to estimate the probability of coefficients, confirms confidence interval, and perform hypothesis tests.

In this study, the effective sample is 315. Although the sample well represents all the manufacturing firms in Suzhou, the sample is relatively small and it may contain some abnormal values. Employing a bootstrapping method could help to obtain more robust regression results. Because whether the firm conducts OBM activities is a dummy variable, we use a binary response model for our empirical analysis. For robustness, we choose the linear probability model (LPM) for bootstrapping methods and the Probit model for non-parametric methods.

4. EMPIRICAL EVIDENCE

In this section, we present empirical results on determinants that affect firm's competitiveness, technology capacity, and product position in the global value chain.

4.1 Determinants of Firm's competitiveness

As argued in Section 2, firm's technology capacity (*tecc*) and product position in the value chain (*chl*) are two major factors affecting firm's competitiveness (*proc*). To examine if any other firm characteristics could also influence a firm's competitiveness, we add more control variables into the following regression model, including firm size (*fsiz*), managers' average educational years (*medu*), technicians' average education years (*tedu*), average wage level of 2008 (*Asa08*) and the dummy variables of whether the firm is located in development zones (*dzd*) or industrial clustering (*icd*).

$$proc_i = \alpha_0 + \alpha_1 tecc_i + \alpha_2 chl_i + \sum_{j=1}^{m} \beta_j control_i^j + \varepsilon_i \quad (1)$$

Before regression, we used the Breusch-Pagan/Cook-Weisberg approach to test if heteroscedasticity exists and found a chi-square value of 0.86, indicating that heteroscedasticity is not a significant problem. In our empirical analysis, we make direct comparisons between results from OLS and bootstrapping methods.

Table 2 presents the results respectively estimated by the OLS and bootstrapping (BS) methods. Generally, we obtained very similar results using two different methods, although bootstrapping produced somewhat less significant estimates. For all models shown in Table 2, both a firm's technology capacity and product position in value chain have significant and positive influence on the firm's competitiveness. For every point increase in firm technology capacity index, the firm's competitiveness index would increase by about 0.8 point. This finding indicates that technology capacity is the primary factor influencing firm's competitiveness. Firms with their own brands exhibit greater competitiveness, with about 0.5 points higher in their competitiveness index than firms without their own brands. This result is consistent with the GVC theory; that is, firms with products on the high-end of global value chain possess stronger competitiveness. The R^2-value of regression model (3) further confirms the significant impact of technology capacity and product position in a firm's competitiveness. The two variables alone explain 71% of the variations of firm's product competitiveness.[6]

For manufacturing firms in Suzhou, the above findings are not surprising. First, the manufacturing industry in Suzhou is technology-intensive and capital-intensive. A firm's product competitiveness thus depends highly on technology capacities. Second, the manufacturing sector in Suzhou is export-oriented. Product position in the global value chain plays an important role in the global market. OBM activities help firms place their products in the high-end of chain value, raising their competitiveness.

Among other control variables, only a firm's production scale is statistically significant in contributing to firm's competitiveness (see regression model (2)). Compared to large-scale production, product competitiveness is 0.82 and 0.32 points lower, respectively for firms with a scale lower than or about the nationally average scale. Thus, large-scale production helps manufacturing firms improve their competitiveness. This conclusion, however, becomes less obvious in regression model (1) when more control variables are included. Other results in regression model (1) suggest that variables such as managers' and technicians' educational

[6] Firm technology capacity and OBM have a correlation coefficient of 0.339. Hence, multicollinearity problem is not serious. From appendix table 1, we can see that the correlation coefficients of all independent variables are not high. We are not concerned about multicollinearity problem in our regression analysis.

background, average employees' wage, and firm's physical location have little influence on firm's competitiveness.[7]

Table 2. Determinants of Firm's Product Competitiveness

Variable	(1) OLS	(1) BS	(1) OLS	(2) BS	(3) OLS	(3) BS
Tecc	0.765***	0.765***	0.757***	0.757***	0.8***	0.8***
	(15.37)	(15.31)	(20.59)	(15.79)	(23.43)	(22.36)
Obm	0.561***	0.561***	0.457***	0.457***	0.552***	0.552***
	(2.93)	(2.74)	(3.2)	(2.84)	(4.01)	(3.46)
fsiz1	-0.095	-0.095	-0.319**	-0.319*		
	(-0.48)	(-0.51)	(-2.03)	(-1.81)		
fsiz2	-0.556*	-0.556*	-0.816***	-0.816***		
	(-1.9)	(-1.74)	(-3.85)	(-3.26)		
Medu	-0.051	-0.051				
	(-1.1)	(-1.09)				
Tedu	0.037	0.037				
	(0.84)	(0.83)				
asa08	0.075	0.075				
	(0.91)	(1.04)				
Dzd	0.061	0.061				
	(0.35)	(0.33)				
Icd	-0.127	-0.127				
	(-0.56)	(-0.54)				
_cons	1.369**	1.369**	1.573***	1.573***	0.964***	0.964***
	(2.16)	(2.03)	(5.67)	(4.32)	(4.82)	(5.11)
F/Wald Chi^2	44.498	837.45	183.912	909.41	373.264	894.22
Adj-R^2	0.68	0.68	0.715	0.715	0.71	0.71
Number of Observations	185	185	293	293	305	305

Notes: For OLS regression, t statistics are shown in parentheses and F-value is reported. For bootstrapping method, z statistics are shown in parentheses and Wald Chi^2-value is reported. We re-did sampling 200 times in our bootstrapping analysis. *, ** and *** respectively indicate the significance levels of 10%, 5% and 1%. Regressions results are obtained by using STATA10.0.

[7] We also included variables of ownerships and industries in our regression but found no significant results.

4.2 Determinants of Firm's Technology Capacity

From the results in Table 2, we concluded that a firm's competitiveness is significantly affected by its technology capacity. But what factors determine a firm's technology capacity? To answer this question, we further employ the OLS and bootstrapping methods to run the following regression model.[8] Variables include firm scale (*fsiz*), product position in value chain (*chl*) measured by three independent dummy variables OBM, OEM and ODM, average education years of managers and technical employees (*medu* and *tedu*), whether the firm is physically located in development zones or industrial clusters (*dzd* and *icd*), and the R&D intensity in the past three years (*rdr*).

$$tecc_i = \beta_0 + \beta_1 fsiz_i + \beta_2 chl_i + \beta_3 tedu_i + \beta_4 medu_i + \beta_4 dzd_i + \beta_5 icd_i + \beta_6 rdr_i + \varepsilon_i \quad (2)$$

Table 3 presents our regression results. Several variables show significant impacts on a firm's technology capacity, including firm production scale, product position in value chains, managers and technical employees' average educational levels, and firm R&D intensity. Specifically, a larger production scale promotes firm technology capacity. Compared to large-scale firms, small-scale firms exhibit significant lower technology capacity, although the difference between large-scale and average-scale firms is not significant in some regression models. Firms with their own brands and products at the high-end of value chain have higher technology capacity than those without their own brands and with products at the low-end of value chain. Both ODM and OEM firms show no significant influence on firm technology capacity.[9] Higher managers' and technicians' educational levels also help firms to improve technology capacity. The results indicate that for every 1 year increase in the average education of managers, a firm's technology capacity increases by 0.18 units (see regression (1)); for every 1 year increase in the average education of technicians, the firm's technology capacity increases by about 1.6 units. Hence, the education of technicians is more important.[10] R&D investment positively affects a

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[8] Because the OLS results are less robust, we only report the results obtained from the bootstrapping method.

[9] OBM, ODM and OEM are not multi-dimension dummy variables but three independent dummy variables for the firms under survey cannot only conduct one to these three activities. Hence, ODM's coefficient is smaller than OEM. Statistically, the impacts of ODM and OEM are insignificant.

[10] Because the average education levels of managers and technicians are highly correlated, we did not included

firm's technology capacity. Among the R&D variables, the estimated coefficients suggest that R&D investment in 2006 made the biggest contribution to a firm's technology capacity, with an estimated coefficient of over 4.5, while the estimated coefficients are significantly smaller for the other two years. This finding suggests a lagging influence of R&D investment on a firm's technology capacity.

We did not find that locating in development zones or industrial clusters helps firms to promote technology capacity (regressions (1-3)). This result could imply that firms chose to locate in the economic developments or industrial clusters not because of possible spatial spillovers but the "policy rent" offered by the Chinese government in such areas. This observation was also found by Zheng J.H. *et al* (2008).

Table 3. Determinants of Firm's Technology Capacity

Variable	(1)	(2)	(3)	(4)	(5)
Fsiz1	-0.789*	-0.509	-0.517	-0.522	-0.632
	(-1.89	(-1.28)	(-1.24)	(-1.3)	(-1.51)
Fsiz2	-1.712**	-1.452***	-1.216**	-1.205**	-0.973*
	(-2.42)	(-2.96)	(-2.47)	(-2.4)	(-1.69)
Obm	0.847**	1.243***	1.079***	1.069***	1.118***
	(2.14)	(3.71)	(2.98)	(3.18)	(3.58)
Oem	0.135				
	(0.3)				
Odm	-0.013				
	(-0.02)				
Medu	0.184**				
	(2.34)				
Dzd	-0.014	-0.138	-0.045		
	(-0.04)	(-0.42)	(-0.13)		
Icd	0.343	0.123	-0.094		
	(0.94)	(0.37)	(-0.26)		
Tedu		0.141*	0.163**	0.162**	0.182***
		(1.88)	(2.13)	(2.26)	(2.63)
rdr08	2.245	3.612**			

them jointly. For the same reason, we did not include three-year R&D variables in the same regression. Please refer to Appendix table 2 for more details.

	(0.88)	(2.23)			
rdr06			4.597**	4.469**	
			(2.02)	(2.08)	
rdr07					2.236
					(1.16)
_cons	3.655***	3.858***	3.606***	3.588***	3.48***
	(3.12)	(3.61)	(3.15)	(3.37)	(3.55)
Wald Chi^2	51.34	46.96	28.87	36.68	32.17
Adj-R^2	0.195	0.234	0.242	0.257	0.202
N	116	114	101	101	112

Notes: z statistics are shown in parentheses and Wald Chi^2-value is reported. We re-did sampling 200 times in our bootstrapping analysis. *, ** and *** respectively indicate the significance levels of 10%, 5% and 1%. Regressions results are obtained by using STATA10.0.

4.3 Determinants of Firm's Product Position in the Value Chain

Because OBM activities help firms place their products in the high-end of chain value, we use OBM as a dummy variable to indicate firm's product position in the global value chain. Table 2 showed that such variable significantly and positively affects a firm's competitiveness. What factors determine whether a firm conducts OBM activities or not? Based on data available from our survey, we selected variables including general managers' local working years (*gme*), high-level technicians' working years in the firm (*hte*), the proportions of medium-level and high-level technicians' as well as medium-level and high-level managers' average wages to the average wage (*mtw*, *htw*, *mmw* and *hmw*), R&D intensity of new products (*npr08*), exporting ratio in total sales (*exr08*), firm technology capacity (*tecc*), scale (*fsize*), and whether or not physical location is in development zones (*dzd*). To ensure robust results, the following binary regression models will be estimated with a bootstrapping linear probability (BLP) method and a Probit probability model (PRO), respectively:

$$P(obm_i = 1 | x_i) = x_i \lambda \quad (3)$$

$$\Pr ob(obm_i = 1 | x_i) = G(x_i \lambda) \quad (4)$$

where x_i refers to each variable mentioned above. For the Probit model, we only report its marginal effects for better explanations. Table 4 presents the results.

Generally, the estimated results of model (3) and model (4) are similar, suggesting that the PRO and BLP models do not produce results that are qualitatively different.

Several variables show significant impacts on a firm's product position in the global value chain, including technology capacity, working experiences of technicians, production scale, and physical location. Specifically, for every unit that technology capacity is improved, the probability of conducting OBM activities increases by about 0.07. Hence, technology capacity helps firms climb up product position on the value chain. The working years of technicians in the firm play a positive role in improving product position in the value chain (see regressions (2) and (3)).[11] Larger firm scale increases the possibility of engaging in OBM activities. For example, compared to firms with scale larger than the national average, firms with scales less than the national average have about 0.4 lower probability of constructing independent brands (see all regressions). This finding may imply that large-scale firms have more resources to do R&D and develop their own brands. A firm's physical location also affects its product position in the global value chain. Interestingly, firms located in development zones have about 0.2 higher probability in developing OBM than those located elsewhere (see all regressions). This result is not very surprising for Suzhou, as the government-led FDI activities in the economic development zones have attracted many large-scale firms and multinational companies, which usually are engaged in developing and producing their own brands.

Table 4 shows that there is no significant correlation between wage levels of different types of technicians and managers and whether firms conduct OBM activities or not (see regressions (1) and (2)). The local working years of general managers is positively but weakly related to the OBM activities (see regression (1)). Sales proportion of new products, whether the firm exports or not are not significantly related to firm product position in the value chain (see all regressions).[12]

Table 4. Determinants of Firm's Product Position in the Value Chain

Variable	(1)BLP	(1)PRO	(2)BLP	(2)PRO	(3)BLP	(3)PRO

[11] Since technology capacity and firm selection of its position in the value chain are correlated with mutual decision, we attempted to adopt simultaneous equation system model to estimate them but had undesirable results. The main reason of such a result lies in that the number of samples has dramatically decreased to only over 50. Nonetheless, the result basically accords with the reports of Table 3 and Table 4.

[12] When we tried to put dummy variables such as R&D input, employees' education level and industrial clustering into the model in the process of regressing, these variables showed no significant relation to firm selection of conducting OBM or not. A great number of medium-size and small firms entered industrial clusters for the sake of clusters' highly-sophisticated division system, and they usually focus on a certain point of the value chain for their products, so their selection does not necessarily and closely related to the construction of independent brands in firms.

mtw	0.016	-0.108	-0.021	-0.178		
	(0.092)	(-0.584)	(-0.137)	(-0.927)		
htw	0.000	-0.005	0.047	0.084		
	(0.000)	(-0.063)	(0.570)	(0.940)		
mmw	-0.004	0.144	0.030	0.155		
	(-0.053)	(1.321)	(0.551)	(1.601)		
hmw	0.042^{**}	0.047^{*}	-0.002	-0.005		
	(2.019)	(1.685)	(-0.092)	(-0.509)		
gme	0.006	0.007				
	(1.150)	(1.293)				
the			0.037^{**}	0.051^{**}	0.025^{*}	0.027^{*}
			(2.005)	(2.129)	(1.864)	(1.760)
npr08	-0.168	-0.149	-0.103	-0.135	-0.070	-0.073
	(-0.757)	(-0.601)	(-0.648)	(-1.250)	(-0.492)	(-1.430)
exr08	-0.050	-0.109	-0.024	-0.259	-0.035	-0.094
	(-0.271)	(-0.474)	(-0.153)	(-1.328)	(-0.407)	(-0.763)
tecc	0.079^{***}	0.077^{**}	0.062^{**}	0.084^{**}	0.056^{***}	0.063^{***}
	(2.603)	(2.116)	(2.396)	(2.577)	(3.072)	(2.813)
dzd	0.221^{**}	0.257^{**}	0.229^{**}	0.301^{***}	0.159^{**}	0.176^{**}
	(2.253)	(2.448)	(2.403)	(2.761)	(2.294)	(2.295)
fsiz1	-0.088	-0.136	-0.071	-0.098	-0.012	-0.006
	(-0.775)	(-1.214)	(-0.768)	(-0.847)	(-0.156)	(-0.072)
fsiz2	-0.397^{**}	-0.517^{*}	-0.325^{*}	-0.397^{*}	-0.315^{**}	-0.337^{**}
	(-1.985)	(-1.789)	(-1.935)	(-1.711)	(-2.283)	(-2.324)
_cons	-0.11		-0.076		0.123	
	(-0.331)		(-0.255)		(0.65)	
Observations	77	77	103	103	168	168
R^2-Ad/Pseudo R^2	0.227	0.337	0.206	0.291	0.119	0.127
Wald/LR chi2	43.74	32.19	40.95	37.65	33.96	27.75
Ratio of valid prediction		79.4%		73.2%		65.4%
Log-Likelihood value		-31.68		-45.77		-95.62

Notes: BLP columns show the results from the bootstrapping linear probability model and PRO columns give the marginal effect calculated by the Probit model. Values in brackets are z statistics. BLP model and Probit model are indicated respectively by Wald chi^2 and LP chi^2. R-square term of Probit model is Pseudo R^2. Explanation of other data is similar to Table 3.

5. CONCLUSIONS AND POLICY IMPLICATIONS

Using the firm-level data collected from manufacturing firms in Suzhou in 2009, this paper has investigated micro factors that affect firm's competitiveness. Our empirical results generally follow the theory of global value chain, suggesting that competitiveness of manufacturing firms in Suzhou largely depends on firm's technology capacity and their product position in the global value chain. The higher the firm technology is, the stronger its competitiveness is. High-end firms in the value chain possess stronger competitiveness than low-end firms. Large-scale production helps manufacturing firms raise their competitiveness.

This paper has also examined determinants of firm's technology capacity and probability of conducting OBM activities. We found that firm's technology capacity is positively and significantly affected by production scale, product position in value chains, managers and technical employees' average educational levels, and firm R&D intensity (which shows a lagging influence). A firm's OBM activities, i.e., product position in the global value chain, are positively related to technology capacity, working experiences of technicians, firm scale, and whether or not the firm is located in an economic development zone.

Several implications could be proposed. First, technology is the key to move up product position in the global value chain and raise product competitiveness. OBM activities help to raise product competitiveness. Thus, China needs to make more efforts to upgrade its industry and encourage firms to develop their own brands. Second, expanding a firm helps it improve technology capacity, promote OBM activities, and raise product competitiveness. This finding has been evidenced by many international successes such as those made in Korea. Third, for manufacturing firms, R&D enhances a firm's technology capacity, moving up product position and raising product competitiveness. Last, economic development zones stimulate OBM activities, in addition to its success of attracting FDI. Therefore, it is important to understand the functions of development zones and make better uses of these functions.

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Appendix table 1: correlation coefficient of variables in table 2

	proc	tecc	obm	Fsiz1	fsiz2	medu	tedu	asa08	dzd	icd
proc	1									
tecc	0.813	1								
obm	0.419	0.339	1							
fsiz1	-0.159	-0.234	-0.003	1						
fsiz2	-0.239	-0.149	-0.310	-0.443	1					
medu	0.224	0.291	0.158	-0.041	-0.067	1				
tedu	0.206	0.214	0.143	-0.108	-0.038	**0.530**	1			
asa08	0.182	0.185	0.044	-0.002	-0.065	0.285	0.173	1		
dzd	0.056	0.035	0.096	-0.011	0.024	0.097	0.108	0.209	1	
icd	0.124	0.167	0.116	-0.029	-0.026	0.090	0.016	0.158	0.155	1

Appendix table 2: correlation coefficient of variables in table 3

	tecc	fsiz1	fsiz2	obm	Odm	oem	medu	dzd	icd	tedu	rdr06	rdr07	rdr08
tecc	1												
fsiz1	-0.143	1											
fsiz2	-0.182	-0.399	1										
obm	0.325	-0.034	-0.278	1									
odm	0.076	0.071	-0.050	0.154	1								
oem	0.010	0.131	-0.149	-0.110	0.36	1							
medu	0.249	-0.027	0.009	0.133	0.099	-0.104	1						
dzd	0.047	-0.007	-0.007	0.239	-0.050	-0.110	0.140	1					
icd	0.082	-0.034	-0.074	0.074	0.149	0.000	-0.012	0.156	1				
tedu	0.292	-0.121	-0.031	0.187	-0.025	-0.181	0.438	0.151	-0.043	1			
rdr06	0.308	-0.296	-0.008	0.088	-0.044	0.015	0.119	0.016	0.333	0.095	1		
rdr07	0.275	-0.313	0.078	-0.001	-0.038	0.070	0.132	-0.028	0.284	0.113	**0.929**	1	
rdr08	0.246	-0.271	0.006	-0.015	0.005	0.152	0.175	-0.059	0.213	0.066	**0.776**	**0.897**	1

Appendix table 3: correlation coefficient of variables in table 4

	obm	mtw	htw	mmv	Hmw	gme	the	npr08	exd	tecc	dzd	fsiz1	fsiz2
obm	1												
mtw	0.022	1											
htw	0.102	**0.720**	1										
mmv	0.124	0.166	0.425	1									
hmw	0.262	0.268	**0.516**	0.61	1								
gme	0.192	-0.096	-0.097	-0.17	0.052	1							
the	0.117	-0.218	-0.174	-0.146	0.000	0.351	1						
npr08	0.094	-0.038	0.076	0.140	0.032	0.089	0.113	1					
exd	-0.125	0.132	0.114	0.034	0.032	-0.164	-0.020	0.339	1				
tecc	0.333	0.096	0.079	-0.067	-0.174	0.037	-0.091	0.287	0.020	1			
exr08	0.277	-0.274	-0.113	0.029	0.055	0.070	-0.152	-0.019	-0.018	0.113	1		
fsiz1	0.114	-0.113	-0.074	0.024	-0.119	-0.125	-0.238	0.057	-0.199	-0.012	0.170	1	
fsiz2	-0.411	-0.030	0.009	-0.024	0.069	0.044	-0.092	0.014	0.313	-0.317	-0.136	**-0.538**	1