DYNAMIC COMPETITION ANALYSIS FOR BUSINESS MODELS OF OEM AND OBM IN THE HIGH-TECH INDUSTRY

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ABSTRACT

This investigation employs the Lotka-Volterra model to explore the market competitions between the strategies of own brand manufacturing (OBM) and original equipment / design manufacturing (OEM/ODM) in the global motherboard manufacturing industry. The parameters of the Lotka-Volterra mathematical model show the predator-prey relationship between OBM and OEM/ODM strategies. The sales volume from the OBM strategy erodes that of the OEM/ODM strategy, while the sales from the OEM/ODM strategy promote those from the OBM strategy. Furthermore, we find Lotka-Volterra model to be superior to the conventional Bass (1969) growth model in the prediction of motherboard because the strategy mutualism is included.

Keyword: business model, motherboard, own brand manufacturing, original equipment manufacturing, original design manufacturing

INTRODUCTION

This research employs the Lotka-Volterra model in ecology to analyze and compare the competitive relations between own brand manufacturing (OBM) and original equipment / design manufacturing (OEM/ODM) in global motherboard manufacturing industry; it seeks to find a resolution concerning how to effectively exercise business strategy in order to conform to customers' demand and to realize the decision process about their purchase. In addition to technological skills, the profitability of a motherboard company depends on whether the company has accurately predicted the demand and supply of the market. Hence, building an effective prediction model to forecast the demand of the market in order to appropriately moderate marketing and managing decisions has become a universal need for motherboard manufacturing companies. However, most researches concerning marketing and business strategy fields are investigated through questionnaires (ex. Khare, 2011; Alibabic et al, 2011). The evidence of the consumers' actual decision for consumptions relies on the verification of actual shipment volume. Thus, this paper uses shipment volumes as the indicator of consumer purchase intentions to discuss the cooperative relations between OEM/ODM and OBM business models, and to provide insights concerning the decision processes of consumer behaviors.

Most studies applied conventional diffusion theory to determine market dynamics via logistical diffusion model. Lee and Lee (2009) applied the Bass (1969) model and a typical logistical S-curve to analyze the growth patterns of telecommunication services. The Bass model assumes a monopolistic market, such that reciprocal cooperation or competition among different business models or strategies is ignored. The above references only focus on development of a single product, but do not consider the competitive and cooperative relations between different strategies. Few studies have considered the effects of reciprocal interactions between OEM/ODM and OBM factories within the same industry.

However, enterprises can utilize OEM/ODM business model to save resources, to diversify risks

and to shorten the period for entering the markets, so they possess new competitive advantages in production through the cooperation with OEM/ODM foundries (Chang and Tsai, 2002). Additionally, the work of Feenstra & Hamilton (2006) indicates that since OBM and OEM/ODM are inter-dependent, the world's motherboard industries have constructed a powerful and complete OEM/ODM supply chain for a long while due to advanced technology, consistent quality of product, and punctual shipments. Once OBM enterprises receive a great deal of orders, they tend to outsource OEM/ODM factories in production. Thus, OEM/ODM could immediately expand for mass production, so OEM/ODM strategy is apt to help the sales growth of OBM strategy. The mutualism between OEM/ODM and OBM relations is inevitable in the supply chains within high-tech industries. For the reasons, we for the first time apply the Lotka-Volterra model to address the effects of interactive relationship between these two business strategies, OEM/ODM and OBM.

According to our empirical results, the parameters of the Lotka-Volterra mathematical model show the predator-prey relationship between the OBM and the OEM/ODM strategy. The sales volumes from the OBM strategy will erode the sales volumes of the OEM/ODM strategy, while the sales volumes from the OEM/ODM strategy will promote those from the OBM strategy. In addition, the shipment growth from the OEM/ODM strategy is estimated to substantially increase because OBM firms spill knowledge to OEM/ODM fabs, thus enhancing their technical levels and skills. Furthermore, we find Lotka-Volterra model performs well in the prediction of motherboard sales because the strategy mutualism is included.

The organization of this paper is as follows. In the second section, methodology and sample used are rendered. In the third section, the results are provided, and a dynamic competition analysis, is performed. Finally, we draw the conclusion.

METHODOLOGY AND SAMPLE

Lotka-Volterra Model

The Lotka-Volterra model uses the logistic equation and a term that accounts for the interaction with the other species (Watanabe, Kondo, and Nagamatsu (2003)). The interaction between two species can be expressed by the following two differential equations:

$$\frac{dX}{dt} = (a_1 - b_1 X - c_1 Y)X = a_1 X - b_1 X^2 - c_1 XY \,, \tag{1}$$

and

$$\frac{dY}{dt} = (a_2 - b_2 Y - c_2 X)Y = a_2 Y - b_2 Y^2 - c_2 YX \,, \tag{2}$$

where X and Y are the populations of two competing species at time t; X^2 and Y^2 are the same species interacting with itself; XY and YX are different species interaction; a_i is the logistic parameter of geometric growth for species i when it is living alone; b_i is the limitation parameter of the niche capacity for species i; and c_i, generally called the coupling coefficient, is the parameter for interaction with the other species. Equations (1) and (2) contain all the fundamental parameters that affect the growth rate of both species. The multi-mode form of competition can be captured by coefficient c_i for two species. The competitive roles are assigned according to the sign of c_i; thus, the multi-mode form can be determined for the case with two species.

To use discrete time data, one must covert the continuous Lotka-Volterra model into a discrete time version. Equations (1) and (2) can be transformed into the following difference equations (Leslie, 1957) :

$$X(t+1)=\frac{\alpha_1 X(t)}{1+\beta_1 X(t)+\gamma_1 Y(t)}, \tag{3}$$

and

$$Y(t+1)=\frac{\alpha_2 Y(t)}{1+\beta_2 Y(t)+\gamma_2 X(t)}. \tag{4}$$

where α_i and β_i are logistic parameters for single species *i* when it is living alone, and γ_i is the magnitude of effects one species has on the growth rate of the other. The relationship between coefficients in the Lotka-Volterra model, and that of transformed difference in Eqs. (3) and (4), are as follows:

$$a_i=\ln\alpha_i. \tag{5}$$

$$b_i=\frac{\beta_i a_i}{\alpha_i-1}=\frac{\beta_i\ln\alpha_i}{\alpha_i-1}. \tag{6}$$

$$c_i=\gamma_i\frac{b_i}{\beta_i}=\frac{\gamma_i}{\beta_i}\frac{\beta_i\ln\alpha_i}{\alpha_i-1}=\frac{\gamma_i\ln\alpha_i}{\alpha_i-1}. \tag{7}$$

where γ_i must be the same as the sign of c_i since $\frac{\ln\alpha_i}{\alpha_i-1}$ is always positive when $\alpha_i>0$ and $\alpha_i\neq 1$ in Eq. (7). Thus, the competitive roles can be determined according to the sign of γ_i.

Assumptions

We assume that the market evolution of global motherboard manufacturing industry corresponds to the original condition in the Lotka-Volterra model. Since no study has determined whether competition exists among OBM and OEM/ODM strategy in motherboard manufacturing industry, this study determines the competitive relationship and influence on the diffusion of each other. Two system equations, Eqs. (3) and (4), are applied separately to determine the mutual impacts of sales volumes in the motherboard manufacturing industry for each other. In Eqs. (3) and (4), X and Y are the cumulative shipments of motherboard of different business strategies; α_i and β_i are logistic parameters for one industry; γ_i is the magnitude of effects one size level's shipment has on the growth rate of the other.

RESULTS AND DISCUSSION

Competitive Relationship Analysis

The quarterly global motherboards shipments are obtained from Market Intelligence Center (MIC) databases. The study period is from the first quarter of 2003 to the second quarter of 2011, 34 quarters in total. The shipments of both business strategies of motherboards from the first quarter of 2003 to the fourth quarter of 2009 are used to estimate the demand function, coefficients and related statistics (Table 1). The interaction parameter of OBM affected by OEM/ODM, γ_2, is significant and negative, indicating that OBM enterprises utilize the outstanding manufacturing ability of OEM/ODM factories to achieve substantive competitive advantages (Sanchez, Heene, & Thomas, 1996). Conversely, the interaction

parameter of the OEM/ODM affected by OBM, γ_2, is positive and significant, indicating that the profit of OEM/ODM is squeezed by the massive stress of OBM (Lin, Chen, Jen, 2007). The results of γ_1 and γ_2 show that the predator-prey relationship exists between OBM and OEM/ODM. Obviously, OBM plays the role as predator and OEM/ODM as prey. Therefore, OEM/ODM will promote the shipment of the OBM, while the shipment from OEM/ODM will be eroded by OBM.

Table 1 Coefficient estimation results of Lotka-Volterra model for OBM and OEM/ODM in motherboard manufacturing industry

	OEM/ODM			OBM	
	Coefficient	*t*-statistic		Coefficient	*t*-statistic
α_1	1.38651	25.8939***	α_2	1.402448	24.0028***
β_1	-0.00000113	-3.5113***	β_2	0.00000376	4.6604***
γ_1	0.00000284	4.21589***	γ_2	-0.00000164	-4.13554***
R^2	0.999472		R^2	0.998632	
Adjusted R^2	0.99943		*Adjusted* R^2	0.998522	
	a	*b*	*c*		
OBM	0.338219	0.0000032	-0.0000014		
OEM/ODM	0.326790	-0.0000010	0.0000024		

*p <0.1 , **p <0.05 , ***p<0.01

We also noticed the *b1* of OEM/ODM is negative and significant. It shows the inner regeneration power of OEM/ODM existed strongly, even though the outer stress from OBM is squeezing. As the hypothesis of sailing ship (Sahal, 1979), the fear of extinction drives the OEM/ODM to seek new application diligently. In other words, OEM/ODM factories absorb the spilled knowledge from OBM enterprises humbly, and then increase their productivity, promote product qualities, enhance consumers' satisfactions and decrease total costs. The empirical results of this study are consistent with the statements in previous studies that companies in developed countries apply OEM/ODM to improve core power, to gain new competitive advantages, and to diversify risks (Hutt, Stafford, Walker & Reingen, 2000).

By contrast, the coefficient *b* of OBM is positive, while the coefficient *b* of OEM/ODM is negative. This suggests the severe saturation pressure existed within OBM business units. As OBM shipment move close to the market saturation, the growth rate of shipment decreases. In other words, OBM face heavier forces from inner rivalry within the same industry than OEM/ODM. In the aspect of adjusted R^2, the adjusted R^2 of Lotka-Volterra model is very close to one. It shows the fitness between simulated and actual shipment in OBM and OEM/ODM is perfect. We can explain the interaction among OBM and OEM/ODM appropriately by using the Lotka-Volterra model.

Performance Comparison

The ability of the Lotka-Volterra model to predict motherboards shipments is assessed. The parameters of both models are estimated using quarterly motherboards shipments from the first quarter of 2003 to the fourth quarter of 2009 (training period). Forecasted quarterly motherboard shipments from the first quarter of 2010 to the second quarter of 2011 (test period) are then compared with actual quarterly shipments. Moreover, forecasting error is measured by mean absolute percentage error (MAPE). The first part of comparison results show that the MAPE of the simulated shipment of Lotka-Volterra model are 4.39％ and 4.87％ for the shipments of OBM and OEM/ODM, respectively, in the training period. Both of them are lower than 5%. The predicted shipments computed by the Lotka-Volterra model fits the actual shipment very well.

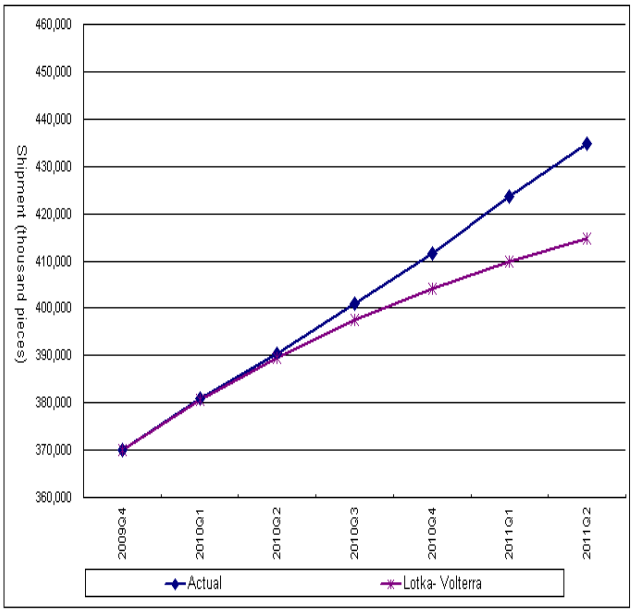

Fig. 1 Comparison between the actual and Lotka-Volterra simulated shipments of OBM strategies

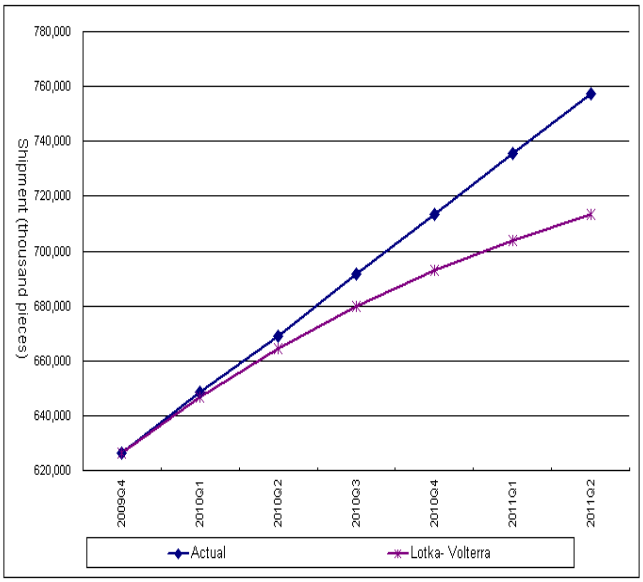

Fig. 2 Comparison between the actual and Lotka-Volterra simulated shipments of OEM/ODM strategies

In addition, the MAPE of the forecasted shipment of Lotka-Volterra model during the test period (the six consecutive quarters after the fourth quarter of 2009) for both of OBM and OEM/ODM are 1.82％ and 2.58％, respectively. Both of them are lower than 5%. According to the criteria of Martin & Witt (1989), the predictive ability is excellent. The results indicate that the forecasting ability of Lotka-Volterra model is reliable in both of OBM and OEM/ODM. The actual shipments versus calculation for the Lotka-Volterra models in test period are plotted and compared in Figs. 1 and 2. In Figs. 1 and 2, the forecasted shipments computed by the Lotka-Volterra model are close to each other and have a similar trend.

CONCLUSIONS

The Lotka-Volterra model was applied to investigate global motherboards shipments with deeply considering the mutual dependence among various strategies of motherboard industry. This work initially focuses on motherboard industry, and investigates the relationships between OBM and

OEM/ODM; thus, the reciprocal influence among shipments of these two different strategies of motherboard industry can be captured by Lotka-Volterra models.

Analytical results demonstrate that the relationship between OBM and OEM/ODM is predator-prey, in which OBM shipments are fundamentally driven by OEM/ODM, while OEM/ODM shipments are eroded by OBM. These empirical results illustrate that the market potential of OEM/ODM is much larger than that of OBM. OEM/ODM enterprises rely on the global supply chains to absorb spilled knowledge and skills from OBM enterprises, while OBM enterprise depends on OEM/ODM factories to provide mass productions at lower costs. The cooperation of OEM/ODM and OBM business models is value-added for both of them. In addition, Lotka-Volterra model performs well in fitness and forecast accuracy. The framework in this study can be applied to state the relations among various business models that contain mutual dependence, and can accurately forecast the evolution process of products, paving the way for the establishment of efficient product marketing and production policies.

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