Analysis on the Dynamic Relationship between the Research and Development Capacity, Net Exports, and Profits of China's Furniture Industry

Baodong Cheng
Yuan Tian
Kai Hao
Lu Wan

Abstract

China's furniture industry has grown rapidly over the past 10 years, which makes China an important furniture exporter in the world. This article focuses on the evolution of research and development (R&D) capacity, net exports of China's furniture industry, and their relationship; analyzes the impact of changes in external factors on R&D capacity, net exports, and profits; and makes predictions for R&D capacity, net exports, and profits. A dynamic model of R&D capacity, net exports, and profits for China's furniture industry is established based on the data from 1993 to 2008; ordinary least squares methods are used for model estimation. The positive correlation between R&D capacity and net exports in regression results illustrates that R&D capacity is conducive to enhancing the competitiveness of Chinese furniture enterprises and likely contributes to export growth as well. If the world economic environment changed radically, exports would decline under the influence of external factors, and then profits would also fall. At present, however, companies are often interested in expanding their exports by increasing R&D investment and, in turn, enhancing their competitiveness. If the world economy grows in a stable manner, China's furniture industry development of R&D capacity and net exports should conform with Virasa and Tang's model (*J. High Technol. Manag. Res*. 9(2):195–205, 1998). If a sharp fluctuation in the international market occurs, however, the development of China's furniture industry most likely will be unstable.

Driven by the rapid growth of the domestic economy, overseas investment, and exports, China's furniture industry has experienced fast development (Bryson et al. 2003). In 2005, China surpassed Italy to become the largest furniture exporter in the world. For a long time, China's furniture industry mainly adopted the export-oriented strategy to develop its processing trade by virtue of its national cheap labor resources. As a result, the size of the industry has increased amazingly.

This article focuses on the evolution of research and development (R&D) capacity, net exports, and profits as well as their relationship in China's furniture industry; analyzes the impact of changes in external factors on R&D capacity, net exports, and profits; and makes predictions for the three. Exports are an important source for business information, a way to challenge the competition and improve productivity, and an important factor in changing business behaviors (Krugman 1980, Bernard et al. 2003).

Kim and Dahlman (1992) showed that developing countries differ from developed countries in the relationship

The authors are, respectively, Associate Professor, College of Economics and Management and Research Center of Forest Product Trade, Beijing Forestry Univ., Beijing, China (baodongcheng@163.com); Lecturer, Business College of Beijing Union Univ., Beijing, China (castledong@126.com [corresponding author]); Associate Professor, College of Economics and Management, North China Univ. of Technol., Beijing, China (haokai@ncut.edu.cn); and Lecturer, College of Economics and Management and Research Center of Forest Product Trade, Beijing Forestry Univ., Beijing, China (dufexiaolu@163.com).

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of technology and foreign trade. Overall, there are two main schools of thought concerning the relationship between trade and technology. The first school is classical and neoclassical theory. This school emphasizes the role of factor endowment and static comparative advantage in determining the specialization of a country. The second school focuses on the concept of imperfect competition and emphasizes the role of market power through innovation as a cause of trade, as discussed by Schumpeter (1947). The first school recognizes technology as an exogenous factor. Most empirical studies of traditional trade theory have used technological proxies, such as R&D expenditure and R&D employment (Hughes 1986). The second school of thought relies principally on the ideas of Schumpeter (1947). Here, the innovation model is extended in the technology gap model (Posner 1961) and the product cycle model (Vernon 1966). At the empirical level, most work has been conducted to understand the relationship between technology and trade and to examine that relationship by regressing with new variables. Much of the empirical literature confirms a positive correlation between technology contribution factor (TCF) and trade (Vestal 1989, Daniels 1993), and most empirical works use a regression approach to examine the relationship between technology and trade. Technology content—for example, R&D expenditure, R&D employment (Hughes 1986), number of patents (Fagerberg 1988), and human capital—is added over time. The trade characteristics are measured by the value of exports, net trade (value of exports − value of imports; Tang and Jing 1994), and export:import ratio (Sharif 1995).

Two hypotheses concern the relationship between exports and productivity. One is the theory of selection into export, which holds that only enterprises with high productivity have access to overseas markets, and the other is the theory of learning by exporting, which deems that export enterprises enjoy high productivity because exports can improve their productivity. These two hypotheses were tested by Bernard et al. (2003) and examined by Clerides et al. (1998) and De Loecker (2007) based on microdata. According to their findings, only high-productivity enterprises commonly select exports. However, no consistent answer was found to the issue of whether exports improve productivity. On the relationship between exports and productivity, Virasa and Tang (1998) provided a concept model of exports and technology for developing countries, which holds that developing countries will consistently adapt themselves through continuous learning in the course of exports, select appropriate technology as needed, and promote exports by technological absorption and innovation. Virasa and Tang's model presents the dynamic path of technology and exports. In their research, the relationship of exports and technology is analyzed from a qualitative point of view, and they conclude that the industries of emerging countries would be upgraded constantly through the interaction of exports and technology. Dai and Yu (2010) studied the relationship of pre-export R&D capacity, productivity, and exports. They concluded that the productivity of enterprises would increase by 2 percent in the first year they started to export their products and that the effect of exports improving productivity would increase as the number of years enterprises engaged in pre-export R&D increased. In the process of testing ''learning by exporting'' on enterprise survey data, Yong and Mallick (2010) found that the productivity of the sample enterprises really had improved. In studies on exports of China's furniture industry, scholars have mostly taken a perspective of competitiveness. For example, Wang et al. (2009) compared the competitiveness of the furniture industry in China, Canada, Italy, Malaysia, and the United States using four indices—namely, the Index of Variation Difference, International Market Share, Trade Competitive Index, and Revealed Comparative Advantage Index. Han et al. (2009) analyzed the competitiveness of Chinese wooden furniture by means of the Revealed Comparative Advantage Index; this competitiveness was also studied by Zhang and Ding (2011).

Previous studies on the relationship between technology, productivity, and exports were mostly intended to test the theories of ''selection into export'' or ''learning by exporting,'' and the hypotheses were mostly verified using microdata available from individual enterprises. However, the models in such studies were not sufficient to analyze the dynamic development capacity of the furniture industry. On the other hand, the technology-trade model provided by Virasa and Tang (1998) is a conceptual one based on the experiences of newly industrialized countries and has not yet been satisfactorily verified. Although it represents the dynamic path of industrial development, this model fails to describe the specific relationship between the variables in the course of that path. This article focuses on the development of R&D capacity, net exports, and profits of China's furniture industry as well as on their relationship by drawing upon the findings of Dai and Yu (2010) for the model of pre-export R&D capacity, productivity, and exports and upon the characteristics of the dynamic path model on technology and trade put forward by Virasa and Tang (1998).

The dynamic simulation model used in this article is established by introducing the variables that influence R&D capacity and net exports. Our model takes into consideration such variables as research expenditure and profit to analyze the function of R&D capacity in exports, the contribution of net exports to profits, and the relationship between research expenditure and profits. Then, the results of the model are used to predict R&D capacity, net exports, and profits of China's furniture industry for the period from 2009 to 2013.

Model

Drawing on Virasa and Tang's (1998) conceptual model about the relationship between technology and trade as well as on Dai and Yu's (2010) elaboration on the relationship between pre-export R&D capacity and productivity, we established a structural model to look at the relationship between R&D capacity, net exports, and profits in China's furniture industry. This model follows the dynamic characteristics of Virasa and Tang's model in exploring the industrialization of the developing countries, and it uses five methods to estimate the structural model; to assess the dynamic relationship of R&D capacity, net exports, and profits on a quantitative basis; and to predict the developmental trend of China's furniture industry.

The model of R&D capacity, net exports, and profits for China's furniture industry

As described by Virasa and Tang's (1998) model, most newly industrialized countries have three stages in their industrial development. Stage 1 is commencement, where in many cases foreign production technology is imported and products primarily processed based on labor cost advantages are exported to import technology, equipment, and capital. Stage 2 is takeoff, where the trade-oriented policy is mostly implemented after capital accumulation to export products heavily based on the advantages of scale and cost. In this stage, the industry boasts favorable production capacity and efficiency, but the overall industrial strength and technical merit are still low. In terms of trade, however, raw material imports and product exports are large, and technology and equipment are renewed very quickly. In Stage 3, the industry gradually transforms from capital-intensive to technology-intensive, enterprises are capable of innovation, and business turns to high-level products with high added value. In this stage, export of medium- and low-level products is reduced.

The relationship between TCF and trade performance can be illustrated by the following relationship, as shown in Figure 1 (Virasa and Tang 1998). The TCF index is shown on the vertical axis; the higher value of the TCF index implies the enhancement of technological capabilities. The trade performance is shown on the horizontal axis, and the higher value of a trade performance index implies higher international competitiveness for the industry. Each point in the diagram indicates an industry's status for a country at a particular point in time. Figure 1 presents some possible combinations of both indexes. Line A shows an improvement in the industrial development by moving from a weak competitive position at time t_0 to higher positions at t_1 and at t_2. Line B shows the industrial development achieved by trade alone, with little emphasis on development of indigenous capabilities. Line C shows industrial development where technology development over time does not seem to contribute much to trade performance.

Virasa and Tang's (1998) model explained the harmonious relations between technology and trade in dynamic development. The model indicated the importance of the coordinated development of industrial technology and foreign trade in new industrialized countries by introducing technology as an endogenous variable. However, because

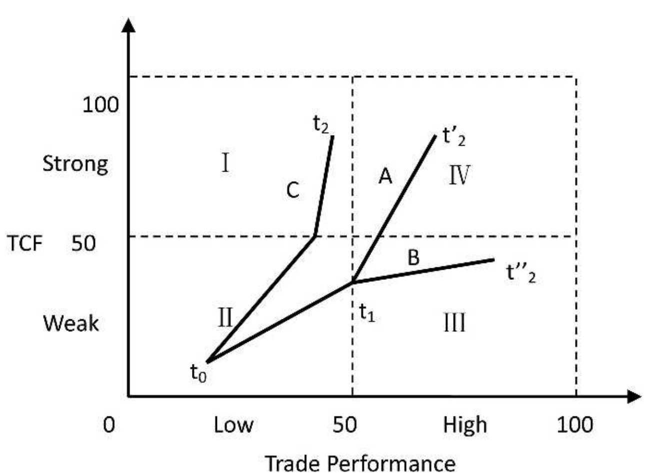

Figure 1.—Virasa and Tang's concept model of technology and trade. A diagram which can be divided into four major quadrants with respect to the different possible combinations of index scores (i.e., strong technology contribution factor [TCF], low trade performance; weak TCF, low trade performace; weak TCF, high trade performance; and strong TCF, high trade performance) can be constructed as shown in this figure. t = *time.*

Virasa and Tang's model was just based on the experiences of development in new industrialized countries and did not illustrate how other variables affect technology and trade, it could not effectively explain the industry behavior patterns in different paths of technical and trade processes.

Based on Virasa and Tang's model, the model of this article analyzes the dynamic relationship between the Chinese furniture industry's R&D capabilities and its exports. By introducing two variables, profit and investment in scientific research, our model links technology and trade in Virasa and Tang's model and analyzes the relationship between the Chinese furniture industry's R&D capabilities and net exports. Our model will indicate that the furniture industry's R&D capabilities will increase the competitiveness of its products and enhance its exports. At the same time, the increase in exports will affect the industry's profits and, finally, the corporate R&D investment. For example, using a survey of sawmills, Jones et al. (2002) found that when corporate profits decline, enterprises will increase investment in technology to reduce costs and so increase future profits. In other words, a kind of negative-feedback relationship exists between technology and profits. Reduction in profits will encourage enterprises to increase investment in technology, and in turn, advances in technology will reduce the cost of enterprise, thereby increasing future earnings.

The structural model provided in this article consists of four equations:

$$\mathrm{TC}_t = \alpha_0 + \alpha_1 \mathrm{Pop}_t + \alpha_2 I_{t-1} \tag{1}$$

$$\mathrm{TR}_t = \beta_0' + \sum_{i=0}^{n} \beta_i \mathrm{TC}_{t-i} + \beta_1' Y_t \cdot \mathrm{WTO}_t \tag{2}$$

$$\pi_t = \delta_0 + \delta_1 \mathrm{TR}_t \tag{3}$$

$$I_t = \gamma_0 + \gamma_1 \pi_t + \gamma_2 (\pi_t - \pi_{t-1}) \tag{4}$$

where

t = time,
TC = R&D capacity of China's furniture industry,
Pop = the number of R&D employment,
TR = net export,
I = technological development expenditure,
Y = world gross domestic product (GDP) growth rate,
π = profits, and
WTO = World Trade Organization, a dummy variable as follows:

$$\mathrm{WTO}_t = \begin{cases} 1 & \text{if China } \textit{is} \text{ in accession to the WTO} \\ 0 & \text{if China } \textit{is not} \text{ in accession to the WTO} \end{cases}$$

Equation 1, representing R&D capabilities, assumes that the number of researchers and the investment in scientific research play a positive role for R&D capabilities. Equation 2 represents a trade equation. Together, R&D capabilities and demand could determine the volume of furniture trade. This article assumes that the furniture industry's R&D focuses on the appearance design of a product. Therefore, R&D behavior only produces short-term benefits; any long-term impact will be relatively weak. To verify this hypothesis, we adopted trade equations without TC delay entries ($n = 0$) and trade equations with two-order delay entries ($n = 2$), respectively. The effect of R&D capabilities on trade was mainly to enhance the competitiveness of products and sales volume, so R&D capabilities should have a positive correlation with trade. In the model, in addition to R&D capabilities, market demand was another important factor to affect trade. Therefore, we introduced the world GDP growth rate and accession to the WTO as a virtual variable to calculate the effect of market demand on trade. Before China's accession to the WTO in 2002, the degree of Chinese furniture industry participation in the international market was not high, so the introduction of the virtual variables eliminated the differences caused by WTO accession.

Equation 3, a profit equation, primarily reflects the contribution of trade to profit. It assumes a positive correlation between trade and profits. Equation 4 describes the relationship between R&D investment and profits. Its parameter assumptions are consistent with those of Jones et al. (2002), so the coefficient of profit difference between the adjacent two terms should be negative. That is to say, a reduction in profits would increase the investment in scientific research. At the same time, we introduced current profits in the equation as the ratio of profits in basic research investment; therefore, the coefficient of this variable should be assumed to be positive.

Variable definitions and data description

The model contains four endogenous variables (TC, TR, I, and π) and three exogenous variables. R&D capacity often covers new product sales, number of patents (Fagerberg 1988), and research expenditure (Hughes 1986). According to the empirical analysis herein, TC (R&D) is defined as the number of patents applied for and approved. Most empirical studies use trade performance proxies, such as value of export, net exports (exports − imports; Virasa and Tang 1998), and export:import ratio (Tang and Jing 1994). So, TR is the value of net exports. The research expenditure I is measured by technological development expenditure. The exogenous variables Y and Pop are defined by the world GDP growth rate and R&D employment.

The data for empirical analysis (number of patents applied for and approved, technological development expenditure, original value of production equipment, and profit) originate from *China Statistical Yearbook on Science and Technology 1994–2009* (http://epub.cnki.net/KNS/oldNavi/n_item.aspx), which covers the patents, technological development expenditure, original value of production equipment, and profits of large enterprises (with total output exceeding RMB¥5 million). The data for imports and exports of China's furniture industry are available from the United Nations trade database (http://comtrade.un.org/db/default.aspx) and the world GDP growth rate from the International Monetary Fund (IMF) database (http://databank.worldbank.org/data/home.aspx). Chinese furniture import and export data are converted into RMB by the exchange rate. The net exports, research expenditure, and profits are deflated by Consumer Price Index (CPI) to be measured in 1990 real terms.

Results

Using GAUSS8.0 software, we applied the ordinary least squares method to estimate the two models, both with delay entries and without delay entries. Model 1 contains a two-order delay entry of R&D capabilities, and Model 2 does not contain the delay entry. Table 1 shows the regression equations, coefficients, and standard errors of the two models. The estimated values for coefficients of TC_{t-1} and TC_{t-2} in Model 2 did not pass the 5 percent confidence level t test, and there was an additional standard error for delay entry TC_t. The regression study showed that the results of the two models were very similar. Only the R&D capacity in trade equations was slightly different. The results verified that the Chinese furniture industry's R&D behavior had only short-term effects; its long-term effectiveness was not obvious. Therefore, we selected the results of Model 2 as the estimates for Model 1.

The estimated values for coefficients of variables in Model 2 passed the 1 percent confidence level t test, and the regression results of coefficients were consistent with the hypothesis. The withdrawal of variables TC_{t-1} and TC_{t-2} from trade equations in Model 2 did not lead to the reduction of R^2 ($R^2 = 0.98$). The regression results of the coefficient of TC_t showed that net exports would increase to about RMB¥292 million for each additional patent if other variables remained constant. The relationship between profit and investment in Model 2 was consistent with the assumptions of Jones et al. (2002) in their system dynamics model. The negative value of coefficients of $\pi_t - \pi_{t-1}$ illustrated that the reduction in profits would increase investment of R&D, and the increase of research investment could also enhance the R&D capabilities (TC), which would lead to the increase in net exports and profits.

Based on the estimation, we regarded the model as a system to do historical simulation and prediction and this study as a chance to evaluate the model's ability to reflect the real situation. The historical simulation included the entire estimated range (1993 to 2008), and the range of forecast was from 2009 to 2013. To predict the endogenous variables of the model, we predicted the exogenous variables first, such as the number of researchers and the growth rate of the world economy. The number of researchers from 2009 to 2013 could be predicted by the moving average method. The growth rate of the world economy from 2009 to 2013 could be obtained from the IMF database.

Figure 2 illustrates the actual, simulation, and prediction values for endogenous variables in the model for the historical simulation covering the entire sample (1993 to 2008) and the prediction covering 2009 to 2013. According to Figures 2A and 2B, the model's historical simulation values tracked the actual values for the number of patents and net exports fairly closely but missed some turning points. The model failed to capture the boom in the number of patents from 1998 to 2001, and due to the influence of the world GDP growth rate, the volatility of the TR simulation value was slightly larger than the actual value. Figure 2C reflects the simulation results for historical profits. Because of the large fluctuations of the real data, the simulation results of the profit could only describe the basic trend of the actual values, and the model's ability to describe the fluctuation of actual values was slightly weak. Historical simulation results of R&D investment before 2003 were more consistent with the actual values, but simulated volatility after 2003 was slightly less than the real volatility. The forecast results from 2009 to 2013 described the situation of the world recession after the financial crisis and

Table 1.—Results of model estimations.

Equation name	Variable name	Model 1				Model 2			
		Estimated coefficient	SE	R^2	F	Estimated coefficient	SE	R^2	F
TC_t	I_{t-1}	0.063[a]	0.034	0.93	85	0.065[b]	0.033	0.93	85
	Pop_t	1.264[b]	0.107			1.270[b]	0.104		
	CONSTANT	1,832.2[b]	307			1,782[b]	286		
TR_t	TC_t	239.45[b]	69	0.98	240	292[b]	22	0.98	104
	TC_{t-1}	16.878	121			—	—		
	TC_{t-2}	101.49	92			—	—		
	R_t	36,253,000[b]	3,530,700			37,565,000[b]	3,697,500		
	CONSTANT	−527,350[b]	165,980			−357,480[b]	103,310		
π_t	TR_t	0.094052[b]	0.014	0.77	43	0.092[b]	0.013	0.77	39
	CONSTANT	−47,954	29,758			−43,503	26,868		
I	π_t	0.069[b]	0.011	0.82	27	0.070[b]	0.011	0.82	25
	$\pi_t - \pi_{t-1}$	−0.094[b]	0.013			−0.094[b]	0.013		
	CONSTANT	2,381	1,820			2,119	1,675		

[a] Significant at 5 percent level.
[b] Significant at 1 percent level.

the sharp decline and recovery process of Chinese furniture exports caused by the crisis, including the effect of the crisis on R&D capacity, profit, R&D investments, etc. The significant reduction of furniture exports in 2009 produced a dramatic fluctuation in corporate profits, R&D investments, and R&D capacity. The plummeted net exports caused the Chinese furniture industry's profits to drop significantly (Fig. 2C). Companies wanted to increase R&D investments and to enhance the competitiveness of their products to expand exports, but they did not have sufficient funds for R&D investments because of the reduction in profits. Finally, companies' R&D capabilities declined slightly (Fig. 2).

Summary statistics for the historical simulation are shown for each endogenous variable in Table 2. We calculated the Theil inequality coefficient along with its components. These statistics are helpful in evaluating the historical simulation. The Theil inequality coefficients of TC and TR

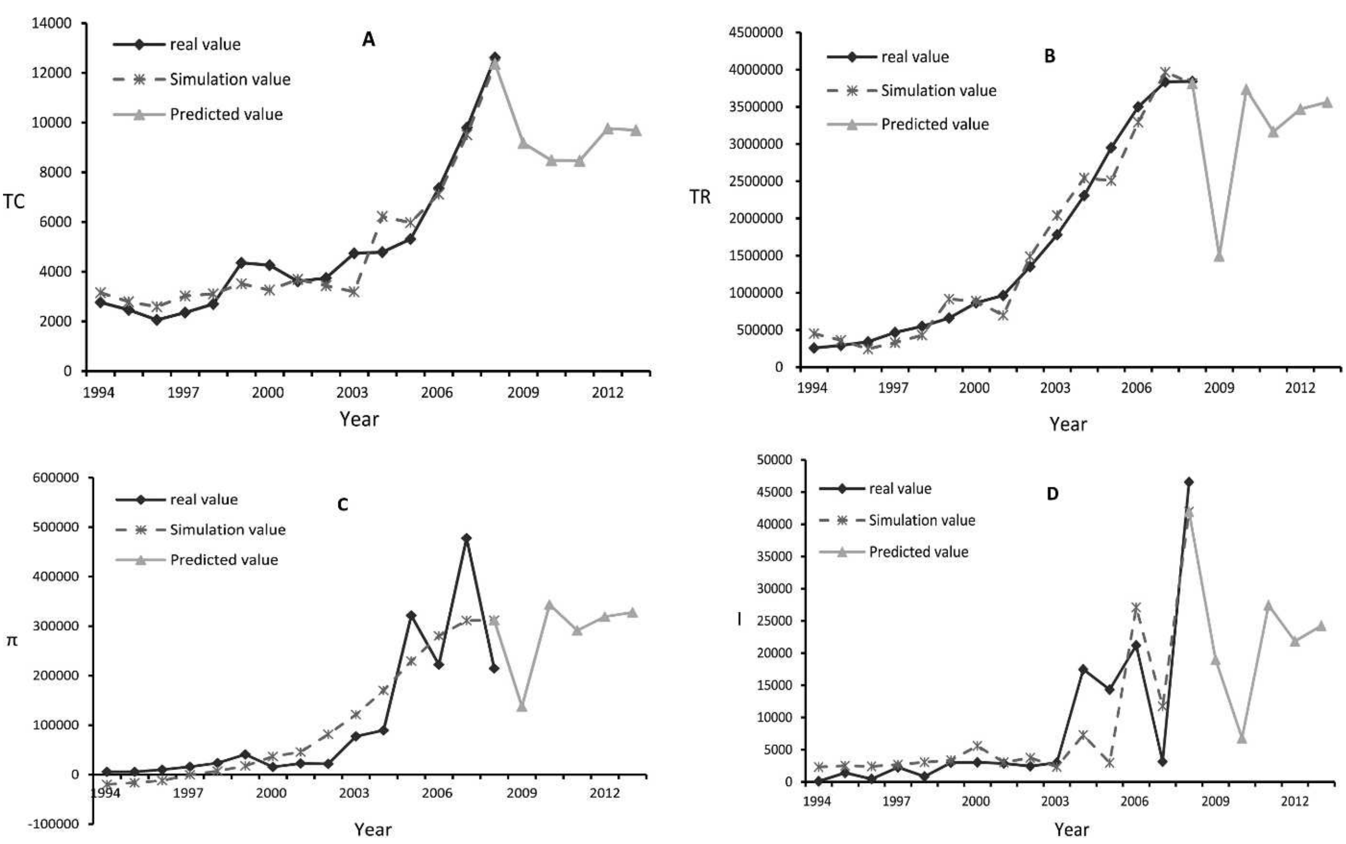

Figure 2.—(A) Historical simulation and prediction of industrial research and development (R&D) capacity, where TC is the R&D capacity. (B) Historical simulation and prediction of net exports, where TR is the volume of net exports with unit RMB¥10,000. (C) Historical simulation and prediction of industrial profits, where π is the industrial profit with unit RMB¥10,000. (D) Historical simulation and prediction of technological expenditure, where I is the research expenditure with unit RMB¥10,000.

Table 2.—Summary statistics for historical simulation.[a]

Variable	Theil U Statistic	U^M	U^S	U^C
TC	0.065	0	0.017	0.983
TR	0.049	0	0.007	0.993
π	0.199	0	0.066	0.934
I	0.180	0	0.049	0.951

[a] U^M = bias proportion of U, U^S = variance proportion of U, U^C = covariance proportion of U.

were very small, whereas the coefficients of I and π were much larger (Fig. 2). The bias proportion (U^M) was zero. This simply means that a small systematic bias was present. Therefore, the model likely was reliable for forecasting. The variance proportion (U^S) indicates the ability of the model to replicate the degree of variability in the variable of interest. The U^S values of I and π were slightly larger. This meant that the actual series had fluctuated considerably, whereas the simulation series showed little fluctuation.

Discussion

The positive correlation between R&D capacity and net exports in regression results illustrated that R&D capacity was conducive to enhancing the competitiveness of Chinese furniture enterprises and would promote export growth as well. These results were consistent with the empirical analyses of Vestal (1989), Daniels (1993), and Dai and Yu (2010). Because the furniture industry's R&D capabilities were mainly reflected by the innovation of appearance design and function of products, it was easily imitated by competitors. So a company's R&D achievements would have obvious effects in the short term, but long-term effects were not obvious. This could be the reason why TC delay entry did not pass the t test in Model 1.

The estimated results of the profit equation and the research funding equation were consistent with the feedback relation given by Jones et al. (2002). This result suggested that the industry would adjust R&D capacity through investment in research according to exports and profit status. If profits declined, furniture companies would stabilize exports by increasing investment in research and enhance their R&D capabilities. In the model, the positive correlation between current profits and investment in research illustrated that enterprises not only would adjust the R&D investment based on the changes in profits but also that a certain percentage of profits would be put into R&D investment. Therefore, the reduction of profits would have a negative impact on R&D investment. The Chinese furniture industry provided funds for R&D through the development of exports. In turn, exports promoted the learning behavior of enterprises, at least to the extent of R&D investment, and created the conditions to enhance the competitiveness of the industry.

Figure 3 shows the scatter diagram of net exports and R&D capacity. Before 2009, TR and TC showed a kind of coordinated development. This is similar to the paths shown in Figures 2A and 2B. Export development provided funds for R&D investment and promoted R&D capabilities, and then R&D capabilities enhanced the competitiveness of products and exports. Therefore, the development of the Chinese furniture industry's R&D capacity and net exports was consistent with the path in Virasa and Tang's (1998) model. If the world economic environment changed radically, however, exports would decline under the influence of external factors, and then profits would also fall. At this point, companies always want to expand exports by increasing R&D investment to enhance their competitiveness. However, the reduction in profits leads to the decrease in basic research funding invested. Ultimately, under the effects of these two forces, the changes in R&D investment will cause the decline of R&D capabilities. Therefore, the path described in Virasa and Tang's model was only the general path of industrial development. The development of China's furniture industry would appear to be recession and fluctuation around the path in Virasa and Tang's model.

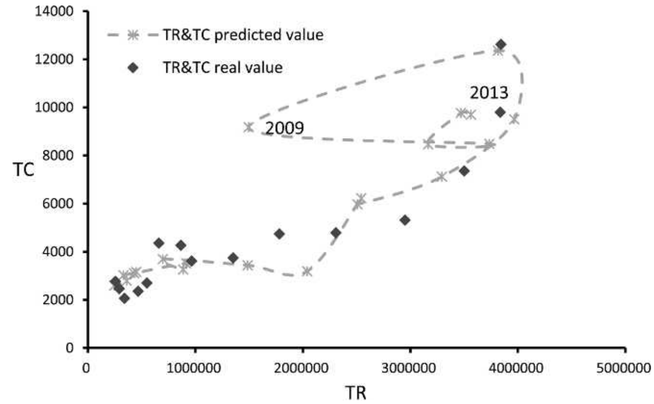

Figure 3.—Relationship of industrial research and development (R&D) capacity and net exports, where TC is the R&D capacity and TR is the volume of net exports, both with unit RMB¥10,000.

Conclusions

This study analyzed the relationship of R&D capacity, net exports, and profits of China's furniture industry. The main objective was to verify whether development of R&D capacity and net exports of China's furniture industry is in accordance with Virasa and Tang's (1998) model. Earlier studies typically assumed a positive correlation between TCF and trade, but the impact of trade on technology remains unclear. We provide an empirical model, developed from Virasa and Tang's model, that allows us to investigate the relationship between R&D capacity and net exports of China's furniture industry and to predict the development trend.

The result of the model regression show that the impact of R&D capacity on net exports for China's furniture industry was in accordance with earlier hypotheses. Our analysis suggests that R&D capacity was helpful to the increase of exports. Our research shows that if falling net exports causes profits to fall, the industry may increase the investment in R&D to enhance its competitiveness and exports. The feedback structure of the R&D expenditure adjustment system is beneficial to learning by exporting. In the case of stable development of the world economy, the Chinese furniture industry's development of R&D capacity and net exports was in accordance with Virasa and Tang's model. In 2009, the world economic recession led to a substantial decline in exports. In this case, profits, R&D expenditure, and R&D capacity fluctuated with exports. The development of the Chinese furniture industry will follow the path of Virasa and Tang's model, in which there will be some phenomena like retrograde movement, fluctuation, and disharmony between technology and trade. The impact of the economic recession suggests that China's furniture industry is too dependent on the international market. When the international market fluctuates, the development of China's furniture industry is likely to be unstable.

Our analysis relies on a number of simplifying assumptions. The model based on the feedback structure of R&D expenditure and profits presents an alternative to Virasa and Tang's conceptual model. Our work could be extended to estimate the model of R&D capacity, net exports, and profits for China's furniture industry with microdata. Future research, with panel data, is needed to investigate whether the relationship of R&D capacity, net exports, and profits for China's furniture industry accords with our analysis.

Acknowledgments

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Literature Cited

Bernard, B. A., J. Eaton, B. Jensen, and S. Kortum. 2003. Plants and productivity in international trade. *Am. Econ. Rev*. 93(4):1268–1290.

Bryson, V., G. Lanzillotti, J. Myerberg, E. Miller, and F. Tian. 2003. The future of the industry: United States versus China. *Ind. Econ*. 3:2–20.

Clerides, S. K., S. Lach, and J. R. Tybout. 1998. Is learning by exporting important? Micro-dynamic evidence from Colombia, Mexico, and Morocco. *Q. J. Econ*. 113(3):903–947.

Dai, M. and M. Yu. 2010. Productivity gains from exporting and the role of pre-export R&D evidence from Chinese firms. Working Paper of the China Center for Economic Research, Peking University, Beijing. pp. 1–17.

Daniels, P. 1993. Research and development, human capital and trade performance in technology-intensive manufactures: A cross-country analysis. *Res. Policy* 22:207–241.

De Loecker, J. 2007. Do exports generate higher productivity? Evidence from Slovenia. *J. Int. Econ*. 73(1):69–98.

Fagerberg, J. 1988. Why growth rates differ. *In:* Technical Change and Economic Theory. G. Dosi, C. Freeman, R. Nelson, and L. Soete (Eds.). Pinter Publishers, London. pp. 432–457.

Han, X., Y. Wen, and S. Kant. 2009. The global competitiveness of the Chinese wooden furniture industry. *Forest Policy Econ*. 11:561–569.

Hughes, K. 1986. Exports and Technology. Cambridge University Press, London, p. 11.

Jones, A., D. Seville, and D. Meadows. 2002. Resource sustainability in commodity systems: The sawmill industry in the northern forest. *Syst. Dyn. Rev*. 2:174–204.

Kim, L. and C. J. Dahlman. 1992. Technology policy for industrialization: An integrative framework and Korea's experience. *Res. Policy* 2(5):437–452.

Krugman, P. 1980. Scale economies, product differentiation, and the pattern of trade. *Am. Econ. Rev*. 70(5):950–959.

Posner, M. V. 1961. International trade and technical change. *Oxford Econ. Pap*. 13:323–341.

Schumpeter, J. A. 1947. Capitalism, Socialism and Democracy. Harper and Row, New York.

Sharif, N. M. 1995. The evolution of technology management studies: Technoeconomics to technometrics. *Technol. Manag*. 2:113–148.

Tang, J. C. S. and J. Jing. 1994. Trade between China and Europe. *J. Euro-Asian Manag*. 12:95–109.

Vernon, R. 1966. International investment and international trade in the product cycle. *Q. J. Econ*. 80(2):190–207.

Vestal, J. E. 1989. Evidence on the determinants and factor content characteristics of Japanese technology trade 1977–1981. *Rev. Econ. Stat*. 4:565–571.

Virasa, T. and J. C. S. Tang. 1998. The role of technology in international trade: A conceptual model for developing countries. *J. High Technol. Manag. Res*. 9(2):195–205.

Wang, B., C. Zhang, and Y. Dai. 2009. Study of international competitiveness of China's furniture industry. *Forest Sci*. 9:176–181.

Yong, Y. and S. Mallick. 2010. Export premium, self-selection and learning-by-exporting: Evidence from matched Chinese firms. *World Econ*. 33(10):1218–1240.

Zhang, J. and R. Ding. 2011. The international competitiveness analysis of Zhejiang's furniture industry and the affecting factors. *In:* Management and Service Science (MASS) 2011 International Conference, Wuhan, China. pp. 1–4.