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Supply chain and operations practice and performance in Chinese furniture manufacturing

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Abstract

The relationship between supply chain/operations practice and operational/financial performance has been of interest to academics and practitioners for many years. We propose and develop a model exploring these connections, utilising data from a survey of 72 furniture manufacturers located throughout China. The industry is of particular interest in that, while labour productivity remains relatively low, exports have undergone substantial growth. Using a structural equation model (significant at $p = 0.05$), we highlight the relative importance of supply chain and operations practices and show that the impact of practice on business performance is mediated by capabilities on operations dimensions.

Keywords: Chinese manufacturing; Supply chain management; Manufacturing strategy; Inventory; Customer and supplier relationships; Enterprise software; Structural equation modelling

1. Introduction

China has emerged as a key player in global business, with 80% of the world's top 500 enterprises investing there (Powers, 2001) and North American companies regarding it as the most important market for expansion (Giffi, 2003). Exports in many sectors are expanding rapidly in many sectors, and in particular in the furniture industry, in which China now vies for the leading exporter position with Italy.

Supply chain management (SCM), dealing with material, financial, and information flows from raw material suppliers through to end consumers, is generally recognised as a key contributor to corporate performance, with practices being closely scrutinised by both practitioners and academics. In this regard, single-country, single-industry studies play a role in assessing the strength of these linkages without confounding national and industry effects.

Here we study practices and performance (operational and financial) relating to supply chain and operations management among 72 furniture manufacturers located throughout China. Supply chain activities covered include production and delivery strategy, inventory, forecasting, and enterprise

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software, as well as integration aspects related to interaction and communications with customers and suppliers. Operations areas include manufacturing technology and systems variables along with human resources issues. The study was conducted in 2001, immediately prior to World Trade Organization (WTO) accession. We exploit structural equation modelling (SEM) in the analysis. The paper complements and extends an earlier one which considered only manufacturing strategy/technology (i.e., without reference to supply chain practice) and moreover only employed correlation analysis (Robb and Xie, 2003).

Section 2 provides a background to SCM and furniture manufacturing in China, as well as highlighting previous findings on practice–performance relationships. Section 3 presents the initial conceptual model along with practice and performance construct and factor development. Section 4 describes the survey administration. Section 5 presents the results—both descriptive and inferential. After describing firm demographics, we provide performance and practice construct results, and then present and discuss the SEM development and results. Section 6 provides a conclusion, including managerial implications.

2. Literature review

By way of background, we discuss the rapidly developing field of SCM in China in Section 2.1, followed by a review of furniture manufacturing in China in Section 2.2, and an overview of SCM/operations management research in the furniture industry outside China in Section 2.3 (there is no known literature covering all three areas of SCM, the furniture industry, and Chinese manufacturing). In Section 2.4, we review some of the literature pertaining to the relationship between practice and performance in operations and SCM.

2.1. Supply chain management in China

Considerable attention is currently being placed on the rapid evolution in operations and supply chains in China, with the recent appearance of numerous consulting reports, special issues (Robb et al., 2007), commentaries (Flynn et al., 2007), and typologies (Zhao et al., 2006). The efficiency of supply chains in China is relatively low, with logistics and transportation costs comprising some 20% of GDP (Easton, 2002)—twice that of the US. Distribution is hampered by inadequate infrastructure and a fragmented logistics industry (Ta et al., 2000), as well as geographical barriers, uneven economic development, and state-related operators privileged by monopolistic regulations at both national and regional levels (Jiang and Prater, 2002; Powers, 2001).

Notwithstanding these challenges, the industry is poised for considerable expansion, with trading restrictions having been removed subsequent to China's WTO admission, and the emergence of hypermarkets and large retailers (Shaw and Wang, 2002). A survey of 29 logistics companies in China (Dai et al., 2003) confirms this view, but also notes the constraints of regulatory issues, undeveloped warehousing, and the low penetration of logistics outsourcing among state-owned firms (which are themselves declining in number; Woetzel, 2004).

2.2. Furniture manufacturing in China

2.2.1. Production and trade

The furniture industry in China has expanded at a compound annual growth rate of 15% since 1978, when the economic system began its transformation from a planned to a market economy. With annual production exceeding US$20 billion and exports exceeding US$5 billion, China is a major player in furniture manufacturing, comprising one-tenth of both global production and trade (Vignetti, 2003; Zhu and Wu, 2003).

Exports of Chinese furniture have risen dramatically in recent years, and are likely to continue with WTO membership securing equal treatment. Half of the exports are destined for the US, where they comprise almost half of US furniture imports and have led several dozen US furniture manufacturers to make claims of dumping. Although these assertions were disputed by US retailers and the *China National Furniture Association*—which argued that the average profit level on exports can be as high as 30% (Anon, 2003)—US regulators proposed tariffs ranging from 4.9% to 198% against 115 Chinese manufacturers of wooden bedroom furniture—which accounted for some 65% of imports to the US (Morse, 2004b). After a bitter battle, the US Department of Commerce, which had found that some 73,000 American furniture jobs had been eliminated between 2000 and the end of 2002, imposed tariffs averaging only 6.65% (Morse, 2004a; Normington, 2005; United States Department of Commerce, 2004).

Imports comprise less than 1% of domestic demand, largely due to the large labour cost advantage (labour costs comprise approximately 10% of domestic furniture cost, compared to 40% for imported furniture (Xu, 2003)). The relatively high cost of logistics (e.g., shipping, customs clearance, and domestic distribution), coupled with an increasing number of foreign-invested enterprises, and an improvement in the medium-quality furniture sub-sectors (Shen and Cao, 1999) have so far staved off the growth in imports that some expected with tariff removal.

2.2.2. Plant size and location

While furniture manufacturers are typically small, privately owned, single-plant enterprises with an average size workforce of 100, large public corporations also exist, such as *Tiantan*, which has 3600 employees in 22 factories (five of them joint ventures), and 400 sales outlets in more than 150 cities (CSIL, 2001).

Due to the difficulty and cost of transporting bulk items, e.g., upholstered furniture which cannot be knocked down, most plants primarily service local markets (Shen and Cao, 1999). However, production has grown fastest in the central and southern coastal regions, owing to higher economic growth and proximity to both export markets and raw materials (there is a growing reliance on imports of wood). The Province of Guangdong alone comprises one-third of national production and 60% of exports (CSIL, 2001).

2.2.3. Supplier relationships

Studies have concluded that finding a capable and loyal supplier is crucial for success in China (The Institute for Manufacturing, 2002), but selecting the right supplier still remains more difficult than in the West—with lack of trust being a major barrier to efficient and effective operations (Dai et al., 2003).

2.2.4. Distribution and sales

Establishing a manufacturing presence in China has enabled foreign manufacturers to reduce delivery lead times considerably, e.g., from 8 weeks to several days (Sun and Bean, 2001). An increasingly common method of distribution is through "furniture cities" in which manufacturers rent space and sell directly to the public (Shen and Cao, 1999). There are now thousands of these towns, some with as much as 2 million m^2 of retail space. Furniture is also sold in large supermarkets (Zhu, 2003), and through specialty furniture stores. The latter include *IKEA* which now has four stores, and *Ethan Allen Interiors* with 10 stores opened since its first joint venture with *Markor Furniture* (Anon, 2002).

2.2.5. Enterprise software

In China as a whole, the business software market is still relatively small, with sales in 2002 totalling only US$420 million. Of this, 55% is ERP, 17% Finance, 8% CRM, and less than 5% SCM (CCW Research, 2003). While many foreign-invested firms would have inherited IT from abroad, some domestic firms report spending up to 30% of their operating revenues on IT development (Dai et al., 2003). Implementation failure is not uncommon, particularly for foreign vendors (Xue et al., 2005), with calls being made for more vendor-side adaptation (Marble and Lu, 2007).

In the furniture industry, ERP systems have generally only been used in the largest firms, e.g., *Shanghai Aurora Furniture*, which implemented SAP R/3 in 2001, "integrating about 100 direct selling points, shortening production cycle time from 2 months to one week, and reducing backlogs" (Wang, 2001). The industry is viewed by many IT providers as "low end". Indeed, there is an acknowledged lack of talented people in furniture companies who understand both IT and management technologies, but also few ERP consultants with expertise in the complexities and particulars of the furniture industry (Zhu and Wu, 2003).

2.3. Operations/supply chain management in the furniture industry

While some empirical studies provide a description of the furniture industry on a national basis, e.g., in the UK (Deeks, 1976) and in the US (Moorman and Montgomery, 1998), there are very few addressing SCM issues. There is a 1990 exploratory study of operations practice and performance in 65 US furniture manufacturers (Vickery et al., 1993, 1997) with which we compare our findings in Section 5.

2.4. Relationship between practice and performance in operations and supply chain management

Numerous researchers have proposed and confirmed that operations and supply chain practices and capabilities impact performance—operational, market, and/or financial. For example, the analysis

of Flynn et al. (1995) on data from 45 US manufacturers found significant paths from practices such as supplier relationships, work force management, work attitudes, and product design, to operational performance (quality, cost, delivery speed, volume flexibility, etc.). The aforementioned 1990 furniture industry study of Vickery et al. showed each of four operational performance factors statistically significant in at least one of the regression analyses with market and financial performance as the dependent variables. Tracey et al. (2005) studied 474 US manufacturers (including furniture firms), showing that SCM capabilities (such as inventory control, and supplier communications) are an important determinant of both market and financial performance.

Recent practice–performance studies have proposed that the impact of practice on business performance may be mediated through capabilities on various operations dimensions. For example, Li et al. (2006), considering 196 US manufacturers (including furniture firms), found a statistically significant impact of SCM practice on financial/market performance ($P = 0.05$), both directly and also mediated through competitive advantage (value, quality, delivery dependability, product innovation, and time to market) ($P = 0.01$). Similarly, a study of 57 North American manufacturers found that cost efficiency and flexibility (along with strategy integration) play a mediating role in the impact of practice on market performance (Swink et al., 2005). Vickery et al. (2003) found the relationship between supply chain integration (customer and supplier relationships, etc.) and financial performance (return on assets, investment, and sales) in 57 first-tier US automotive suppliers to be *fully mediated* by customer service (responsiveness, delivery speed, delivery dependability, etc.).

3. Conceptual framework and hypothesis development

3.1. Initial conceptual model

What emerges from the literature (see Section 2.4) is that the relationship between practice and financial performance may be complex—in particular concerning the extent to which operational performance mediates the relationship. We believe it is important to model this complexity.

A further complexity concerns the operational dimensions, which may be considered from the perspective of performance and/or importance. While most research focuses on one of these views, some researchers have combined the two measures, e.g., into "production competence" (Vickery et al., 1993). Including (realized) performance along with importance (i.e., emphasis) is valuable, as recent studies have determined that the former may be better than the latter in explaining financial performance (Zhao et al., 2006). Our research reflects this by considering the relationship of practice with market/financial performance to be potentially mediated by *both* the importance and performance of various operational dimensions/factors.

With the above in mind, and taking an exploratory research route, the initial conceptual model is presented in Fig. 1. We hypothesise that practice (in both supply chain and operations) impacts the

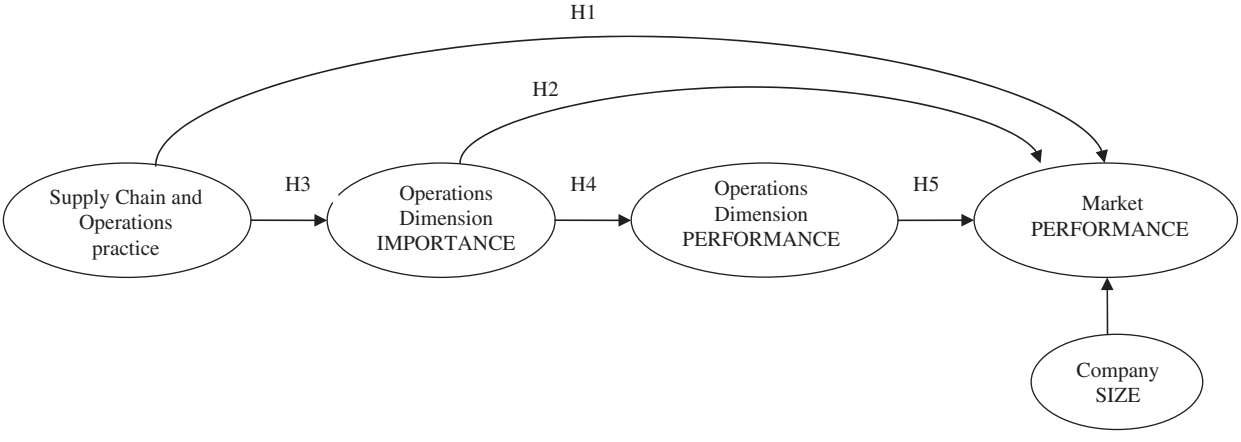

Fig. 1. Initial conceptual model.

market performance of the firm, both directly and indirectly—through the importance of, and performance on, operations dimensions. We are thus considering several sources and pathways for a firm's financial/market performance, viz., what the firm does, what operations dimensions it emphasises, and how well it performs on those dimensions. We suggest that capability development leads to improved performance.

The hypotheses are:

H1. Operations and supply chain practice has a positive impact on market performance.

H2. The importance of an operations dimension has a positive impact on market performance.

H3. Operations and supply chain practice has a positive impact on operations dimension importance.

H4. Operations dimension importance has a positive impact on operations dimensions performance.

H5. Operations dimension performance has a positive impact on market performance.

We represent *performance* capabilities on operations dimensions by self-reported improvement over time, and postulate that such an improvement is related to the *importance* the firm places on those dimensions. We control for company size using a moderating construct consisting of the logarithm of annual sales and the logarithm of the number of employees.

In the remainder of this section we describe the development and operationalisation of the model components (constructs and variables). The refinement of the conceptual model is provided in Section 5.4.

3.2. Practice constructs

The survey administered included 68 variables relating to supply chain and operations practice derived from the literature and items of particular interest to the authors and industry. Variables relating to extent of implementation were elicited using 3-point Likert scales (1 = none, 2 = in progress, and 3 = full [with missing values recorded as "1"]). All other variables, generally more qualitative in nature, were sought using 7-point Likert scales, with missing values being substituted with the average response across respondents.

From a review of the literature, e.g., Chopra and Meindl (2004), and business knowledge we allocated SCM practice variables to a four-dimensional construct, viz., *Customer Relationships*, *Supplier Relationships*, *E-Commerce*, and *Enterprise Software*. Similarly, Operations practice is conceptualized as a three-dimensional construct: *Advanced Manufacturing Technology* (AMT), *Advanced Manufacturing Systems* (AMS), and *Human Resources*.

3.3. Operations dimension factors

Numerous attempts have been made to characterise operations dimensions (or "competitive priorities"). We adopted the 10 dimensions of a previous furniture industry study (Vickery et al., 1997), supplementing it with three dimensions pertinent to our broader supply chain focus, viz., new product development time, after-sale service, and modification flexibility. Utilising 7-point Likert scales, we measured both *importance* (degree of emphasis relative to competitors) and realised *performance* (degree of improvement during the past year) for the same 13 operations dimensions.

3.4. Market performance construct

We follow other researchers (e.g., most of those listed in Section 2.4) in employing a multi-dimensional construct for market performance, viz., combining degree of improvement in market share in the past year (a 7-point Likert scale), degree of improvement in profitability (profit/sales) in the past year (a 7-point Likert scale), and the logarithm of sales growth in past year (calculated from reported sales volumes).

4. Method

A questionnaire was developed with one part focusing on manufacturing strategy and technology, using questions similar to previous studies of Chinese manufacturers (Pyke et al., 2002; Robb and Xie, 2001). Results of a correlation analysis of these data were reported in Robb and Xie (2003). In the present study we include the second part of the questionnaire, relating to supply chain practices. The questions utilised Likert scales, as well as nominal qualitative and metric measures. Reverse-coding on several questions attested to content validity. The English version was translated into Chinese and back-translated to ensure translation

accuracy. All but one respondent used the Chinese version.

The survey was conducted in mid-2001, immediately prior to China's accession to the World Trade Organization. A total of 360 surveys were mailed out, allocated evenly among 12 Provinces selected to represent a range of geographic and economic conditions. As the unit of analysis was the plant, the survey was addressed to the General Manager, with a suggestion that if they considered it more appropriate, a Senior Production/Manufacturing/Plant Manager could respond instead. The most common respondent was a General Manager (26%), followed by Vice-General Manager (13%) and Factory/Plant Manager (8%).

Seeking to overcome typically single-digit response rates to mail surveys in China (Whybark and Vastag, 1993; Zhu and Sarkis, 2004), a letter of endorsement from the 4000-member *China National Furniture Association* was included, along with a reply-paid envelope and return fax number.

The total number of usable surveys (after rejecting two that answered too few questions) was 72, comprised of 59 responses to the mail survey (constituting a 16% response rate) supplemented with personal interviews at 13 additional plants in the Beijing area (a 24% response rate from 55 phone calls to randomly selected furniture manufacturers in the Beijing "Yellow Pages"). The interviews facilitated assessment of validity and methods variance. There were no significant differences ($P = 0.01$) in any responses between the data from the interview and the mail survey data from the 15 other high-income region (Beijing/Guandong/Zhejiang) respondents—indicating that these results were homogeneous and could thus be combined.

As a partial test for non-response bias we compared respondents returning the survey within 14 days (the median time from the date the survey was distributed until the postmark date on the response envelope) with those returning it on or after 14 days. There was only one significant difference ($P = 0.01$) on any of the survey items, viz., the proportion of payments to suppliers made on a fixed date in the month (i.e., "date-terms" trade credit)—which was higher for the earlier returns.

5. Results and discussion

We begin the results section by summarising the demographics of the firms. This is followed by the practice construct findings, and the results of a factor analysis conducted on the emphasis firms placed on the 13 operations dimensions. Section 5.4 presents and discusses the structural equation model—linking practice through operations dimensions to market performance.

5.1. Demographics

The distribution of company size (both annual sales and number of employees) is provided in Table 1. The sample is clearly biased towards larger firms, with the mean number of employees (377) almost four times the industry average (100).

5.1.1. Ownership

Average ownership is 67% private, 17% state, 9% collective, and 8% foreign. Private firms are typically smaller than their state-owned counterparts, with only 31% of total year 2000 sales, and 38% of total employees, attributable to state ownership. Exports comprised 15% of total year 2000 sales, with no significant correlation with the form of ownership.

5.1.2. Product range

The most common furniture manufactured was office furniture (42% of firms), followed by sofas (36%), bedroom furniture (28%), hotel furniture (13%), dining room furniture (13%), and general

Table 1
Enterprise characteristics (1 RMB = US$0.12)

		Percentile					
	Mean	SD	0th	25th	50th	75th	100th
Annual sales (2000) (US$million)	4.9	8.5	0.1	1.1	2.2	5.1	56
Sales growth (1999–2000) (%)	23.1	35.7	−50	6	17	40	150
Number of employees (mid-2001)	377	554	16	125	225	450	4000
Annual sales per employee (US$thousand)	13.3	10.4	1.1	5.8	9.4	17	47

furniture (13%). Some 80% of firms listed at least three product groups, contrasting with earlier studies in the US and UK (Deeks, 1976; Skinner and Rogers, 1968) showing that most companies focused on just one product group.

5.1.3. Labour productivity

Sales per employee averaged US$13,300/year, with a very wide variation between firms. The average is twice the figure reported for Chinese furniture manufacturing overall, $US6300 (CSIL, 2001), perhaps accounted for by the survey's bias towards larger firms, or a potential bias towards more successful firms. However, the figure is still only 11% of the equivalent figure in the US (US Census Bureau, 2002). Average wages for furniture production workers in China are only 5% of that of their US counterparts (i.e., 9978 RMB per year (National Bureau of Statistics of China) versus US$11.76/h (US Census Bureau, 2002)).

5.1.4. Regional differences

While the survey involved stratification across three geo-economic regions of differing GDP per capita, viz., high (Beijing/Guangdong/Zhejiang, 12,365 RMB/year), medium (Hebei/Heilongjiang/Hubei/Jilin/Liaoning/Shandong, 8506 RMB/year), and low (Henan/Shaanxi/Sichuan, 5101 RMB/year), there were very limited differences between regions. Indeed, none of the questions had significant differences (even at $P = 0.10$) on all three pairs of regions (low–medium, medium–high, and high–low). However, on several questions one region stood out from the other two ($P \leqslant 0.10$ on both pairs). In particular, high-income regions tended to have weaker relationships with both customers (consulting them less frequently about production schedules and investing less in improving relationships) and suppliers (consulting them less frequently about new product development). Low-income regions tended to have less-developed implementation of long-term capacity-planning software.

5.2. Practice construct results

Tables 2 and 3 present the constructs for SCM and operations-related practice, respectively. Variables were assigned to constructs based on an understanding of business practice and literature. Each construct was determined as the equally weighted sum of the component variables. The reliability of the constructs was improved by means of a greedy algorithm: successively removing the variable which generated the greatest increase in Cronbach's α, until no further improvement was possible.

We considered normalising the measures, by standardising the 3-point Likert scale items from 1–2–3 to 1–4–7, but this reduced Cronbach's α values (likely due to the lower information content associated with the coarser grain), and was thus dropped in favour of the non-standardised measures. Note that while mixing scales may lower precision, if scales have weak correlation Cronbach's α values will be low. Similarity comes from the concept being measured rather than the number of points on the scale—indeed, even ordinal variables can be used in SEM (Moustaki et al., 2004).

In the sections below, we discuss the meaning and composition of each final construct—highlighting anomalies, rather than commenting on all variables. While the items and constructs are not exhaustive, e.g., we do not cover reverse logistics, eco-design, and green packaging (Zhu and Sarkis, 2004), we believe that the general list of 68 practice variables is wider in scope than any other study—facilitating comparison of the relative contribution of both supply chain and operations practices.

5.2.1. Customer relationships

The extent and strength of customer relationships has been found to be positively related to organisational performance (Tan et al., 1998). Our study considered various aspects, including general communication, as well as more specific consultation on new product development (Lin and Germain, 2004) and production scheduling. With a significant ($P < 0.05$) correlation between these three variables, and all five variables being retained in the final construct ($\alpha = 0.73$), it appears that communications development is multidimensional in nature. Firms reported increasing use of distributors and marketing networks, suggesting a desire to reduce the number of direct customers.

5.2.2. Supplier relationships

Table 2 reveals Chinese furniture manufacturers reporting a high emphasis on programmes for monitoring supply quality, and improving relationships with suppliers. The average number of domestic suppliers reported was 117 (median 25, maximum 5000). Only 22% of the respondents reported any direct foreign suppliers. Little work is outsourced.

Table 2
Supply chain practice variables: scale items and descriptive statistics

	Included in model?	Likert scale	Mean	SD
Customer relationships ($\alpha = 0.73$, retained 5 from 5 variables)				
Our customers are consulted in deciding which new products to develop	✓	7	5.80	1.27
We communicate with our customers [1 = never, 7 = often]	✓	7	5.54	1.46
The relationship between our firm and the majority of our customers is [1 = very weak, 7 = very strong]:	✓	7	5.53	1.34
Our customers are consulted in deciding the production schedule	✓	7	4.76	1.71
Improve relationships with customers	✓	3	2.18	0.72
Supplier relationships ($\alpha = 0.68$, retained 3 from 7 variables)				
We communicate with our suppliers [1 = never, 7 = often]	✓	7	5.35	1.58
The relationship between our firm and the majority of our suppliers is [1 = very weak, 7 = very strong]	✓	7	4.80	1.35
Monitor the quality of materials from suppliers	✓	3	2.40	0.62
Our suppliers are consulted in deciding the production schedule		7	4.55	1.70
Our suppliers are consulted in deciding which new products to develop		7	4.23	1.78
The primary consideration in dealing with suppliers is cost (reverse coded)		7	3.93	1.65
Improve relationships with suppliers		3	2.13	0.60
E-Commerce ($\alpha = 0.83$, retained 3 from 3 variables)				
Web-based Data Exchange with Suppliers	✓	3	1.38	0.54
Web-based Ordering for Customers	✓	3	1.33	0.58
Electronic Data Interchange (EDI) with Suppliers	✓	3	1.25	0.52
Enterprise software ($\alpha = 0.90$, retained 14 from 14 variables)				
Degree of computerization involved in production planning	✓	7	3.07	1.83
Controlling	✓	3	1.76	0.76
Finance	✓	3	1.75	0.78
Sales and Distribution	✓	3	1.54	0.67
Human Resources	✓	3	1.51	0.65
Inventory Control	✓	3	1.47	0.63
Purchasing	✓	3	1.39	0.59
Quality Control	✓	3	1.36	0.59
Customer Relationship Management (CRM)	✓	3	1.33	0.58
Knowledge Management	✓	3	1.31	0.60
Short-term Production Scheduling	✓	3	1.28	0.56
Plant Maintenance	✓	3	1.28	0.51
Long-term Capacity Planning	✓	3	1.26	0.53
Supply Chain Management (SCM)	✓	3	1.22	0.48

Unless otherwise stated, a Likert scale of 7 refers to 1 = strongly disagree … 7 strongly agree.
A Likert scale of 3 refers to current status of Improvement Action [1 = none, 2 = in progress, 3 = full].
Null responses on the 3-point Likert scales were set to 1.

Four of the seven variables were omitted from the final construct, including consultation with suppliers on new product development. Interestingly, correlations between this variable and the time and ability to introduce new products (both performance and importance) are all negative, although not significant. It could be the case that such consultations are more appropriate for more complex products (Primo and Amundson (2002).

For both customers and suppliers, strong relationships are, unsurprisingly, highly correlated with frequent communications ($P<0.0001$). Our results indicate stronger relationships and more frequent communication with customers than with suppliers. This applies in general, as well as in terms of new product development and production scheduling, and concurs with earlier findings from another China-based survey (Pyke et al., 2000).

5.2.3. *E-commerce*

All three E-Commerce variables were retained in this construct. While respondents indicated

Table 3
Operations practice variables: scale items and descriptive statistics

	Included in model?	Likert scale	Mean	SD
Advanced Manufacturing Technology ($\alpha = 0.73$, retained 8 from 11 variables)				
Degree of specialization of production equipment	✓	7	5.37	1.31
Proportion of automated manufacturing equipment	✓	7	4.13	1.56
Reduce production cost	✓	3	2.15	0.52
Increase production capacity	✓	3	2.00	0.63
JIT (Producing parts only when products are needed)	✓	3	1.65	0.65
Automation in Production (equipment)	✓	3	1.63	0.66
CAM (Computer aided manufacturing)	✓	3	1.36	0.56
Robotics	✓	3	1.21	0.47
Proportion of production equipment developed by our firm		7	2.51	1.51
CAD (Computer aided design)		3	2.06	0.71
FMS (Flexible manufacturing systems)		3	1.01	0.12
Advanced Manufacturing Systems ($\alpha = 0.68$, retained 11 from 16 variables)				
Manufacturing decisions are screened for consistency with marketing and business strategies/plans	✓	7	6.01	1.12
Manufacturing participates in making marketing, engineering and business strategy/planning decisions	✓	7	5.70	1.33
We design products using parts that are common to multiple products	✓	7	5.48	1.26
We employ a well-defined plan for launching new products	✓	7	5.47	1.19
Our manufacturing performance is evaluated on the basis of long term objectives	✓	7	4.97	1.32
We design products for foreign markets as well as domestic markets	✓	7	4.73	1.84
Introduce more new products	✓	3	2.31	0.52
Promote Quality Circles	✓	3	1.99	0.70
Adopt ISO 9000	✓	3	1.92	0.87
Statistical Process Control (SPC)	✓	3	1.44	0.60
Adopt ISO 14000	✓	3	1.07	0.26
The primary consideration of our quality management efforts is continuous product development		7	4.39	1.97
Our manufacturing performance is evaluated on the basis of short term objectives		7	4.04	1.76
We only consider implementing new manufacturing practices or technologies if they have been adopted successfully by our competitors (i.e., we take a "follower" approach)		7	3.30	1.73
Manufacturing has the ability to run very small batches at virtually the same cost as larger batches		7	2.96	1.73
Reduce the time to adjust (set-up) machines		3	1.86	0.72
Human Resources ($\alpha = 0.72$, retained 5 from 12 variables)				
Improve worker safety	✓	3	2.56	0.55
Motivate workers	✓	3	2.32	0.58
Increase supervisor training	✓	3	1.99	0.64
Provide more worker training	✓	3	1.94	0.55
Give workers a broader range of tasks	✓	3	1.75	0.67
Our production personnel are heavily involved in product design decisions		7	5.01	1.46
The worker's skills at doing their own jobs.		7	5.00	1.53
Level of training given to workers		7	4.79	1.64
Our workers are trained to manage different stages of the production process		7	4.77	1.60
Our workers are consulted in deciding the production schedule		7	3.58	1.70
Our workers have no role in improving the manufacturing process		7	2.80	1.38
Give workers more planning responsibility		3	1.85	0.74

A Likert scale of 7 refers to 1 = strongly disagree … 7 strongly agree.
A Likert scale of 3 refers to current status of Improvement Action [1 = none, 2 = in progress, 3 = full].
Null responses on the 3-point Likert scales were set to 1.

relatively low utilisation of the Internet in their supply chains—both for ordering from suppliers and receiving orders from customers—they anticipated increased adoption. Some of the antecedents for this are in place, with more than half of the companies providing website addresses. Progress in e-fulfillment is highly desirable given the high costs associated with distribution, handling, and storage of furniture, which is often bulky (Pyke et al., 2001).

5.2.4. Enterprise software

The standard modules of ERP packages (controlling, finance, sales and distribution, and HR) predictably lead the list of currently installed enterprise software (see Table 2), with CRM, Knowledge Management, and SCM lagging considerably. However, for all 13 categories the majority of firms plan further investment. Due to the very high reliability ($\alpha = 0.90$), all 14 components were retained in this construct.

5.2.5. Advanced manufacturing technology (AMT)

This construct contains specific manufacturing technologies generally related to direct and indirect "hardware". All but three of the 11 variables were retained in the final construct.

5.2.6. Advanced manufacturing systems (AMS)

This construct includes a wide variety of "soft" technologies, concepts, procedures, and systems. One could argue that the construct is too broad, as the maximum Cronbach's α achieved was a relatively low 0.68 (Chronbach's α), with five of the 16 variables omitted. Implementation of the least popular of the technologies, ISO 14000, was "full" for no firm, and "in progress" for only five. However, half the firms expressed that they were contemplating or committed to seeking registration.

5.2.7. Human resources

Like AMS, this construct is relatively mixed, with seven variables being deleted before an α value of 0.72 was attained. The final construct focuses on safety and training aspects of the workforce.

5.3. Operations dimensions and factor analysis

The results for importance and performance of the 13 operations dimensions are presented in the first five columns of Table 4. The close correlation of the importance and performance measures, demonstrated in Fig. 2 and indicated by the high average of the 13 correlations (0.42), provides further evidence of validity.

Delivery dependability is the highest-ranked operations dimension on both measures, indicating the high priority given to reliable delivery of furniture. The majority (51%) of our firms quoted a standard delivery time to customers—average and median of 10 days. Most firms (70%) negotiated delivery dates, with 38% paying penalties for lateness (median penalty of 5%). Interestingly, the 1990 US furniture industry study found Delivery dependability ranked second (on importance and performance), after Conformance Quality (Vickery et al., 1997).

The only "outlier" in terms of consistency between importance and performance is cost, which exhibits a relatively lacklustre improvement. This may reflect the intense competition faced in the industry due to market pressures and overcapacity. For example, during the latter half of the 1990s, wholesale and retail prices declined by 40–60% and 50–80%, respectively (CSIL, 2001).

To facilitate greater understanding, a common factor analysis was conducted on the *importance* of the 13 dimensions using principal components analysis with varimax rotation. To investigate the degree to which importance (presumed to reflect intentions) transpires into improvement on those same factors, we applied the same (importance) factor loadings to *performance*.

The results here are summarised from Robb and Xie (2003). Scree plot and latent root criteria suggested the use of four factors, as presented in Table 4. We denote the factors as *Value* (combining the six highest importance dimensions, relating to quality, dependability, and cost), *Speed* (production and delivery time), *Flexibility* (volume and modification flexibility), and *Innovation* (new products, new product development time, and product mix flexibility). In terms of convergent validity, reliability assessments on the items dominantly loading onto the four factors gave all items loading on their respective factors, with most loadings exceeding 0.70. Cronbach's α values (see Table 4) all exceeded the minimum α value considered acceptable for exploratory research, viz., 0.60 (Nunnally and Bernstein, 1994). The cumulative variance explained by the four factors was 70.9%.

5.3.1. Construct validity

Construct reliability values for all except one retained practice construct were between 0.72 and

Table 4
Factor analysis of the importance rating (four-factor solution, Varimax rotation)

Operations Dimension	Importance		Performance		Communality	Rotated factor pattern				Standardised Scoring Coefficients			
	Mean	SD	Mean	SD		Factor 1	Factor 2	Factor 3	Factor 4	Factor 1	Factor 2	Factor 3	Factor 4
Delivery dependability	6.2	1.2	5.8	1.0	0.714	**0.709**	0.368	−0.083	0.262	0.245	0.092	−0.257	0.079
Product reliability	6.2	1.1	5.7	1.0	0.737	**0.806**	0.269	0.067	0.104	0.294	0.035	−0.131	−0.071
After-sale service	6.1	1.3	5.7	1.1	0.696	**0.668**	0.128	0.461	−0.144	0.214	−0.021	0.229	−0.300
Consistent quality	6.0	1.1	5.7	1.0	0.723	**0.784**	−0.201	0.237	0.111	0.312	−0.257	0.035	−0.009
Product durability	5.8	1.4	5.6	1.0	0.735	**0.718**	0.153	0.426	0.123	0.205	−0.057	0.149	−0.083
Low production cost	5.8	1.4	5.3	0.9	0.491	**0.556**	0.324	−0.129	0.245	0.194	0.092	−0.256	0.099
Production time	5.8	1.3	5.6	0.9	0.830	0.052	**0.896**	0.134	0.083	−0.122	0.499	−0.004	−0.117
New products	5.8	1.4	5.6	1.1	0.699	0.357	−0.064	0.467	**0.591**	0.011	−0.226	0.182	0.379
Delivery time	5.7	1.5	5.5	0.8	0.763	0.279	**0.795**	0.214	0.084	−0.025	0.404	0.023	−0.139
New product development time	5.7	1.7	5.6	1.1	0.741	0.295	0.500	0.167	**0.613**	−0.038	0.138	−0.075	0.356
Product mix flexibility	5.6	1.5	5.5	1.0	0.662	0.027	0.098	0.080	**0.803**	−0.113	−0.093	−0.088	0.631
Volume flexibility	5.4	1.5	5.3	1.0	0.604	0.146	0.398	**0.589**	0.278	−0.121	0.118	0.318	0.045
Modification flexibility	5.0	1.7	5.2	0.9	0.825	0.085	0.142	**0.884**	0.125	−0.148	−0.025	0.588	−0.077
Eigenvalue						3.361	2.270	1.924	1.665				
Proportion variance explained						0.259	0.175	0.148	0.128				
Cumulative variance explained						0.259	0.433	0.581	0.709				
Cronbach's α (standardised)						0.853	0.804	0.662	0.692				
Named						Value	Speed	Flexibility	Innovation				

Operations dimensions listed in descending order of mean importance.
Adapted from Robb and Xie (2003).
Each operations dimension has one and only one factor loading over 0.5 (deemed to be "practically significant" by Hair et al., 2006). These are designated in bold.

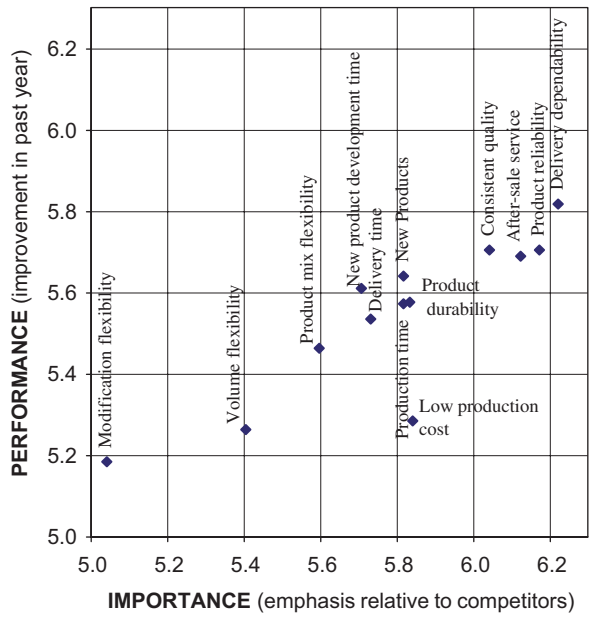

Fig. 2. Average performance and importance of the 13 operations dimensions.

0.86, indicating good reliability (Hair et al., 2006). *AMS* had a relatively low value (as it did for Chronbach's α) of 0.55 (construct reliability, see Hair et al. (2006) for a definition).

In terms of *Discriminant validity*, a correlation matrix of the included practice variables shows highly significant correlations clustering around the diagonal terms. The only significant off-diagonal terms relate to supplier and customer relationships (which one would expect to be correlated but we maintain are quite separate conceptually). A stronger test is that the variance extracted for any pair of constructs should exceed the square of the correlation estimate (Hair et al., 2006). Our results show that this occurs in the majority (6) of the (10) pairs of retained practice constructs, with the deviation for the remaining four pairs being small: the largest discrepancy (0.29 versus 0.38) is associated with the pair *Human Resources* and *AMT*.

Correlations for the retained practice constructs are all positive, with significances all less than $P = 0.062$, indicating strong *nomological validity*.

5.4. Structural model and discussion

In this section, we describe the development, testing, and refinement of a model to evaluate the theoretical relationships and hypotheses proposed in Section 3. Several procedures, including bootstrap estimation (Mooney and Duval, 1993), were used to mitigate the limitations of a relatively limited sample size (72) on SEM.

5.4.1. Model with a single-practice construct

We first tested the simple model shown in Fig. 1, with practice defined as a *single* latent construct summing all seven practice constructs developed in Section 5.3. We found, through SEM using the software package AMOS 6.0 (Arbuckle, 2005), that practice had no *direct* effect on market performance (a construct combining the logarithm of year-on-year sales growth, profitability improvement, and market share improvement ($\alpha = 0.75$)), but rather was mediated through both *importance* and *performance* on the four factors identified in Section 5.3, viz., *Value*, *Speed*, *Flexibility*, and *Innovation*. Thus we reject Hypotheses H1 and H2. This finding concurs with the study of Swink et al. (2005), which also found the influence of practice on market-based performance to be mediated by efficiency and flexibility.

5.4.2. Final model form and significance

Concluding from the above that practice generates market-based performance only through its influence on operations dimensions, in the final model—in which practice was represented by multiple constructs (as presented Section 5.2)—we removed the direct links between practice and market performance, and between importance and market performance.

The final model developed (as shown in Fig. 3) had $\chi^2 = 127.33$ ($P = 0.186$, GFI = 0.849, AGFI = 0.773, RMSEA = 0.041). Hoelter's critical N (Hoelter, 1983)—the largest sample size for which one would accept at the 0.05 level the model with this χ^2-statistic and this many degrees of freedom (114))—is equal to 79. As our sample size was 72 the model was not rejected at the 0.05 level.

5.4.3. Controlling for size

We sought to control for company characteristics by associating surrogates for company size (number of employees, sales, etc.) with Market Performance, but this only reduced the significance of the

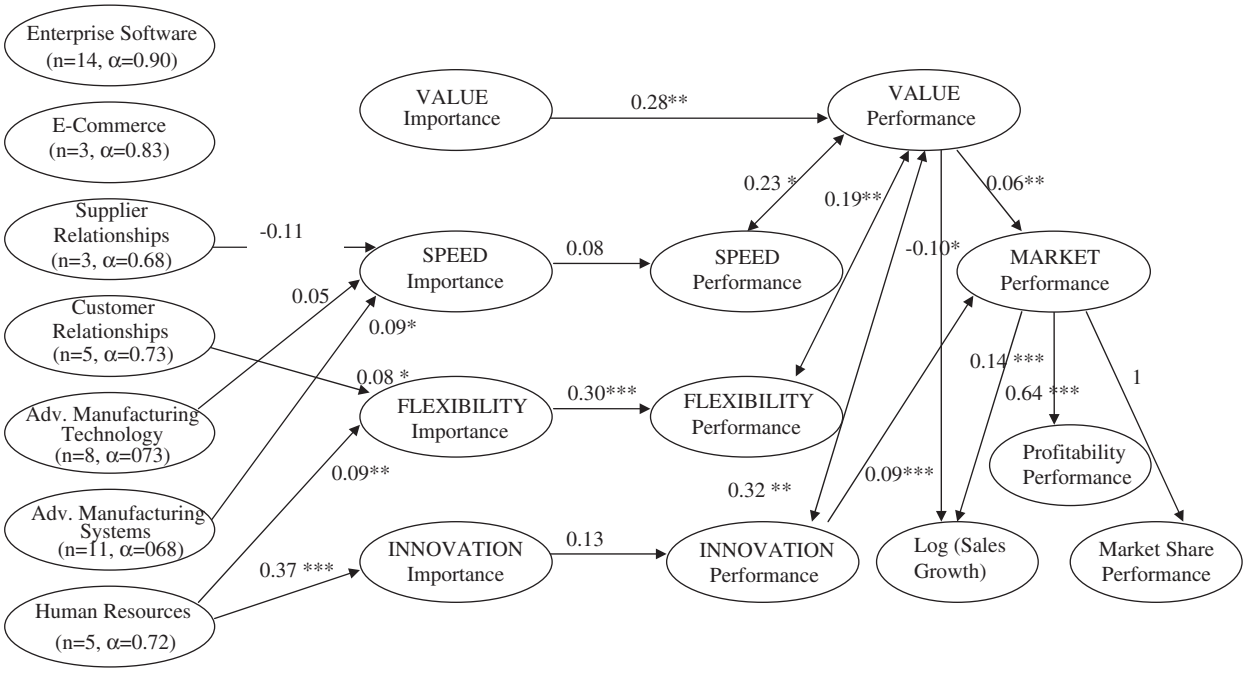

Fig. 3. Final model with path coefficients. *Note*: *Significant at $P<0.05$, **significant at $P<0.01$, ***significant at $P<0.001$. Error terms amongst the seven practice constructs are not shown.

model—Hoelter's N declined to 68. This seemingly odd result may stem from the mixed effect of the economies of scale of larger firms being moderated by state ownership.

5.4.4. Relationship between practice and importance

In the final model, we removed any insignificant paths between the practice and importance constructs. We found that an emphasis on *Speed* is strongly associated with investments in both AMS and AMT. However, the loading with supplier relationships is negative ($\gamma = -0.11$, $P = 0.08$). This may indicate tradeoffs between speed and other performance dimensions such as dependability (of delivery and the product).

Flexibility (e.g., volume and modification) is emphasised by those firms with high degrees of AMS and/or customer relationships. This finding suggests that managers seeing flexibility as important need to look both inside and outside the firm for support.

An emphasis on *Innovation* (e.g., new product development) is most closely associated with the Human Resources construct—again an unsurprising but important result, indicating that the primary source in this area (which we note again is directly associated with market performance) is investment in people.

There are no significant direct paths between any of the practice constructs and an emphasis on *Value*. Indeed there is only one positive ($P = 0.1$) direct relationship between the four supply chain practice constructs and the four importance factors, viz., Customer Relationships and *Flexibility* Importance. However, one should not conclude from this that supply chain practice is unimportant, for all but two of the 21 correlations between error terms (included in the model but omitted from Fig. 3) between the seven practice constructs are positive and significant at $P = 0.10$. The managerial implication of this is that supply chain practice *supports* other initiatives, rather than directly affects business performance. For example, Enterprise Software and E-Commerce (e.g., EDI) should be seen as enabling technologies.

An alternate explanation for the lack of positive direct links between three of the supply chain practice constructs and any of the importance factors may be the limited diffusion of advanced capabilities in China. For instance, SCM was the least implemented module in Enterprise Systems. As further evidence, inventories, closely connected to each of the constructs, are very high, as shown in Table 5. The figures, even when weighted by annual sales, are significantly higher than the year 2000 industry average in the US. Indeed, they are closer to the 1961 US figures, which may indicate that Chinese firms lag in the adoption of IT and modern inventory control methods (Irvine, 2003) as well as advanced supply practices. Particularly high raw material inventories perhaps reflect long or volatile supplier lead times or high seasonality,[1] but are also driven by relatively infrequent purchasing, with 69% of respondents indicating review periods of 1 month or longer (which in turn is likely influenced by "fixed date in the month" terms of trade credit applying to about half of all orders). The strong correlation ($r = 0.37$, $P = 0.012$) between raw material inventory holdings and percentage of state ownership suggests that vestiges of the centrally planned economy remain—in a study relating to data during the 1970s and 1980s, China was found to have the highest aggregate inventory investment to GDP ratio of the 88 countries surveyed (Chikán and Horváth, 1999).

In summary, considering each of the practice–importance pairs, there is support for Hypothesis H3 (operations and supply chain practice has a positive impact on operations dimension importance), viz., that human resources, customer relationships, manufacturing technology, and manufacturing systems are each closely associated with the emphasis placed on at least one of the operations dimensions. We believe the lack of direct positive association for other relationships, could be due to intercorrelation between the practice constructs.

5.4.5. Importance and performance

There is also partial support for Hypothesis H4 in that two of the four loadings between importance and performance were significant at $P = 0.01$, viz., *Value* and *Flexibility*. The association between importance and performance on *Speed* was weak (see Fig. 3), perhaps indicating greater difficulty in securing performance improvement on that

[1]Respondents indicated a considerable degree of seasonality, with 44% considering seasonality in their forecasting, and highest quarter sales exceeding lowest quarter sales by an average of 70% (median 40%). While this appears relatively high, e.g., an equivalent figure in US furniture store sales was 31% (Skinner and Rogers, 1968), it was not significantly correlated with volume flexibility (importance or performance)—perhaps indicating the relative ease with which output can be changed through overtime or additional shifts (level production strategies are not attractive due to style changes and storage limitations).

Table 5
Days inventory

	Mean	SD	Median	Mean weighted by year 2000 sales	US industry average[a]		Logarithmic regression of days inventory against year 2000 sales, s (in 10,000 RMB)	F-statistic (significance)
					Year 2000	Year 1961		
Raw materials	61.3	102.4	30	44.4	25	48	$162\ s^{-0.23}$	1.37 (0.248)
Work-in-process	26.2	37.4	15	12.8	8	15	$316\ s^{-0.41}$	7.37 (0.009)
Finished goods	29.5	30.9	20	12.7	9.5	15	$562\ s^{-0.46}$	9.19 (0.004)

[a]*Source*: 2000 figures (US Census Bureau, 2002) using the inventory ratio methodology of Huson and Nanda (1995)—the source of the 1961 figures.

dimension. Note that while removing the *Speed* and *Innovation* pairs increased the model significance (through a small change in the degrees of freedom) we retained all four pairs in the model to show the relative strength of the relationships for all four dimensions.

5.4.6. Operations dimensions and market performance

Market Performance is positively related to both *Value* ($P = 0.006$) and *Innovation* Performance ($P < 0.001$), suggesting competitive advantage accrues from these areas. This finding compares well with a year 2000 survey of 91 Chinese manufacturers (Li, 2005), which found, using multiple linear regression, that manufacturing control capability (comprised of improved capacity utilisation, productivity, delivering products on assigned due dates, and reducing production leadtime [and hence similar to our *Value* construct]) positively related to market performance (market share, new product introduction) ($P < 0.10$). Li also found Staff skill significantly related to market performance ($P < 0.05$), but Technology (CAD, CAM, MRP/ERPII, and Production Planning) was not found to be a strong predictor of the same. Our own results show a similar contrast, with market performance being more strongly impacted by Human Resources than AMT.

There is a *negative* loading on the direct path from *Value* Performance to the Logarithm of sales growth ($P = 0.013$). This result is difficult to explain apart from the nature of the Value performance factor—including a mixture of quality and cost variables, and our use of the factor scores from the *importance* rather than *performance* factor.

Of great interest is the result that improvements in *Speed* and *Flexibility* have no direct impact on market performance, but are mediated through improvement in *Value*. The observation that improvements in both Value and Innovation have significant direct and mediated impact on market performance, and that both are closely associated with importance, suggests that these should be primary areas for firms seeking improved financial performance. These results confirm earlier findings that innovation is a much stronger predictor than is flexibility on market performance (Swink et al., 2005; Vickery et al., 1997).

In summary, Hypothesis H5 is largely supported, with *Market Performance* strongly related to Performance in *Value* and *Innovation*, and indirectly to Performance in *Speed* and *Flexibility*.

6. Conclusions

Growth in the Chinese furniture industry over the past decade, in both domestic sales and exports, has been both rapid and sustained. This paper demonstrates that Chinese firms are actively engaged in many forms of improvement relating to operations and supply chain management. It highlights which priorities, programmes, and initiatives are most closely related to financial and market performance, and confirms several earlier studies concerning the relationship between practice and performance.

In terms of operations dimensions there are similarities with a 1990 US study of 65 furniture manufacturers (Vickery et al., 1997). For example, in both markets Delivery reliability and dependability were ranked very highly, and Cost and Quality-related dimensions loaded onto a single

factor (*Value*). However, some differences are apparent in that US firms emphasised *Innovation*, whereas Chinese firms in general compete on *Value* (*Innovation* ranks second), which ranks very highly in both importance and performance and is associated with higher financial performance.

The hypotheses that practice (H1) and importance (H2) *directly* influence market performance were rejected. Instead, a model with the practice–market performance relationship being mediated by operations importance and performance was supported (Hypotheses H3–5). Market performance is directly impacted by performance on *Value* and *Innovation*, and indirectly impacted through *Speed* and *Flexibility* (mediated via *Value*). The survey reveals that intentions (i.e., importance) on *Flexibility* and *Value* are more readily translated into performance on the same dimensions, whereas *Innovation* and *Speed* performance are more difficult to secure.

One could surmise that *Innovation* is thus the key to competitive advantage—it is difficult to secure (and thus inimitable), but directly (and indirectly) related to market performance. The development of new products is clearly vital in this industry in which style is becoming more important, and customers are changing furniture more frequently (the average number of products listed by our respondents is 321 (median 67, SD 1253) and ranges from 1 to 10,000). With increasing variety, and the rapidly changing economic conditions (in particular, disposable income), it is not surprising that make-to-order (MTO) production dominates, comprising an average of 64% (median 70%, SD 31.6%) of production. This result contrasts another that MTO production rose from less than 20% in 1999 to 30% in 2004, and raises some doubt over the assertion of US manufacturers that the custom-order market is the "Achilles' heel" of their Chinese competition" even with 5–6-week shipment times (Tan, 2004).

Another key finding is that practices are related to the importance placed on various dimensions—the strongest link being between human resources and innovation (thus training can be seen to be a key to securing competitive advantage). While supply chain practice constructs do not have as strong direct links to operations objectives, they are all indirectly related, and thus can be considered as enabling technologies, i.e., promoting the contribution of other practices including AMT, AMS, and HR.

Relationships and communications with customers (e.g., consultations on production schedules and New Product Development) are strongly connected with financial performance (market share and profitability) via *Flexibility* and *Value* performance. It appears that such relationships partially compensate for the relatively undeveloped distribution infrastructure, and are likely to be increasingly important in this industry (Pyke et al., 2001; Volpe, 2002; Xie et al., 2003).

From our study, we may infer a need for the industry to somehow absorb new product development and introduction without substantially increasing costs. However, we believe that the large gap identified between cost importance and performance will unlikely be reduced by a focus on innovation and/or larger product range without reduction of high inventories and increased use of MTO production. There are strong indicators that value is rapidly improving, viz., lower prices, and substantial increases in labour productivity (17% from 1995 to 2002) related to increases in AMT and AMS, along with growth in foreign-invested and private firms, and the downsizing and restructuring of SOEs (Jiang et al., 2004).

There are some limitations of our study, including a relatively small sample size, which required us to utilise the same data to both create the constructs and confirm the scales. Also, while construct reliability values are good, the variance extracted tests (especially the stronger ones) showed relatively poor results. Finally, face validity, while supported by the literature review, our experience in the field, and well-attested scales, could have been evaluated by means of rigorous piloting or involving other experts prior to the study.

We envisage future research to confirm our findings. Any longitudinal analysis would need to consider the impact of WTO accession. It would also be useful to consider performance and perspectives of more units in the supply chain, especially wood processors and furniture distributors, which are playing an increasingly significant role in the industry.

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