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The impact of organization ownership structure on JIT implementation and production operations performance

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Abstract

Purpose – The purpose of this paper is to empirically explore the relationships among organization ownership structure, implementation of just-in-time (JIT), and production operations performance.

Design/methodology/approach – A theory model for explaining the relationships among ownership, manufacturing strategy and performance was constructed, and then several hypotheses were tested using statistical analysis models based on questionnaire responses from Chinese manufacturing firms.

Findings – The results show that organization ownership not only impacts the implementation of JIT and operations performance, but also impacts the relationship between JIT implementation and operations performance. Moreover, the results show that, for firms operated in China, the implementation frequency of JIT practices varies with organization ownerships; the foreign and joint venture firms (JVFs) were found to have a higher level of JIT implementation and can also achieve better performance from JIT implementation than state-owned and private-owned firms (POF). Also, JIT implementation was found to have a significantly positive relationship with operations performance in all types of ownership firms, with the exception of private ownership firms.

Research limitations/implications – The research only covers manufacturing firms in China. Further research is needed to test the wide implications of this research in other countries or industries.

Practical implications – This paper provides insights into how to improve JIT implementation performances, especially in various organization ownership structures.

Originality/value – The paper appears to be one of the first studies of relationship between ownership structure and JIT implementation in China manufacturing environment.

Keywords Manufacturing companies, Ownership structure, Operational performance, Survey study, JIT production

Paper type Research paper

1. Introduction

Just-in-time (JIT) production system, which originated from Toyota in the mid-twentieth century, has been accepted globally as an effective manufacturing strategy. For many

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firms, JIT has provided a competitive boost and has enabled them to meet the demands of global competition (Mackelprang and Nair, 2010).

Ohno (1982), the originator of the JIT management philosophy, defined JIT simply as "having the right part at the right time, and in the right quantity, to go to assembly". The American Production and Inventory Control Society (APICS) defines JIT as a philosophy of manufacturing based on a management plan that identifies and then eliminates all waste and that emphasizes continuous improvement (CI) in plant productivity (Brox and Fader, 2002). Monden (1983) described JIT philosophy as CI activities aiming to reduce cost through elimination of wastes, and he viewed JIT as one of the two pillars of Toyota Production System (another pillar is called automation, which is called "Jidoka" in Japanese). Summarily, a broader understanding is that JIT is a philosophy of CI in which non-value-adding activities are identified and removed in order to reduce cost, as well as to improve quality and delivery (Brox and Fader, 2002; Hall, 1983; Zelbst *et al.*, 2010). From the standpoint of JIT, there are seven types of waste-overproduction, waiting and idle time, invalid motion, transportation, inventory, ineffective processing, and product defect (Hall, 1983; Jacobs *et al.*, 2009; Gomes and Mentzer, 1988; Ramaswamy *et al.*, 2002). Because waste is non-value-adding for customers, all activities of JIT production are deployed around waste reduction, including both internal and external processes of the organization (Claycomb *et al.*, 1999).

Since the 1980s, JIT production has been one of the hottest research topics in academics and there is a large body of empirical study about the JIT problem. A number of researchers have examined the critical success factors and influence factors of JIT implementation (Ahmad *et al.*, 2003; Bayo-Moriones *et al.*, 2008; Chong *et al.*, 2001; Inman and Boothe, 1993; Kim and Takeda, 1996; Lee and Ebrahimpour, 1984; McLachlin, 1997; Peters and Austin, 1995; Power and Sohal, 2000; Sriparavastu and Gupta, 1997; White *et al.*, 1999). Other researchers have discussed the implementation methodology, elements, and problems of JIT (Al-Maarneh, 2012; Crawford and Cox, 1991; Furlan *et al.*, 2011; Harber *et al.*, 1990; Matson and Matson, 2007; McTavish *et al.*, 1991; Ramaswamy *et al.*, 2002; Sohal *et al.*, 1993; Swanson and Lankford, 1998). Some researchers have conducted international comparison of JIT implementation (Aghazadeh, 2003; Billesbach *et al.*, 1991; Kristensen *et al.*, 1999; Matson and Matson, 2007; Swamidass, 2007). Some researchers have compared the difference and complementary relationships between JIT and other manufacturing technologies, such as TQM, TOC, MRPII, agile manufacturing and supply chain (Cua *et al.*, 2001; Danese *et al.*, 2012; Dreyfus *et al.*, 2004; Flynn *et al.*, 1995; Furlan *et al.*, 2011; Inman *et al.*, 2011; Kannan and Tan, 2005; Lau, 2000; Sale and Inman, 2003; Sriparavastu and Gupta, 1997; Vuppalapati *et al.*, 1995; Youssef, 1994; Zelbst *et al.*, 2010). Also, some researchers have examined the relationship between JIT implementation and operations performance or business performance (Danese *et al.*, 2012; Fullerton and McWatters, 2001; Fullerton *et al.*, 2003; Inman *et al.*, 2011; Meybodi, 2009).

However, issues and challenges of JIT implementation also still exist in practice, such as practice of JIT and survey research have revealed that organization and culture factors play more and more important roles in implementing JIT (Wong, 2007). Moreover, prior research has paid a very little attention to the effect of contextual factors on JIT implementation, especially the effect of organization ownership structure on JIT implementation. Theoretically, different firms with different ownership types have different operations strategies, which affect the implementation of advanced manufacturing technologies such as JIT system. The purpose of this paper is to examine how the enterprise contexture variable – organization ownership influences the implementation of JIT in manufacturing companies. To the best of our knowledge, there is no literature that systematically researches the impact of organization ownership structure on JIT implementation, although several authors' works have been concerned with ownership issues in analyzing the implementation of new manufacturing technology (NMT), such as Salaheldin (2007) and Rahman *et al.* (2010). The results of this research will contribute to the body of knowledge on JIT application, offer evidence of the role of contexture factors in JIT implementation, and helpful managerial implications for firms to improve operations performance while implement JIT production system.

There exists a number of compelling reasons why Chinese manufacturing firms are the focus of this study. First, China is the world largest exporter, i.e. so-called "manufacturing floor of the world". Thus, no operations or strategic theory can claim to be complete without considering China environment. Second, as China shares many important common cultures with Korea, Vietnam, Indonesia, etc. the Chinese experience can help shed light on future firm growth in Asia. Finally, as China is becoming one of the biggest economy bodies, improved understanding of Chinese firms will have enormous practical implications for Western firms that have business dealings in China.

The paper is organized as follows: Section 2 is the theoretical background and research framework, which presents theory model and constructs hypotheses based on literature review; Section 3 introduces the research method, including questionnaire design, data collection, and method of analysis; Section 4 tests hypotheses using survey data, and discusses the results; Section 5 summarizes our conclusions and addresses the limitations of the study.

2. Theoretical background and research framework

2.1 Organization ownership theory and ownership pattern in China

In this subsection, we first discuss the influence of ownership on manufacturing strategy and performance, construct an interpretation model for explaining the relationships among ownership, manufacturing strategy and performance, and then discuss the four types of ownership patterns and characteristics of Chinese manufacturers.

2.1.1 Organization ownership, manufacturing strategy and performance. Ownership represents the control and directional power of an organization – that is, the person who, or entity that, owns the organization. There are several reasons why a firm's ownership structure impacts its strategy and performance (Beaumont *et al.*, 2002; Delios *et al.*, 2008; Douma *et al.*, 2006). First, differences among owners, especially on identity, concentration, and resource endowments put power sharing, incentives management and manager control in various directions. Second, divergent goals of owners will create different influences on organizational decisions and action policies. Third, firms with different ownership types have different organizational structures, cultures, and business processes. Thus, the influence of ownership on manufacturing strategy and performance can be explained from the viewpoints of three separate theories: agency theory, resource-based theory (Douma *et al.*, 2006), and organization theory. Using these three theories as a basis, we propose a theory model to illustrate the relationships among ownership, manufacturing strategy and performance (Figure 1).

The proposed model shown in Figure 1 shows the triangular relationships among ownership, manufacturing strategy, and operations performance based on three theoretical views, i.e.:

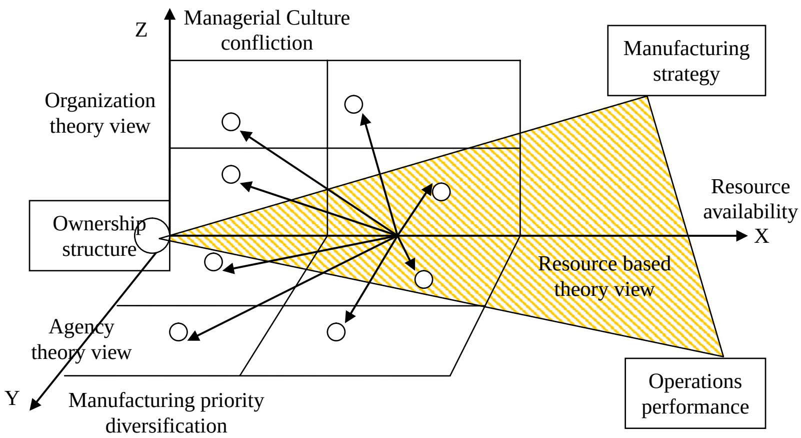

Figure 1.
Multiple-theory explaining model for ownership, manufacturing strategy and performance

- *X*-axis view of resource-based theory;
- *Y*-axis view of agency theory; and
- *Z*-axis view of organization theory.

The model can be interpreted as follows:

- *Resource-based theory view*. The *X*-coordinate axis represents resource availability of a firm from a resource-based theory view (Paiva *et al.*, 2008). Under this view, firms with different types of ownership have different resource availabilities, especially their availabilities in human resources (Jayaram *et al.*, 1999) and financial resources (Douma *et al.*, 2006). Thus, manufacturing practices and operations performances vary depending on the resources.
- *Agency theory view*. The *Y*-coordinate axis represents the manufacturing priority diversification from an agency theory view. This means that different ownership firms will have different manufacturing priorities, because agency theory demonstrates the existence of principal-principal and principal-agent goal incongruence (Dharwadkar *et al.*, 2000), confirming that firms with dispersed ownership will diversify their goals.
- *Organization theory view*. The *Z*-coordinate axis represents the managerial culture confliction of a firm from organization theory view. Organization theory is often used to explain the differences in managerial behavior of different ownership firms (Child and Yan, 2001). Usually, firms with different types of ownership have different organizational structures. Consequently, they have different managerial culture conflicts. For instance, foreign investment firms have more managerial culture conflict than domestic firms.

2.1.2 Ownership patterns and characteristics of Chinese manufacturers. The coexistence of different types of ownership is a unique economic phenomenon in China. Before 1978, only state-owned or collective-owned enterprises existed (Clarke and Du, 1998). Since the economic reform movement and the open market policy initiated by the leader of Deng Xiaoping in 1979, foreign investment has been continuously flowing into China. Currently, in China, ownership structure mainly comprises foreign-owned, joint venture, Chinese private- and state-owned enterprises. Some firms still can be categorized as collective ownership, but most of these firms having been transferred to state-owned or private firms in recent years (Kynge, 2000). Thus, true collectively owned firms no longer exist, so we do not consider this type of ownership in our study.

The four types of ownership firms play different roles in China economy, because different types of ownership have a range of advantages, disadvantages, and strategies. Based on the theory model of Figure 1, we make a comparison from three dimensions, i.e. resource availability, managerial culture conflict and manufacturing priority diversification. The comparison is listed in Table I.

The detailed analysis for Table I is conducted as follows.

(1) Foreign-owned firms (FOFs). FOFs have been entering the Chinese market since the early 1980s when China begun to open to the outside world. A representative FOF is the Coats Group, which produces a wide range of textiles and garments. The headquarters of Coats Group Company is located in the UK, and the company has invested in establishing several manufacturing plants in China.

Typically, FOFs are international and global in their reach. Thus, the internationalization gives these firms an advantage over domestically owned firms. Especially, FOFs have greater human resources advantages in terms of:

- higher levels of skilled and experienced managers; and
- a more highly skilled labor force (Beaumont *et al.*, 2002; Chamarbagwala *et al.*, 2000).

Moreover, FOFs tend to have stronger resource availability, and emphasize a higher manufacturing priority diversification (i.e. in order to have a wide reach in a global market). Also, FOFs have more experience in managing managerial culture conflict in light of their global operations.

(2) Joint venture firms (JVFs). JVFs are those companies in which foreign and domestic firms invest cooperatively. Similar to FOFs, these kinds of firms began to emerge in China in the early 1980s. A representative example of JVF is Guangzhou Honda Co. Ltd, an automobile enterprise jointly invested by the Chinese-owned Guangzhou Automobile Group and the Japanese-owned Honda Motor Co. Ltd with an investment proportion of 50 percent to 50 percent in 1998.

Ownership	Resource availability	Managerial culture conflict	Manufacturing priority diversification	Example
Foreign-owned	Strongest (++)	More (+)	High (+)	Coats Group
Joint venture	Strong (+)	Most (++)	Highest (++)	Guangzhou Honda
State-owned	Weak (−)	Least (−)	Lowest (−)	Bao Shan Steel & Iron Group
Private-owned	Weakest (−)	Less (−)	Low (−)	Huawei

Table I.
Comparison of different ownership's firms characteristics

A JVF usually is an organization with stock shared by two or more cross-border partners who both hold equity (Contractor and Lorange, 1988). The motivations of joint ventures include:

- reducing costs and risks (Acquaah, 2005);
- transferring and sharing complementary resources (Acquaah, 2005);
- overcoming restrictive government-enforced controls on foreign investments (Contractor and Lorange, 1988);
- reducing competition by binding competitors as allies (Porter and Fuller, 1986); and
- fast learning knowledge from other firms (Inkpen and Crossan, 1995).

Some researchers have examined the characteristics of JVFs in China, such as Child and Yan (2001), whose study indicates that joint ventures with transnational firms, as opposed to national firms, are more likely to lead to a transfer of management practices into China. JVFs have stronger resource availability than Chinese domestic firms. As pointed by Child and Yan (2001), JVFs also experience more culture conflict than domestic firms, especially when come to management practice transfer. Backing by the foreign partners' resources, JVFs also tend to have a higher manufacturing priority diversification when pursing their operations in China.

(3) State-owned firms (SOFs). SOFs play an important role in China's economy. In China, many important and large manufacturers are state-owned, such as Bao Shan Steel & Iron Group Company, which is the largest state-owned manufacturer. Before the 1979 reform campaign, state-owned enterprises dominated the national economy. However, with an increase in other types of ownership, the overall ownership structure has become increasingly hybrid, and SOFs now account for an ever-decreasing segment of industrial output. In 1978, state-owned enterprises accounted for 77.6 percent of industrial output, but only 26.5 percent by 1998 (Anon, 2001).

However, SOFs are not without their own problems and challenges. Delios *et al.* (2008) contend that state-owned enterprises are usually driven by government policy, and they tend to lack the experience and capabilities necessary to deal with organizational and managerial complexities. Lin (2010) concludes that, compared with private-owned firms (POFs), SOFs are likely to be driven by motives beyond economic rationality, and are also more likely to "leap frog" into an integrated entry strategy in the internationalization process. A number of authors indicate that state-owned enterprises with poor profitability, low labor productivity, and principal – agent factors have encountered challenging reform issues (Moore and Wen, 2006; Hassard *et al.*, 2010).

Due to state ownership and investment in a single country, SOFs have weak resource availability (but stronger than private firms), low managerial culture conflict, and low manufacturing priority diversification. These characteristics prevent SOFs from obtaining sufficient high-skilled workforces with international management experience to implement advanced manufacturing technologies and management practices. All these factors lead to SOFs have lower performance than foreign-owned and joint ventures firms.

(4) Private-owned firms. POFs play an increasing role in China's economy, though private ownership was not legal in China until the late 1970s. In the last decade, in contrast to the steadily shrinking state-owned sector, the private sector has seen rapid

growth (Lin, 2010). Koretz (2001) reports that China's private sector accounts for over 75 percent of the country's output. A representative private firm is Huawei, one of the well-known brands of telecommunication and IT equipment manufacturers in the world.

Compared with SOFs, Chinese POFs are young, and have a simple and flexible organization structure (Peng *et al.*, 2004). Also, POFs have a strong interest in profit maximization although they are resource poor (Delios *et al.*, 2008). They typically pursue more diversification strategies than SOFs do, but the diversification level is lower than that of JVF and FOFs. On the other hand, private firms have less managerial culture conflict because they tend to be family-owned enterprises, or owned by private investors with common business goals, so their managerial culture conflict is less than that of foreign-owned and JVFs, but more than that of SOFs.

2.2 Research hypotheses

So far, we have inferred that different types of ownership can lead to different management styles and corporate governmental structures, and this will impact the adoption of manufacturing technologies and management practices. In strategic management and financial literature, there are many studies looking into the relationship between a firm's ownership and its financial or social performance (Chaganti and Damanpour, 1991; Delios *et al.*, 2008; Douma *et al.*, 2006; Johnson and Greening, 1999; Miguel *et al.*, 2004; Oswald and Jahera, 1991). However, little attention has been paid to the relationship between ownership and operations strategy, or relationship between ownership and operations performance (Nakamura *et al.*, 1998; Salaheldin, 2005, 2007). In particular, the relationship between ownership and manufacturing operations management in the economic environment of China has largely been ignored (Zhang and Goffin, 1999). Our study tends to address this gap. Especially, this study will analyze the impact of ownership on JIT implementation performance of manufacturing firms in China. For this, this paper seeks to answer the following questions:

- Does the organization ownership structure impact the total implementation extent of JIT and operations performance?
- In the different categories of firm ownership, are there any preferences in the use of individual elements of JIT?
- Does the organization ownership structure affect the relationship between JIT implementation and production operations performance?

Because the literature presents no systematic study of the relationship between ownership and JIT implementation, we mainly refer to other relevant research, i.e. how ownership impacts manufacturing technology or management practices in other countries.

Schroeder and Sohal (1999) report that among Australian manufacturers, foreign- and multinationally owned companies are more willing to adopt advanced manufacturing technology (AMT) than Australian-owned companies. Similar results can be found in research carried out by Beaumont *et al.* (2002), in which empirical data proves their proposition that foreign-owned companies manage the implementation of AMT better than their domestic counterparts in Australia. In related research addressing ownership issues in the emerging economy of Ghana, Acquaah (2005) reports that foreign-domestic joint venture enterprises place more emphasis on achieving manufacturing priorities (manufacturing efficiency, cost reduction, delivery speed and reliability, production flexibility, and quality improvement) than wholly domestic-owned private enterprises.

Similar confirming evidence from northern Africa is found in Salaheldin (2007), who shows that, in Egypt, private and multinational companies are more willing to spend money on the acquisition of advanced manufacturing technologies than those companies owned by the Egyptian Government (state-owned companies).

Based on survey set in China, Pyke *et al.* (2002) compare differences in the implementation levels of manufacturing technology among the four types of ownership – state-owned enterprises, private firms, joint ventures, and FOFs. Their results show that FOF and JVF have higher levels of AMT implementation than private and SOFs. Laosirihongthong *et al.* (2003) examine the implementation of NMT in Thailand's automotive industry. They compare the differences among Thai-owned, joint venture, and FOFs in implementing various elements of NMT. Their results show that the degree of NMT implementation varies widely among companies with different types of ownership. Similarly, Rahman *et al.* (2010) examine the impact of lean strategy on operations performance, based on survey data from Thai manufacturing companies. In their study, they compare the differences in the relationships between lean practices and operational performance among different types of company ownership – Thai-owned, foreign-owned and joint venture. Their results show that for firms with different types of ownership, the impact of lean strategy on performance is different, but their research does not detail the analysis of individual elements of JIT.

Based on the extended literature review and above discussion, we establish following hypotheses:

H1. There is a significant difference among Chinese manufacturing firms concerning the implementation extent of JIT.

H1a. For integrated bundles of JIT systems, foreign-owned and JVFs have a higher extent of JIT implementation than state-owned and private firms.

H1b. For individual elements of JIT, firms with different types of ownership have different preferences when implementing JIT production systems.

H2. Foreign-owned and JVFs can obtain higher performance from implementing JIT than state-owned and POFs.

H3. Ownership will moderate the relationship between JIT implementation and operations performance – in other words, foreign-owned and JVFs will have stronger positive relationships between JIT implementation and operations performance than SOF and POFs.

2.3 Control variables

Although this study's interest centers on investigating the relationship between ownership and JIT implementation, the results may be influenced by other factors such as type of industry or size of firm (Ahmad *et al.*, 2003; Dreyfus *et al.*, 2004; Lawrence and Hottenstein, 1995). Thus, industry type and sales revenue per year are included as control variables in the model.

Type of industry is an important factor for two reasons. First, different types of industries have different competitive environments, which influence the adoption and implementation of JIT. Second, industry type determines the type of product and process. For example, the chemical industry primarily adopts batch and continuous manufacturing processes, whereas the automobile industry uses the assembly line.

This inherent nature of processes can impact the ability of various industries in implementing individual elements of JIT systems. Hence, industry type is included as control variable.

We use sales revenue per year as a second control variable. Although it is typical for researchers to use the number of employees as a control variable of organization scale, we think that sales revenue can more precisely reflect the operational scale and the ability of an organization to implement JIT. Because the higher the sales revenue, the more resources (human resource and other resources) an organization can pay for, hence, the higher the ability for adopting JIT, etc. advanced manufacturing technologies. The research framework of these hypotheses is shown in Figure 2.

3. Research design and methodology

This section introduces the research methodology, including measure variables, data collection, and processing method.

3.1 Measures of operations performance

Though many metrics can be used to measure operations performance, based on literature review and our observations in practice, combined with characteristics of our research problem, we adopt the following four measures for production operations performance:

(1) *Operations cost*. Cost is always the most frequently mentioned operations performance metric for examining JIT implementation (Cua *et al.*, 2001; Hallgren and Olhager, 2009; Mackelprang and Nair, 2010). In this paper, we use this measure to evaluate the satisfaction degree of cost control in JIT implementation.

(2) *Quality level*. Quality is the most frequently used metric for operations performance (Chong *et al.*, 2001; Fullerton and McWatters, 2001; Hallgren and Olhager, 2009; Mackelprang and Nair, 2010). A successful JIT implementation will lead to better quality level (QL) in operations. Thus, it is very natural to use QL as one metric to measure JIT implementation.

(3) *On-time ratio of product delivery*. Many authors set on-time delivery or delivery reliability as important performance measure of JIT implementation, such as

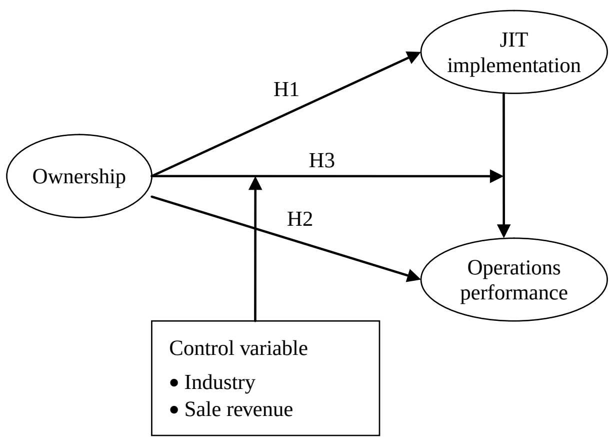

Figure 2.
Research framework

Upton (1998), Ahmad *et al.* (2003), Aydin *et al.* (2008), Hallgren and Olhager (2009) and Sakakibara *et al.* (1997). Thus, in this paper, we use on-time ratio of product delivery as delivery performance.

(4) *WIP inventory level.* JIT production system strives to reduce work-in-process (WIP) by producing the minimum number of required parts (Finch and Cox, 1986); furthermore, minimize the WIP inventory and minimize fluctuations in WIP are two objectives of JIT (Huang *et al.*, 1983). Other inventories, e.g. finished goods inventory, are dependent on WIP level, so WIP inventory level is a appropriate measure to reflect the inventory control ability of JIT production system.

In our questionnaire, we use a five-point Likert scale to measure operations performance, respondents were asked to rank their firms performance as "very satisfactory", "satisfactory", "normal", "unsatisfactory" and "extremely unsatisfactory".

3.2 Measures of JIT implementation practices

Although, JIT has been implemented by different companies around the world and studied by academics for several decades, there has been no consistent agreement regarding which practices comprise JIT (Sakakibara *et al.*, 1997; Mackelprang and Nair, 2010). The numbers and descriptions of JIT elements reported in literature vary quite significantly. White *et al.* (1999) through survey study of US manufacturers summarized a set of ten JIT practices. Recently, other researchers, such as Ward and Zhou (2006), Matsui (2007) and Mackelprang and Nair (2010) also sorted JIT practice into ten elements although the descriptions of JIT elements are different. Based on literature review and our examination in China, we now summarize ten elements of JIT production system implemented by Chinese firms:

(1) *Setup time reduction.* This element is not only often mentioned by most literature but also widely used by Chinese firms in their JIT initiatives. Setup time reduction (STR) is also called quick changeover (Shah and Ward, 2003), its function is to reduce the time involved in changing from producing one product to other products. Reducing the setup times will allow for reducing economic lot sizes and reducing inventory (Fullerton *et al.*, 2003; White *et al.*, 1999).

(2) *Small lot size.* Small lot size is a typical practice of JIT system implemented in Toyota. Small lot size enables JIT systems to operate effectively, e.g. less WIP inventories, less space required, and increased flexibility (Zhu and Meredith, 1995). However, in China, this element has not been widely accepted by firms, Nonetheless, it is an important element of JIT system.

(3) *Quality control.* This is an infrastructure element of JIT. In certain literature, it is also named as "Total quality control" (Chong *et al.*, 2001), "quality circle" (Meybodi, 2009; White *et al.*, 1999), "quality management programs" (Shah and Ward, 2007) and "Total quality management" (Browning and Heath, 2009). In China, more and more firms are practicing quality improvement activities like quality control (QC) circle (QCC) and Six Sigma improvement. We name this element as "quality control", a general term to denote different quality activities in a firm.

(4) *JIT purchasing.* This is a supplier participation and partnership program. This program involves suppliers in long-term mutually rewarding cost-reduction

efforts (White *et al.*, 1999). Usually, it requires frequent and on time delivery, quality certification (Matsui, 2007), sole sourcing and developing a long-term relationship (Jacobs *et al.*, 2009). In China, now more and more firms are recognizing the importance of JIT purchasing in implementing JIT production system, and beginning to initiate JIT purchasing activity.

(5) *JIT facility layout.* In JIT system, equipment layout, such as U-shape manufacturing cell (Im and Lee, 1989) is notably different from the traditional process layout pioneered in Ford system. This kind of manufacturing cell and other smaller equipment designed for flexible floor layout (Matsui, 2007) can eliminate operator's motion waste and have flexibility in responding to demand variations. However, this element has not been widely applied in China, this is because many firms are still blinded by traditional factory design idea and have not yet understood the benefits of U-shaped layout. Nonetheless, some firms, especially foreign-owned and JVFs have adopted this element in their JIT initiatives.

(6) *Total productive maintenance.* This element attempts to establish a routine preventive maintenance and replacement program (White *et al.*, 1999) in order to reduce waste of machine breakdown and failure. This requires operators to actively participate in the machine maintenance. This element is widely accepted by Chinese firms when implement JIT production system, even some firms which have not yet implemented JIT system also actively promote this kind practice.

(7) *Kanban and visual management.* In JIT system, the original meaning of Kanban is a signaling device (usually is a card) to regulate material flows (Jacobs *et al.*, 2009), its function is establish a "pull" system to authorize the production or supply of materials at workstations or between workstations. In China, the definition of Kanban has been extended, it is used to denote all kinds of visual management tools. In this study, the measure includes the implementation of production Kanban and other visual management tools.

(8) *Level scheduling.* In Japanese, this idea is called "Heijunka". It requires materials to be pulled into final assembly in a pattern uniform enough to allow the various elements of production to respond to pull signals (Jacobs *et al.*, 2009). This element attempts to stabilize and smooth the production workload (White *et al.*, 1999), reduce the waste of WIP and obtain high flexibility to respond to diverse demand. For the majority of Chinese firms, this element has not been widely understood and implemented, especially in some order driven manufactures.

(9) *5S campaign.* Sometime it is called "housekeeping". "5S" is a synthetic abbreviation word consisting of the five first letters of the following five words: sort, straighten, sweep, standardize, and self-discipline (Browning and Heath, 2009). 5S is translated from the five Japanese words: "seiri", "seiton", "seiso", "seiketsu" and "shitsuke". Sort means that separate the things into what are needed and what are not needed; straighten means that make everything in proper place for quick retrieval and storage; sweep means that keep the workshop in clean situation; standardize means that standardize the way of maintaining cleanliness; self-discipline means that practice 5S everyday, and make it a way of life, commit to keep cleanliness and orderliness by oneself. 5S is a basic practice of JIT, although it is not frequently mentioned by academic literature, from our practice observation and others' case

studies (Monden, 1983; Gubata, 2008; Browning and Heath, 2009), it is usually viewed as an important prerequisite for implementing JIT, especially in China.

(10) *Multi-skill employee.* This element in literature has different expressions, such as "flexibility of worker's skill" (Brox and Fader, 2002), "cross-functional workforce" (Browning and Heath, 2009; Shah and Ward, 2003), "cross-functional training" (Cua *et al.*, 2001), etc. The basic idea is to equip employees with various skills so that they could work on several different machines and in several functions (White *et al.*, 1999), the aim is reduce waste of human resource. In China, more and more firms are recognizing the benefit of multi-skill employee (MSE), and begin to promote this practice.

The above ten practices are used as measure items of JIT implementation in this study. All items are set on a five-point Likert scale, i.e. "always used", "often used", "sometime used", "seldom used" and "not used".

3.3 Questionaire design and data collection
The questionnaire comprises three parts:

- The first part is about basic information of surveyed companies and respondents.
- The second part is about the information of JIT implementation situation in the surveyed companies.
- The third part is about the production operations performance (Appendix is main body of questionnaire).

During the questionnaire design, we contacted several plant managers and asked them to participate to pre-test the questionnaire. Their suggestions were used to revise the questionnaire. These plant managers were part-time MBA students of the author's business school and were working at different manufacturing companies. Based on the feedback from the pilot study, we clarified the language expression of some questions, made all items easier to understand and can be precisely answered.

Data collection was conducted in several districts in China, i.e. south, east, west, center, and north of China, in each district we chose one or two representative cities to collect data. Two approaches were used:

(1) mail through post; and
(2) on-site form filling in MBA classrooms.

In the first approach, surveyed companies were selected according to the districts and industries distribution. The mail addresses of these companies were obtained in company catalogues (Yellow Pages of China Telecom). As regarding the second approach, we chose several universities in different districts around the country (all these universities should have MBA programs). Prior to the survey, we contacted relevant professors in each university, sought their agreement, then mailed the questionnaires to them and told them the method of collecting data. Through these professors, questionnaires were given to MBA students in classrooms. The requirement was announced to students that the respondents must be working at manufacturing firms. The completed questionnaires were then mailed back to the first author's institute.

3.4 Characteristics of the plants in the study sample

Totally, 246 questionnaires were obtained, in which there are 224 effective questionnaires. The regional breakdown of the 224 effective questionnaires is: 30 are from west district, 23 from north district, 50 from south district, 52 from east district, and 69 from central district. The detail characteristics of the surveyed firms are listed in Table II. The characteristics of the surveyed firms are summarized as follows.

In terms of the sales revenue per year, 14.3 percent surveyed firms have sales revenue < 50 millions, about 48.3 percent firms have more than 500 millions but less than 500 millions, 37 percent firms have > 500 millions. This reveals that the surveyed sample covers different scale firms. As industry distribution, the sample covers the most important ten industries in China. For production type, 35.3 percent of the firms adopt make-to-order (MTO), and 52.2 percent firms adopt mix of MTO and make-to-stock (MTS) production types, only 12.5 percent firms adopt MTS production type. For batch type of production process, only 4 percent firms adopt small batch process, 44.2 percent firms adopt middle batch process, and 51.8 percent firms adopt large batch process. This shows that most firms adopt middle or large batch production processes.

An ANOVA analysis was conducted to compare the five waves of respondents (questionnaires from different districts are grouped into different response waves) based on industry. Result shows that *F*-value is 1.617, *p*-value (Sig. value) is 0.171 (> 0.05), indicating that non-response bias does not exist for all samples in this study.

Item	Answer type	Description	Response number	Percentage
Sales revenue/yearly (million RMB)	1	≤50	32	14.3
	2	(50, 100]	40	17.9
	3	(100, 500]	68	30.4
	4	(500, 1,000]	20	8.9
	5	> 1,000	64	28.6
Ownership	1	Foreigner owned	64	28.6
	2	Jointed venture	37	16.5
	3	Private	44	19.6
	4	State-owned	79	35.3
Production type	1	Make to order	79	35.3
	2	Make to stock	28	12.5
	3	Mixed	117	52.2
Industry	1	Family apparatus industry	14	6.3
	2	Chemical industry	26	11.6
	3	Pharmaceutical industry	12	5.4
	4	Textile industry	7	3.1
	5	Metallurgy industry	16	7.1
	6	Electronic industry	30	13.4
	7	Automobile industry	29	12.9
	8	Mechanical industry	20	8.9
	9	Food industry	21	9.4
	10	Others	49	21.9
Type of process	1	Small batch job shop process	9	4.0
	2	Medium size batch process	99	44.2
	3	Large batch process	116	51.8

Table II.
Characteristics of surveyed companies

4. Data analysis and research results discussion

4.1 Construct validity and reliability analysis

Construct validity measures whether a scale is an appropriate operational definition of a construct (Flynn *et al.*, 1990). Exploratory factor analysis (EFA) is considered most powerful method of construct validation. A principal component factor analysis with varimax rotation was done. Factor analysis shows that all elements except small lot size can be included into the same factor. According to the viewpoint of Gupta and Somers (1992), correlation analysis can be used to provide further evidence of the construct validity of the instrument. Initial correlation coefficient matrix shows that all JIT elements except small lot size have significant correlations under $p < 0.01$ or $p < 0.0$ level (two-tailed). Then the element of small lot size in this study can be discarded in the next analytical models. Correlation analysis for the remainder nine elements was conducted again and result is shown in Table III. For all four measures of operations performance, factor analysis shows that all factor loadings are larger than 0.5, meaning all belong to one factor. Correlation coefficient matrix shows the four measures have significant correlations at $p < 0.01$ or $p < 0.05$ level (Table III).

Reliability analysis is an assessment of the degree of consistency between multiple measurements of a variable, corrected item to total correlation (CITC) scores and Cronbach's α are usually used for reliability analysis.. Generally, the acceptable criterion of Cronbach's α value is 0.6 (Lawrence and Hottenstein, 1995; Flynn *et al.*, 1990), and acceptable value of CITC is 0.3 (Shah and Ward, 2007). For the nine retained measures of JIT, all items' CITC value ranges from 0.473 to 0.683, and Cronbach's α value of construct is 0.850, both reach the acceptable criteria (Table IV). For measures of operations performance, based on the Cronbach's α values and CITC values (Table V), the scale of performance is reliable.

Finally, we conducted confirmatory factor analysis (CFA) analysis to further test unidimensionality and reliability of the instrument using AMOS. CFA for JIT model shows all model fit indices are acceptable ($\chi^2 = 46.219$, df = 27, RMSEA = 0.056, GFI = 0.954, NFI = 0.928, NNFI (TLI) = 0.958). For operations performance, model fit indices are also acceptable ($\chi^2 = 5.763$, df = 2, RMSEA = 0.092, GFI = 0.988, NFI = 0.971, NNFI (TLI) = 0.940). This indicates that the model is acceptable and unidimensionality and reliability are further confirmed (CFA result is shown as Table VI).

4.2 Analysis method and hypotheses testing

In this section, the test results for each hypothesis will be described and discussed.

*4.2.1 Impacts of organization ownership structure on the integrated bundles of JIT implementation and individual element of JIT (*H1*)*. To examine the *H1*, i.e. the impacts of ownership structure on the integrated bundles of JIT and individual element of JIT, we first used one-way ANOVA statistical analysis method to compare the difference of ownerships regarding JIT implementation, and then analyzed their impact on the individual elements of JIT.

To take one-way ANOVA analysis, we first tested homogeneity of variance (only if variances are homogeneous can we carry out ANOVA analysis). Levene Statistic value of JIT implementation is 0.896, and Sig. = 0.444 > 0.05, indicating that the variances of different ownerships regarding JIT implementation satisfy the homogeneity of variance assumption of ANOVA analysis (i.e. variance heterogeneity is not significant).

Table III.
Spearman's ρ correlation matrix of JIT elements and operations performance

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. STR	1.00												
2. QC	0.201**	1.00											
3. JITP	0.265**	0.277**	1.00										
4. FL	0.393**	0.213**	0.393**	1.00									
5. MSE	0.248**	0.410**	0.382**	0.330**	1.00								
6. 5S	0.350**	0.420**	0.269**	0.356**	0.434**	1.00							
7. KB	0.403**	0.330**	0.334**	0.414**	0.400**	0.560[illegible]	1.00						
8. LS	0.337**	0.389**	0.332**	0.403**	0.414**	[illegible]	0.503**	1.00					
9. TPM	0.374**	0.352**	0.379**	0.510**	0.462**	[illegible]**	0.492**	0.576**	1.00				
10. WIP	0.184**	0.169*	0.249**	0.090	0.213**	[illegible]*	0.081	0.086	0.213**	1.00			
11. OTD	0.231**	0.268**	0.264**	0.260**	0.300**	0.324**	0.223**	0.280**	0.250**	0.460**	1.00		
12. QL	0.156*	0.276**	0.134*	0.137*	0.249**	0.262**	0.158*	0.217**	0.172**	0.277**	0.433**	1.00	
13. OC	0.221**	0.158*	0.225**	0.209**	0.337**	0.322[illegible]	0.208**	0.215**	0.282**	0.457**	0.470**	0.427**	1.00

Notes: Significant at: $^{*}p = 0.05$ and $^{**}p = 0.01$ level (two-tailed); STR – setup time reduction, QC – quality control, JITP – JIT purchasing, FL – JIT facility layout, MSE – multiple skill employee, 5S – "5S" campaign, KB – Kanban system, LS – level scheduling, TPM – total productive maintenance, WIP – WIP inventory level, OTD – on time ration of product delivery, QL – quality level, OC – operations cost

Item	Measures	Mean	SD	CITC	Cronbach's α if item deleted
1	STR	2.53	1.369	0.473	0.845
2	QC	4.09	1.003	0.464	0.844
3	JIT purchasing (JITP)	3.59	1.068	0.476	0.843
4	JIT facility layout (FL)	2.83	1.417	0.557	0.836
5	MSE	3.45	1.178	0.559	0.835
6	"5S" campaign (5S)	3.79	1.290	0.625	0.828
7	Kanban and visual management (KB)	3.28	1.441	0.644	0.826
8	Level scheduling (LS)	3.25	1.278	0.642	0.826
9	TPM	3.13	1.328	0.683	0.822
Cronbach's α				0.850	

Table IV. Reliability analysis of JIT implementation

Item	Measures	Mean	SD	CITC	Cronbach's α if item deleted
1	WIP inventory level (WIP)	3.44	0.906	0.508	0.703
2	On time ratio of delivery (OTD)	3.82	0.830	0.590	0.655
3	Quality level (QL)	3.92	0.756	0.472	0.719
4	Operations cost (OC)	3.34	0.910	0.586	0.655
Cronbach's α				0.743	

Table V. Reliability analysis of production performance

Variables	Items	Unstandardized factor loading	Standardized factor loading	SE	*t*-value
JIT practices (JIT)	STR	1.000	0.509	–	–
	QC	0.738	0.513	0.128	5.783
	JITP	0.775	0.505	0.135	5.728
	FL	1.221	0.600	0.191	6.378
	MSE	1.031	0.609	0.160	6.434
	5S	1.276	0.688	0.186	6.875
	KB	1.456	0.703	0.209	6.949
	LS	1.311	0.714	0.187	7.000
	TPM	1.431	0.750	0.200	7.164
Operations performance (PER)	WIP	1.000	0.616	–	–
	OTD	1.058	0.712	0.148	7.158
	QL	0.773	0.571	0.122	6.346
	OC	1.146	0.704	0.161	7.134

Table VI. CFA analysis results

From ANOVA analysis result, we can see that for different ownerships, the effect of JIT implementation has significant difference (see Table VII, $F = 7.262$, Sig. $= 0.000 < 0.05$). This means that the implementation degree of JIT varies widely among companies with different types of ownership.

Multiple comparisons of *post hoc* test by LSD were conducted (Table VIII). From the analysis, the priority order of four types of firms (based on the means of implementation extent of JIT) from high to low is: FOFs (3.6528) > JVFs (3.5195) > SOFs (3.1139)

> POFs (3.0657). The homogeneous subsets classification at Subset $\alpha = 0.05$, which clearly indicates the presence of two groups. The result points out that, foreign-owned and JVFs are at one set, SOF and POF are at another set. This result confirms the hypothesis *H1a*.

For the hypothesis *H1b* (i.e. whether there is any preference in adopting elements of JIT among different ownership firms), we used the MANOVA method to test it. The reason we selected the MANOVA method is because the dependent variables are a set (nine elements of JIT) and MANOVA is more robust than ANOVA, although multiple individual ANOVAs also can be applied (Laosirihongthong *et al.*, 2003). Table IX shows the multivariate tests, indicating that ownership has a significant effect on adopting of individual elements of JIT.

Table X is the *post hoc* test result based on the LSD method of MANOVA. The result indicates that for seven of nine elements of JIT, i.e. STR, JIT purchasing, JIT

Table VII. ANOVA analysis result for ownerships – JIT implementation

	Sum of squares	df	Mean square	*F*-value	Sig.
JIT implementation					
Between groups	14.755	3	4.918	7.262	0.000*
Within groups	149.009	220	0.667		
Total	163.764	223			

Note: Significant at: $^*p = 0.05$

Table VIII. *Post hoc* tests of ownerships – JIT implementation

Type of ownership (i)	Type of ownership (j)	Mean different (i − j)	SE	Sig.
Foreign-owned (3.6528)	Joint venture	0.13326	0.16997	0.434
	Private-owned	0.58712*	0.16117	0.000
	State-owned	0.53885*	0.13841	0.000
Joint venture (3.5195)	Foreign-owned	−0.13326	0.16997	0.434
	Private-owned	0.45386*	0.18357	0.014
	State-owned	0.40560*	0.16395	0.014
Private-owned (3.0657)	Foreign-owned	−0.58712*	0.16117	0.000
	Joint venture	−0.45386*	0.18357	0.014
	State-owned	−0.4827	0.15481	0.756
State-owned (3.1139)	Foreign-owned	−0.53885*	0.13841	0.000
	Joint venture	−0.40560*	0.16395	0.014
	Private-owned	0.04827	0.15481	0.756

Notes: Significant at: *0.05 (LSD) level; dependent variable – JIT implementation

Table IX. Multivariate tests of ownership on elements of JIT

Effect	Model	Value	*F*-value	Hypothesis df	SE	Sig.
Intercept	Pillai's trace	0.958	539.581	9.000	212.000	0.000
	Wilk's lambda	0.042	539.581	9.000	212.000	0.000
Ownership	Pillai's trace	0.235	2.019	27.000	642.000	0.002
	Wilk's lambda	0.778	2.057	27.000	619.000	0.001

Element of JIT		FOF	JVF	POF	SOF
STR	Mean score →	3.05	2.81	2.16	2.18
	JVF	0.24 (0.387)			
	POF	*0.89 (0.001)*	*0.65 (0.028)*		
	SOF	*0.87 (0.000)*	*0.63 (0.017)*	−0.02 (0.942)	
Quality improvement	Mean score →	4.23	4.30	3.86	4.00
	JVF	−0.06 (0.760)			
	POF	0.37 (0.059)	0.43 (0.052)		
	SOF	0.23 (0.163)	0.30 (0.136)	−0.14 (0.468)	
JIT purchasing	Mean score →	3.81	3.65	3.61	3.37
	JVF	0.16 (0.455)			
	POF	0.20 (0.339)	0.04 (0.882)		
	SOF	*0.45 (0.013)*	0.28 (0.184)	0.25 (0.217)	
JIT facility layout	Mean score →	3.42	2.84	2.36	2.61
	JVF	*0.58 (0.040)*			
	POF	*1.06 (0.000)*	0.47 (0.122)		
	SOF	*0.81 (0.000)*	0.23 (0.399)	−0.24 (0.344)	
MSE	Mean score →	3.67	3.30	3.45	3.33
	JVF	0.37 (0.124)			
	POF	0.22 (0.346)	−0.16 (0.549)		
	SOF	0.34 (0.084)	−0.03 (0.892)	0.13 (0.571)	
"5S" campaign	Mean score →	4.27	4.11	3.30	3.53
	JVF	0.16 (0.538)			
	POF	*0.97 (0.000)*	*0.81 (0.004)*		
	SOF	*0.73 (0.001)*	*0.58 (0.020)*	−0.24 (0.311)	
Kanban and visual management	Mean score →	3.61	3.70	[illegible].02	2.95
	JVF	−0.[illegible]9 (0.74[illegible])			
	POF	*0.59 ([illegible])*	*0.68 (0.[illegible]32)*		
	SOF	*0.66 (0.006)*	*0.75 (0.008)*	0.07 (0.782)	
Level scheduling	Mean score →	3.41	3.59	2.95	3.13
	JVF	−0.19 (0.472)			
	POF	0.45 (0.070)	*0.64 (0.024)*		
	SOF	0.28 (0.191)	0.47 (0.065)	−0.17 (0.471)	
TPM	Mean score →	3.41	3.38	2.86	2.94
	JVF	0.03 (0.918)			
	POF	*0.54 (0.036)*	0.51 (0.081)		
	SOF	*0.47 (0.035)*	0.44 (0.093)	−0.07 (0.768)	

Notes: Figures outside brackets are mean difference; figures inside brackets are sig. value; for example, 0.47 (0.035) at the last row of the third column indicates that the mean difference of FOFs and SOFs is 0.47, and the sig. value is 0.035; all italicised characters represent significant at 0.05 level

Table X. Elements of JIT and type of ownership (LSD)

facility layout, "5S" campaign, Kanban/visual management, level scheduling, and total productive maintenance (TPM), the implementation degrees are different in respect to ownership (although they are not all significant). Especially, for STR, JIT facility layout, 5S campaign, Kanban/visual management and TPM, FOFs significantly were found to have higher implementation degree than state-owned and POFs However, the analysis also shows that two elements, i.e. quality improvement and MSE, have not significant difference for all ownership firms. This reflects that all firms take quality improvement and employee training as important practices in implementing JIT.

*4.2.2 Impact of organization ownership on the perceived performance of JIT implementation organizations (*H2*).* Similar to *H1*, we tested *H2* using ANOVA method, i.e. we tested whether the difference of perceived performance of organizations is significant in respect to ownership. To take one-way ANOVA analysis, we first tested homogeneity of variance. Levene Statistic value of perceived performance is 0.681, and Sig. $= 0.564 > 0.05$, indicating that the variances of different ownerships regarding JIT implementation satisfy the homogeneity of variance assumption of ANOVA analysis.

Table XI is the ANOVA analysis result for the relationship between ownership and perceived performance. From the result, we can see that the difference of perceived performance of organizations is significant in respect to ownership (F value is significant because Sig. $= 0.000 < 0.05$). Further analysis of multiple comparisons of *post hoc* test by LSD was then conducted (Table XII). From the multiple comparison analysis, the priority order of four types of ownership firms (based on the means of perceived performance) from high to low is: FOFs (3.9453) > JVFs (3.6486) > SOFs (3.5063) > POFs (3.3750).

*4.2.3 Impact of organization ownership on the relationship between JIT implementation and operations performance (*H3*).* In order to verify *H3*, i.e. we need construct hierarchical regression models for four types of ownerships. For this, the comprehensive measure value of JIT is treated as independent variable, and comprehensive measure value of performance as dependent variable. The comprehensive measure value is the average value of all individual measure, i.e. comprehensive performance

Table XI. ANOVA analysis result for ownerships – perceived performance

	Sum of squares	df	Mean square	*F*-value	Sig.
Perceive performance					
Between groups	10.445	3	3.482	9.436	0.000*
Within groups	81.175	220	0.369		
Total	91.621	223			

Note: Significant at: $^{*}p = 0.05$

Table XII. *Post hoc* tests of ownerships – perceived performance

Type of ownership (i)	Type of ownership (j)	Mean different (i − j)	SE	Sig.
Foreign-owned (3.9453)	Joint venture	0.29666*	0.12545	0.019
	Private-owned	0.57031*	0.11896	0.000
	State-owned	0.43898*	0.10216	0.000
Joint venture (3.6486)	Foreign-owned	− 0.29666*	0.12545	0.019
	Private-owned	0.27365*	0.13549	0.045
	State-owned	0.14232	0.12101	0.241
Private-owned (3.3750)	Foreign-owned	− 0.57031*	0.11896	0.000
	Joint venture	− 0.27365*	0.13549	0.045
	State-owned	−0.13133	0.11427	0.252
State-owned (3.5063)	Foreign-owned	− 0.43898*	0.10216	0.000
	Joint venture	−0.14232	0.12101	0.241
	Private-owned	0.13133	0.11427	0.252

Notes: Significant at: *0.05 (LSD) level; dependent variable – JIT implementation measure = (cost performance + quality performance + WIP performance + delivery performance)/4. Similarly, the formula was applied to the JIT measure as well.

In the first step, we tested whether the relationship between JIT and operations performance is dependent on industry and sales revenue of the respondent firms. We treated the sales revenue and industry type as control variables. Because industry type is a kind of classification variable, in order to construct regression model, we first changed the industry type into dummy variable (2 digit code) and entered them into the model (i.e. dummies 1-9 in Table XIII). In total, three models were developed, i.e. Models 1-3.

Under hierarchical regression analysis method, the input sequence of variables is: first, dummy variables were entered into the model, then, sales revenue was entered into the model, and finally, JIT was entered into the model. Regression models are shown in Table XIII. The results show that both industry and sales revenue of surveyed firms have not significant effect on the relationship between JIT implementation and operations performance (in model 1, $R^2 = 0.023$, model $F = 0.557$, Sig. $= 0.831 > 0.05$, model 2, $R^2 = 0.034$, model $F = 0.744$, sig. $= 0.682 > 0.05$, all β coefficients Sig. > 0.05) From the results, we can see that as an integrated system, JIT implementation has significant positive influence on production operation performance (model 3, F $= 4.642$, Sig. $= 0.000 < 0.05$).

Next, we tested the impact of ownership on the relationship between JIT implementation and performance. Regression models for four types of ownerships were then constructed. The analysis result is shown in Table XIV.

Analysis of results of Table XIV shows that for foreign-owned, joint venture, and SOFs, the relationships between JIT implementation and performance are significant. However, for POFs, the relationship is not significant (p = 0.05 level). From the models' β-value, we can also see that JIT implementation in foreign-owned and JVFs have more improvement effect on performance than in state-owned and POFs. Hence H[illegible] is supported.

5. Discussion and conclusions

Using empirical data, this study examines the relationships among implementation of JIT, organization ownership structure and production operations performance.

Model	Model 1		Model 2		Model 3	
Variable	β	Sig.	β	Sig.	β	Sig.
Dummy1	0.058	0.436	0.043	0.565	−0.022	0.755
Dummy 2	0.085	0.281	0.080	0.308	0.070	0.329
Dummy3	−0.036	0.622	−0.038	0.607	−0.051	0.448
Dummy 4	−0.036	0.612	−0.080	0.651	0.001	0.984
Dummy 5	0.076	0.312	−0.032	0.544	0.053	0.456
Dummy 6	0.096	0.230	0.047	0.261	0.041	0.573
Dummy 7	0.049	0.536	0.090	0.622	−0.047	0.523
Dummy 8	−0.011	0.890	0.039	0.937	0.044	0.535
Dummy 9	0.005	0.952	−0.006	0.862	0.026	0.707
Sales revenue			0.110	0.124	−0.24	0.729
JIT					0.448	*0.000*
R^2	0.023	0.034			0.194	
Adjusted R^2	−0.018	−0.012			0.152	
ΔR^2	0.023	0.034			0.194	
F	0.557	0.744			4.642	
Sig. F	0.831	0.682			*0.000*	

Table XIII. Hierarchical regression analysis of dependent variable (operations performance)

Table XIV.
Regression models of JIT implementation and performance for different ownerships

Model	Foreigner-owned ($n=64$)	Joint venture ($n=37$)	Private-owned ($n=44$)	State-owned ($n=79$)
β	0.458	0.382	0.284	0.321
t value	4.061	2.449	1.919	2.978
Sig.	*0.000*	*0.019*	0.062	*0.004*
R^2	0.210	0.146	0.081	0.103
Adjusted R^2	0.197	0.197	0.059	0.092
F	16.491	5.995	3.684	8.866
Sig. F	*0.000**	*0.019**	0.062	*0.004**

Notes: Significant at: $^{*}p = 0.05$; independent variable – JIT implementation; dependent variable – operations performance

This research brings forth new findings based on the Chinese firms' environment. More importantly, this study addresses an important gap in the existing operations management and JIT literature, i.e. the impact of organization ownership structure on JIT implementation and its performance.

This paper contributes to theory and practice in three ways. First, we provide empirical evidence on the relationships among organization ownership structure, JIT implementation and production operations performance. Second, we propose a multi-view framework model for explaining the relationships among organization ownership, manufacturing strategy and operations performance based on three theoretical views, i.e. resource-based theory view, agency theory view and organization theory view. Third, we identify the different roles elements of JIT play in the implementation process; this will be a helpful guideline for firms in implementing JIT.

In this study, we find that ownership not only impacts the JIT implementation and operations performance, but also impacts the relationship between JIT implementation and operations performance. For firms operated in China, FOF and JVF have higher implementation level and obtain more benefit than state-owned and POFs in implementing JIT system. For all types of ownership firms (except for private firms), JIT implementation has a significantly positive relationship with operations performance. Most important, on the implementation of individual elements of JIT system, we uncovered information which has never been found in other literature, i.e. FOFs and joint ventures have dominant higher implementation level than state-owned and POFs in the four elements, i.e. STR, 5S activities, Kanban and visual management, and TPM. Surprisingly, two of the JIT elements, i.e. QC and MSE, were adopted by all types of ownership firms. This reveals that all types of ownership firms have understood the importance of QC and human resource in JIT implementation.

This research sheds helpful insights into JIT implementation. First, firms should adopt a step-by-step approach when implementing JIT instead of replicating Toyota without taking into account the specific operating conditions of their plants. This findings is particular helpful for Chinese manufacturers who lack managerial resource and advanced management culture. It is vital that during JIT implementation, they should first implement and reinforce the basic elements of JIT, e.g. employee training, 5S campaign and supplier cooperation (JIT purchasing) before extending to other elements of JIT. Second, for Chinese firms (SOF and POFs), it is necessary to benchmark and learn from

FOF and JVF on how to improve JIT implementation performance. The implementation of STR TPM, 5S activities and Kanban/visual management are areas where the Chinese firms should learn most from FOF and JVF.

While this study extends previous empirical investigation of JIT implementation and its relationship with organizational ownerships, several extensions can be made to this research area to add further insights. First, since the conclusions of this research only reflect part of China manufacturing industry situation; future research should include a larger data sample to conduct a multi-group analysis to examine the moderating effect of different regions, it is also important to test the generalizability of these findings to other countries. Second, the conclusions of the research are all based on statistical data and not based on particular case, so the further research can be taken through case study. Third, in this paper, we only classify practices of JIT into ten elements, but not further define detailed items of each element, so the future research can been extended to include more detailed items for each element of JIT, and then conclusions will be more reasonable and more valuable.

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Appendix. Questionnaire (partly)

Section A: basic information of respondent

1. Sales revenue per year of our company
   (1) <50 millions RMB (2) 50 millions to 100 millions (3) 100 millions to 500 millions
   (4) 500 millions to 1 billion (5) larger than 1 billion
2. Ownership of your company
   (1) Foreign owned (2) Sino-foreign joint venture (3) state owned (4) private owned
3. Production type of your company
   (1) make-to-order (2) make-to-forecasting (3) mixed of make-to-order and make-to-forecasting
4. Industry type of your company
   (1) Family apparatus industry
   (2) Chemical industry
   (3) Pharmaceutical industry
   (4) Textile industry
   (5) Metallurgy industry
   (6) Electronic industry
   (7) Automobile industry
   (8) Mechanical industry
   (9) Food industry
   (10) Others (please note)
5. Production batch of your company
   (a) Job shop (b) small-middle batch (c) large batch
6. Your Job is --------------------

Section B: Just-in-time (JIT) production system implementation

If your company has implemented JIT (Just-in-time) production system, please select one answer to each of the following activity

JIT production activities	Implementation degree 1 not used 2 seldom used 3 sometime 4 often used 5 always used				
a. Setup time reduction	1	2	[illegible]	4	5
b. Small lot size production	1	2	[illegible]	4	5
c. Quality improvement activities (e.g., QCC or TQM)	1	2	3	4	5
d. JIT purchasing	1	2	3	4	5
e. JIT facility layout (e.g., U shaped production cell)	1	2	3	4	5
f. Multi-skill employee training	1	2	3	4	5
g. “5S” activities	1	2	3	4	5
h. Kanban and visual management	1	2	3	4	5
i. Level scheduling (smoothing production)	1	2	3	4	5
j. Total productive maintenance (TPM)	1	2	3	4	5

Section C: Operations performance

Please accord to your company’s situation to evaluate the current production operations performance of your company. You only need give out the perceived performance level based on five scale of your company in the industry and needn’t give out any concrete data.

(Five scales are: 1. extremely unsatisfactory, 2. unsatisfactory, 3 normal, 4 satisfactory, 5. very satisfactory)

Performance measures	Perceived performance level				
a. Work-in-process inventory level	1	2	3	4	5
b. On time ratio of product delivery	1	2	3	4	5
c. Quality level	1	2	3	4	5
d. Operations cost	1	2	3	4	5