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Product innovation and process innovation in SOEs: evidence from the Chinese transition

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Abstract This paper offers an analysis of the influence of management behavior on the relationship between factors such as market, governance and resources of a firm, and the choice of the type of technological innovation in Chinese state-owned enterprises (SOEs). The authors develop a structural equation model and 12 hypotheses and test the model and hypotheses using a sample of 274 SOEs in China. This study discovers that the choice of innovation types among Chinese SOEs depends on the turbulence in the environment, and on the organizational resources. The key contributions of the study include: testing existing theories of innovation in the context of Chinese SOEs; studying the factors that affect product innovation and process innovation in that context; and demonstrating that market forces and internal governance simultaneously influence SOE innovation.

Keywords Product innovation · Process innovation · State-owner enterprise · China

JEL Classifications M1 · O31 · O32

1 Introduction

China's economy is currently undergoing a historical transition. A shrinking centrally planned sector coexists and interacts with a growing market sector. Gradually, state-owned enterprises (SOEs) are transforming from planned produc-

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ers to market-oriented organizations. After nearly two decades of economic reform which has brought a sustained double-digit growth unprecedented in Chinese history, the restructuring of SOEs has become the key to successful economic transition. According to recent reports, the Chinese state sector earns the largest proportion of revenues (Kynge, 2000). This attests to the importance of this sector and the need to pay more attention to it. But because of their long dependence on government planning, most SOEs are inefficient and lack market experience and associated competitive advantage. We believe one of the most effective ways for SOEs to develop, enhance and sustain competitive advantage is to constantly upgrade SOEs' facilities and activities through innovation (cf., Dougherty & Bowman, 1995; Lu & Lazonick, 2001).

Technological innovation has played an important role in business success and has frequently been trumpeted as crucial to organizational competitiveness and success in a dynamic and turbulent market environment (Maurer, 1999; Qi, Wu, & Zhang, 2000; Schumpeter, 1975). A rapidly changing environment reduces structural rigidity and organizational inertia, thereby opening up opportunities for innovation (DeTienne & Koberg, 2002). Shleifer and Vishny (1997) noted that current models for researching innovation are fundamentally static and do not fit well with economies in transition. In addition, the extant literature on corporate strategy generally assumes that firms operate in a market economy, where property rights are well defined, and adequately protected, have substantial discretion in resource allocation. Since the emerging economy context appears to be substantially different from those developed economies, theories and research developed in those settings may have limited applicability to the transitional economy context such as China's. As these economies move to market-based functioning, improved knowledge about managerial decision-making including the choices of innovation clearly becomes more and more important for theory development and practice (Tan, 2001).

Innovation is not a single function but rather a network that interacts with all value-chain activities. Furthermore, innovation plays different roles for SOEs and for government. SOEs develop new products through innovation to gain competitive edge in the market place, while the government uses innovation policies to enhance the innovative capacity of various industries as well as overall economic development (Shyu, Chiu, & Yuo, 2001). Interestingly enough, the governments that control SOEs in various ways affect corporate governance directly as well. Both governance and innovation have been central to strategic management (Graves, 1988; Hitt, Keats, & DeMarie, 1995). What has been lacking are theoretical and empirical links between these two factors and the role of the market during the transitional phase. To address this need, this paper uses empirical data to study technological innovation by SOEs in China's transitional economic environment. The purpose is to test how market and governance simultaneously influence SOEs' technological innovation choice, given the particular resources and capabilities of the enterprises.

2 Chinese SOE reform and technological innovation

China's economic growth has been stimulated by changes in ownership and property rights, with the State playing a diminishing role. Before the enterprise reform of the early 1980s, all production and distribution decisions were centrally planned and SOEs were simply operating as cost centers. By 1989, around two-thirds of SOE output were

determined through market mechanisms. This process was further accelerated in the early 1990s. Just 7% of the total value of industrial output was controlled directly by planners in 1993 (Jefferson & Rawski, 1994). Large-scale upstream industry was slowest to be liberalized. But even for these enterprises resource allocation and prices had been substantially liberalized by the mid-1990s. SOEs have already undergone significant changes due to the greater autonomy they enjoy. These include the impact of market forces, rapid growth of domestic demand for high end products, and strategic integration with the world economy (Boycko, Shleifer, & Vishny, 1994; Nolan & Wang, 1999; Rawski, 1994). It was based on the belief that if markets for products and factors of production were established and became competitive, SOEs could be transformed from loss-making cost centers into modern, profit-seeking and making enterprises without radical changes in ownership structure (Qi et al., 2000; Kao, 1996).

The Chinese planned economic system is organized in a decentralized multi-layer and multi-regional form (Rawski, 1994). SOEs are legally owned by the government and administered either by various industrial ministries in the central government or by local governments. Central government ministries control only a small proportion of SOEs. Most are under the control of regional governments. Therefore, there are several governance characteristics unique to China's SOEs in transition (Dougherty & Bowman, 1995). They include the enhanced autonomy of enterprises, the change of ownership structure and transparency, and the special process of CEO appointment and dismissal. While the autonomy and ownership change may be consistent with market-oriented firms, the governmental control of CEO appointment and dismissal appears to be a unique characteristic of the Chinese SOE transition. The government indirectly controls SOEs through CEOs. This indirect control may lead to agency problems. CEOs may not be making decisions based on firm performance (Freeman, 1987). Another important feature of China's transition process has been the transformation of the nation's science and technology (S&T) system to support industrial development. The Asian financial crisis of the late 1990s made it very clear to the Chinese government that the nation's prospect for sustainable growth in a global economy depends on further developing the S&T system and continuing to integrate it with the world economy (Lu & Lazonick, 2001). Before the current reform, SOEs were responsible for development, prototyping, and other ''downstream'' R&D activities. Their R&D performance largely depended on the management skills, corporate strategy, and other characteristics of the enterprises with which they were affiliated (Xue, 1997), while governmental command and control affected their innovation orientation and decisions.

In China innovation activities take place in three types of organizations: enterprises, universities and research institutes. During the transition period, China transformed her innovation strategy from a focus on technology introduction and incremental improvement to a focus on internal or endogenous development of advanced technologies. SOEs now have greater autonomy due to greater marketization and also technological policy shifts. They can make decisions related to the domains and directions of innovation, and have gradually turned their attention to product innovation in face of increased customer demands. At the same time, however, SOEs also face pressures to reduce product cost through process innovation.

As a source of competitive advantage, technological innovation must be closely linked with a firm's strategic and competitive context (Ester, 2000; Porter, 1985). Because innovation encompasses activities such as technology, organization, finance, and commerce, it is related to the primary activities of the organization and may

encompass either product innovation or process innovation or both (Daft, 1978; Damanpour & Evan, 1984). New product introduction and product differentiation, through innovation, is critical to business success and customer satisfaction. Process innovation is concerned with identifying new and more effective internal operations, and embraces quality function deployment and business process reengineering (Cohen & Levin, 1989). New tools, devices, and knowledge in throughput technology mediate between input and output, and help reduce production costs (Freeman, 1987). The cost reduction clearly helps enhance company competitive position, and may produce tangible benefits quickly. Most SOEs may however lack inner motives to innovate due to the inherent risk associated with innovation, and various investment restrictions. Under such circumstance, SOEs may focus on process innovation to reduce production cost and materials consumption as it presents relatively lower risk and greater tangible results to management.

There is a large body of theoretical and empirical literature in economics that attempts to understand the factors influencing technology innovation. DeTienne and Koberg (2002) indicate that three forces, environment, organization and management behavior, affect technology innovation. The literature on organization has developed and empirically examined many models of the innovative behavior of firms (Hansen & Hill, 1991). In general, these models analyze the role of market structure, and firm's resource and capability as incentives to engage in innovation. Simply stated, studies have shifted from a view of innovation as an almost exclusively knowledge-driven activity to the view that it is a market-driven activity (Scott-Kemmis, Darling, & Johnston, 1988). The market-driven view suggests that the objective of innovation is to satisfy market demand. If the market structure changes, firms must proactively innovate to fit the new environment.

On the other hand, the literature on management has only partially addressed the relationship between governance and innovative activity (Graves, 1988; Hitt et al., 1995). Governance is a control force in an organization, and impacts decision-making and innovation activity through organizational structures, rules and culture (Butler, Price, Coates, & Pike, 1998). The basic function of governance is to balance benefits between shareholders and firms' CEOs, and the main tools of governance are incentives and monitoring of CEOs (Coles, McWilliams, & Sen, 2001; Li & Simerly, 1998). In Chinese SOEs, the sponsoring government ministry has the right to appoint and dismiss the CEO, and monitors and evaluates CEO behavior and performance. Thus governmental control and governance are linked together.

The extant research shows that the government is directly and indirectly involved in innovation development through policy tools (Roessner, 1988; Rothwell & Zegveld, 1981) of three major types: supply-oriented, demand-oriented, and indirect (environment-oriented) innovation policy (Rothwell & Zegveld, 1988). Government supply-side innovation policies provide funds, human resources, and technical infrastructure to encourage firm innovation. In many defense-related innovations, the government also carries out demand-oriented innovation policies through government procurement. Supply-oriented innovation policies seem to be the most popular form of state government innovation policy and include the provision of an intellectual infrastructure, a skilled and educated workforce, risk capital, base capital, and technical assistance to new businesses (Goldsmith, 1990). In general, these researchers have suggested that government has a positive influence on innovation.

Because of the economic reform, the government has handed over almost all decision-making authority to enterprises other than the authority to appoint and

dismiss CEOs. As a result of economic reform, the CEOs of SOEs find themselves still part of a bureaucratic command system yet increasingly responding to an emerging market system. They must pursue objectives that only partially relate to market requirements. Because the government's criteria for evaluating CEOs include not only performance or capability, but also many political factors, there is a disconnection between firm performance and CEO evaluation. This suggests a negative influence of government control on innovation. Given the apparent conflicting impact of government on firm innovation, it would be beneficial for us to explore and examine how the enhanced autonomy and the government's control of CEO would affect innovation decisions.

In addition to factors outside the organization, forces within the organization also affect innovation (DeTienne & Koberg, 2002). The resource-based view of firm emphasizes internal capabilities and resources as the bases for strategy formulation and innovation. It centers on a firm's resource heterogeneity, and views a firm's internal capabilities and resources as the main drivers of its strategy formulation and economic behavior (Wegloop, 1995). The resources examined form an important source of competitive advantage for the company (Barney, 1991) because they are valuable and scarce, do not depreciate with use and imitation, and are not easily transferable (Dierickx & Cool, 1989; Itami, 1987).

Following the resource based view of firm, we would posit that resources and capabilities will have a positive impact on innovation. Since the pervasive impact of command economy, SOEs had little motivation or need to develop resources and capabilities. In a market-oriented environment coupled with significant technological changes, they are facing significant challenges. Understanding the impact of resource and capability constraints experienced by the SOEs on their innovation therefore will help shed greater light on effective business management in the broader context. In general, the resource-based view of firm indicates that firms' resources—human resources, financial capital, equipment, and information—are what sustain innovation (Barney, 1991). In China's transitional period, financial capital is the resource most often lacking in SOEs since they are only able to retain a certain portion of the profit, have difficulty getting loans, and possess very limited internal capital reserves. Limited capital would therefore become a major constraint on firm innovation.

The previous discussion shows that the inter-related factors of market, governance, resource and capability are the important determinants affecting SOEs' innovation during China's transitional period. Streeck (1985) identified three limiting and ideal cases that define the set of determining factors: state, community, and market. During transition, market and state can be considered equivalent to market-driven and state-regulated (Andrews and Dowling, 1998). Although many researchers refer to the market as the main force for innovation and have presented detailed studies of the influence of the market on innovation, there is little empirical agreement on how different types of ownership, and governance contribute to the choice of product and process innovation (Levin, Levin, & Meisel, 1987; Nee, 1992). We attempt to integrate extant literature and examine how these factors together affect firm innovation choice in China's transition.

3 Theoretical model and research hypotheses

As China deepens her economic reform, the SOEs' operations and decision-making have also seen significant enhancement. Therefore, we believe the changes in SOEs'

governance during China's recent transition period have been beneficial and have enhanced firm competence and performance. This study refers to external forces as ''*market drive*,'' internal forces as ''*internal governance improvement*'' and ''*government control*,'' and refers to resources as ''*capital and capability constraint*,''—all of these are factors that affect innovation decisions.

Technological innovation is a value-adding process that includes innovation strategy formulation, resource allocation and innovation outcome. A firm's innovation decisions, such as when, how, and in what fields to specialize, depend on the particular expectations, insights and motives of its decision-makers (Wegloop, 1995). Porter (1985) considered that, in the long-term, the extent to which a firm is able to create competitive advantage in an industry is a major determinant of its success in outperforming its competitors. Leading the competition and following the competition are two possible innovation strategies. The strategy of ''*leading the competition*'' may help satisfy new customer demand more quickly than competitors. The formulation and implementation of this strategy is based on enterprises' resources and capability, and will influence other innovation activity. The ever-present need for an enterprise to improve its market position provides a strong incentive for innovation and an enthusiasm for learning new technology and for following current trends in science and technology. The asymmetry of information between shareholders, creditors and firm managers, together with the limited liability financial structure, impacts the investment decisions of firms (Maurer, 1999). Investment in innovation is a capital input activity that impacts R&D, manufacturing, marketing, and the speed as well as magnitude of innovation. With given financial capital and capabilities, the innovation strategy determines the type and timing of investment. Although innovation strategy and innovation investment both influence product and process innovation, these two factors have different effects. Miller and Friesen (1983) found that when the environment is viewed as dynamic, successful firms employ a number of different innovative responses. Therefore, we need to construct a framework for researching the relationships between important determining factors, on the one hand, and innovation behaviors and choice of innovation type, on the other hand. This theoretical model is presented in Fig. 1.

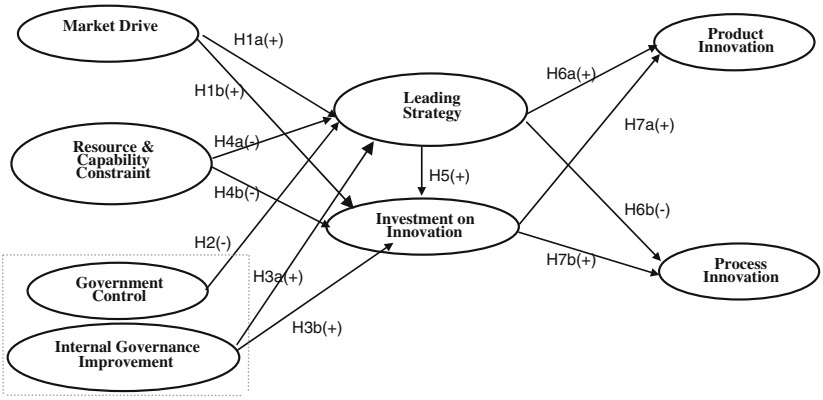

Fig. 1 The theoretical model

3.1 Market drive, leading strategy and investment in innovation

Perceived market dynamism is considered an important environmental variable leading to externally induced changes within organizations. Arrow (1962) demonstrated that the returns generated by technological innovation were greater when the innovation was used in a competitive as opposed to a monopolized market. Hence competitive markets imply greater incentive and opportunity for innovation. In this study, the market is considered an external driving force for product and process innovation. This driving force includes ''requirement pull'' and ''technology push'' (Mowery & Rosenberg, 1979). Various scholars have argued in favor of one or the other (Smyth, 2000). Requirement pull is demonstrated by industrial attraction and competitive pressure (Porter, 1990). Industrial attraction implies the possibility of providing technological leadership and gaining competitive edge through innovation. Increase product demands and new marketing mix may result subsequently. On the other hand, when enterprises face great competitive pressure with limited profit potential, they should improve their competitive position and increase their market share through innovation. Technology push is the potential for technological innovation to produce great profits. New technology will create demand and inspire enterprises to carry innovation through to new production (Porter, 1990).

As a driving force for innovation, the market explains the various strategies and marketing orientations of firms. Market structure and market pressure affect a firm's selection from three strategies: cost leading, differentiation and focus (Porter, 1985). In order to increase market share, SOEs must decide between leading competitors and following them. Some researchers suggest that following and leading are two different strategies for firms (Wegloop, 1995). In this paper, the strategy of leading represents enterprises' attempt to gain competitive advantage and leading position compared to competitors.

During China's transitional period, the support and protection of SOEs by government was gradually reduced. Technological innovation in China during SOE reform is a special situation. Early in the reform, the Chinese government emphasized the introduction of techniques from Western countries and pushed incremental technological improvement. But in a fast-changing environment of technological development, and with improved R&D capability, SOEs' innovation strategies will be driven by technological push (Tan, 2001). Certainly these firms must respond to market changes and new technological development by increasing investment in innovation. But a key decision is how much emphasis firms should put on leading the competitors. Generally, the stronger the market drive, the greater the expected benefit there will be for firms to adopt the leading strategy. Hence, SOEs are inclined to try to lead competitors despite restrictions on resources and capability. We claim that innovation depends on the initial force of the market on the enterprise and on the subsequent effects of strategy and investment. We thus advance that

Hypothesis 1a Market drive is positively related to leading strategy, and

Hypothesis 1b Market drive is positively related to investment in innovation.

3.2 Government control of CEOs and its effect on motivation to innovate

As a stakeholder, government would prefer not to pay attention to trivial matters but just focus on major firm decisions and the overall mission. Although the

government continually emphasizes removing its administrative function from SOEs, indirect control still exists through the appointment and dismissal of CEOs. In other words, the control of CEO personnel decisions is the only significant power retained by government. In China, the CEOs of SOEs are a type of government staff position and even have a certain administrative grade. They are often appointed for political or other reasons rather than for demonstrated performance and ability, and they may not necessarily be the best ones to manage the company effectively (De Mente, 1989). There are various reasons for changing CEOs. The CEO may be unqualified and government does not see the expected performance, or there may be some political or ineffable reason, such as appointment as manager of a different enterprise simply because there is a vacant position there. Even when a CEO's performance is excellent, government may remove him as CEO and appoint him to political office because, in China, it is a greater honor to hold high state office.

In Chinese SOEs, the change of CEO is not directly related to performance but rather to vague causes emanating from government (Nolan & Wang, 1999). CEOs are often political appointees, who tend to be ''extra conservative'' (De Mente, 1989) and to value job security over innovation. Therefore, government control may create an indecisive top management team (TMT) and lead to unsuccessful innovation strategies. Furthermore, as the head of the enterprise, the CEO usually establishes and overseas the implementation of strategy. So frequent CEO changes are not conducive to consistent innovation strategy formulation and implementation. Many studies of Chinese SOE CEOs have found that they share a common concern for security and are likely to avoid risky decisions when faced with uncertain environments (Adler, Brahm, & Graham, 1992; Nee, 1992; Tan & Litschert, 1994). Under government control, CEOs tend to prefer to avoid responsibility rather than enhance firm performance through innovation. Therefore:

Hypothesis 2 Government control on CEOs is negatively related to leading strategy.

3.3 Improvement in internal governance, leading strategy, and investment in innovation

Corporate governance defines the framework that enables top managers to create value (Davis, Schoorman, & Donaldson, 1997). The resultant value can be distributed among various corporate claimants (Phillips, 1995). Many researchers indicate that an effectively designed governance system can result in significant competitive advantage (Kraft, 1990). The basic principle of corporate governance is that shareholders select a board of directors and the board selects the CEO. In a Chinese SOE, however, a sponsoring ministry, as the main agent-shareholder, has the actual authority to appoint or dismiss the CEO. The CEO then appoints the TMT and management personnel. As the supervisor, the sponsoring ministry controls and manages some of the most important decision-making of SOEs.

As China deepens its economic reform, and as SOEs gain greater autonomy while loss governmental protection, SOEs have to actively implement a leading strategy in order to improve their competitive situation. Some research suggests that one of the most important factors in innovation is management support, which encourages technological innovation by explicitly supporting the innovation (Selnes, Jaworski, & Kohli, 1997). The effectiveness of management personnel is affected not only by its

composition and size, but also by its internal administrative structure, which directly affects the choice of innovation strategy. Management personnel are also regarded as a TMT for decision-making. Chinese economic transition is a dynamic process, and Brown and Eisenhardt (1997) suggest that a rapidly changing environment gives a TMT more options for innovation. If a particular manager enthusiastically endorses a new product as being customer focused, and continually discusses its importance, others within the organization will tend to adopt similar attitudes (Jaworski & Kohli, 1993, Levin et al., 1987).

Because innovation must be implemented by a team that includes managers, engineers, and experts, effective personnel policy will inspire staff to innovate and ensure that the goals of innovation are supported by team members. A new TMT that provides an internally developed strategy for a project must be supported by a suitable organizational structure that supports efficiency of governance (Grover & Goslar, 1993). Organizational structure influences innovation in several ways (Damanpour, 1987). Recently, a large proportion of SOEs undertook organizational restructuring, for the purpose of improving flexibility and the competitive capability to adapt to market and customers. An organization's willingness and flexibility to adapt or change its structure to accommodate innovation appears to impact implementation of innovation strategy (Maddala & Knight, 1967).

Investments in product and process innovations are essential. But the high cost and efficient investment scale of the innovation often make it difficult for firms to innovate using their own financial resources. Different forms of corporate governance play different roles in solving investment problems. With improved internal governance, SOEs have more autonomy in financial decisions, such as acquiring funds through loans or other financing from outside the enterprise. When enterprises have the right to retain profits, they will want to reap the greater benefits of implementing innovation. The newly gained autonomy will help these enterprises gradually pay more attention to economic performance and competitive advantage. Therefore, internal governance improvement improves decision-making on innovation investment. This leads us to propose:

Hypothesis 3a Internal governance improvement is positively related to leading strategy, and

Hypothesis 3b Internal governance improvement is positively related to investment in innovation.

3.4 Capital and capability constraints, leading strategy, and investment in innovation

Lack of resources is an important constraint on innovation. Recent empirical findings by Phillips (1995) indicate that financial restructuring has a significant impact on (dis-)investment decisions not only for the restructured firm, but also for competitors in the same industry. In Chinese SOEs, financial capital is probably the key resource—there is a lack of capital from retained earnings and feeble financing ability, even though government allows SOEs to reserve a proportion of profits as an internal resource. Jensen (1993) argued that the failure of the market to exercise effective corporate control regarding innovation is partly due to legal restrictions of the capital market (Roe, 1990). Compared to publicly traded companies, one main

financing approach of conventional SOEs is borrowing from banks. It is now widely acknowledged that financial decisions and business decisions of enterprises interact—since the government stopped financial subsidies, most SOEs tend to go to state banks that make ''political loans''. So much so that the state-owned sector now threatens the stability of the Chinese banking system, as many banks are state-owned and are forced to carry non-performing SOE loans on their books (Drew, 1997). Therefore, restrictions on capital discourage Chinese SOEs from technology development and changes of strategy.

Economists who study innovation have viewed the theory of the enterprise as actually a theory of markets (Mowery & Rosenberg, 1979). In this view, enterprises strive to use their capability to deliver output that is accepted by the market. In a competitive environment characterized by greater changes, the capability to innovate would be crucial because it is the key to gaining dynamic competitive advantage (Romijn & Albaladejo, 2002). Innovation capability is defined as the skills and knowledge needed to effectively absorb, master, and improve existing technologies, and to create new ones (Kynge, 2000). As Hitt, Hoskisson, Johnson and Moesel (1996) argued, the capability of enterprises to innovate is at the heart of strategic competitiveness. Therefore, as a factor of internal control, innovation capability integrates several elements. These elements include management ability, R&D ability, manufacturing ability, reserve ability, and marketing ability, and can be expected to contribute to the build-up of innovation capability (Romijn & Albaladejo, 2002). In a survey of over 700 managers by Dosi (1988), respondents revealed that improving their enterprises' capability to innovate was their top concern. But during the long period of command economies, SOEs had little enthusiasm or need to improve capability, and their lack of capability became a limiting factor for innovation. Now, with the greater difficulty in leading competitors and the higher risk of innovation investment, capability constraints have become one of the main obstacles to formulating a leading strategy and to decisions to increase innovation investment. The foregoing discussion suggests:

Hypothesis 4a Capital and capability constraints are negatively related to leading strategy, and

Hypothesis 4b Capital and capability constraints are negatively related to investment in innovation.

3.5 Leading strategy, investment in innovation, and product or process innovation

One of the most crucial innovation decisions is the decision to invest in new or improved equipment and facilities. For instance, Nair (1995) states that these ''decisions are not only important because of the large initial capital costs involved, but also because of its impact on the firm's performance for many years into the future. Reasons for retrospection on the decision would arise if newer technologies appear soon after the purchase, or if the need for capability or adaptability to changes were not foreseen earlier when the decision was made, or they were not incorporated in the model at that time.'' One of the main difficulties with investment decisions in practice is the speed of technological progress. Current technologies are fast replaced by new ones. R&D needs increased expenditure and has high risk.

Several researchers have noted that innovation investment is a real option. Current investment is viewed as a link in a chain of future projects used to open up growth opportunities (Grenadier & Weiss, 1997). Lenos (1996) has shown that market competition may force a firm to invest too early, so that the flexibility gained by deferring investment is eroded. Following a real options perspective, the firm, in effect, has a call option on the value generated by the innovation plus future growth options by use of a strike price equivalent to the investment costs. But, facing an immature market system, SOEs should enter a new market with a new product and marketing mix before the oligarchies control the market. This way, SOEs can win customers with new products and competitive prices.

Given the current emphasis on the advantages of taking the lead, the need to be first to introduce products has increased the pressure for new product development (Cooper, 1998). At the same time, a leading strategy can be copied and implemented by others (followers) through the successful design and marketing of new products at competitive prices. It is no longer optimal for two firms both to invest in the latest technology immediately. Hence, one firm must refrain from investment, and this implies that the firm that does invest obtains monopolistic profits until the arrival of still newer technology. To capture these monopolistic profits, a firm must invest earlier than its competitor. In other words, innovators pursuing a leading strategy should invest early and keep increasing their investment in innovation. But the crucial problem faced by Chinese SOEs is choosing the types of technological innovation—the amount of lead that an enterprise has over its competition may affect the emphasis on product or process innovation.

The immature market system in China provides opportunities for more subdivision of markets, and enterprise restructuring allows SOEs to enter new industries with the support of government policies. In general, process innovation will be driven by cost reduction, while product innovation seeks product differentiation (Du & Yong, 1998). One would expect that each type of innovation would be affected in a different way by the explanatory variables (Lundvall, 1992; Kraft, 1990). Different strategies dictate different types of innovation. Product innovation can quickly satisfy customers' new demands and can capture a new market before a competitor. With early entry into a new market, an enterprise stands to acquire a greater market share. Thus, winning in the market place may depend on implementing a leading strategy. Although process innovation may indirectly affect an enterprise's market performance through reduced product cost, product differentiation provides a market advantage that lasts for a longer period of time. During the transitional period, for example, SOEs often introduced advanced products from Western countries but lacked product innovation. To lead the market, the SOEs production of the products must be strongly competitive. Process innovation brings obvious advantages, but not necessarily a lead over competitors. To lead the competition, SOEs should choose product innovation first, rather than process innovation, even though process innovation does help enhance an enterprise's competitiveness. We thus advance the following hypotheses:

Hypothesis 5 Leading strategy is positively related to investment in innovation,

Hypothesis 6a Leading strategy is positively related to product innovation, and

Hypothesis 6b Leading strategy is negatively related to process innovation.

3.6 Investment in innovation and product or process innovation

A willingness to invest in innovation implies that the enterprise already has the motivation to innovate (Kovenock & Phillips, 1995). The investment decision depends on several internal factors, of which financial capital is the most fundamental in SOEs. There is a relationship between the amount of financial capital available and the degree of enthusiasm for investment (Barney, 1991). Innovation is a continuous process that includes R&D, manufacturing, marketing and so on, and all of these need ongoing investment. SOEs can use capital to finance new materials, equipment, and marketing. Furthermore, investment in research labs and R&D human resources is key as well. Because product and process innovations may be considered alternatives to each other, we could not distinguish what portion of expenditure was used for new product development and what portion for cost reduction. We propose:

Hypothesis 7a Investment in innovation is positively related to product innovation, and

Hypothesis 7b Investment in innovation is positively related to process innovation.

4 Methodology

4.1 Sample

The sample was drawn from the SOEs of Shaanxi, Henan, and Shanxi provinces in China. We used data on product and process innovation from 1995 to 1999. The period was chosen because significant restructuring activities occurred during this time. Therefore, although this study focuses on these three provinces, the conclusions and implications may have a wider appeal to other SOEs in the Chinese setting.

The Economy Commerce Committee (ECC) of these provinces provided the list of all SOEs in these provinces. In order to survey a random sample of these firms, each enterprise on the official list was assigned a sequential number, we then selected the sample firm in the following manner. Random numbers were generated, modulated by the total number of enterprises and incremented by one until unique vectors were generated (duplicates were discarded). SOEs were allocated sequential identifiers according to the order they were drawn, forming a final list that included 600 enterprises in about 12 industries. The survey began with the first enterprise on the survey list and was to continue until about 300 questionnaires were received or the list was exhausted.

4.2 Survey

Before the formal survey, we selected fifteen enterprises as pilot cases. The purpose of the pilot survey was to modify questionnaires to reflect the characteristics of different industries and of different scales. This process helped modify and improve the survey questionnaire. Data collection procedures were designed to ensure a meaningful response rate. Questionnaires were distributed to employees in three

departments of the surveyed organizations (every department in a certain province), in a way that preserved the proportions. Because response rates can be significantly increased when verbal commitment is obtained prior to sending a survey instrument (O'Keefe & Homer, 1987), the investigator made an appointment with the CEO in advance to ensure his or her cooperation in completing interviews. Each enterprise also was provided a cover letter outlining the purpose of the survey and stating that participation was voluntary. Generally, a firm's technological innovation experts were invited to attend the interview, in order to confirm the CEO's answers to questions about innovation. In several cases where the CEO could not be reached, investigators interviewed a CEO designee—a chief financial officer or a top officer in charge of strategic planning and technology management. Each visit took one to two hours. In contrast to the objective sources of data such as industry reports, financial statements, and other archival data, perceptual measures rely on data that is subjective (Boyd, , Dess, & Rasheed, 1993). The use of single respondents can increase the possibility of common method variance problems. We, therefore, employed multiple key informants in each enterprise surveyed.

The data collection phase was mainly completed in the summer of 2000. A total of 550 questionnaires were distributed and 313 responses were returned, 39 of which were unusable because necessary data were missing. The 274 responses included in the study gives a final useable rate of 49.8%, which is good.

4.3 Variables

In the questionnaire, the majority of answers were measured on a 5-point scale, using either ''1—not important'' to ''5—extremely important,'' or ''1—no change'' to ''5—very much has changed.''

4.3.1 Market drive ($\alpha = 0.76$)

Market drive has two aspects: ''requirement pull'' and ''technology push'' (Mowery & Rosenberg, 1979; Smyth, 2000). The ''requirement pull'' was measured by variables in the questionnaires: ''enlarging share'' and ''enlarging demand.'' The ''technology push'' can be described as ''competition for technical performance'' (Li, 1994).

4.3.2 Internal governance improvement ($\alpha = 0.72$)

We measure it by four variables: ''improvements in organization,'' ''change of sponsoring ministry,'' ''appropriate changes in management personnel,'' and ''changes in personnel policy'' (Damanpour, 1987; Grover & Goslar, 1993; Maddala & Knight, 1967; Selnes et al., 1997). These four variables constitute the main internal improvements in SOEs during transition, and reflect the outcome of reform on enterprise governance.

4.3.3 Government control

Government control is another internal governance factor influencing innovation by SOE. This is a factor peculiar to China's transitional economy as it differs from a market economy. We use ''frequency of CEO change'' to indicate government's

influence in appointing and dismissing CEOs. As noted earlier, government now has only the CEO appointment authority in SOEs. Because of the uncertain and vague reasons for changing CEOs, we use an output variable to reflect government control.

4.3.4 Capital and capability constraint ($\alpha = 0.67$)

Much research has shown that an organization's financial resources and capability impact innovation, defining capability as ability in management, R&D, manufacturing and marketing (Romijn & Albaladejo, 2002). In comparison with other organizations, China's SOEs have deficient capital supply and poor innovative capability. Therefore, financial capital and capability are a constraining factor on innovation for all SOEs. For the purposes if this study, we use five items to explain SOEs' capital and capability: ''capital constraint during technological innovation'' (Achilladelis & Antonakis, 2001), ''management ability constraint,'' ''R&D ability constraint,'' ''manufacturing ability constraint'' and ''marketing ability constraint.''

4.3.5 Leading strategy

A leading strategy can be shown by the degree to which the firm leads its competitors (Wegloop, 1995). Therefore, we use the variable ''leading the competition.''

4.3.6 Investment in innovation

To measure investment in innovation, defined as financial activity to sustain innovation, we use ''new investments or change in technology'' (Kovenock and Phillips, 1995).

4.3.7 Product innovation ($\alpha = 0.68$)

This is composed of ''improvement in product quality'' and ''change in product mix'' (Jelenik & Schoonhoven, 1993).

4.3.8 Process innovation ($\alpha = 0.82$)

This is composed of ''reduction in material inputs'' and ''savings on energy inputs'' (Freeman, 1987; Young, Ahlstrom, Bruton, & Chan, 2001).

5 Results

The hypotheses were tested using a structural equation model. By definition, structural equation analysis is a combination of factor analysis and path analysis. The analysis was conducted using SPSS and AMOS software. Figure 2 is the final model that best fits the data collected. The correlations between variables, presented in Table 1 (including means and standard deviations), were used in the study. An analysis of the correlation matrix shows initial evidence of good validity. The corresponding GFI indices for the final path model are presented in Table 2, which highlights the importance of the relationship between innovation behavior and innovation type. A summary of the hypotheses supported appears in Table 3.

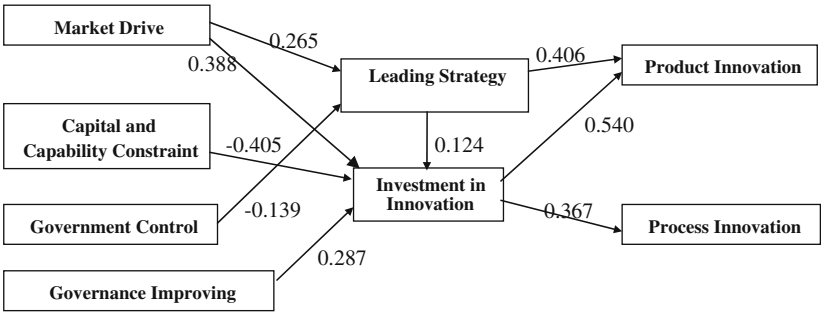

Fig. 2 Path analysis using AMOS

Market drive was found to have a positive and significant direct relationship with leading strategy and investment in innovation, whereas government control has a negative effect on the leading strategy. A key relationship is that leading strategy is positively correlated with investment in innovation. Although the factor of capital and capability constraints has no direct influence on leading strategy, it does have a significant negative influence on investment in innovation, which in turn influences product and process innovation. Furthermore, leading strategy and investment in innovation affect product innovation and process innovation in different manners. As Table 3 shows, a leading strategy has a significant positive impact on product innovation only, whereas investment in innovation has a significant and positive impact on both product innovation and process innovation. Nine of the 12 hypotheses were supported. Three hypotheses were not supported.

6 Discussions

This study provides preliminary evidence for the impact of market, governance and firm resources and capabilities on innovation among Chinese SOEs. Previous research concentrated more on either market factors or governance factors alone. In this study, we mainly studied the combined impact on innovation of market, governance, and SOEs' resources. Importantly, given the institutional circumstances and reform process faced by Chinese SOEs, governance was shown to have two aspects—internal governance improvement and government control—which have opposite impacts on innovation.

We find that internal governance improvement has a positive impact on innovation. This is consistent with the literature that effective governance is beneficial to firms' innovation implementation and effective decision-making in turbulent environments (e.g., Li & Simerly, 1998). SOEs have already seen a great increase in autonomy, which suggests that internal governance improvement benefits innovation in Chinese SOEs. This finding is also consistent with organization theory (Hansen & Hill, 1991) and with Qi and colleagues' (2000) suggestion that ownership reforms have been introduced to improve decision-making autonomy and the performance of SOEs.

From a national innovation system point of view (Roland & Sekkat, 2000; Smyth, 2000), government involvement may prove to be constructive for the diffusion of

Table 1 Mean, standard deviations and correlations

Variable	Mean	S.d.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Enlarging demand	3.17	1.52																		
2. Enlarging share	3.11	1.41	.561***																	
3. Competition of technical performance on product for customers	1.57	1.15	.159*	.099																
4. Management ability constraint	2.64	1.29	.145*	.180**	–.097															
5. R&D ability constraint	3.25	1.34	.222***	.302***	.113	.150*														
6. Manufacture ability constraint	2.42	1.37	.280***	.288***	.070	.234***	.327***													
7. Marketing ability constraint	3.17	1.36	.292***	.379***	.028	.276***	.349***	.266***												
8. Capital constraint	3.70	1.29	.108	.187**	.086	.138*	.157**	.253***	.352***											
9. Frequency of CEO change	1.93	1.00	.054	.023	–.062	.048	.011	.047	.059	.056										
10. Changes in organization	2.63	1.24	.087	.102	.124*	.059	–.036	.065	.085	.098	.036									
11. Change of sponsoring ministry	1.85	1.37	.099	.088	–.022	.085	.047	.097	.091	.091	.064	.311***								
12. Changes in mgt personnel	2.74	1.12	.091	.028	–.003	.154*	–.071	–.071	.014	.018	.198***	.437***	.246***							

Table 1 continued

Variable	Mean	S.d.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
13. Change in personnel policy	2.26	1.09	.109	.017	.049	–.053	–.043	.006	.012	.035	–.015	.413***	.379***	.222***						
14. Leading with competitors	2.59	1.54	.127*	.183**	.217***	.150*	.101	.139*	.179**	.032	–.120*	.072	.032	–.043	.091					
15. New investments or change technology	2.61	1.12	.128*	.085	.142*	–.038	.045	.143*	.025	–.149*	–.144*	.216**	.146*	.068	.314***	.187***				
16. Improvement in product quality	2.83	1.08	.186**	.215***	.200***	.035	.054	.134*	.102	.012	–.131*	.178**	.167**	.043	.237***	.265***	.440***			
17. Change in product mix	2.44	1.15	.102	.180**	.237***	.008	.031	.204***	.045	.040	–.053	.256***	.185**	.106	.224***	.130*	.336***	.338***		
18. Reduction of material inputs	2.17	1.12	.202***	.165**	.048	–.081	.035	.031	.013	–.009	.016	.136**	.096	.035	.204***	.129*	.257***	.303***	.179**	
19. Saving on energy inputs	2.42	1.02	.200***	.091	.059	–.106	.006	.073	–.091	–.007	.044	.164*	.137*	–.004	.263***	.082	.323***	.305***	.201***	.600***

Correlations greater than or equal to .19 are significant at ***$p < 0.001$; those greater than or equal to .15 are significant at **$p < 0.01$; those greater than or equal to .12 are significant at *$p < 0.05$; and those greater than or equal to .10 are significant at $p < 0.10$.

Table 2 Measures of overall fit

GFI test	Model estimate	Interpretation
Model fit		
X^2 value	93,543	Very good fit. The X^2 value is not significant
Cmin/*df*	1.006	Good fit, close to 1
GFI	0.964	Almost perfect fit, very close to 1
Adjust GFI (AGFI)	0.933	Almost perfect fit, exceeds to 0.90
RMSEA	0.018	<0.05 indicates a good fit
CFI	0.999	Almost perfect fit, very close to 1
Model comparison		
Tucker-Lewis index (TLI)	0.999	Very close to 1, a very good fit
Normed fit index (NFI)	0.916	Very close to 1, a very good fit
Model parsimony		
P for test of close fit (Pclose)	0.999	Very close to 1 indicates a very good fit
Akaike information criterion (AIC)	249.543	Small score indicates a good fit

innovation. By now, Chinese SOEs have already acquired considerable autonomy, and the government does not interfere with daily decision-making and management, conditions important for improved public firm performance (Boardman & Vining, 1989). Several agency problems, arising from the separation of ownership and control, however, continue to exist in SOEs where the State is the most important shareholder. As we know, the power to appoint and dismiss CEOs is still held by government and ministries. As long as the government and its agencies have inadequate resources and expertise to monitor and discipline management, conflicts of interest between government and CEO will exist. Our results suggest that government control of CEOs has a negative impact on innovation strategy, which contradicts Smyth's (2000) and Roland and Sekkat's (2000) conclusions. In our view, CEOs are not effectively monitored because there is little incentive for bureaucrats to diligently monitor SOEs' performance, as the bureaucrats are neither rewarded for good performance nor punished for bad. Moreover, bureaucrats for SOEs are dispersed throughout the government—the State lacks a clear, accountable representative to enforce its will. Therefore, SOEs have little interest in innovation, given

Table 3 Summary of support for hypotheses

Hypothesis	Estimate	*p* Value	Result
H1a Market drive → Leading strategy	0.213	0.071*	Supported
H1b Market drive → Investment in innovation	0.396	0.039**	Supported
H2 Government control → Leading strategy	–0.122	0.012**	Supported
H3a Governance improvement → Leading strategy	0.022	0.688	Not supported
H3b Governance improvement → Investment in innovation	0.308	0.000***	Supported
H4a Resource constraint → Leading strategy	0.202	0.414	Not supported
H4b Resource constraint → Investment innovation	0.308	0.000***	Supported
H5 Leading strategy → Investment innovation	0.158	0.081*	Supported
H6a Leading strategy → Product innovation	0.409	0.003***	Supported
H6b Leading strategy → Process innovation	–0.028	0.664	Not supported
H7a Investment on innovation → Product innovation	0.430	0.000***	Supported
H7b Investment on innovation → Process innovation	0.297	0.000***	Supported

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

the high risk. They are constrained to a large extent by a rigid system, and the rigid system causes discord between enterprises and government, over such things as selection of the type of innovation. The most important feature of China's transitional period is that government indirectly controls SOEs through CEOs. This is the most significant difference in context compared with Smyth's and Roland and Sekkat's studies. This study's contribution to the academic literature on Chinese SOE reform comes from this difference in perspective.

We also found that market drive can remarkably induce formulation and implementation of a leading strategy and push investment in innovation directly—this result is consistent with Schumpeter's (1975) study indicating that there is a positive relationship between market structure and innovation. Facing market pressure, the CEOs of SOEs should design a transparent competitive strategy and innovation plan. From this result, we can further confirm that market forces have become the key driving force of SOEs' innovation.

Our research also shows that SOEs' capital and capabilities influence the direction and scale of investment for innovation. During China's transitional period, the equipment and technology of SOEs are inferior and many of them lag by decades in efficiency. A key obstacle is the limitation on resources (including capital and capabilities). Facing market competition, CEOs of SOEs have to make the crucial decisions on investing in new or improved equipment and facilities, but given the constraints on resources, CEOs do not have an incentive to make efficient innovation decisions.

There are obvious reasons why product and process innovation are not independent of each other. Frequently, the manufacturing of a new product will only be possible if a new process is implemented. In fact, enterprises often implement these two kinds of innovation at the same time. When SOEs have a leading strategy, they should choose product innovation over process innovation or at least focus primarily on product innovation. Interestingly, we found that a leading strategy does not have a strong negative influence on process innovation (the negative relationship stated in Hypothesis 6b is not significant). The preference for product innovation does not obviously influence the process innovation itself. There may be several reasons that Hypothesis 6b is not supported. First, because the R&D capability of SOEs is weak, cost reduction and energy savings may be key approaches to enhancing performance. Many SOEs hope to acquire leading position by cost cutting. Second, process innovation is a continuous process with less risk than product innovation. The CEOs of SOEs have short-term appointments and can be replaced at will on criteria not entirely linked to firm economic performance. Although product innovation will provide greater returns and new markets, radical product innovation is high risk and takes a prolonged period of time. To develop a new product, a CEO has to invest a large amount of human resources, equipment and financial capital in a project that will have no direct return by the time his term is over. Because a CEO's future career is partially related to short-term firm performance, some CEOs may prefer to pursue lower-risk process innovation.

Additionally, neither the relationship between internal governance improvement and leading strategy nor the relationship between capital and capability constraints and leading strategy is significant. These results indicate that improvement in SOEs' internal governance and resource constraints may not significantly influence the formulation of a leading strategy, in spite of the theoretical reasons supporting Hypotheses 3a and 4a. We think that there are two reasons for these results. First,

although internal factors, including internal governance and resources, are important factors affecting strategy formulation, the CEOs of SOEs mostly care about their appointment and dismissal. Meanwhile, to address market competition, the TMTs of SOEs have to increase investment in innovation in order to pursue a leading strategy. Under these circumstances, changes in internal governance seem not to be among the key influencing factors affecting strategy formulation—government demands that CEOs improve SOEs' situations often make the CEOs prefer to obtain external resource support in the short-term. Second, during China's transitional period, internal governance improvements may need more time to show their effects, whereas SOE CEOs have short-term appointments. This may explain the insignificant effects of internal governance improvement on formulation of leading strategy.

It is important to observe the limitations and delimitations of this study. First, since the study is based on sample firms from three inland provinces in China, the conclusions may reflect mainly relationships of the study population in these provinces. Caution should be exercised in generalizing the results to firms in other provinces that have different degrees of economic reform and different competitive structures. Second, since China's transition is an ongoing process, new characteristics and changes may emerge that limit the validity of the conclusions in the future.

Because of the dramatic economic transition underway in China, SOE reform represents an exciting research problem among emergent countries. In future research, there is a need to compare the innovation of SOEs with that of other kinds of enterprises such as VTEs and joint ventures, so that the different characteristics of these enterprises can be found.

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