MARKETS FOR INNOVATION IN CHINA

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I INTRODUCTION

Innovation involves the recognition of opportunities for profitable change through "new combinations" and the pursuit of those opportunities all the way through until they are put into business practice. For both Schumpeter and Marx, entrepreneurial action and technical change are systemic features of the competitive dynamics of market capitalism. In transitions from state socialism, it is the shift to the private organization of markets that drives the rise of entrepreneurial action. We examine the organization of emergent production markets to identify social mechanisms that enable, motivate and guide innovative activity. Addressing how markets shape innovative activity involves viewing markets as opportunity structures in which firms and entrepreneurs compete for survival and profits. Our specification of opportunity structure turns on the conception of markets both as self-reproducing social structure (White 1981) and as structure of payoffs (Baumol 1990).

China's transition economy provides a broad spectrum of institutional environments within which to analyze variability in innovative activity of industrial and commercial firms. This large canvass enables us to assess the link between the emergence of a market economy based on private production and the rise of innovation as a consequence of institutional change. Only thirty years ago, China was an impoverished agrarian economy without competitive export production. Today more than 60 percent of technologies have reached or are close to standards in developed economies, a transformative change that has rapidly closed the technological gap between China and the advanced industrial economies (Porter et al. 2008).[1] The emergence and growth of privately organized markets create new opportunities for entrepreneurs of start-up private firms that innovate to compete with the established state-owned enterprises and local government-owned enterprises (Nee 1992). Marketization and innovativeness, however, remain unevenly

[1] Reliance on innovative activity to drive economic performance grew rapidly from 0.8% to 1.3% of gross domestic product between 1999 and 2003, and is expected to further increase to 2.5% by 2020 (Chong 2006).

distributed, providing the ideal natural experiments to examine the causal effect of the structure of markets on the rise of innovation in China. We explore the effect of variation in the extent of private organization of market structures and state intervention on innovation by firms using three different types of sources: quantitative firm-level data from the World Bank Investment Climate Survey, complemented by interview information generated during field-studies in the Yangzi Delta region between 2005 and 2008, and provincial-level data capturing the private organization of markets by industrial sectors.

Social science research on innovation has mainly focused on high-technology industries in advanced industrial economies, with patenting activity as a convenient indicator of innovativeness. In contrast, our empirical applications analyze the rise of routine innovation—piece-meal innovations embedded in learning-by-doing and learning-by-imitation—that drives China's transition to dynamic capitalism. Firms may develop new technologies through patenting activity, but they often fail to capitalize on their inventiveness to bring new products to the market (Sorensen and Stuart 2000:109). We examine patenting activity, but also include measures of innovation used by Schumpeter—product innovation, innovation in production process and organizational innovation as exemplified by new quality control mechanisms. We subscribe to Van de Ven's (1986) claim that any idea that is new to the people involved should be treated as an innovation, though in the strict sense of intellectual property law it would be regarded as an imitation. Limiting the concept of innovation to ideas that are entirely new to the world would render the concept almost useless for innovation research in developing and transition economies, which typically undergo technological catching-up processes at their initial phase of reform and development. As Gupta et al. (2007:886) show, any "episode of innovation is always specific to a social system and to one or more particular domains that are relevant to this social system."

We next examine why institutional change in transition economies is accompanied by dynamic change and growth in opportunity structures embedded in markets. The emergence of privately organized markets changes the relative payoff between unproductive and productive entrepreneurial activity. Following this, we sketch the rise of innovation in China since the beginning of market reforms in 1978.

Subsequent sections present our data, measurement and model specification, and proffer quantitative firm-level evidence supporting our theory and hypotheses.

II ENTREPRENEURSHIP AS AN EMERGENT INSTITUTION

Early social science research on entrepreneurial action focused on identifying essential traits of entrepreneurial talent, such as "need achievement" (McClelland 1961). Despite extensive empirical research effort, findings on psychological traits of entrepreneurs contributed little to understanding the globally unequal distribution of innovative activities (Kilby 1971). For example, cross-country findings comparing entrepreneurs in European Union countries failed to support the view of entrepreneurs as a social group with similar psychological traits and qualities of personality (Cowling 2000). There is little reason to believe that psychological traits associated with entrepreneurial talent vary much across societies (Diamond 1999). Moreover, traits that contribute entrepreneurial talent may be distributed randomly in society. What matters is the opportunity structure that determines the relative payoffs for unproductive or destructive rent-seeking and productive innovative activities (Baumol 1990).

A shift from unproductive to productive entrepreneurial activity is not automatic or universal. In transition economies organized and controlled by predatory political actors, politicians generate rents through control over the terms and conditions of exchange, and "continue to hold onto considerable local power—*not only despite, but because of marketization*" (Parish and Michelson (1996:1045). Where public officials sell rent-generating advantages, firms actively seek to shape the laws and regulations to their own advantage by providing illicit private gains to public officials. Such forms of unproductive entrepreneurship developed as a common business practice (Hellman et al. 2003). Rent-seeking often yields positive short-term effects on firm performance for those firms that operate in economies where illicit forms of lobbyism are widespread. The extensiveness of rent-seeking activities in a transition economy confirms that such unproductive entrepreneurship is a rational response to structural features of the emerging market environment (Shleifer and Vishny 1994). What redirects the firm's efforts away from unproductive rent-seeking to innovative activities?

In transition economies, institutional change has resulted in the emergence of new opportunity structures for private entrepreneurial action. In China's transition economy, the ensuing upsurge of "bottom-up" entrepreneurial action led to an explosive burst of organizational innovations and births, across a wide organizational spectrum, from hybrid ownership and privatized firms to wholly private enterprises (Nee 1992; Lin 1995; Jin and Qian 1998; Keister 2000; Tsui et al. 2006). The effects of institutional change in China's transition economy changed the relative payoffs to unproductive and productive entrepreneurial action. Economic actors and firms responded to new opportunity structures by shifting from reliance on positional advantage to investments in the firm's capabilities, and starting up new firms. Self-reinforcing mechanisms embedded in emergent private production markets shape incentives and opportunity, which jointly explain the broadly observed increase in innovative activities.

Market transition and change in economic power

Market transition entails a general shift of economic power. In communist-era command economies, the state owned and managed all productive assets from farmland to factories, and set prices by administrative fiat to control the allocation of resources. Firms had no means to generate income from competitive advantage, since all firms fully depended on financial appropriations from the state administration. Under the central plan, government bureaucrats and party officials maintained an overwhelming advantage in power over economic actors. In their role as party officials and bureaucrats, political actors intervened directly in virtually all transactions in the production and distribution of goods and services (Szelenyi 1978). The emergence and growth of markets necessarily involves reducing the scope of state controls over resource allocation (Kornai 1980). Following the expansion of markets, opportunities to generate revenue from innovative activities grow and drive incentives to invest more in a firm's capabilities than in positional advantage (Saloner et al. 2001; Swaminathan and Wade 2001). As government's capacity to subsidize loss-making industries declines, the expected payoffs for unproductive rent-seeking activities drop. This is illustrated by the declining proportion of the state budget to GDP. Between 1978 and 2005, the proportion of China's government revenues to GDP fell

from 31.1% to 17.3%. Simultaneously, government appropriations declined. While subsidies to loss-making enterprises were over 25% of total government expenditures in 1985, they were down to less than 1% in 2005. Similarly, the relative size of government expenditures for Innovation Funds and Science and Technology Promotion Funds decreased from 1.7% to GDP in 1978 to 0.8% to GDP in 2005 (National Bureau of Statistics of China 2006). Clearly, this encompassing redistribution of financial resources from political control to private control implies a shift in the general reward structure which affects firm decision making and strategic orientation. With a shrinking redistributive budget, the expected payoffs for rent-seeking activities naturally decrease, while incentives and opportunities for economic actors to engage in innovative market activities grow.

Markets as opportunity structures

Markets are opportunity structures that vary with respect to differential access to rewards for buyers and sellers. The openness and scope of these opportunity structures is to a great extent determined by informal norms and formal rules. In transition economies, a continuum of market structures range from state monopolies through partly liberalized state-dominated markets—with restricted opportunities for private economic actors—to privately organized markets with relatively low entry barriers. In China, the broad base of participation by entrepreneurs from marginal social backgrounds reveals the openness and low entry barriers of privately organized markets, which shaped a distinct form of "bottom-up" entrepreneurship. Privately organized production markets offer the most open and continuously growing opportunity structure for economic actors. These market structures approximate the Hayekian conception of free markets in which transactions between buyers and sellers are on the basis of mutual agreement on the price and terms of exchange. However, as self-reproducing social structures, real markets are far from the image of the atomistic market of standard economic models. First, in privately organized markets many economic transactions are guided informally by mechanisms regulated by ongoing social relationships (Granovetter 1985; Burt 1992; Abolafia 1996; Uzzi 1996). Second, privately organized market structures are much less subject to direct regulation by political actors. By contrast, in state-

controlled markets, political actors monitor and often intervene directly in economic transactions (Olson 2000).

The open opportunity structures of privately organized markets facilitate the creation of legitimacy, which is one of the critical challenges in bringing innovations to the market. Legitimacy increases the survival chances of firms in a niche insofar as it eases access to strategic resources (Meyer and Rowan 1977; DiMaggio and Powell 1983). As long as firms in a market lack legitimacy, they are vulnerable to competitive exclusion and discrimination, impeding access to financial and human capital (Aldrich and Fiol 1994). Organizational ecologists maintain that for new combinations in production to be recognized as legitimate, a threshold density of firms is needed (Hannan and Freeman 1989). Lacking a critical mass, private firms are bound to operate as isolated players in market niches, where social relations remain inherently unstable and therefore markets are unable to operate as self-regulating social structures (White 1981). Open opportunity structures of private markets facilitate the entry of competitors into a new niche and thereby enable a self-reinforcing process of institutionalization as innovations gain in market share and cognitive legitimacy.

In privately organized markets, the social construction of markets entails an endogenous problem-solving process wherein market players build informal institutional arrangements to solve market failures. Enforceable trust and cooperation build on the strength of ongoing relationships connecting economic actors in the market (Portes and Sensenbrenner 1993; Uzzi 1996). Organizational innovations typically arise from entrepreneurial action embedded in the self-reproducing social structure of markets. Similarly, private markets develop informal mechanisms to alleviate resource constraints. It is commonplace in privately organized markets for access to credit capital to be secured by the personal reputation of the creditor and for norms to guide acceptable business practice (Greif 1994). For example, in China's transition economy, most market entrants secure their start-up capital through loans from friends and relatives. News of failure to perform on a loan spreads quickly through cross-cutting networks in the market's social organization. Loans secured through personal reputation in privately organized markets

rarely default, whereas commercial loans made to state-owned enterprises in politicized markets often end up on state-owned banks' sizeable portfolio of non-performing loans (Tian and Estrin 2007).

Further, in open opportunity structures innovators and new market entrants benefit from positive spillover effects stemming from imitation and learning. The visible and frequent entry of newcomers into open markets serves as a motivational force to innovate. Entrepreneurs who successfully bring new products to the market serve as role models, attracting more entrepreneurial talent into emergent production markets. In periods of explosive founding of private firms, local business culture even generates a social movement dynamic to join in entrepreneurial endeavors and to innovate. Some of our interviewees confirmed that social pressure and general expectations to "take the entrepreneurial route" strongly influenced their decision to join the private sector. Similarly, coming up with new ideas to compete successfully in the market is a widely held norm of entrepreneurial action.

Maturation of markets as self-reproducing social structures facilitates the acquisition of tacit knowledge that stems from mutual observation, signalling and copying of entrepreneurial behaviour (White 2002). The diffusion of tacit knowledge in patent acquisitions depends on social interaction and geographic proximity of market participants (Jaffe et al. 1993). Learning how others detect and realize market opportunities is an essential lesson that is greatly affected by ongoing social interactions of market players. It is commonplace for entrepreneurs to carefully analyze the factors for success and failure for innovative activities by talking about the experience of other market players in their industry. As one entrepreneur who migrated to Zhejiang province, the center of China's private economy, commented on his own experience:

> *It struck me that Zhejiang people are shrewd and smart. The private firms were very successful. They are the same people as I, but they did things much better than my hometown's people. People in my hometown would not start their own firms. They would play mahjong after the harvest season, or go out to work in the cities. They never would start their own business. One's surrounding is important. When I came to Zhejiang, I learned from the surrounding …. After one year, I started a business with two local partners.*[2]

[2] Interview conducted on November 10, 2006 with the co-owner of a company in Zhejiang province producing sewage system.

It is only after a threshold point of private market players in a particular industrial sector is reached that private markets in that sector gradually acquire the capacity to operate as self-reproducing social structures. With a critical mass of private enterprise, entrepreneurs gain the capacity through their networks to institutionalize alternative sources of finance capital, build private supply and distribution outlets that bypass state monopolies and government-controlled political markets, organize labor markets to recruit human capital, and compete with the dominant state-owned enterprises for resources and market share. We thus specify:

Hypothesis 1: *The greater the extent of private organization of a production market, the higher the innovativeness of any firm operating in this niche.*

In China's early reform period of the 1980s, innovation was most pronounced in notoriously underdeveloped consumer goods markets, where state firms with their emphasis on heavy industrial production had no stake. Technology clusters and active technology markets developed within the consumer goods opportunity structure. Most of China's globally recognized private firms succeeded in newly established markets, such as computer technologies (Lenovo Computers), internet services (Alibaba) or electrical appliances (Huawei Technologies; Delixi Electronics).

Most importantly, private markets allow the free development of technology collaborations. Market mechanisms help to identify the most promising collaborators. Driven by survival and profit-making motives, inter-firm networks evolve, linking the firms' research and development activities (R&D) with universities and research institutes (Powell et al. 1996). Close interest alignment is ensured and improves the prospects of technological cooperation and exchange. Bivariate scatterplots of provincial-level data comparing the number of cooperation agreements and patenting activities confirm the close relation between the technology market and innovativeness (figure 1). Based on these observations, we predict:

Hypothesis 2: *In markets for innovation, research and development networks have a positive effect on firm innovativeness.*

[Insert figure 1 here]

Markets and competitive pressure

The ferocity of competitive pressures on capitalists underlies the firm's strategy to invest in innovative activity (Marx 1954). Market entry of new producers offering the same or similar quality products intensifies competition, which lowers prices and erodes profits. Hence firms invest in acquiring new technology just to stay in place to survive competitive pressures of the market (Baumol 2002). To escape the competitive pricing situation, producers strive to innovate. (1) By means of cost-saving innovations, firms try to temporarily increase the profit margin until rival firms discover a similar or even better technology; (2) alternatively, firms can develop new products to reach a new customer class which prefers a different price-quality combination; (3) finally, firms can extend existing customers' choice options by reshaping the firms' cost structure without necessarily reducing overall costs. The second and the third types of innovation respectively represent the process of consumer- and producer-differentiation. In sum, the greater the market competition, the more firms are compelled to innovate in one way or another.

Competition drives innovation not just for large-scale corporations, but also for smaller firms. As the owner of a small textile company (40 employees) in Zhejiang province emphasized, "we strive to be unique for a short period of time… We need to be different… Only differentiation… leads to sales." In China's market economy, only few industrial sectors such as finance, telecommunications, tobacco, selected heavy industries and high-technology (the latter until 1999) still enjoy regulatory protection and remain off-limits for private enterprise. With an unprecedented founding rate of non-state firms, China has developed into one of the most competitive market economies, with comparatively low market concentration ratios. The five largest machinery builders in the US, for instance, have a combined market share of 69%, and in Japan the top five hold 42%, whereas the top five manufacturers in China have only 20% of the market (OECD 2002, 403).

The beneficial effect of market competition on innovation, however, has an upper limit. While market competition spurs innovative activity, crowding among competitors in a technological niche weakens the survival chances of firms. Competitive crowding, defined as niche overlap in technological antecedents, has a negative effect on innovative activities in the semi-conductor industry (Podolny et al. 1996). This is consistent with the density dependence literature (Carroll and Hannan 2000), and also with the more recent economic literature on innovation. At low levels of competition, profits from incremental innovation rise and thereby speed up innovative activities; at high levels of competition where innovation is mainly driven by laggard firms with low initial profits, competition affects postinnovation rents and thereby decreases incentives to innovate (Aghion et al. 2005). Although the mechanisms differ, organizational and economic analyses point to an inverted-U shape relationship between competition and innovation.

Hypothesis 3: *Competition has a non-linear effect on innovation. Up to a threshold point, competition has a positive impact on innovation; beyond this threshold competitive crowding has a negative effect on innovation in a particular market niche.*

Casual evidence from our field interviews supports this hypothesis. While entrepreneurs in less competitive market niches emphasize innovation, those in crowded market niches are typically less innovative. Those who still strive to innovate typically focus their research efforts on the development of new products, in order to relocate in less crowded market niches. Shifts to new market niches often involve big technological shifts and fuel China's technological catch-up process. One of our interviewees, for instance, had gradually moved out of his original market of scissor production to x-ray bulb production to escape competitive crowding. Facing growing competition and shrinking profit margins in the new market niche, he was currently preparing a further technical shift into the less crowded market niche of x-ray machines[3]

Markets as structure of payoffs

[3] Interview conducted in Wenzhou (Zhejiang) on April 28, 2008.

In the context of punctuated equilibrium, self-reinforcing mechanisms embedded in rapidly growing market structures shape an overall shift in incentives. Markets provide powerful incentives for economic actors to innovate. Whether innovative activity is for the sake of the fruits of success, or for success itself, in price-making markets rewards are based on the competitive sorting and matching of quality and price (Rosen 1974; White 1981). It is thus the restoration of consumer and producer sovereignty in the process of market transition that activates incentives to innovate.

In China's transition economy new combinations of materials and processes to create new products, production processes, and organizational forms come predominantly from new firms. While new market entrants are quick to innovate and respond to a rapidly changing institutional environment, state-owned enterprises are tied down by organizational inertia, complex restructuring and reorganization processes. Partial or full state ownership invites political intervention and rent-seeking. Managers of state-owned firms will hence be less inclined to respond to growing opportunity structures and market competition through capability development and innovation. This is clearly illustrated by the low R&D effectiveness in socialist economies.

Under the central plan, the incentive structure for enterprise managers discouraged innovation. Managers were assigned annual production quotas. If they increased capabilities through innovation, they risked increasing next year's production quota, but with no tangible increase in private gains for the manager. Managers of state-owned enterprises therefore chose to pursue unproductive entrepreneurial activities such as bargaining for the allocation of extra-budgetary appropriations and lower production quotas. This involved building positional advantage through personal ties with political actors.

In the absence of a market for innovation, public research institutes conducted innovation projects without a link to firms in competitive markets. Government bureaucrats lacked the commitment to hard budget constraints, and hence the capacity for effective *ex post* screening required for divesting from innovation projects that are not viable (Qian and Xu 1998). For this reason, bureaucrats relied on *ex ante* screening, which resulted in rejecting promising projects and funding fewer projects, especially those involving higher uncertainties and less research in the initial stages of development. Political actors were

therefore particularly weak in coordinating innovations in industries involving high uncertainties *ex ante*, where weak prior knowledge imposed insurmountable challenges for bureaucrats to select promising projects.

Even following the emergence of a competitive market economy, involvement of political actors at the firm level persists. Political intervention typically focuses on firms that are either wholly or partially owned by the state. Residual rights of control in public enterprises reduce the expected transaction costs of state intervention, which makes it more cost efficient for politicians there than in private firms (Jones 1985; Sappington and Stiglitz 1987). Residual control rights also facilitate flexible strategic adjustments, if further interventions are deemed necessary (Shleifer 1998). This makes state-owned enterprises structurally vulnerable to arbitrary state involvement. Privatization, in contrast, limits political involvement in firms (Shleifer and Vishny 1994).

Politicians pursue multiple goals when they intervene in the strategic decisions of firms. Social objectives, such as maintaining high employment levels or wage rates, compete with the firm's strategic response to market forces (Shleifer 1998). In return for adjustments to meet political guidelines, targeted firms receive financial assistance in the forms of tax breaks, subsidized loans or allocation of government contracts. Financial transfer payments, however, often lead to a softening of budget constraints, if firms develop *ex ante* expectations of continuing infusion of resources from the state (Kornai 1980; 1998). A self-reproducing dynamic involving political intervention in the firm's strategic decisions and alliance in exchange for financial transfers dilutes both incentives and opportunities for productive entrepreneurship because it skews the structure of rewards towards rent-seeking. Based on the well-documented connection between firm-level intervention by political actors and state ownership (Wong et al. 2004; Nee et al. 2007), it is straightforward to expect that innovation strategies will be less effective the larger the state's involvement as a shareholder. Hence, we predict:

Hypothesis 4: *The larger the proportion of public ownership in a firm, the more extensive the political interventions and the more skewed the structure of rewards towards rent-seeking and the less the firm will successfully innovate.*

Scatter-plots illustrating the relationship between the share of distinct ownership forms in the provincial economy and innovativeness measured by granted patents support our hypothesis (see figure 2). For state ownership and collective ownership, the relative proportion of ownership and patenting activities are negatively related at the provincial level. In contrast, the share of the private economy is positively associated with patenting activities. It is noteworthy that this positive association is observable already at relatively low proportions of the private sector of about 5%. It falls in line with the general trend that the only Chinese firm listed on the World Property Organization's list of the 50 most innovative global firms is the private high-tech firm Huawei.

This is not to rule out that government can effectively support innovative activity of entrepreneurs. China's industrial policy is to encourage and facilitate the shift to knowledge-driven economic growth by providing access to funding for research and helping firms gain access to new technologies. Particularly the development of new break-through technologies requires the massive infusion of resources. In the case of Huawei, the state helped to acquire a 10 billion USD bank loan for overseas expansion and played an active role in organizing strategic alliances with international telecom companies such as Motorola, Siemens and Nokia (MOFCOM 2005). The important aspect, however, is that the state did not impose direct control rights through ownership shares, but acted within the general framework of industrial policy guidelines. Within our current focus on routine innovation, such cases of government sponsorship of high technology firms are negligible. Our emphasis is on the overall pattern, and here the main drivers of innovation are new, often small-scale private market entrants, which flexibly respond to incentives and opportunities in newly emerging markets.

[Insert figure 2 here]

III. CHINA'S TRANSITION TO DYNAMIC CAPITALISM

Although central planning and planned prices were not immediately abolished in China, a "market-track" was introduced at the start of economic reform in 1978 to complement the "plan-track," which was then incrementally phased out in the 1990s. This dual-track system provided incentives at the

margin as firms were granted the right to market their surplus production on free markets after fulfilling compulsory delivery obligations. By 1990, with few exceptions, market allocation was the dominant mechanism in China. For industrial products, the share of plan price transactions fell from 100% before reform to 45% in 1990; and in retail sales, the percentage of market sales already reached 70% by 1990 (Lau et al. 2000). Following China's WTO accession, price controls are now limited to a small group of strategic items, such as natural gas, electric power supply, train tickets and basic telecommunication service.

As a first response to the emergence of markets, China witnessed an accelerating process of organizational innovation. Initially, innovation was limited to rural areas—traditionally marginalized in China's state allocation system—which provided a broader scope of opportunities to establish new nonstate organizational forms. For example, rural township village enterprises (TVEs) were quick to adapt to the needs of a partially liberalized institutional environment as a new hybrid form that utilized positional advantage with local government to gain a competitive edge in state-dominated markets. Many of these firms operated under the guise of collective ownership, but actually constituted the first burst of private entrepreneurial efforts responding to opening market opportunities in China's rural economy. Newly released data confirms that since 1990 the majority of TVE employees actually belonged to private enterprise, disguised as formally government-owned, so-called "red hat" firms. No similar organizational hybrid developed in the urban sector, where industrial production remained heavily state-dominated until the early 1990s. In urban state-dominated markets, discriminatory rules and barriers to entry were effectively enforced. Hence, firms formally registered as private companies first operated in isolated rural and peri-urban niche markets where local regulatory control was less restrictive. Not until 2003, when the private enterprise economy was fully established as the most dynamic sector of the Chinese economy, did the central government grant full constitutional recognition of the legitimacy of private ownership forms. Legal equality enabled private firms to shift the main locus of entrepreneurial activity from rural and peri-urban markets to urban China (see figure 3).

[Insert figure 3 and 4]

Confronted with fierce market competition from private start-ups, the market share of state-owned enterprises decreased from 78% to only 35% of gross industrial production between 1979 and 2005 (National Bureau of Statistics of China 2006). Figure 4 shows that employment shares in publicly-owned firms (state-owned and collective forms of productions) declined steeply from 1990 to 2002, dropping from more than 80% of non-agricultural employment to about 50%, while there was a simultaneous burst of private entrepreneurship. The aggregate account, however, glosses over greatly varying regional and provincial development paths. In spite of formal legality of private firms, external legitimacy varies greatly across China. Only in the most liberalized provinces, such as Shanghai, Beijing, Guangdong, and Zhejiang, do private firms seem to operate on a fairly level playing field with foreign firms, domestic partially state-owned corporations, and collective firms. In the less marketized inland provinces, administrative discrimination and competitive exclusion still persist in distinct sectors and impede organizational innovation.

With the increase of private forms of production and growing diversity of organizational forms, the central government has lost much of its direct control over R&D decisions and there has been a natural shift to privately conducted R&D activities. With more than 60% of R&D funds provided by firms, the national expenditure structure resembles that of advanced market capitalist economies such as the US at 63%, Germany at 66%, and Switzerland at 69% (National Bureau of Statistics/Ministry of Science and Technology 2005). In parallel, total R&D funds increased dramatically. Between 1999 and 2003 alone, national R&D-expenditures increased from 0.8% to 1.3% of GDP, even surpassing the average value of the EU-15 countries.[4] A further increase to 2.5% of GDP is expected by 2020 (Chong 2006).

[4] For comparison, current R&D expenditures are 2.6% of GDP in the US, 1.9% in the UK, and 1.6% in Australia (National Bureau of Statistics/Ministry of Science and Technology 2005).

IV. METHOD

Sample

To analyze the relationship between market structure, research networks, ownership, competition and innovativeness at the firm level, we use data from the World Bank Investment Climate Surveys, which we complement with market structure data from *China data online* and China Labour Statistical Yearbooks. The World Bank's Investment Climate Surveys were conducted in two waves in 2002 and 2003. These surveys provide a broad selection of different institutional environments and market structures for testing our hypotheses. The 2002 survey includes firms located in 5 middle-size and large cities (N=1,548); the 2003 survey includes firms in 18 middle-size and large cities (N=2,400). These 23 cities are located in 20 different provinces, ranging from the Southwestern province of Guizhou (only 1% private employment and practically no private enterprise economy) to Shanghai with more than 41% of employees in the private sector (National Bureau of Statistics of China 2004). Participating firms were randomly selected in each city. The industry mix comprises both labor-intensive and technology-intensive sectors across a broad spectrum of different production technologies and levels of competition (see Appendix, table A1 for industry distribution). Both surveys share a set of in-depth questions covering innovation activities and related firm-level strategic decisions. Most importantly, both surveys jointly offer a wide coverage of firms located in regions with greatly varying levels of marketization. They thus enable comparative institutional analysis of a diverse sample of organizational and ownership forms—private, hybrid and state-owned enterprises.

Model Specification

Formally, our model is

$$y_{ij} = \mathbf{X}_{ij}\boldsymbol{\beta} + \nu_i + \varepsilon_{ij}$$

where *i* denotes each city and *j* each firm. $\mathbf{X}_{ij}$ is a set of variables covering market structure, ownership and research activities and distinct firm characteristics and $\boldsymbol{\beta}$ is a vector of corresponding coefficients. ν_i

denotes regional fixed effects, while ε_{ij} residuals.[5] Note that we do not introduce fixed effects at either the provincial or the industrial level that are already built into our measure of market structure. The regional fixed effects in our model reflect five Chinese regions, as will be specified in control variable descriptions. We apply Tobit and Probit models.

Dependent variable

To assess the broader concept of a firm's innovativeness, we employ four measures of innovation which work well with a mixed data-set that combines different industrial sectors. Our key measure is the share of new products (which includes new services) in a firm's total annual sales. This measure has the advantage not only of providing information on the occurrence of innovative activity, but also of reflecting whether new product developments were successfully brought to the market. In addition, we use binary data on the introduction of new products and services[6], the introduction of new production processes or work routines, and the introduction of new quality-control measures. The inclusion of the latter innovation-type responds to Solow's (2007:18) warning not "to lapse into the tacit presumption that 'innovation' consists of new products and new technology only, whereas an important component is organizational innovation." For the 2003 survey, our innovation measures refer to the year 2002; for the 2002 survey, we use innovation measures for the year 2000.

Finally, we use patent acquisitions as another measure of a firm's capacity for innovation (Schmookler 1966). A dummy variable indicates whether a firm received a patent in the last available survey year (i.e. in 2002 and 2000). A couple of reservations are worth noting. First, a patent or invention is not an innovation until it is brought to the market (Schumpeter 1983). Second, not all innovations are

[5] The use of city-clustered standard errors provides the appropriate tool to capture within city correlations given relatively low intraclass correlation in our stratified sample of firms and the limited number of clusters (23 cities).

[6] We are aware that the use of a binary variable capturing product innovation is not ideal. The survey design of the study, however, did not cover information on respective count data. We seek to overcome this limitation by emphasizing the share of new products in a firm's total annual sales as our key variable capturing success in product innovation.

patented by firms. Investment in patenting activity presupposes a certain level of trust that intellectual property rights are effectively protected and will be enforced by an independent judiciary. This is a crucial qualification, which renders patenting a weak measure of a firm's inventiveness in China's transition economy. Another reservation is that patenting in China differentiates between patents for inventions, patents for design (patents on an ornamental design of functional items) and utility models. The latter, often called "minor patents" or "petty patents", involve more lenient approval procedures and shorter periods of property rights protection. The survey data, however, does not differentiate between substantial inventions, the development of new design and utility models. Finally, not all industries are equally likely to register patents, which may be an additional concern when using datasets with different industrial sectors.

Independent Variables

Market structure

An adequate measure of private organization of market activities is essential. The transition from state-guided to privately organized production does not vary simply by region or locality, but rather the speed of deregulation and privatization varies greatly across industrial sectors. In so-called key sectors, such as electricity, automobile, chemicals, and most service sectors, state-guided production remains in a dominant or controlling position. Other industries, mainly light industrial production of consumer goods, were quickly liberalized. Entry barriers were reduced, and state subsidies were rapidly phased out. We thus decided to use industry-specific measures of private production at the provincial level in order to capture the level of private firm activities in distinct market niches.

For our purpose, the original industry coding provided by the World Bank was not sufficiently accurate to construct industry-specific private production measures at the provincial level. We observed inconsistencies between the industry categories and the firm's main business activities coded by an open-ended question. Most importantly, these categories were inconsistent with official categories of industrial classification and therefore did not allow the construction of variables measuring distinct market structures. To correct these problems, we re-categorized the industry categories in the World Bank data

into 15 discrete industrial sectors (see appendix, table A1) that are consistent with industry categories in *China data online* and China Labour Statistical Yearbooks, which we used to collect and code provincial-level information on the extent of privately organized production. With reference to the firm's main business activity, we recoded industry classifications of individual firms into those 15 sectors. Finally, we constructed the provincial level measure of private firm activities for each sector, defining as private all firms that are not registered as state-owned or collective, including wholly foreign-owned and joint-venture firms. To approximate the market share of private firms, we used industrial output values retrieved from *China data online* for manufacturing sectors, and for service sector activities, we used employees' earnings provided by China Labour Statistical Yearbooks. We created this measure for the years 2000 and 2002, the former for the 2002 survey and the latter for the 2003 survey, and matched its values to each firm based on the firm's province and survey year in the World Bank data set.

The sector with the lowest mean private share in our sample is "traffic, transport and storage services" with 14%, and the sector with the highest mean value is "electrical appliance for daily use" with 92% (see appendix, table A1). The shares of privately organized production within each industry vary considerably across provinces. For "traffic, transport and storage services", for instance, the share of private production ranges from 1.16% in Jiangxi province to 34.37% in Zhejiang province; similarly in the most privatized sector "electrical appliance for daily use," shares range from 69.02% in Beijing to 100% in Chongqing, Guizhou, Heilongjiang and Shaanxi provinces. Within each province, the extent of privately organized production varies greatly across the different industrial sectors. It is typically lowest in the state-dominated and highly regulated service sectors, and most pronounced in light industrial manufacturing, where new market entrants found open and quickly expanding opportunity structures. Overall, the scope of private firm participation in markets in our sample has a mean value of 45% (see appendix, table A2).

Research and development networks

The emergence of markets for innovation is measured by three variables indicating the existence of contractual agreements and strategic alliances for cooperative research and development (R&D) over a period of three years. We differentiate strategic alliances between the firm and (1) other firms, (2) universities, and (3) research institutes because they are connected with different organizational behavior and competences in innovation markets (Rosenberg 2007; Schilling and Phelps 2007).

Competition

Reflecting assumptions on the role of monopoly power (Schumpeter 1947; Arrow 1962), a dichotomous variable indicates whether a firm's domestic market share is more than 10%. We also control for the perceived competition via the self-reported number of competitors in the main domestic market, using a five point scale (1: 1-3, 2: 4-6, 3: 7-15, 4: 16-100, 5: more than 100).[7] As we expect competition to have different effects on innovation in less and highly competitive markets, we allow for a non-linear relation (Scherer 1967; Aghion et al. 2005) and specify a square-term of the number of competitors. Lastly, whether firms participate in the export market is indicated by a dummy variable. None of the competition measures correlates closely with our measure of market structure.[8] This confirms that our focus on the private organization of production markets introduces a distinct concept which goes beyond the measurement of competition.

Political Control

State-owned enterprises are in general subject to more active monitoring by government units, operate under softer budget constraints, and engage in routine rent-seeking activities to secure resources allocated by the state. Collectively owned firms are administered by local governments and are similarly subject to direct monitoring and intervention of political actors. Firms legally registered as shareholding companies or limited liability companies are partly privatized former state-owned enterprises in which the

[7] Reliance on self-reported measures provides a more accurate assessment of a firm's market position in China's transitory economy than, for instance, industry-specific concentration ratios, as competition is still affected by the uneven development of distribution channels, non-tariff trade barriers and local and provincial trading networks.

[8] Complete Pearson Correlation Table is available upon request from the authors.

state retains partial ownership rights. We construct three dummy variables to differentiate between these three ownership forms with varying levels of state ownership and political controls.

Control Variables

To isolate the structural effects on innovative activity stemming from private organization of markets, research networks, competitive pressure and ownership form, we control for other factors that prior research has confirmed are closely associated with a firm's innovativeness.

First, a dummy variable indicates whether a firm has invested in R&D over the preceding three years (Mairesse and Mohnen 2002; Kochhar and David 1996). In addition, we use the average ratio of a firm's R&D expenditures to total sales over the three preceding years as an indicator of research intensity. We take into account the path-dependent nature of a firm's innovative capacity and approximate the firm's most recent stock of technological capital by noting whether a firm acquired patents over the same period. In addition, we include membership in business associations and location in industrial parks to control for the extent to which firms have ready access to strategic alliances and information on technological developments.

Other firm characteristics—including age, size, financial leverage, and location—may correlate both with a firm's innovation strategies and innovativeness. A firm's age is generally believed to affect adaptability (Hannan and Freeman 1989). Pre-reform firms are encumbered by more structural inertia. Hence these firms are likely to exhibit a structural disadvantage, especially under conditions of rapid institutional change when the fit between organizational competence and environmental demands declines with age (Sorensen and Stuart 2000). To differentiate between new and older firms, we introduce a dummy for firms founded after the start of market reform in 1978. Furthermore, firm size reflects scale economies and access to finance (Schumpeter 1947; Mohr 1969; Singh 1986; Acs and Audretsch 1987). To control for scale effects from firm size, we include the natural logarithm of the average value of a firm's net assets and the natural logarithm of a firm's total employment over the last three years. Similarly, a firm's financial leverage may determine the ability to fund R&D and also the choice of R&D

projects (Schumpeter 1983). The natural logarithm of the average debt-asset-ratio over the preceding two years serves as an indicator of financial health. To control for geographic conditions we include a set of binary variables for five regions: northeast, coastal, central, southwest, and northwest. Finally, since we use pooled data from two survey waves, one dummy variable controls for the survey year. Table A2 shows descriptive statistics. Pearson correlations between independent and control variables and variance inflation factors were calculated and indicate that multicollinearity is not a concern.

RESULTS

Hypothesis 1 predicts increasing rates of innovation with the emergence of privately organized production markets. For all five outcome variables, the effect of the extent of privately organized markets on firm innovativeness is positive and significant. For models I to IV, coefficient estimates are highly significant at the 0.1% level. We explored the question whether the relationship between marketization and innovativeness might be non-linear, but we could not confirm such an effect.

Only for "granted patents" (model V) does the significance of the coefficient estimate decrease to a marginal level (10%). A firm's decision to "patent" its inventions may not be a universally reliable measure of innovativeness. Submitting a patent application implies expectation of effectiveness in legal protection and enforceability of formal rights once a patent is acquired. In China, where legal protection is ineffective, patenting is as a weak indicator of capacity for innovative activity.

[Insert table 1 about here]

Hypothesis 2, which predicts that R&D networks increase firm innovativeness, is broadly supported. Among the three types of research cooperation under review, inter-firm networks perform best. For models I to IV, the positive effect of inter-firm cooperation in research and development is consistently strong and highly significant (0.1% level). Also, the effect of research ties with research institutes is positive and statistically significant for models I to IV. Only the effect of R&D contracts with

a university seems slightly weaker, with insignificant results in the case of process innovation (model III). For patenting activities (model V), we observe an entirely different pattern. None of the three types of R&D networks significantly increases a firm's likelihood to patent inventions. We suspect that China's weak legal system with ineffective intellectual property right protection may at least partly explain why firms rely to a lesser extent on research cooperation to increase their patent production. Frequent theft of intellectual property rights has caused growing security concerns not only among international investors, but increasingly among China's domestic entrepreneurs. High exposure to potential information loss at the development stage coupled with lengthy and cumbersome bureaucratic patenting procedures puts the individual firm at a high risk. Unsurprisingly, some of our interviewees signaled a certain reluctance to cooperate with external partners, when it comes to patentable research.

Given the consistently strong effects of private organization of markets and R&D networks on innovation, we have further explored whether we can identify any interaction effects between these. It is a straightforward extension of hypotheses 1 and 2 to explore whether the productivity of strategic R&D alliances varies with the quality of embedding market structures. Privately organized markets provide a greater choice of potential research partners and closer interest alignment due to profit motives than do state-dominated markets. We estimated positive and significant interaction effects between inter-firm R&D networks and marketization for process innovation (model III) and quality control innovation (model IV).[9] Interaction effects between marketization and R&D networks with university and research institutes, however, remained insignificant in all five models. Without wishing to ascribe too much importance to these preliminary findings, further exploration of R&D networks, especially in high technology industries, seems promising.

Our measures of competition behave as expected. Large market shares of more than 10% have a significant positive effect on a firm's innovativeness, confirming a positive link between monopoly power

[9] As interaction effects computed in non-linear models do not equal the marginal effect of the interaction term and standard errors, we followed the procedure suggested by Ai and Norton (2003) to calculate corrected coefficient estimates and standard errors (complete tables of regression output including interaction effects are available on request).

and innovativeness (Schumpeter 1947; Arrow 1962). As predicted by hypothesis 3, there is a non-linear relation between competition and innovation. At low levels of competition, a rise of competitive pressure increases firm innovativeness; beyond a certain turning point, the positive effect turns negative as competitive crowding sets in, and any further increase in competition reduces incentives to innovate. Coefficient estimates for the number of competitors in business and the respective quadratic terms confirm an inverted U-shape relationship with statistically significant coefficient estimates in all cases except patent registrations (model V). Our findings are consistent with the earlier literature predicting non-linear effects of competition on innovation (Podolny et al. 1996; Aghion et al. 2005).

The final hypothesis predicts a negative effect of state ownership on a firm's likelihood to innovate. For wholly state-owned enterprises, this is confirmed in all cases except product innovations (model II). Also the locally controlled collectively owned firms are less innovative than purely privately held firms. Collective ownership has a significant negative effect on innovation with regard to percent of new products in total sales, product innovations, and patent registrations (models I, II and V). The negative effect of state ownership disappears, however, when the state's involvement is reduced to the role of a partial shareholder within modern corporate structures of limited liability firms or joint stock enterprises. In one case (model III on process innovation), corporations with partial state ownership even enjoy advantages over wholly privately run firms.

The observed pattern is consistent with our general prediction as to the negative effect of the extent of state ownership. Exclusive state ownership exerts the strongest negative effect on innovation, while mixed forms of ownership seem not to significantly affect it. This may be due to the influence of private shareholders within modern corporations with mixed ownership forms. Non-state owners may help to promote the firm's capability development as a response to changing incentives and reward structures in emerging market economies. We cannot, however, rule out that the seemingly better performance of modern corporations with partial state-ownership is simply due to a selection effect. China's strategy has been to corporatize "competitive" parts of conglomerate state-owned enterprises, changing them into joint stock or limited liability firms.

Other control variables

Investment by the firm in research and development and previous patent registrations both have the expected positive and statistically significant impact on firm innovativeness, which underlines a path dependency of success in innovation activities. It is striking, however, that research and development intensity as measured by the R&D to sales ratio seemingly does not increase firm innovativeness. Only process innovation (model III) is positively associated with higher R&D investments. In the case of quality control innovations (model IV) higher R&D-to-sales ratio even has a negative effect on innovativeness. Our data does not suggest any causal explanations for the observed pattern. We assume, however, that our model specification using a binary outcome variable instead of count variables on innovation activities may have contributed to this unexpected result. R&D intensity may actually be a more effective measure in explaining the total number of innovations.

Among the remaining control variables, location in industrial parks and membership in business associations both exert the expected positive effect on innovation. Also average management education and the firm's debt-asset ratio have significant positive effects. Firm size, as measured by the natural logarithm of firm assets and labor force, does not seem to play a decisive role, only affecting process (model III) and quality control innovation (model IV). Large market players lose their comparative advantage to innovate when it comes to new product development (model I and II) and patenting (V). This is in line with our earlier discussion emphasizing that new and typically small market entrants are better equipped to identify and react to opening market opportunities and respond quickly to shifting consumer demand. Our results suggest that large (already established) market players rely instead on cost-reducing innovations, such as process and quality control innovation.

Overall, we find strong support for all four hypotheses. The private organization of markets and R&D networks are particularly strong predictors of firm innovativeness.

Robustness

The inclusion of a broad set of control variables, in an aim to not overlook potentially confounding effects, may lead to over-control. To address this concern we re-estimated reduced models without any control variables. Table A3 (see appendix) summarizes the results. A comparison with our full models (table 1) confirms almost all main effects at a highly significant level, though coefficient estimates naturally vary. Only for variables measuring the extent of state ownership do we observe some differences. Lower innovativeness of state-owned firms compared to private firms is confirmed only for quality control innovation (model IV) and patenting (model V). But corporatized firms with partial state ownership enjoy significant advantages in product innovation (model II) and process innovation (model III). We presume that these results are attributable to the uneven distribution of firm characteristics across different ownership forms. Hence we conclude that omission of control variables such as firm size, age and financial leverage leads to confounding effects.

Another concern is the potential risk of reverse causality, which could be important in the case of our measure of the extent of private organization of markets. More innovative firms might simply locate in regions where the private enterprise economy has reached a tipping point, while less innovative firms might locate in provinces with low private production shares in order to escape neck-to-neck competition. Such selective sorting would require a high level of cross-provincial and cross-industrial firm mobility. While new start-up firms could indeed choose their location in line with their preference for distinct market structures, older firms would need flexible relocation strategies. Casual evidence and extensive interview information suggests that this type of inter-provincial mobility is not prominent in China. State-owned and collectively-owned firms are tied to the responsible provincial or municipal government administration, which rules out relocation. Even private firms rarely relocate across provincial borders, as business success in specific market niches can depend on the asset-specific bilateral contracting in firm-to-government and firm-to-firm relations (Williamson 1981). Once founded, firms typically stay in their home province to further exploit their local business advantages.

To more systematically explore whether reverse causality was driving our results, we reran our estimations with two sub-samples: (1) firms founded before 1993; (2) firms founded after 1993. Given

low cross-provincial mobility, reverse causality could only have been caused by younger firms which, at their founding stage, were able to distinguish and choose between the more marketized and state-dominated provinces. To prove that our main effects were not driven by such selective sorting, we thus need to confirm our results for those firms that were already founded before the period of rapid marketization of China's industrial economy. We choose 1993 as a benchmark year of the start of transformative institutional change and marketization of China's non-agricultural economy. Before 1993, cross-provincial variation in the extent of privately organized markets was negligible, ranging between a low of 0.1% and a high of 3.1% (National Bureau of Statistics of China, 1994); hence, selective sorting was clearly not an option.

A comparison of the descriptive statistics for both subsamples reveals no serious selective sorting by marketization levels. Also the reliance on R&D networks and the intensity of market competition are comparable (see appendix, table A4). Only the ownership structure varies for both subsamples, which is in line with the organizational dynamics of creative destruction: increased founding rates of private enterprise and restructuring of state- and collective-owned firms through corporatization and privatization. Table 2 compares our results of main effects with those of the total sample. The positive association between marketization and innovation is confirmed for the subsample of firms founded before 1993 for all models except for patent acquisitions (model V), where the estimated coefficient is just short of statistical significance. This confirms that our main effects of the extent of private organization of markets on firms' innovativeness are not subject to reverse causality. Further, the consistent confirmation of market structure effects on innovation for older firms reinforces our argument that the social structure of markets has an independent effect on organizational performance in innovative activity, net of the individual history of the firm.

[Insert table 2 about here]

We briefly note some further comparisons between the two sub-samples. Older and new firms seem to rely on different forms of research and development cooperation. For those founded before 1993,

inter-firm R&D networks appear to provide the most effective form of cooperation. Those firms founded since 1993 are most successful in promoting innovativeness through R&D cooperation with research institutes. Also noteworthy are different competition effects. The positive effect of monopoly power (market share >10%) on innovation is only observable for firms founded before 1993. And the inverted U-shaped effect of competition is more salient among firms founded since 1993. Both findings jointly suggest that firm-level competition is more effective in promoting innovative activity in the newer firms founded after 1993. This is consistent with Sorensen and Stuart's (2000) view that in periods of rapid change in environment, the fit between organizational capabilities and environmental demands declines with age. Also older firms have better positional advantage through past investments in network ties with government, helping through state subsidies to alleviate competitive pressures.

V. CONCLUSION

In economics, Schumpeter's idea of creative destruction motivates endogenous growth theory, but that theory (as set forth in Aghion and Howitt's (1992, 1998) model, for instance) sidesteps the question of where innovation comes from. Mechanisms giving rise to creative destruction are relegated to a black box. A promising insight in the economics literature on innovation is Baumol's (1990) assertion that the relative supply of entrepreneurial talent is constant over time and across societies. Similar to the sociological approach, the new institutional economics focuses on the causal effect of institutional structures on performance of firms. What matters in determining the volume of entrepreneurial action and innovative activity is the institutional structure that shapes the relative payoffs in rewards for unproductive activity and productive entrepreneurial action and innovation. Yet the new institutional economics approach relies almost entirely on historical case studies and analytical narratives to demonstrate the effects of institutions and institutional change on innovative activity (North 1981; Baumol 1993; Greif 2006). Moreover, it emphasizes the role of the state and formal rules of the game, factors which are exogenous to markets and innovative activity.

In extending the sociology of markets conceived as self-reproducing social structures, we specify an endogenous explanation of the rise of routine and piecemeal innovation in China's transition economy. In the sociological approach, creative destruction does not arise from within the established order of older firms, but from new start-up firms.[10] These are led typically by entrepreneurs—often from marginal social groups—who launch robust entrepreneurial action from outside the established business order (Young 1971). Their aim in discovering new combinations in production and distribution is the competitive elimination of the old. This is Schumpeterian cycle of creative destruction in capitalist economic development. The wish to innovate, to succeed, and to prove superiority, however, is in the Schumpeterian perspective exogenously given and has its roots in a person's *Unternehmergeist*, the entrepreneurial spirit. In the markets-as-opportunity-structure approach, it is not uncommon for competitive exclusion and differential access to resources and rewards to motivate robust entrepreneurial action and innovative activity. The opportunity-structure approach on innovation thus moves social constraints and opportunities and subsequent individual choices and behavior to center stage.

We focus on the emergence of privately organized production markets in the context of the large canvass provided by China's transition economy. In China, private production markets emerged as open opportunity structures characterized by low entry barriers and competitive pressure on firms to innovate. These open opportunity structures help to explain a social movement dynamics of entrepreneurial action and innovative activity in China's evolving market economy. The huge, virtually unlimited supply of entrepreneurs in rural areas and in marginal groups outside of the established order of dominant state-owned firms in urban China fueled the rapid entry of new start-up firms. The competitive elimination of public-ownership forms is evidenced in every industrial sector, outside of a few key government-protected industries where state-owned firms continue to dominate business activity.

Unlike political markets controlled by the state and political actors, privately organized markets enable economic actors to construct self-reproducing social structures that facilitate innovative activity.

[10] But in advanced capitalism, as Schumpeter (1947) emphasized in *Capitalism, Socialism and Democracy*, established big firms become the source of technical change.

We confirm that R&D networks advance innovation (Powell et al. 1996). Given low entry barriers, an expanding niche attracts new market entrants that join in a self-reinforcing competitive dynamics of innovative activity. A threshold density of market players contributes to a self-enforcing process of legitimization and institutionalization of innovation, but at a critical level, competitive crowding leads to a decline in innovation (Podolny et al. 1996; Aghion et al 2005). Incentive structures embedded in ownership forms shape the innovation activity of firms. Overall, our results suggest that mechanisms giving rise to innovation are embedded in self-reinforcing institutional dynamics of markets as opportunity structures.

The organizational research on competition and network linkages has an inherently egocentric perspective. That is, the boundaries of the relevant firm environment are defined by the scope of direct firm linkages with either existing competitors in a technological niche or with research collaborators. Our markets-as-opportunity-structures approach incorporates the effect of R&D networks and competitive crowding in market niches, but also allows for indirect effects stemming from profit-making opportunities as markets evolve as self-reproducing social structures. In this light, the positive effect of status on a firm's success in innovative activity (Podolny and Stuart 1995) may be a function of the maturation of markets for innovation.

Previous research on innovation has focused on high-technology industries in advanced market economies, typically in the framework of single country or regional studies. The opportunity structure approach opens the way for social science research to examine why innovative activity varies across industries and across societies. The adequate specification of the quality and scope of opportunity structures is crucial for further research. For transition economies, the private sector share is a reliable measure of institutional change and shifting reward structures. Research on mature market economies and particularly cross-country comparisons, however, call for modified measures to also capture institutional heterogeneity across a larger set of factors shaping resource accessibility and relative reward structures. For instance, the corruption level of bureaucracies, taxation rates, and start-up business costs all have a direct effect on the reward structure and may easily bias individual choices against productive

entrepreneurship and innovation. Measures capturing resulting market dynamics such as founding rates of firms and national rates of change in entrepreneurial activity can serve as useful complements to our structural measure.

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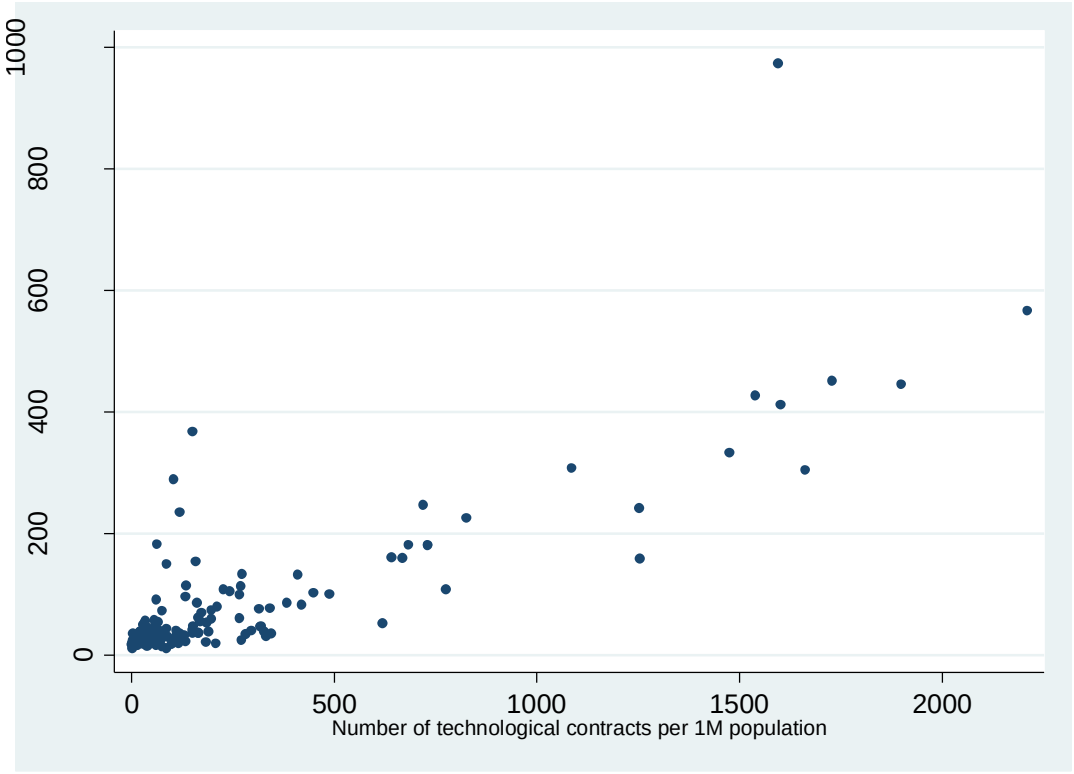
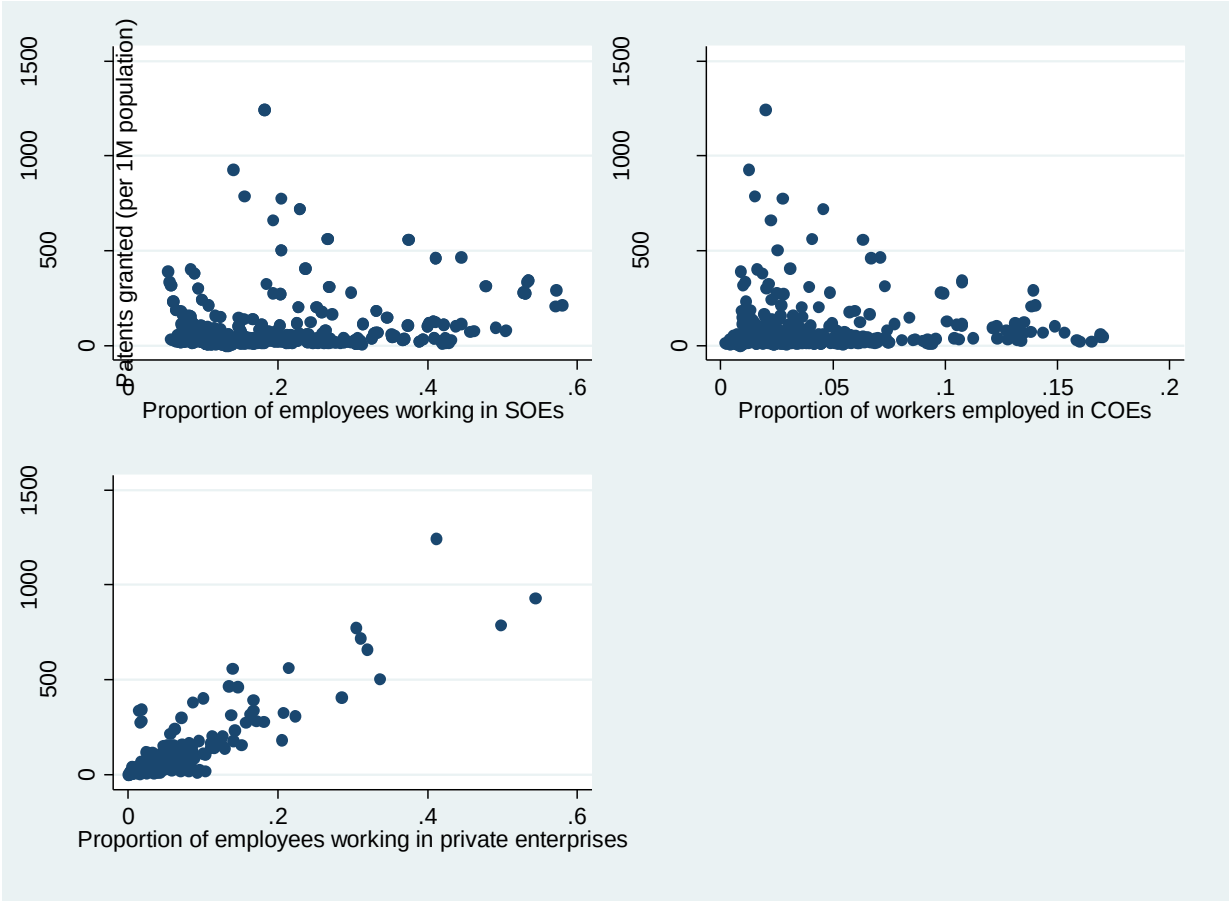
FIGURES

Figure 1: Cooperation agreements and patenting at the provincial level, 1998-2003



Source: National Bureau of Statistics of China, 1999-2004.

Figure 2: The relation between state-ownership, collective ownership, private ownership and patenting across provinces, (1993-2005)

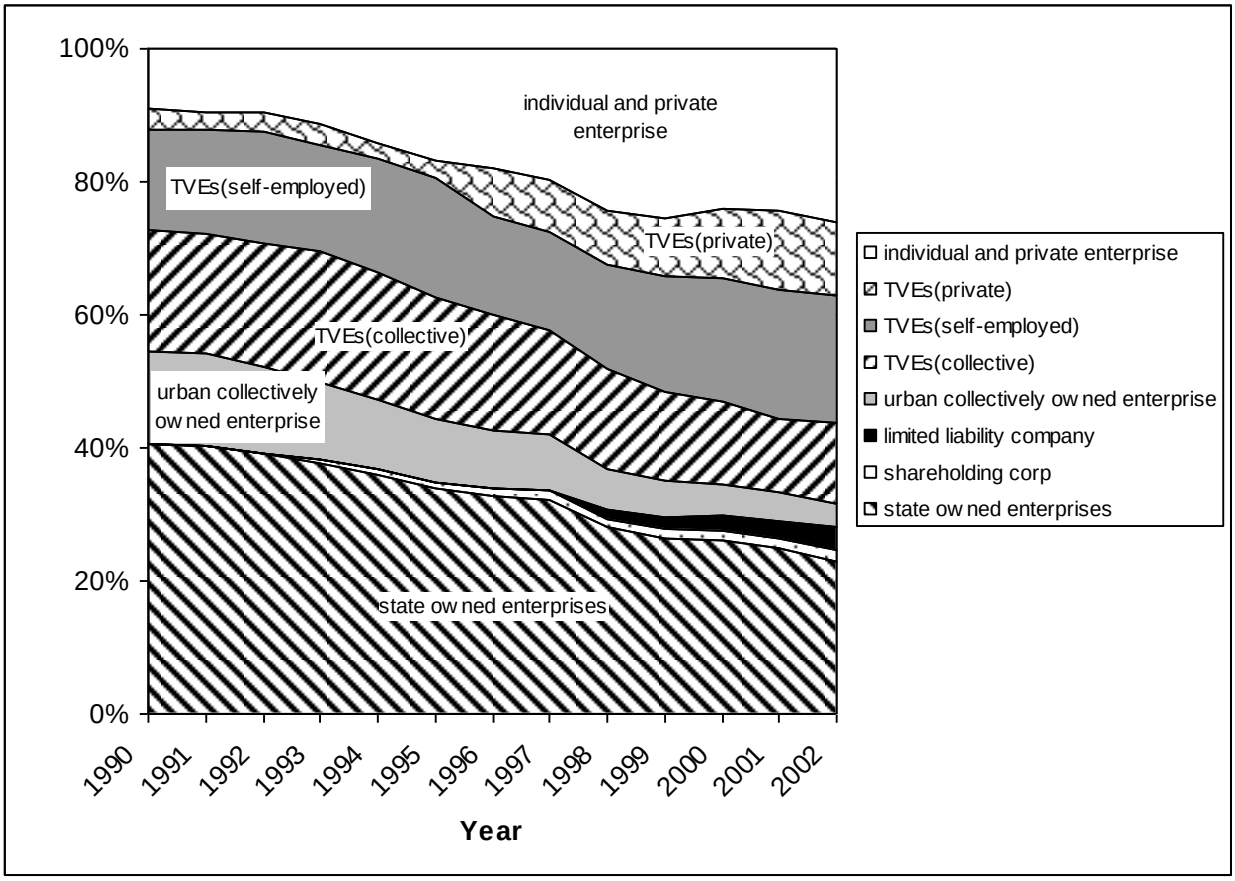


Source: National Bureau of Statistics of China, 1994-2006.

Figure 3: Employment in private firms

Source: National Bureau of Statistics of China, 1991-2006. Disaggregated private employment data for rural and urban sector is not available for the years before 1990.

Figure 4: Employment shares by organizational form (1990-2002)



Source: National Bureau of Statistics of China, 1991-2003.

TABLES

Table 1: Regression results of marketization, research activities competition, and ownership

	% new products in total sale	Product innovation	Process innovation	Quality control innovation	Patent
	(I) Coefficient (SE)	(II) Coefficient (SE)	(III) Coefficient (SE)	(IV) Coefficient (SE)	(V) Coefficient (SE)
Marketization					
Proportion of private	13.515***	0.486***	0.894***	0.369***	0.294+
Economy	(3.334)	(0.101)	(0.097)	(0.104)	(0.175)
Research cooperation					
R&D cooperation with firms	11.541***	0.458***	0.354***	0.274***	0.216
	(2.236)	(0.070)	(0.091)	(0.077)	(0.155)
R&D cooperation with	8.232***	0.250***	0.143	0.173**	0.22
Universities	(2.216)	(0.076)	(0.096)	(0.064)	(0.145)
R&D cooperation with	5.737*	0.346***	0.415***	0.400***	0.116
research institutes.	(2.565)	(0.086)	(0.087)	(0.093)	(0.170)
Competition					
Market share > 10%	7.028***	0.219**	0.264***	0.201*	0.099
	(1.932)	(0.081)	(0.076)	(0.082)	(0.102)
Number of competitors	6.043+	0.349*	0.318**	0.167*	0.103
in main business	(3.139)	(0.165)	(0.108)	(0.084)	(0.132)
Number of competitors^2	-1.326**	-0.067*	-0.054**	-0.030*	-0.033
	(0.497)	(0.026)	(0.018)	(0.013)	(0.021)
Firm exports	3.944*	0.107+	0.159+	0.176*	-0.017
	(1.917)	(0.055)	(0.081)	(0.069)	(0.117)
Ownership					
State-owned firm	-4.379+	-0.036	-0.121+	-0.233***	-0.460**
	(2.306)	(0.070)	(0.067)	(0.071)	(0.154)
Collectively owned firm	-6.434*	-0.106+	-0.072	-0.035	-0.383**
	(2.586)	(0.064)	(0.074)	(0.083)	(0.138)
Partial state-ownership in limited	-0.578	0.042	0.13	-0.053	-0.218
liability or joint stock company	(4.311)	(0.158)	(0.123)	(0.133)	(0.208)
Firm controls					
Firm holds patents	6.923**	0.254**	0.420***	0.121	2.008***
	(2.270)	(0.090)	(0.066)	(0.091)	(0.330)
Firm conducts R&D	15.487***	0.533***	0.356***	0.320***	0.104
	(1.847)	(0.058)	(0.048)	(0.054)	(0.104)
Average R&D to sales ratio	-0.042	0.018	0.051*	-0.079***	-0.008
	(1.082)	(0.028)	(0.020)	(0.022)	(0.024)
Located in industrial park	2.936	0.147**	0.100**	0.197***	0.175*
	(1.850)	(0.056)	(0.037)	(0.053)	(0.097)
Member of business	9.376***	0.314***	0.149**	0.208***	0.258**
Association	(1.734)	(0.043)	(0.056)	(0.052)	(0.082)
Firm is founded after1978	-0.41	-0.038	0.015	0.284***	0.078
	(2.399)	(0.059)	(0.069)	(0.086)	(0.125)
Log of average firm assets	1.03	0.036	0.022	0.041+	0.028
	(0.659)	(0.026)	(0.026)	(0.021)	(0.040)

Table 1 contnd:

Average debt asset ratio	2.702*	0.075*	0.006	0.005	0.106+
	(1.067)	(0.038)	(0.038)	(0.019)	(0.063)
Log of average employees	0.192	0.017	0.094*	0.096***	0.04
	(1.003)	(0.039)	(0.041)	(0.030)	(0.059)
Average education of	4.242***	0.139***	-0.04	0.038	0.215***
Manager s	*(1.105)*	*(0.039)*	*(0.033)*	*(0.039)*	*(0.055)*
Surveyed in 2003	2.22	0.211**	0.152	0.198**	-0.898***
	(1.991)	*(0.078)*	*(0.096)*	*(0.071)*	*(0.116)*
Constant	-68.616***	-2.673***	-2.320***	-2.186***	-2.938***
	(9.068)	*(0.308)*	*(0.271)*	*(0.297)*	*(0.395)*
Method	Tobit	Probit	Probit	Probit	Probit
Pseudo R^2	0.052	0.207	0.186	0.143	0.415
N	2859	2937	2934	2930	2128

Note: In parentheses are standard errors; + p<.10, * p<.05, ** p<.01, ** p<.001

Table 2: Comparisons of coefficient estimates and significance levels between the total sample and subsamples.

		% new products	Product innovation	Process innovation	Quality control	Patent
Marketization						
Proportion of non-public economy	Total	13.515***	0.486***	0.894***	0.369***	0.294+
	<1993	19.312***	0.602***	0.977***	0.408**	0.479
	≥1993	9.011+	0.430**	0.816***	0.354*	0.177
Research cooperation						
R&D cooperation with firms	Total	11.541***	0.458***	0.354***	0.274***	0.216
	<1993	13.985***	0.530***	0.576***	0.291*	0.123
	≥1993	9.441**	0.416***	0.198	0.271*	0.25
R&D cooperation with universities	Total	8.232***	0.250***	0.143	0.173**	0.22
	<1993	11.049***	0.372***	0.231+	0.277*	0.268
	≥1993	6.252*	0.172+	0.093	0.083	0.182
R&D cooperation with research institutes	Total	5.737*	0.346***	0.415***	0.400***	0.116
	<1993	1.378	0.288*	0.371*	0.247	0.286
	≥1993	8.490*	0.392***	0.444***	0.537***	-0.01
Competition						
Market share >10%	Total	7.028***	0.219**	0.264***	0.201*	0.099
	<1993	7.028**	0.329***	0.335***	0.336***	-0.014
	≥1993	6.379*	0.116	0.188	0.076	0.146
Number of competitors in main business	Total	6.043+	0.349*	0.318**	0.167*	0.103
	<1993	4.682	0.394+	0.153	0.08	-0.113
	≥1993	6.775	0.312+	0.449***	0.218*	0.201
Number of competitors^2	Total	-1.326**	-0.067*	-0.054**	-0.030*	-0.033
	<1993	-1.142+	-0.073*	-0.03	-0.018	-0.008
	≥1993	-1.440*	-0.062*	-0.073***	-0.038*	-0.042+
Firm export	Total	3.944*	0.107+	0.159+	0.176*	-0.017
	<1993	5.419*	0.143	0.186	0.185+	0.021
	≥1993	2.479	0.058	0.110	0.169*	-0.022
Ownership						
State-owned firm	Total	-4.379+	-0.036	-0.121+	-0.233***	-0.460**
	<1993	-0.189	0.006	-0.109	-0.231*	-0.689***
	≥1993	-7.480+	-0.006	-0.156	-0.194	-0.109
Collectively owned firm	Total	-6.434*	-0.106+	-0.072	-0.035	-0.383**
	<1993	-2.119	-0.056	-0.188	-0.044	-0.503**
	≥1993	-7.420+	-0.101	0.099	0.089	-0.353
Partial state ownership in limited liability or joint stock company	Total	-0.578	0.042	0.13	-0.053	-0.218
	<1993	8.329	0.183	0.309	0.059	-0.762**
	≥1993	-8.873	-0.092	-0.07	-0.252	0.116
N	Total	2858	2937	2934	2930	2128
	<1993	1311	1345	1345	1344	955
	≥1993	1548	1592	1589	1586	1173

+ p<0.10, * p<0.05, ** p<0.01, **** p<0.001

Appendix A

Table A1: Sector distribution of survey firms and marketization of sectors

Sector	2002	2003	Sum	Percentage	Mean value of private sector share
1. Garment & leather products	224	351	575	14.8	66.75
2. Electrical & electronic products	278	354	632	16.27	66.85
3. Computer, TV & communication electronics	126	117	243	6.25	80.50
4. Electrical appliance for daily use	146	61	207	5.33	91.83
5. Auto & auto parts	221	359	580	14.93	53.54
6. Information transfer, computer & software services	144	187	331	8.52	30.48
7. Accounting & non-banking financial services	36	75	111	2.86	17.57
8. Advertising, marketing & business services	80	117	197	5.07	37.60
9. Consulting & information services	67	82	149	3.84	38.05
10. Food & Drinks	0	67	67	1.72	65.42
11. Chemical, biotech products & medicine	1	102	103	2.65	42.61
12. Wholesale & Retail Trade	10	25	35	0.9	28.53
13. Metallurgical products (manuf. & tools)	13	155	168	4.32	50.38
14. Traffic, transport & storage services	100	271	371	9.55	14.03
15. Post & Telecommunication services	84	32	116	2.99	17.44
Total	1530	2355	3885	100	

Table A2: Descriptive Statistics of Variables in Analysis

	N	Mean	S.D.
Dependent variables			
% new products in sales	3818	10.301	20.150
Product innovation	3878	0.385	0.487
Process innovation	3874	0.319	0.466
New quality control	3870	0.490	0.500
Firm receives patent in the year	2621	0.110	0.313
Marketization			
Proportion of non-public economy[a]	245	0.450	0.292
Research Activity			
Firm holds patents	3948	0.114	0.318
Firm has patents granted in the past 2 years	2612	0.054	0.226
Firm conducts R&D	3540	0.278	0.448
Average R&D to sales ratio	3540	0.020	0.604
Network/Cooperation			
Located in industrial park	3847	0.240	0.427
Member of business association	3879	0.568	0.495
R&D cooperation with firms	3948	0.130	0.337
R&D cooperation with universities	3948	0.140	0.347
R&D cooperation with research institutes	3948	0.100	0.300
Ownership/Political control			
State-owned firm	3948	0.234	0.423
Collectively owned firm	3948	0.152	0.359
Partial public shares	3948	0.028	0.165
Competition			
Market share > 10%	3948	0.265	0.441
Number of competitors in main business[b]	3710	3.561	1.393
Firm exports	3804	0.235	0.424
Firm characteristics			
Firm is founded after1978	3899	0.810	0.393
Log of average firm assets	3766	8.556	2.686
Log of average debt asset ratio	3633	1.013	0.869
Log of average employees	3694	4.970	1.531
Average education of managerial personnel[c]	3730	4.883	0.796

Table A3: Estimation results for reduced models

	% new products in total sale	Product innovation	Process innovation	Quality control innovation	Patent
	(I) Coefficient (SE)	(II) Coefficient (SE)	(III) Coefficient (SE)	(IV) Coefficient (SE)	(V) Coefficient (SE)
Marketization					
Proportion of private enterprise economy	20.064***	0.601***	0.867***	0.419***	0.579*
	(2.894)	(0.107)	(0.105)	(0.101)	(0.264)
R&D networks					
R&D cooperation with firms	16.379***	0.545***	0.411***	0.369***	-0.025
	(2.122)	(0.067)	(0.099)	(0.079)	(0.129)
R&D cooperation with universities	17.044***	0.523***	0.391***	0.425***	0.594***
	(2.122)	(0.077)	(0.099)	(0.082)	(0.134)
R&D cooperation with research institutes	11.776***	0.539***	0.585***	0.541***	0.287*
	(2.476)	(0.079)	(0.092)	(0.089)	(0.122)
Competition					
Market share > 10%	10.829***	0.317***	0.324***	0.234***	0.417***
	(1.778)	(0.065)	(0.070)	(0.056)	(0.105)
Number of competitors in main business	6.382*	0.296*	0.293***	0.168*	0.326*
	(2.922)	(0.138)	(0.086)	(0.073)	(0.141)
Number of competitors^2	-1.512**	-0.061**	-0.052***	-0.031**	-0.077***
	(0.464)	(0.021)	(0.015)	(0.012)	(0.023)
Firm Exports	6.093***	0.176*	0.228**	0.351***	0.196+
	(1.781)	(0.073)	(0.079)	(0.069)	(0.113)
Ownership forms					
State-owned firm	-2.259	0.023	0.037	-0.159**	-0.362***
	(1.864)	(0.067)	(0.075)	(0.055)	(0.101)
Collectively owned firm	-11.450***	-0.324***	-0.146*	-0.214**	-0.358**
	(2.355)	(0.071)	(0.070)	(0.072)	(0.133)
Partial state ownership in limited liability or joint stock company	5.134	0.280*	0.457***	0.191	0.082
	(4.082)	(0.141)	(0.105)	(0.128)	(0.114)
Constant	-30.645***	-1.057***	-1.531***	-0.593***	-1.867***
	(4.493)	(0.202)	(0.141)	(0.136)	(0.252)
Method	Tobit	Probit	Probit	Probit	Probit
Pseudo R^2	0.038	0.139	0.13	0.091	0.184
N	3460	3565	3561	3560	2453

Note: In parentheses are standard errors; + p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Table A4: Descriptive statistics by founding year

	Founded before 1993			Founded in or after 1993		
	N	Mean	S.D.	N	Mean	S.D.
Dependent variables						
% new products in sales	1638	9.682	18.892	2131	11.014	21.214
Product innovation	1680	0.379	0.485	2197	0.390	0.488
Process innovation	1679	0.328	0.470	2194	0.312	0.463
New quality control	1676	0.459	0.498	2193	0.515	0.500
Firm receives patent in the year	1154	0.101	0.302	1467	0.117	0.322
Marketization						
Proportion of private economy	1654	0.521	0.278	2180	0.513	0.282
R&D networks						
R&D cooperation with firms	1687	0.119	0.324	2212	0.142	0.349
R&D cooperation with universities	1687	0.134	0.341	2212	0.147	0.354
R&D cooperation with research institutes	1687	0.105	0.307	2212	0.099	0.299
Ownership forms						
State-owned firm	1687	0.394	0.489	2212	0.116	0.321
Collectively owned firm	1687	0.238	0.426	2212	0.090	0.287
Partial public shares	1687	0.033	0.178	2212	0.025	0.156
Competition						
Market share > 10%	1687	0.251	0.434	2212	0.260	0.439
Number of competitors in main business	1594	3.592	1.373	2115	3.537	1.408
Firm exports	1644	0.238	0.426	2159	0.232	0.422