Ownership, Efficiency, and Firm Survival in Economic Transition: Evidence from a Chinese Science Park *

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Abstract

Using panel data from a Chinese science park, this paper explores the role of ownership, efficiency and financial resources in determining firm survival in China's economic transition. We find that efficiency has become crucial for the survival of all high-tech firms in the science park, indicating the rising significance of market forces in China's high-tech industry. However, we also find evidence of the lingering impact of the soft budget constraint. We find that 1) *ceteris paribus*, state-owned firms are less likely to exit than non-state firms and; 2) the measure of financial distress has a smaller negative effect on the survival of state-owned firms than non-state firms and the smallest effect on that of firms owned by the central government.

JEL Classification: G30; L10; P31

1 Introduction

Aggregate productivity growth in a well-functioning market economy stems mainly from two sources: the improvement in resource allocation within a firm and the weeding-out of inefficient firms through market competition. As envisioned by Schumpeter (1934), economic development involves a process of "creative destruction," in which competition in technology innovations plays the role of a filter—selecting the winners and driving out the losers. In this sense, the extent and pace of inefficient firms dying out in the evolutionary process of firm entry and exit are indicators of a well-functioning and dynamic market economy.

China began its transition from a planned economy to a market economy in the late 1970s. In the traditional, planned regime, industries were monopolized by state-owned enterprises, and all decisions regarding firm entry and exit were made by the government. Since the late 1970s, China has abolished many of the former restrictions on the entry of non-state firms into its industries. As a result of these reforms, product markets have become more competitive in the sense that there is a faster turnover of firms in each industry, and the decision-making process as to the entry and exit of firms is no longer a monopoly of the government.

Despite the increasing competitiveness of markets, one might still wonder how far the Chinese economy, after more than two decades of economic reforms, has moved towards being a true market economy; an economy that is characterized by firm dynamics in the Schumpeterian sense. More specifically, can market competition perform the function of driving inefficient firms out of the market? Given the decisive role of government in determining the fate of a firm in the traditional, planned regime, does government ownership also

affect firm survival in the new, market regime?

This paper aims at answering these important questions by empirically examining the determinants of firm survival in China's economic transition. In particular, we focus on the role of efficiency and ownership. Our study relies on a unique dataset from a survey of all firms in the Zhongguancun Science Park in Beijing from 1995 to 2002. Zhongguancun Science Park has been the most important one in China not only because of its size,[1] but also because, like the rest of the Chinese economy, it has been undergoing a dramatic transition. While state-owned firms are still active in the park, in recent years, the new entrants have increasingly been private firms or foreign joint-ventures. The results obtained from this study, we believe, will shed light on the dynamics of China's high-tech industry and also to some extent China's economic transition in general.

Our empirical findings show that firm turnover in the park resembles that in industrialized countries, i.e., both "fitness" (efficiency) and "fatness" (financial resources) are important for firm survival (Zingales, 1998). On average, those firms that survive have higher technical efficiency, higher labor productivity, higher return on sales and higher return on assets than those firms that exit; at the margin, an increase in these efficiency measures significantly increases the chance of firm survival. We also find that leverage significantly reduces the chance of firm survival. These findings suggest that after two decades of economic reforms, market forces have risen to become the main drivers of firm turnover in China's high-tech industry.

[1]Zhongguancun Science Park is the largest of its kind in China, containing most of the large domestic high-tech firms (e.g. Legend and Beida Founder) and many of the major foreign companies (e.g. Nokia and Motorola). The Park's industrial output accounts for one seventh of the total output of all national science parks combined, and contributes as much as two thirds of Beijing's total growth in industrial output (Beijing Bureau of Statistics, 2002).

While both fitness and fatness are important for firm survival, our work adds a unique twist: we examine whether ownership also matters for firm survival in the high-tech industry under economic transition. The empirical evidence points to the lingering impact of the soft budget constraint (SBC), i.e., the protective role of state ownership in firm survival. We find that *ceteris paribus*, state-owned firms are less likely to exit than non-state firms. A further analysis reveals that the impact of financial distress on firm survival depends crucially on the nature of ownership: financial distress has a smaller negative impact on state-owned enterprises than on non-state ones, and the smallest impact is on those firms that are owned by the central government. All these results are consistent with the predictions of the soft-budget constraint theory originated by Kornai (1979) as well as with evidence found elsewhere (Anderson et al., 2000). In the final part of the empirical analysis, we investigate the varying coefficients of state ownership and efficiency over time; the regression results generally show a trend that efficiency has become increasingly important while the role of state ownership has been declining.

This paper contributes to the literature on economic transition, corporate finance and firm demographics. While most of the transition literature studies enterprise restructures and privatization,[2] our rare dataset allows us to study a unique issue: firm survival. The results obtained in this study are largely complementary to the literature studying firm restructures. Moreover, our findings have a close bearing on the empirical literature testing the soft-budget constraint theory (Gao and Schaffer, 1998; Li and Liang 1998; Anderson et al., 2000; Cull and Xu, 2000; Kornai et al., 2003). We are not only among the first to show

[2]See Djankov and Murrell (2002) for a comprehensive review of the empirical studies of firm restructures in transition.

that the effect of leverage differs across ownership types, we also show that this effect differs for firms owned by governments of different levels. This study also has a close bearing on the larger literature on corporate finance and firm demographics (see e.g., Zingales (1998), Caves (1998) and Ahn (2001)). While we follow this literature and examine how firm size, efficiency and finance affect firm survival, we also go on to explore a new area—how ownership itself and its interaction with other variables affect firm dynamics during economic transition.

The rest of the paper is organized as follows. Section 2 describes the firm dynamics in the Zhongguancun Science Park. Section 3 reviews the literature and develops hypotheses. Section 4 specifies the econometric model. Section 5 describes data and variables. Sections 6 and 7 report empirical findings. Section 8 concludes.

2 The Zhongguancun Science Park

Impressed by the great success of the Silicon Valley model, the Chinese government, in 1988, built its own version, the Zhongguancun Science Park (the Park hereafter), the idea being that it will one day become the Chinese Silicon Valley. The Park is located in Zhongguancun in the northwestern Haidian District, the largest district in Beijing. Zhongguncun is well known for having the highest concentration of universities and research institutions in China, including the top three academic institutions in the country–Peking University, Tsinghua University and the Chinese Academy of Science. The first science park in China, the Zhongguancun Park has remained the largest one in China since its establishment. In 2002, the Park was home to more than 9,500 firms, employed 400,000 people, and produced an industrial output of 187 billion yuan. This output amounted to one seventh of the total output of all science parks combined in China, and contributed two thirds of the industrial

growth in Beijing (Beijing Bureau of Statistics, 2002).[3]

Firms in the Park have enjoyed several preferential benefits. The most notable is the tax incentive which was issued in 1988. All eligible firms pay an income tax of 15 percent, less than half the normal tax rate of 33 percent. Newly certified entrants can get their first three years of tax waived, and can get a 50 percent reduction in tax over the subsequent three years. In 1999, amid the heightened awareness and enthusiasm for the "New Economy," the Chinese government introduced additional preferential policies for high-tech firms. The scope of tax waivers and deductions was enlarged to include sales taxes on technology transfers, consulting, services, and R&D expenditure. Another unprecedented policy allows people employed in the Park to automatically get Beijing residence,[4] which attracted strong inflows of brainpower from other parts of China as well as from overseas.

Since the primary purpose of the Park lies in promoting high-tech innovation and development, entry into the Park is regulated. The high-tech status of entrants is checked and renewed on an annual basis. A separate government office, *Administrative Committee of Zhongguancun Science Park* (the Committee hereafter) is in charge of reviewing firm status. In order to pass the check, firms in the Park need to file an annual report, which discloses information on the firm's management, balance sheet, human resources, etc. The dataset used in this paper is compiled from the annual reports filed by all certified firms for the period of 1995-2002.

The entrants have to satisfy a number of qualification criteria. Firstly, the applying firm

[3]China has 58 national-level science parks and more than six thousand industrial parks at local levels.

[4]China has long instituted a strict *hu kou* (household registration) system to regulate the mobility of people across localities. A person is not allowed to find a job in a locality if she does not have a *hu kou* (residence booklet) in that locality.

must engage in high technology products or R&D activities. High-tech related revenues are required to account for no less than 50 percent of total revenue. Secondly, R&D expenditure must amount to no less than three percent of total revenues. Finally, employees with college degrees must make up at least 20 percent of total employees. When an applying firm fulfills these requirements, it will receive a high-tech firm certificate issued by the Committee.

3 The Determinants of Firm Survival in Transition: Hypothesis Development

In this section we review the prior literature on corporate finance, industrial organization and economic transition, and develop hypotheses regarding the determinants of firm survival and exit. The literature on firm survival and exit dates back to Schumpeter (1934) who put forward an influential argument, that economic development is a dynamic process of "creative destruction" in which inefficient firms will be eventually wiped out. This evolutionary approach stresses the crucial role of efficiency for firm survival in market competition. Thus, our first hypothesis is:

Hypothesis 1: More efficient firms are more likely to survive in a market economy.

Hypothesis 1 is also a way to test market development. Since economic reforms started in the late 1970s, China has made consistent progress in developing the product markets. Price control was virtually eliminated in the early 1990s, and after 1992 private firms were allowed to enter many industries. If these developments really lead China to a more competitive market economy, we should expect that efficiency plays an important role in determining firm survival.

Efficiency is not the only important factor for firm survival. A firm may be forced to claim bankruptcy when it cannot service its debt. As argued in the corporate finance literature, the level of debt, usually measured by the leverage ratio, i.e., the net debt-capital ratio,[5] may negatively affect firm survival because highly indebted firms are unable to finance large investment projects, are unable to compete, and are very likely to liquidate (Myers, 1977; Bolton and Scharfstein, 1990; Harris and Raviv, 1990). Zingales (1998) presents strong evidence that both economic efficiency (fitness) and financial resources (fatness) matter for firm survival. This leads to the following hypothesis.

Hypothesis 2: More leveraged firms are more likely to exit.

While both efficiency and leverage are important for firm survival, in this paper, we focus on a special factor for firm survival in the context of economic transition: state ownership. Not surprisingly, state ownership provides a very important protective role in assuring firm survival. In transition economies, where the markets are imperfect and the market-supporting institutions are not fully developed, state-owned enterprises (SOEs) may enjoy many advantages in doing business. For example, they may have access to the markets for certain inputs that are not easily accessible to private firms. SOEs may even enjoy monopoly profits if they are in highly regulated industries (i.e., telecommunications). The state may also use its power to help SOEs in contract enforcement, since China's legal system does not function well. Lacking this special protection, private firms are more likely to become the victims of breaches of contract, and they may sometimes be forced to exit because of defaults on the part of their business partners. To summarize, state ownership itself can

[5]The net debt-capital ratio is defined as (total debt-cash reserves)/total equity.

mean a better chance of survival in transition countries. This leads to Hypothesis 3.

Hypothesis 3: SOEs are more likely to survive than non-state firms.

Aside from monopoly power and legal privileges, SOEs could, even when in financial distress, have a better chance of survival than non-state firms. In other words, financial distress may have an interaction effect with ownership. This hypothesis is based on the idea of soft budget constraint (SBC) which can be traced back to the earliest work by Kornai (1979).[6] According to his theory, a state firm in financial distress will be bailed out by the paternalistic government through various means, such as fiscal subsidy or bank loan extensions. The implication of the SBC theory based on state paternalism is the persistent survival of state firms in prolonged distress. Since state-owned firms have easier access to government aid, their survival should be less sensitive to leverage. We summarize the above arguments as our next hypothesis.

Hypothesis 4: Financial distress has a smaller impact on the exit of SOEs than it has on the exit of non-state firms.

Although economic reforms have made Chinese state banks more profit-oriented and more independent from government influence, the legacy of soft-budget constraint has remained in one shape or another (Brandt and Li, 2003). Intervention by government has steadily declined, but is far from eliminated. Therefore, soft budget constraint may still help financially distressed SOEs to survive even today.

To test Hypothesis 4, we examine whether the interaction of financial distress and state ownership has a significant effect on firm survival. Ideally, we need a direct measure of the

[6]See also Maskin, et al. (2003) for more recent developments in SBC theory.

prolonged financial distress of a firm to test the SBC theory. However, a direct measure is very hard to come by due to the nature of this problem and data limitations.[7] In this paper, we use firm leverage as a proxy for financial distress. Firm leverage is a good proxy because financially distressed firms commonly experience an accumulation of unpaid debts, and the debt level affects the ability of firms to compete and fund large investments.

Despite the protective role of the SBC, the firm's access to fiscal or financial resources for rescue might vary across SOEs owned by different levels of government. Walder (1995) and Che and Qian (1998) extend the theory of SBC to explain the rise of township-village enterprises in China's economic transition. They both stress the differentials between the capacities of central government and local governments to bail out loss-making firms. The central government can presumably mobilize more resources when a massive bailout is needed. For example, the central government has easy access to bank loans and is capable of setting tax polices to finance deficits. This leads to the differential degrees of SBC syndrome for firms owned by different levels of government. Anderson et al. (2000) conduct their empirical analysis based on a similar idea and find evidence of differential expectations of state aid in times of trouble between central SOEs and local ones. In accordance with these arguments, we develop the following hypothesis:

Hypothesis 5: Financial distress will exert a smaller impact on the exit of central SOEs than on local ones.

[7] See Schaffer (1998) for detailed discussion.

4 Econometric Specification

Although many studies of firm survival (or exit) use the probit model, some recent studies appeal to the duration model which can properly deal with the right-censoring problem (Meta and Portugal, 1994; Audretsch and Mahmood, 1995; Hojon, 2000). For panel data in the period $(0, T)$, the right-censoring happens because we do not observe firm turnovers beyond year T. The Cox Proportional Hazard Rate Model addresses this censoring issue.

The Cox Proportional Hazard Rate Model is specified as follows. Let the hazard rate of exit at time t be $\lambda(t)$. We estimate the following Cox proportional hazard rate function

$$\lambda(t) = \lambda_0(t) \exp[x'(t)\beta],$$

where $\lambda_0(t)$ is a baseline hazard at time t, which is not estimated, $x(t)$ is a vector of time-varying explanatory variables, and β is a vector of parameters to be estimated. The effect of the kth variable of $x(t)$ on the relative hazard rate is measured by $\exp(\beta_k)$. We will report the coefficient β_k, which equals $\partial ln\lambda / \partial x_k$, analogous to the partial effect of a variable in a linear regression model. The parameter estimates are obtained by the method of maximum likelihood estimation. To test our hypotheses, the explanatory variables in x include the firm's ownership type, efficiency measures, leverage, size, age, and industry dummies.

5 Data and Variables

The data set used in this paper is from the annual reports of all firms in the Park for the period 1995-2002. In these annual reports, firms are required to report information on firm ownership, personnel, R&D activities, and detailed financial and cost accounting records. In total, we have 30,419 firm-year observations.

Following Bartelsman et al. (2003), we call it an *entry* of a firm in year t if the firm was not registered in the park in year t-1 but was registered in the park in year t.[8] Accordingly, we call it an *exit* of a firm in year t if the firm was registered in the park in year t-1 but was not registered in the park from year t on.

Since firm exit is the key variable in this study, we need to examine it more carefully. According to our definition, a firm exit can happen in the following situations: (1) The firm either was shut down or went bankrupt; (2) The firm voluntarily moved out of the park or was merged into another firm; (3) The firm did not meet the high-tech standard; and (4) The firm failed to file the annual report. Since ideally we want to examine only exits of the first two types, we need to make sure that the number of exits of the other two types is small. Although, theoretically, all four types could happen and as a result exit in this case does not necessarily imply business failure, exits of the last two types are not very likely. Because the preferential benefits require the firms to meet the high-tech standard, firms have incentives to meet them in order to stay in the Park. Thus, the number of exits in situation (3) should be small. For the same reason, the firms in the Park normally filed the report on time, and did not want to lose the certificate. A careful examination of the data also shows that the number of "re-entering" cases due to reporting failures is negligible. To summarize, although there could be some measurement error for the variable exit, this error must be very small.[9]

Figure 1 depicts the general pattern of firm entry and exit in the Park during the

[8]Before entering the Park, some firms may have registered with the Bureau of Industry and Commerce in Beijing, a government agency that is in charge of the registration of all firms. So the entry here only refers to the entry into the Park.

[9]This measurement error should not cause any systematic bias in the estimation, since there is no reason to believe the independent variables such as ownership and leverage are correlated with such mis-measured exits.

period 1995-2002. In terms of entry, the first three years only saw a rather steady and relatively low inflow of new firms (only around 500 firms on average). The situation began to change in 1998. After a small increase in 1998, the new entry figures began to increase dramatically in 1999, and hit a record high level of about 2,500 firms in 2001. There are two important factors that contributed to this. First, the worldwide optimism in connection with IT technology and the new economy was at its height in 1999, following the persistent boom of the new economy in the United States, and this propelled Chinese entrepreneurs (including some returning overseas Chinese) to rush in and start new ventures in the Park. Second, as discussed earlier, the Committee also introduced a series of new preferential policies in 1999 to encourage entry and the growth of hi-tech firms.

Firm exits demonstrate a slightly different pattern. The overall rate of firm exits in the Park is around 12.5 percent (Table 2). Up to the end of 2000, the number of exiting firms was rather stable at the level of 500, and then steadily went up. The rise was mainly due to the intensified competition resulting from the sharp increase of new entrants. Overall, the exits show a smaller fluctuation.

The hazard rate over time also shows an interesting pattern (see Table 1).[10] Overall, the hazard rate in a given year, averaged across all entry cohorts, increased steadily over time, and it more than doubled in 2002 compared to 1995. Even for a given entry cohort, the hazard rate also generally increases, although not monotonically, over time. For instance, the 1995 entry cohort had a hazard rate of 0.032 in the first year after entry, but this rose to 0.125 in the seventh year. The observation that the hazard rate increases with the age

[10]The hazard rate is calculated as the ratio of the number of exiting firms in a given year to the total number of continuing firms last year.

of the firm comes as something of a surprise, since studies of firms in western countries generally find a reverse relationship between firm age and the hazard rate. Our multivariate regressions in the ensuing sections will confirm this interesting relationship.

Since our analysis focuses on the effects of ownership on firm exits, the major variables we are concerned with are those indicating a firm's ownership type. There are four ownership types: state-owned firms, overseas Chinese firms, foreign firms, and other non-state firms (including collective and private firms).[11] State-owned firms include not only the traditional state-owned firms but also those share companies in which the government holds a controlling number of shares. Overseas Chinese firms refer to joint ventures in which some funds come from three special regions of China, i.e., Hong Kong, Taiwan, and Macao. Foreign firms refer to the ventures or joint ventures with an injection of foreign funds. Figure 2 depicts the distribution of ownership types over the time period 1995-2002. Note that in Figure 2 we combine foreign and overseas Chinese firms into one category which is denoted as "joint ventures". The state-owned firms have accounted for a declining share in the Park over time while the share of domestic non-state firms has been on the rise, among which private firms become the major driver behind the spike. This shift reflects the general, nationwide trend of privatization of SOEs and the entry of non-state firms since the mid-1990s. By contrast, the joint ventures have maintained a relatively stable share in the Park, at around 10 percent.

We use several measures of efficiency, which include two productivity proxies, i.e., technical efficiency and labor productivity, and two financial performance measures, i.e., the

[11]Some privately-operated start-ups in the Park were actually the spin-offs from state research institutions or universities, and thus probably received state support at least in their early stage of development. From this perspective, the property rights arrangements of the high-tech firms in the Park may not be as clear-cut as expected. However, we are not able to differentiate these firms from others due to data limitation.

return on sales and the return on assets. Technical efficiency is a well-received measure for efficiency in economics. The measure of technical efficiency is obtained from estimating a stochastic frontier production function.[12] The labor productivity is defined as the ratio of production and employment. Return on sales is the ratio of profits over sales and return on assets is the ratio of profits over assets. We also use the export indicator to indirectly measure the efficiency of a firm. The ability to be export-oriented may also be positively related to efficiency because more efficient firms have a higher likelihood of entering international markets, and the more competitive international markets will pressure firms to increase their efficiency.[13]

Table 2 summarizes all variables used in the empirical analysis. The firm is on average 4.51 years old, but the oldest firm in our sample has operated for 20 years. State-owned firms accounted for nearly 21 percent of all firms in the Park, foreign-owned firms accounted for 7.6 percent, and overseas Chinese firms accounted for 4.7 percent. The efficiency measures show a large variation across firms.[14] For example, technical efficiency ranges from 0 to 0.820 with a standard deviation of 0.181.

Compared to exiters, surviving firms are larger, younger, less leveraged, more efficient, financially healthier and more likely to be exporters (Table 3). The differences in these

[12]Following Hay and Liu (1997), our stochastic frontier production function is specified as $y_{it} = a_i + b_t + \alpha l_{it} + \beta k_{it} + v_{it} - u_{it}$, where y_{it} is log output of firm i in year t, l_{it} is the labor in log, and k_{it} is the capital in log. a_i and b_t are firm and year dummies, and α and β are estimated coefficients on labor and capital. The random term v_{it} is the disturbance term that is normally distributed. The term u_{it} is the inefficiency term, which is assumed to be distributed either as truncated normal or half normal, or exponential distributions. In this paper, we use $exp(-u_{it})$ to transform it into our technical efficiency measure. For more details about the stochastic frontier production function, please refer to Kumbhakar and Lovell (2000).

[13]Some evidence shows that exporting is positively associated with a firm's productivity (Bernard and Jensen, 1999).

[14]In order to minimize the effects of some outliers, we restrict the net debt-capital ratio, return on assets, and return on sales between -100 percent and 100 percent.

aspects are also economically important. For instance, the average technical efficiency is 0.246 for survivors but it is 0.214 for non-survivors. The difference is notable and statistically significant. Other measures of efficiency, such as return on assets and return on sales, demonstrate a similar pattern. Ownership also matters for firm survival. The SOEs account for a larger share of survivors than exiters, and the difference is statistically significant at the one percent level. Foreign and overseas Chinese firms are also more likely to survive. The results presented in Table 3 suggest that ownership, efficiency, and leverage are all important factors for firm survival.[15] Since these comparison results only rely on univariate tests, they are descriptive in nature. A more rigorous multivariate regression analysis follows.

6 Ownership, Efficiency, Leverage and Firm Survival

In this section, we use the Cox proportional hazard rate model to estimate the effects of ownership and efficiency on firm exit. We first report the results of our basic regressions, which are under different specifications mainly through alternating efficiency measures. To control the potential differences in firm survival in different industries, we control for 13 industry dummies in these regressions. We then have two sets of sensitivity tests to check whether the basic results remain for different industries and different years.

6.1 Basic Regression Results

Regression results reported in Table 4 support Hypothesis 1 which states that efficiency has become a significant factor in determining the turnover of firms in the Park. All the efficiency proxies yield a consistent result, that is, more efficient firms are more likely to survive. The

[15]We also conduct the same univariate test by using data for each year, and have similar results.

coefficients of technical efficiency, return on assets, return on sales and the log of labor productivity are all negative and significant at the one percent level. The indirect efficiency measure, export indicator, also has the expected sign, i.e., exporting firms being more likely to survive. We interpret these findings as evidence supporting the notion that China's high-tech industry has been moving towards a market environment in which efficiency is playing a very important role in firm survival.

The estimated coefficient of firm age gives us a rather surprising result. Contrary to the general empirical finding about the negative correlation between age and exit, we find a positive correlation (Table 4). Given the fact that younger start-ups are less prepared for the uncertainty in technology and market shocks, one might expect to see a higher failure rate among them. However, our regression results seem to indicate that age becomes a liability in the early years of a firm's development. The variable firm age has a positive coefficient and its square term has a negative coefficient, both of which are significant at the one percent level. The magnitudes of their coefficients suggest that the average age effect is positive. Take column 1 as an example. The average age effect is $0.484 + 2 * age * (-0.031) = 0.205$, where we set age at its mean. These numbers also imply that age has an inverted U-shaped effect on exit: age affects exit positively for firms younger than 7.8 years, but negatively for firms older than 7.8 years. Note that one qualification we should make is that our regression model is unable to disentangle the age effect from the cohort effect. Because of this, the age variable may actually capture both the age and cohort effects. One might as well interpret our finding as a result of dominant, positive cohort effect: the survival advantage embodied in younger start-ups stems from their cohort or vintage advantage in better learning capabilities

or better aligned property rights arrangements within the firm. To this extent, what we find about the age effect on exit has something to do with the special nature of the high-tech industry, such as the swiftness of its technical change.

Consistent with Hypothesis 2, we find that leverage does affect the survival of a firm negatively (Table 4). The coefficient on the net debt-capital ratio is positive in all specifications. This result is consistent with the theoretical arguments as well as the empirical finding in Zingales (1998).

Table 4 also shows that ownership matters for firm survival. After controlling a host of efficiency variables, the coefficient of state ownership is negative and significant at the one percent level, which strongly supports Hypothesis 3. Foreign firms are shown to be less likely to exit, but the coefficient is significant in only one case. Interestingly, our results show that, compared to Chinese inland private firms, overseas Chinese firms do not have any intrinsic advantage assuring their survival.[16] Having multi-plants also helps a firm to survive.

6.2 Sensitivity Tests

There are potentially large differences in the entry and exit patterns across different high-tech industries. The industry dummies in previous regressions only capture the differences between industries by some constants, but they cannot capture whether ownership, efficiency and leverage exert different effects on firm exit for different industries. In order to capture these potentially different effects, we estimate the above model for each of the four selected industries: (1) electronics and information technology, and products, (2) laser and

[16]This result is consistent with the anecdotal indications that some of the funds from Hong Kong actually had domestic origins but were channeled through an outside location in view of the better tax treatment accorded to joint ventures in Mainland China.

optoelectronic, (3) mechatronic technology and products, and (4) life science and biological engineering. These four industries account for 73 percent of total observations in the sample.

Regression results (Table 5) indeed show a substantial disparity in the role of ownership, efficiency, and leverage across industries. While state ownership plays a significant protecting role in the first two industries, it does not matter much for the other two industries. In all the selected industries, technical efficiency has a positive effect on firm survival, but the magnitude of its effect has a large variation. For example, the estimated coefficient of technical efficiency is -1.642 for the third industry, which is nearly eight times that of the fourth industry. The effect of leverage also varies greatly across industries. Despite these differences, the qualitative results on the role of ownership and efficiency remain for these selected industries.

As discussed earlier, the process of economic transition in China has been accompanied by the entry of firms in a large number and intensified competition in most industries. As a result, one would expect that the role of state ownership and efficiency may change over time. More specifically, as the government gradually retreats from directly managing enterprises and the economy, state ownership would play a weaker role in the protection of SOEs over time. Meanwhile, efficiency is expected to figure more prominently in the exit decisions of firms. Since the Cox Proportional Hazard model does not allow the coefficients to vary across time, we turn to the probit model to explore this time trend. In addition to those independent variables included in the Cox models, we also add to the probit model year dummies and a series of interaction terms of year dummies with state ownership and efficiency.

Our regression results reported in Table 6 generally show that efficiency has become

increasingly important in determining firm exit over time while the role of state ownership is diminishing. From the reported coefficients of these interaction terms, we can see an overall increasing trend for the interaction terms with efficiency but a decreasing trend for the interaction terms with state ownership. For example, the magnitude of the estimated effect of technical efficiency jumps from 0.251 in 1996 to 0.908 in 2002. By contrast, that of state ownership drops from 0.196 in 1996 to 0.137 in 2002.

7 Soft Budget Constraint and Firm Survival

In the previous section, we have found that SOEs are less likely to exit than other firms. The advantage of SOEs for survival could be due to the soft budget constraint. We test whether SBC has an effect on firm survival, i.e., Hypotheses 4 and 5 in this section.

To further examine the role of state ownership, we divide SOEs into central SOEs and local SOEs and use two dummy variables for them in regressions. The regression results reported in column 1 of Table 7 show that central SOEs are less likely to exit than local ones. As with the advantage of SOEs versus non-state firms, it is much harder for central SOEs to fail than local ones. This advantage should at least partially be due to the central government's deep pocket, which can be drawn on to back up these firms.

To test the effect of SBC, we need to examine whether firm leverage has a differential impact on state and non-state firms as well as state firms owned by different levels of government. We include two interaction terms for this purpose: central state ownership interacted with leverage and local state ownership interacted with leverage. These interaction terms capture the additional effect of central or local state ownership on the relationship between financial distress and exit.

Regression results generally support Hypotheses 4 and 5 concerning the impact of SBC (columns 2-5). Column 2 shows that the coefficients of the two interaction terms are both negative and the interaction term with central government ownership is significant at the one percent level. A Wald test shows that the coefficients of the two interaction terms are jointly significant at the one percent level. This implies that for a given increase in indebtedness, both types of SOEs are less likely to exit than non-state firms, which lends strong support for Hypothesis 4.

Regressions results also provide evidence consistent with Hypothesis 5. The coefficient of the interaction term with central ownership is -0.971 while the interaction term with local ownership is only -0.122. The larger magnitude in the coefficient of the first interaction term means that a 1-unit increase in indebtedness will have a much smaller effect on the exiting central SOEs than the local ones. Note also that the own effects of central and local state ownership become smaller in magnitude after controlling the interaction terms. The coefficient of the central ownership dummy even becomes smaller than that of the local ownership dummy. This implies that the large part of the protective role of government ownership stems from the SBC. Therefore, the difference in the coefficients of the two government ownership types shown in column 1 can virtually be explained by the stronger SBC associated with central government-owned firms. Columns 3-5 repeat the regression in column 2 except for using different efficiency proxies and yield a very similar result.

An alternative way to test the two hypotheses is to divide our sample into three categories according to the firm's ownership: central SOEs, local SOEs, and non-state firms, and run regressions using each of the sub-samples. The results are reported in Table 8. Note

that the estimated coefficients of the debt-capital ratio differ remarkably across ownership types in a manner consistent with our two hypotheses. While the debt level has a positive effect on the exit of non-state firms, it does not have such an effect on SOEs. Higher debt level even significantly improves the chance of survival for central SOEs.

8 Conclusion

Using panel data from a Chinese science park, this paper explores the role of ownership and efficiency in determining firm survival in China's high-tech industry in economic transition. We find that efficiency has become crucial for the survival of firms of all ownership types, indicating the rising significance of market forces over the two decades of economic reforms in China. However, we also find evidence of the lingering impact of the soft budget constraint on the survival of SOEs.

Since we only have data from one high-tech science park in Beijing, this study has its own limitations. For example, since our sample only includes firms from high-tech industries, we are not able to compare the mechanisms governing firm entry and exit in high-tech industries with those in other more traditional industries. Despite such limitations, these data are among the best available, since a firm census of this kind is very rare in China. Our study is among the first to examine the determinants of firm survival in economic transition. The diversity of firm ownership in the Park and its transition parallel that in the rest of the Chinese economy, which helps shed light on understanding the institutional dynamics of China's high-tech industries in particular and China's economic transition in general.

China began its industrial reforms by gradually loosening the state control of firms, allowing domestic private firms and foreign firms to set up, and even privatizing many

SOEs. The ultimate goal of these reforms is to have all firms competing in a fair market environment. Our findings suggest that these reforms have been very successful at least in China's high-tech industry, because efficiency is becoming an important determinant of firm survival there, as happens in a truly competitive market in the Schumpeterian sense. Our finding of the lingering role of the soft budget constraint also suggests that it may still take some time before the Chinese high-tech industry operates under a true market environment, but it is moving in that direction.

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Table1: The Hazard Rate for Different Entry Cohorts in 1995-2001

Year	1996	1997	1998	1999	2000	2001	2002
Entry cohorts							
1995	0.032	0.078	0.131	0.150	0.140	0.149	0.125
1996		0.06	0.085	0.112	0.108	0.148	0.142
1997			0.022	0.091	0.124	0.127	0.160
1998				0.060	0.074	0.104	0.136
1999					0.044	0.111	0.140
2000						0.092	0.152
2001							0.119
Overall average	0.060	0.095	0.105	0.115	0.110	0.126	0.144

Table 2: Summary Statistics

Variables	N	Mean	Standard Deviation	Min	Max
Exit	30419	0.125	0.330	0	1
Log(assets) (1,000 yuan)	30419	8.043	1.781	-4.605	17.509
Firm age	30419	4.506	3.029	0	20
Net debt-capital ratio	30419	0.443	0.303	-1	1
State ownership	30419	0.209	0.406	0	1
Foreign ownership	30419	0.076	0.266	0	1
Overseas Chinese ownership	30419	0.047	0.211	0	1
Technical efficiency	30324	0.234	0.181	0	0.820
Log(labor productivity) (1,000 yuan)	30419	3.600	2.482	-5.617	11.478
Return on assets	30234	0.0008	0.140	-1	1
Return on sales	26104	0.005	0.192	-1	1
Export indicator	30419	0.036	0.185	0	1
Multi-plant firm indicator	30419	0.074	0.261	0	1

Table 3: Comparison of Means between Survivors and Exiters

	Survivors	Exiters	Difference	P-value
Log(asset)	8.355	7.560	0.795	0.000
	(0.014)	(0.014)	(0.020)	
Firm age	4.402	4.668	-0.266	0.000
	(0.023)	(0.026)	(0.0036)	
Net debt-capital ratio	0.429	0.464	-0.035	0.000
	(0.002)	(0.003)	(0.004)	
State ownership	0.199	0.180	0.019	0.000
	(0.003)	(0.003)	(0.004)	
Foreign ownership	0.087	0.060	0.027	0.000
	(0.002)	(0.002)	(0.004)	
Overseas Chinese ownership	0.049	0.035	0.014	0.000
	(0.001)	(0.003)	(0.003)	
Technical efficiency	0.246	0.214	0.032	0.000
	(0.001)	(0.002)	(0.001)	
Log(labor productivity)	3.894	3.131	0.763	0.000
	(0.018)	(0.023)	(0.029)	
Return on assets	0.010	-0.013	0.023	0.000
	(0.001)	(0.001)	(0.003)	
Return on sales	0.015	-0.012	0.027	0.000
	(0.001)	(0.004)	(0.001)	
Export indicator	0.043	0.025	0.017	0.000
	(0.001)	(0.002)	(0.002)	
Multi-plant firm indicator	0.093	0.043	0.051	0.000
	(0.002)	(0.002)	(0.003)	
Number of observations	18,433	11,891		

Note: The numbers in parentheses are standard errors. The t-test on the equality of means for each variable is performed on the assumption that the variances are not equal.

Table 4: Cox Proportional Hazard Rate Model Estimating the Effects of Ownership and Efficiency on Firm Exit

	(1)	(2)	(3)	(4)
State ownership	-0.247***	-0.256***	-0.245***	-0.236***
	(-5.11)	(-5.01)	(-5.13)	(-4.87)
Foreign ownership	-0.091	-0.262***	-0.169**	-0.111*
	(-1.36)	(-2.89)	(-2.46)	(-1.66)
Overseas Chinese ownership	-0.034	-0.119	-0.112	-0.044
	(-0.42)	(-1.19)	(-1.33)	(-0.53)
Technical Efficiency	-0.781***			
	(-7.56)			
Return on sales		-0.613***		
		(-8.09)		
Return on assets			-0.814***	
			(-9.62)	
Log(labor productivity)				-0.084***
				(13.07)
Net debt-capital ratio	0.182***	0.087	0.076***	0.209***
	(3.31)	(1.35)	(1.39)	(3.83)
Log(assets)	-0.168***	-0.180***	-0.169***	-0.145***
	(-16.52)	(-14.79)	(-16.45)	(-13.87)
Firm age	0.484***	0.456***	0.487***	0.516***
	(21.82)	(18.16)	(22.24)	(22.44)
Firm age squared	-0.031***	-0.028***	-0.031***	-0.033***
	(-15.54)	(-12.54)	(15.74)	(-16.07)
Export indicator	-0.311**	-0.160	-0.160	-0.277**
	(-2.40)	(-1.10)	(-1.10)	(-2.13)
Multi-plant firm indicator	-0.496***	-0.583***	-0.5***	-0.475***
	(-5.56)	(-5.38)	(-5.60)	(-5.37)
Number of observations	30324	26104	30375	30419
Log pseudo-likelihood	-32295	-23104	-32154	-32358

Note: 13 industry dummies are included in all the regressions but not reported. The t-ratios based on robust standard errors are in parentheses. Significance levels of 1%, 5%, and 10% are noted by ***, **, and * respectively.

Table 5: Cox Proportional Hazard Rate Model Estimating the Effects of Ownership and Efficiency on Firm Exit: Some Selected Industries

	(1) Electronics and information technology, and products	(2) Laser and optoelectronic	(3) Mechatronic technology and products	(4) Life science and biological engineering
State ownership	-0.238***	-0.232**	-0.115	-0.379
	(-2.94)	(-1.96)	(-0.59)	(-1.30)
Foreign ownership	0.005	-0.192	0.024	-0.385*
	(0.05)	(-0.84)	(0.09)	(-1.66)
Overseas Chinese ownership	-0.025	0.198	0.243	-32.1***
	(-0.22)	(0.86)	(0.98)	(-31.47)
Technical Efficiency	-0.909***	-1.387***	-1.642***	-0.221***
	(-5.84)	(-3.92)	(-2.68)	(-2.67)
Net debt-capital ratio	0.317***	0.193	-0.109	-0.924***
	(3.75)	(1.19)	(-0.45)	(2.56)
Log(assets)	-0.181***	-0.222***	-0.149***	-0.041
	(-11.99)	(-8.13)	(-3.04)	(-0.82)
Firm age	0.507***	0.503***	0.633***	0.483***
	(15.30)	(8.50)	(5.36)	(4.54)
Firm age squared	-0.031***	-0.029***	-0.041***	-0.027***
	(-10.64)	(-5.80)	(3.87)	(-2.94)
Export indicator	-0.598***	0.206	-0.004	-0.429**
	(-2.78)	(0.60)	(-0.01)	(-0.44)
Multi-plant firm indicator	-0.318***	-0.836***	-0.904**	-1.180***
	(-2.92)	(-3.27)	(-2.22)	(-1.10)
Number of observations	14326	5020	1947	728
Log pseudo-likelihood	-13538	-3483	-1101	-521

Note: The t-ratios based on robust standard errors are in parentheses. Significance levels of 1%, 5%, and 10% are noted by ***, **, and * respectively.

Table 6: Probit Model Estimating the Varying Effects of Efficiency and State Ownership over Time

	Dependent variable: 1=exit, and 0 otherwise
Technical efficiency*year 1996	-0.251
	(-1.08)
Technical efficiency*year 1997	-0.491**
	(-2.55)
Technical efficiency *year 1998	-0.315*
	(-1.70)
Technical efficiency *year 1999	-0.247
	(-1.55)
Technical efficiency *year 2000	-0.449***
	(-2.89)
Technical efficiency *year 2001	-0.908***
	(-6.36)
Technical efficiency *year 2002	-0.819***
	(-6.94)
State ownership *year 1996	-0.196**
	(-2.01)
State ownership*year 1997	-0.428***
	(-5.01)
State ownership*year 1998	-0.641***
	(-7.53)
State ownership*year 1999	-0.147**
	(-2.38)
State ownership*year 2000	-0.049
	(-0.82)
State ownership*year 2001	0.014
	(0.22)
State ownership*year 2002	-0.137**
	(-2.16)
Number of observations	30324
Log pseudo-likelihood	-10208

Note: The regression above controls for firm size, age, leverage, export indicator, multi-plant indicator, year dummies, and 13 industry dummies but their coefficients not reported. The t-ratios based on robust standard errors are in parentheses. Significance levels of 1%, 5%, and 10% are noted by ***, **, and * respectively.

Table 7: Cox Proportional Hazard Rate Model Estimating the Effects of Soft Budget Constraint on Firm Exit

	(1)	(2)	(3)	(4)	(5)
Central government ownership	-0.689*** (-11.58)	-0.257** (-2.49)	-0.256** (-2.22)	-0.273*** (-2.70)	-0.230** (-2.22)
Local government ownership	-0.487*** (-9.07)	-0.425*** (-4.00)	-0.442*** (-3.62)	-0.395* (-3.77)	-0.379*** (-3.59)
Central government ownership*net debt-capital ratio		-0.971*** (-4.92)	-1.070*** (-4.89)	-0.878*** (-4.62)	-0.994*** (-5.06)
Local government ownership*net debt-capital ratio		-0.122 (-0.69)	-0.162 (-0.81)	-0.118 (-0.68)	-0.205 (-1.15)
Technical Efficiency	-0.815*** (-7.92)	-0.818*** (-7.89)			
Return on sales			-0.586*** (-7.75)		
Return on assets				-0.753*** (-9.04)	
Log(labor productivity)					-0.085*** (-13.54)
Net debt-capital ratio	0.195*** (3.57)	0.280*** (4.75)	0.225*** (3.19)	0.173*** (2.94)	0.315*** (5.36)
Log(assets)	-0.176*** (-17.41)	-0.175*** (-17.15)	-0.194*** (-15.88)	-0.180*** (-17.58)	-0.151*** (-14.66)
Firm age	0.512*** (23.28)	0.503*** (22.84)	0.478*** (19.08)	0.501*** (23.04)	0.534*** (23.43)
Firm age squared	-0.031*** (-15.99)	-0.031*** (-15.73)	-0.027*** (-12.67)	-0.030*** (-15.77)	-0.033*** (-16.24)
Export indicator	-0.423*** (-3.41)	-0.348** (0.155)	-0.376*** (-2.78)	-0.465*** (-3.74)	-0.403*** (-3.25)
Multi-plant firm indicator	-0.487*** (-5.46)	-0.426*** (3.44)	-0.581*** (-5.37)	-0.496*** (-5.56)	-0.474*** (-5.38)
Number of observations	30324	30324	26104	30375	30419
Log-likelihood	-32222	-32211	-23025	-32081	-32275

Note: 13 industry dummies are included in all the regressions but not reported. The t-ratios based on robust standard errors are in parentheses. Significance levels of 1%, 5%, and 10% are noted by ***, **, and * respectively.

Table 8: Cox Proportional Hazard Rate Model Estimating the Determinants of Firm Exit for Different Ownership Types

	State-owned enterprises (SOEs)		Non-state firms
	Central SOEs	Local SOEs	
	(1)	(2)	(3)
Technical Efficiency	-0.939**	-1.138***	-0.804***
	(-2.33)	(-3.41)	(-7.29)
Net debt-capital ratio	-0.624***	0.091	0.255***
	(-3.24)	(0.51)	(4.34)
Log(assets)	-0.195***	-0.106***	-0.175***
	(-5.08)	(-3.30)	(-15.95)
Firm age	0.128*	0.112	0.606***
	(1.84)	(1.38)	(22.79)
Firm age squared	-0.003	-0.007	-0.042***
	(-0.69)	(-1.27)	(-16.19)
Export indicator	0.637	-0.578	-0.448***
	(0.98)	(-0.63)	(-3.53)
Multi-plant firm indicator	-0.639**	-0.645**	-0.473***
	(-3.00)	(-2.21)	(-4.60)
Number of observations	4668	3557	22099
Log-likelihood	-1916	-2145	-25926

Note: 13 industry dummies are included in all the regressions but not reported. The t-ratios based on robust standard errors are in parentheses. Significance levels of 1%, 5%, and 10% are noted by ***, **, and * respectively.

Figure 1 The Firm Exit and Entry in Zhongguancun Science Park of Beijing: 1995-2002

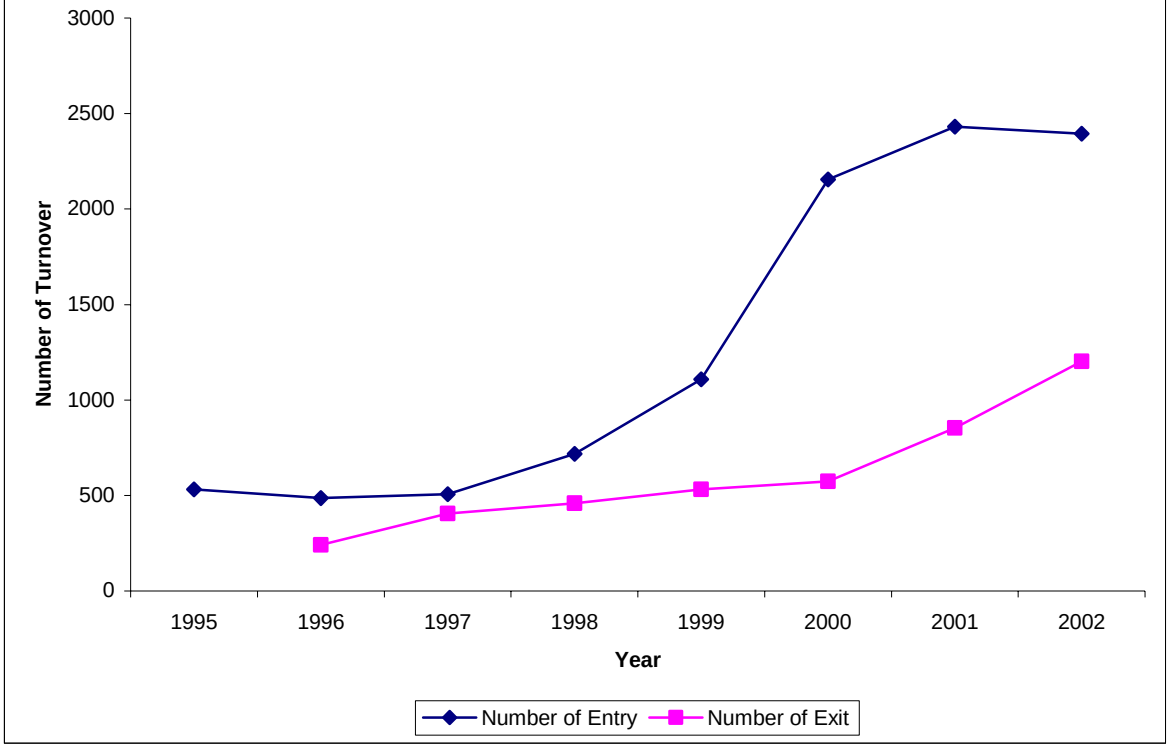

Figure 2 The Distribution of Ownership Types in Zhongguancun Science Park by Year